BETWEEN the TIDES

Friends of Fitzgerald Marine Reserve

September 2012

From the Editors: Recent activity centered around counting marine animals in the tidepools has prompted us to make surveys the focus of this issue: what is being counted, where the information is going, and what the future plans are. And to give a global perspective, we decided to review the accomplishments of a survey that was completed in 2010, an unprecedented, decade-long, global inventory called the First Census of Marine Life 2010. The resulting report of Census highlights is a brilliant, beautifully illustrated document. We hope the articles printed here will be of interest and motivate you to explore some of the websites we have listed.

Citizen Science at Pillar Point Reef:
bringing scientists and volunteers together to document biodiversity

by Alison Young

On June 5, 6, and 7, 2012, cars started pulling up in the Pillar Point parking lot just as dawn was breaking. People in rubber boots, clutching donuts and cups of coffee, introduced themselves to one another as this group walked out to the reef. Many of them were docents with Friends of Fitzgerald, others Beach Watch volunteers with Gulf of the Farallones National Marine Sanctuary, some were scientists. Everyone had a common interest: the rocky intertidal. Despite the early morning, the mood was enthusiastic. What were all these people doing out there so early in the morning, three days in a row? Not only did the first week of June have some of the lowest tides of the year, but the California Academy of Sciences was conducting a "citizen science test case" by means of a survey of the reef's biodiversity, and these people had volunteered to be the "citizen scientists."

Citizen Scientists carefully exploring the reef

Citizen science is an intersection of education and research. The definition varies depending on what source you're looking at, but generally it applies to any research project where non-professional scientists are involved in some part of the scientific process—often gathering data. Because the California Academy of Sciences is an institution with both a public education space and an active research division, we have a strong interest in citizen science; not only does it promote scientific literacy, but it can also further our research goals, especially those requiring that data be collected over a large geographic area.

continued on page 3

Friends of Fitzgerald Marine Reserve

P.O. Box 669
Moss Beach, CA 94038
Phone: 650.728.3584
www.fitzgeraldreserve.org

Our Mission:

To inspire the preservation of our unique intertidal environment through education and the support of research.

Newsletter Editors:

Janet Pelinka
Sasha Greenawalt

Consultant:

Jenna Kinghorn

Design and Production:

Martie Sautter
Sautter Graphics and Print

Webmaster:

Sandy Emerson

June 6 Quarterly Nudibranch Survey

Julie Walters rounded up 9 volunteers at 7 a.m. to participate in the June 6, 2012, nudibranch count. Quarterly counts are usually conducted at FMR, but due to a recent San Mateo County review of policy this one was held at the Pillar Point tidepools. Here is a brief summary of the findings:

106 individual nudibranchs
20 different species
2.5 hours of survey time
-1.9 tide

The most commonly found were:
Dendronotus subramosa 29
Triopha catalinae 18
Triopha maculata 15

Thanks to all who participated: Scott Snow, Dot Norris, Piming Lai, Susan Evans, Tom Ciotti, Karen Madsen, Kris Lannin, Jan Pelinka, and Sasha Greenawalt ◆

Two Dendronotus subramosa, *different colors*

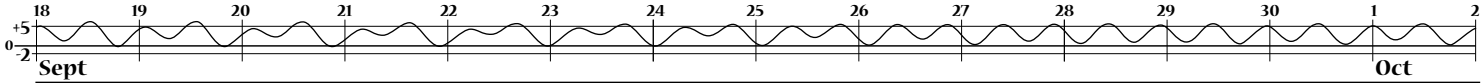
Dendronotus subramosa, *another view*

The graph displayed across the page bottoms shows tides for 9/18/12 to 01/05/13. Where the date appears is mid-night. The reefs are accessible for exploring during low tides—at least 0 or below. See: http://fitzgeraldreserve.org/resources and click on "Tides" for a more detailed tide chart.

Good summer tides are in the early morning. There are almost equally low tides several days before and several days after the noted low tide dates.

The lowest tides this period are:

-1.06	10/17	6:48 pm
-1.62	11/15	5.33 pm
-1.78	12/13	4:31 pm
-1.45	1/11	4:17 pm



Citizen Science *from page 1*

This year the Academy redefined its version of citizen science. We wanted any projects we undertook to have an overall theme, and we decided to focus on California biodiversity. It is also important to us to have our citizen science projects tied to a real research question at the Academy, and for them to have conservation outcomes. In the Academy's collection one can find the best representation of California species of any organization. By strategically selecting locations to survey that are well represented in our historic collections, we can begin to understand how biodiversity and species distributions, abundances, and ranges have changed over time, while also creating a current baseline for future comparisons. We can use this information to inform management decisions designed to protect California's unique biota.

During the 14 hours of the three survey days, 46 volunteers and seven Academy staff explored the Pillar Point reef. Over 200 individual organisms were documented, comprising around 150 species.

The Pillar Point surveys were the first of their kind at that location; no species list specific to the reef had been established. Working off the species list that former ranger Bob Breen had compiled during his time at the Fitzgerald Marine Reserve, the Academy created a checklist of select, relatively-easy-to-identify taxa to have volunteers look for at Pillar Point. Groups were led by Academy staff, and species were documented via georeferenced photographs. A small number of specimens were collected, mainly tube feet from sea stars to build a genetic profile of the populations at Pillar Point, but also a few organisms that the biologists were unable to identify in the field.

During the 14 hours of the three survey days, 46 volunteers and seven Academy staff explored the Pillar Point reef. Over 200 individual organisms were documented, comprising around 150 species. Numerous interesting observations were made:

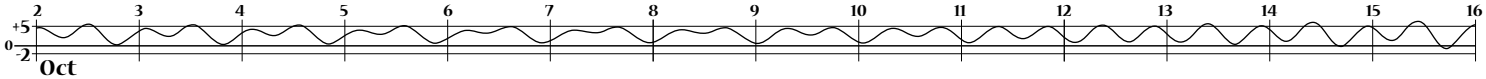
- The nudibranch *Hancockia californica* was found, previously recorded only one other time at Pillar Point.
- The recently described sea star *Henricia pumila* was found (previously grouped with *Henricia leviuscula*).
- While the porcelain crab *Petrolisthes eriomerus* was documented numerous times, the flat porcelain crab *P. crassipes,* recorded as "common" at the Fitzgerald Marine Reserve, was not found at all.
- The blue-banded hermit crab *(Pagurus samuelis),* an abundant central coast hermit crab, was not observed during the Pillar Point surveys (other hermit crab species were found, though).
- A number of species not found on the Fitzgerald Marine Reserve list were found at Pillar Point.

The June Pillar Point surveys were only the beginning of establishing a baseline of biodiversity on the reef. They also helped to inform the Academy's citizen science program; we learned quite a bit about useful protocols, taxa that might be best to focus on for future surveys, and areas of the reef that are unique in their microhabitats and thus in their species composition. The Academy is planning to continue the surveys, hopefully quarterly, to document seasonal species and to build a baseline for use in documenting change over time. In the future the Academy would also like to conduct similar surveys at Fitzgerald Marine Reserve to compare to Pillar Point. Looking ➤

Spiny brittle star, Ophiothrix spiculata

Northern kelp crab, Pugettia producta

Juvenile red rock crab, Cancer productus



Citizen Science *from page 3*

at the adjacent protected vs. unprotected intertidal areas will help us better understand the impacts of human activities and of reef closures. We are also considering the possibilities for a photo-based portion of the intertidal citizen science surveys that interested members of the public, youth groups, families, etc. could do on their own during their visits to rocky intertidal areas, while still providing valuable species occurrence records to the Academy.

Volunteers get a closer look

Thank you again to all of the wonderful volunteers who came out to be citizen scientists with the Academy this past June—we couldn't have done it without you! If you're interested in participating in future Academy intertidal surveys, send an email to citizenscience@calacademy.org. ◆

California Academy of Sciences Group Leaders

Terry Gosliner – Dean of Science and Research Collections

Rebecca Johnson – Citizen Science Research Coordinator

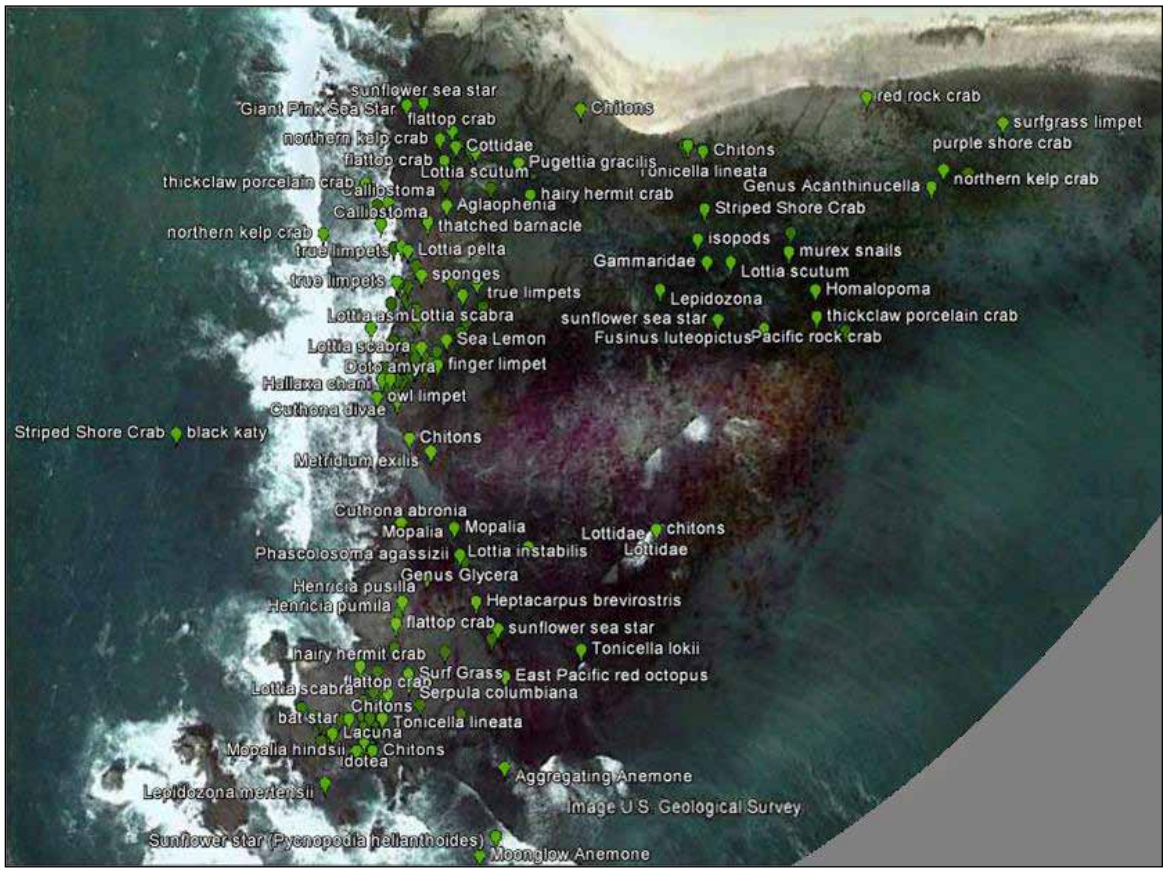
Chrissy Piotrowski – Curatorial Assistant, Invertebrate Zoology

Liz Kools – Curatorial Assistant, Invertebrate Zoology

Roberta Ayres – Naturalist Center Manager of Programming

Alison Young – Citizen Science Educator

Nic West – Graduate Student Assistant, Invertebrate Zoology



Map of species found

Tunicates: Our closest invertebrate relatives

by Jessica Donald

Tunicate larvae exhibit some of the same features as chordates (that is to say animals with a backbone, like us!), but most of these features are lost in transition to adulthood, with the exception of pharyngeal gill slits, which are primarily used for feeding and filtering water. Some tunicates like *Botryllus schlosseri*, which you may recognize from Ernst Haeckel's famous scientific illustrations, exhibit a crude form of self versus non-self recognition similar to the immune system found in humans that helps in fighting infections. All these features make tunicates, specifically ascidians, prime candidates for studying the fundamental development process of chordates, and they provide insight into the links between chordates and ancestral invertebrate relatives.

Tunicates come in many different forms and occur in varied habitats. There are about 3,000 species of tunicates that are divided into four classes:

Ascidiacea are typically known as sea squirts and are found in shallow water on hard surfaces like docks, reefs and the hulls of boats.

Thaliacea include salps, further described below. They can be found anywhere from the surface waters of the open ocean down to 1500 meters deep.

Appendiculaira or **larvaceans** are found in the open ocean. Their clear gelatinous bodies resemble the form of a tadpole, but typically do not get any bigger than 1 cm in length.

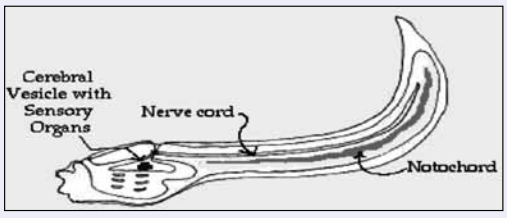
Sorberacea are deep water species that superficially resemble sea squirts.

Thetys vagina — photo by Scott Snow

In July of this year one of the docents for the Friends of Fitzgerald Marine Reserve discovered a salp (typically found only in the open ocean) on FMR's own beach! The species is called *Thetys vagina* and is one of the largest salps, with a body length measuring up to 306 mm (1 ft.). Salps have a life history that includes alternation of generations between aggregated sexual forms and the solitary asexual form which is the one pictured at right. They have rarely been caught and occur at very low densities in most oceans. When out in the open ocean these creatures can be found anywhere from the surface waters to a depth of 1500 meters. They feed on phytoplankton like diatoms and on small crustacean zooplankton called copepods. Salps filter their food using pharyngeal mucous nets that they cast out into the water and then reel back in after their prey has been caught. ◆

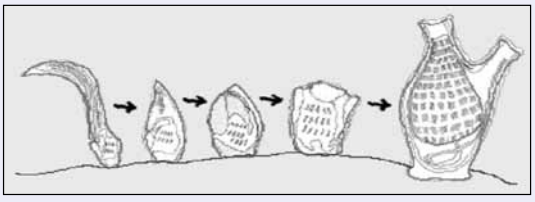
Are they really our cousins? One clue that tunicates are related to vertebrates is found in the tunicate larva, or tadpole. It even looks like a tiny tadpole, and has a nerve cord down its back, similar to the nerve cord found inside the vertebrae of all vertebrates. The Cerebral Vesicle is equivalent to a vertebrate's brain. Sensory organs include an eyespot, to detect light, and an otolith, which helps the animal orient to the pull of gravity.

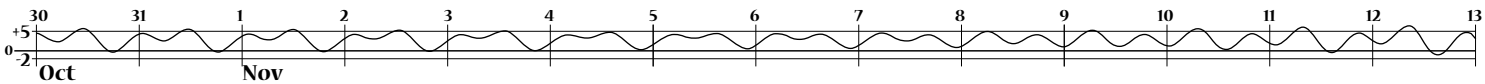
University of Washington, Student Projects



Tunicate tadpoles mature extremely quickly, in a matter of just a few hours. Since the tadpoles do not feed at this stage of their lives, they have no mouths. Their sole job is to find a suitable place to live out their lives as adults. When ready to settle, a sticky secretion helps them attach head first to the spot they have chosen. They then reabsorb all the structures within their tail and recycle them to build new structures needed for their adult way of life.

University of Washington, Student Projects





2010 Marine Life Census: A Brief Review of Highlights

by Sasha Greenawalt and Janet Pelinka

2700 scientists
80+ nations
540 expeditions
US $650 million
2600+ scientific publications
6000+ potential new species
30 million distribution records

The figures in the box reflect the astonishing scope of the ten-year Census of Marine Life that began in the late 1990s when leading marine scientists conceived of the idea of a worldwide survey of the diversity, distribution and abundance of life inhabiting the oceans. They agreed to report in 2010 with data that could be used as a baseline from which future changes in marine life could be evaluated. Scientists representing more than 670 laboratories, universities, natural history museums and aquariums from all continents worked together to compile the most comprehensive record of marine diversity ever. The international network was coordinated by the Census Secretariat at the Consortium for Ocean Leadership in Washington D.C. and governed by an international Steering Committee which in turn gave guidance to 13 National and Regional Implementation Committees. Following is a summary of a report highlighting the accomplishments of the Census.

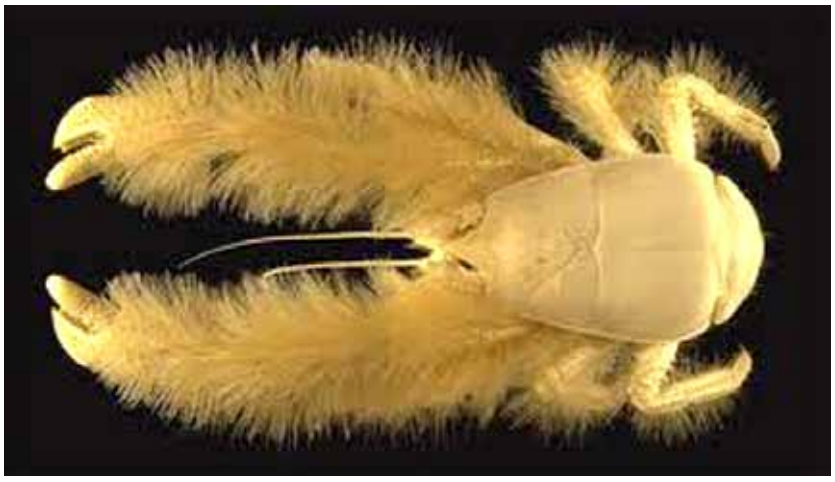
Diversity

Biodiversity is commonly considered an important measure of the health of an ecosystem. Accordingly, Census work centered on an inventory of marine species. In their explorations Census researchers discovered 6000 potentially new species and completed formal descriptions of more than 1200 of them. To store their collected data they created the Ocean Biographic Information System (OBIS), an online network of publicly accessible information now spanning 120,000 species, with more than 30 million data records. With the support of various governments throughout the world it continues to grow.

In the seafloor sediment newly found species included three from a group called Loriciferans, animals known to survive without oxygen. Exploration of a hydrothermal vent near Easter Island revealed a crab (dubbed "yeti" for its white, hairy look) that belongs to a new species, genus and family. In cold conditions, researchers observed that slow growth occurs, along with increased longevity and size. In Antarctic waters giant macroptychaster sea stars grow up to 60 cm across. In waters deeper than 1000 meters, scientists found a group of large, unusual squids with long fins and measuring up to seven meters. They constitute a new family.

Exploration of a hydrothermal vent near Easter Island revealed a crab (dubbed "yeti" for its white, hairy look) that belongs to a new species, genus and family.

In Australian waters explorations confirmed a contemporary Jurassic "shrimp" thought to be extinct 50 million years ago. It ranks as one of the oldest marine organisms found by the scientists. In the northeast Atlantic a new species of oyster that forms reefs on deep cliff sides was discovered. These oysters reach 100-500 years of age, making them among the longest-lived mollusks known. Scientists went deep to search for species that have never experienced sunlight. Deep-towed cameras, autonomous free-swimming robots, and smart nets that opened at programmed depths were used to inventory these creatures. Known species that thrive there now number 17,650. To deal with the millions of specimens ➤



Yeti crab

collected, a genetic sequencing analysis called "barcoding" was employed. Census researchers used a short "barcode" region of a specimen (fin, tentacle or other fragment of tissue) to distinguish the species to which it belongs. The Census sequenced DNA identifiers for more than 35,000 species.

DNA technologies were also used to identify marine microbes (classified by phylotypes rather than species). Phylotyping is similar to barcoding but uses DNA sequences relating to phylogeny, or evolutionary relationships to other organisms. Census investigators gathered 18 million microbial DNA sequences spanning more than 100 major phyla. It is estimated that up to 90% of ocean biomass can be attributed to marine microbes, their collective weight being equivalent to that of 240 billion African elephants. When even a single liter of seawater can contain more than 38,000 kinds of bacteria, it is possible that up to one billion kinds of marine microbes may live in the oceans.

Scientists formed a global picture of coral reef diversity, observing and monitoring creatures that moved in and out of strategically placed plastic structures resembling reefs. These structures are known as Autonomous Reef Monitoring Structures (ARMS).

In the northeast Atlantic a new species of oyster that forms reefs on deep cliff sides was discovered. These oysters reach 100-500 years of age, making them among the longest-lived mollusks known.

The researchers were interested to discover which environments favored diversity. Using OBIS, they determined that diversity was highest in mid-latitude or subtropical strips in all oceans and in tropical areas like Indonesia and the Philippines for coastal species.

It is unknown how many types of marine life are yet to be discovered. The Census affirmed the probable existence of about 250,000 named, known species and contributed to the development of an authoritative accessible list in the World Registry of Marine Species, now approaching 200,000. Census scientists developed web pages for 80,000 species in the Encyclopedia of Life.

Distribution

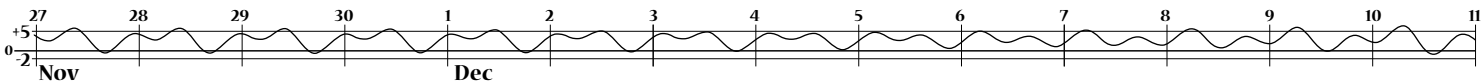
Scientists searched areas never before explored and found life wherever they ventured. Various tracking methods (electronic, sound and satellite), enabled them to determine where animals survive and breed, as well as where they travel and where they die. Researchers extended their reach by using 41 different species of animals as assistants. They tagged 16,000 fish with tiny microphones that were read by curtains of acoustic receivers placed on the ocean floor from California to Alaska. Using this method they followed two juvenile salmon from the headwaters of the Columbia River in the Rocky Mountains to the coast of Alaska, a journey of 2500 kilometers completed in three months.

Deep-towed cameras, autonomous free-swimming robots, and smart nets that opened at programmed depths were used to inventory creatures that have never experienced sunlight.

Open ocean requires a different method of tracking whereby data from the tags' sensors are picked up by satellites. These tags have enhanced capabilities that record measurements of environmental data such as temperature, salinity, light level and depth of the water around a tagged animal. This technique, called "biologging", can even include an estimate of chlorophyll made from light and pressure sensors on the tags; from that an estimate of phytoplankton abundance can be made. ➤

In Australian waters explorations confirmed a contemporary Jurassic "shrimp" thought to be extinct 50 million years ago.

Jurassic "shrimp"



Census *from page 7*

Satellite tagging revealed interesting migratory patterns of white sharks in the Pacific. Tracked from the California coast to a meeting place between Baja California and Hawaii, an area named by the scientists as the "White Shark Café", each shark was noted to return to its exact California home address in waters only 30 meters deep. Satellite tracking has supported conservation efforts to protect the leatherback turtles, providing information leading to the closure of fisheries during the turtles' migration.

Tracked from the California coast to a meeting place between Baja California and Hawaii, an area named by the scientists as the "White Shark Café," each shark was noted to return to its exact California home address in waters only 30 meters deep.

Using new types of echo sounders moored 1000 meters below the water near the mid-Atlantic Ridge, investigators observed regular vertical migrations of fish. They recorded what the researchers called "a summer rush hour...fishes and plankton rising about 400 meters at approximately 2100 hours to the zone where sunlight and photosynthesis have produced food. About 0600 hours, they descended to twilit waters below." (The First Census of Marine Life: Highlights of a Decade of Discovery, 2010)

Distribution data by species can be found on OBIS.

Off the central northern coast of South America scientists observed enormous filamentous mats formed by megabacteria, visible to the naked eye and covering almost 130,000 square kilometers (about the size of Alabama)… They may be a living fossil ecosystem from the Proterozoic era (2.5 billion-650 million years ago)…

Abundance

The third goal of Census scientists was to determine the abundance of life in the world's oceans. Census historians first established historical baselines for ten groups of marine animals using archives of sea life, archaeological and paleontological data, molecular markers, and fishery statistics. They even surveyed over 10,000 archived menus. (Menu prices tend to fluctuate with species' abundance, rising when species are in decline.)

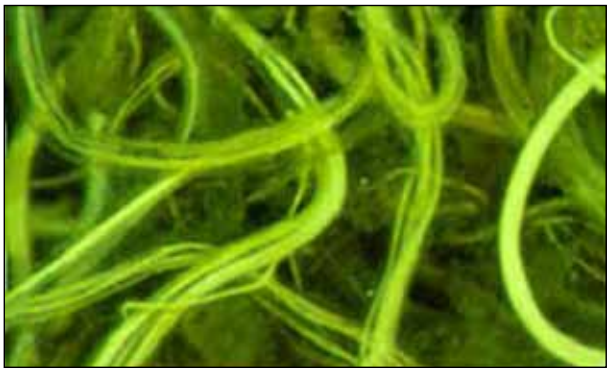
Then, using a new sensor system, scientists explored tens of thousands of square kilometers along the continental shelf. The sonar gave images that were updated every minute, allowing researchers to monitor size and density of millions of fish in shoals as well as the shape of the shoals.

Off the central northern coast of South America they observed enormous filamentous mats formed by megabacteria, visible to the naked eye and covering almost 130,000 square kilometers (about the size of Alabama). These bacteria subsist mostly on methane-associated hydrogen sulfide on an oxygen-starved sea floor. The mats are estimated to weigh 14 million tons, ranking them among the Earth's largest structures. They may be a living fossil ecosystem from the Proterozoic era (2.5 billion–650 million years ago), when the Earth was transitioning to an oxygenated atmosphere.

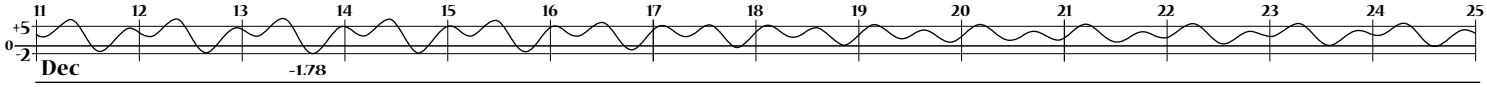
Census scientists documented the decline (and sometimes recovery) of large marine animals and attempted to answer the question of whether global changes are occurring in life at certain trophic levels. They looked for changes at the bottom of the food chain. Using indirect observations made from ocean vessels since 1899, investigators found indication of a significant decline in the phytoplankton that feeds the upper trophic levels.

They estimated the seafloor biomass (which depends on food production by photosynthesis in the water above; the nutrients then fall and settle on the seafloor) from primary production, the fall of organic debris, and the topography of the seafloor. They then used these estimates to approximate populations of individuals in groups such as fishes, invertebrates and bacteria.

There are some indications of a decline of abundance at the top and the bottom of the food chain caused primarily by fishing practices, ocean habitat destruction and ocean ➤



The Chilean Thioploca, a megabacteria



temperatures. However, scientists have yet to determine if the total weight of marine life is changing. As the report says, "Systematically measuring the abundance of the approximately 250,000 known species and the kinds of microbes as well remains a task for the next decade."(The First Census of Marine Life: Highlights of a Decade of Discovery, 2010).

Legacy

The Census of Marine Life has left a rich legacy to marine science. In the realm of knowledge more than 2600 published scientific papers are publicly accessible. The Census developed an infrastructure for future research in OBIS. It established baselines of marine diversity, distribution and abundance at the beginning of the 21st century and revised ideas of the genetic structure of marine life, charting the proximity and distance of relationships between distinct species.

Census scientists pioneered new technologies and enhanced others. They developed barcoding and similar genetic methods. They proved methods of acoustic, electronic, and satellite data collection to enable global ocean tracking. In all, researchers tagged 41 species of animals, more than 23,000 individuals. They developed the Autonomous Reef Monitoring Structure.

Regarding work habits, scientists worldwide with different interests were brought together by the Census. They set common goals, standardized sampling protocols, and recorded authoritative results for all to see. Collaboration across borders included partnerships with scholars in the humanities and natural and social sciences.

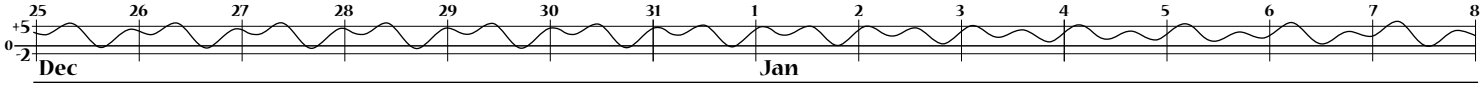
Careful mapping of areas explored by Census researchers gives future scientists a sense of what is left to be explored. As Sylvia Earle, explorer-in-residence at the National Geographic Society in Washington, D.C., says, "One conclusion [of the report] is that we have a lot more to learn about the ocean. A conservative estimate of ocean species is 10 million, and it may be 50 million or more. Less than 5% of the ocean has been seen, let alone explored."

Public Access Sites:

- First Census of Marine Life 2010: Highlights of a Decade of Discovery: http://www.coml.org/Highlights-2010
- Encyclopedia of Life: http://www.eol.org
- World Register of Marine Species: http://www.marinespecies.org
- Catalog of Life: http://www.catalogoflife.org
- Ocean Biographic Information System (OBIS): http://www.iobis.org ◆

"A conservative estimate of ocean species is 10 million, and it may be 50 million or more. Less than 5% of the ocean has been seen, let alone explored."

— Sylvia Earle, explorer-in-residence at the National Geographic Society in Washington, D.C.



LiMPETS:
Long-term Monitoring Yields More than Data

by Amy Dean

If you have been tidepooling at Fitzgerald Marine Reserve (FMR) in the last few years, you may have been lucky enough to see huddles of teens on the reef near Cypress Point. Sitting or kneeling over their quadrats (frames used for monitoring), they laugh, shriek, and shiver. What may look like a school field trip is actually real science in action. These carefully trained students are monitoring algae and invertebrates, and they take their work pretty seriously.

My students find the data collection invaluable; they get excited about research and see first hand what it entails.

— Roberta Chisam, teacher, St. Francis High School, Mountain View

These students, with about 4000 others throughout the state, are participating in LiMPETS (Long-term Monitoring Program and Experiential Training for Students). This hands-on program was developed to monitor the coastal ecosystems of California's national marine sanctuaries to increase awareness and stewardship of these important areas. Two distinct programs make up the core of the LiMPETS network: the Rocky Intertidal Monitoring Program and the Sandy Beach Monitoring Program. From the Channel Islands to the Gulf of the Farallones and beyond, students are using the same LiMPETS protocols to monitor their local intertidal areas. This is truly a collaborative program that is managed locally by the Farallones Marine Sanctuary Association (FMSA) in partnership with NOAA's Gulf of the Farallones National Marine Sanctuary.

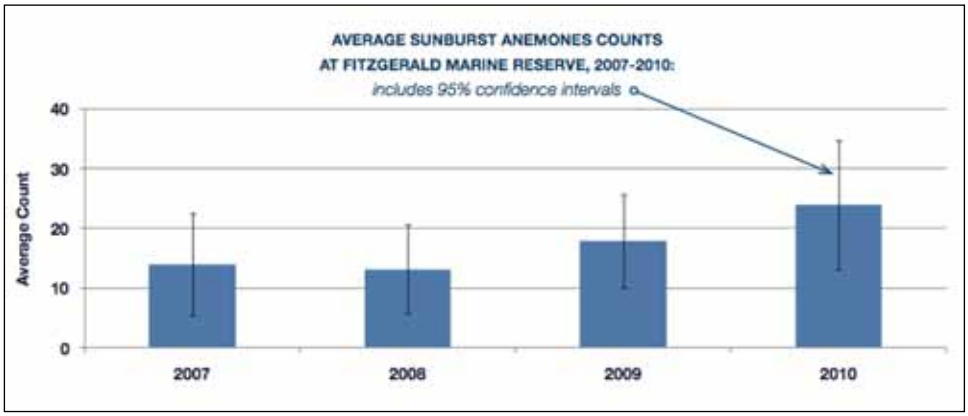
Getting up close and personal with the rocky shore inhabitants, touching slimy algae and squishy anemones, taking careful and accurate measurements, is not for everyone.…But afterwards…students say the experience was "awesome, amazing, hella fun."

All of our field sites and methodologies have been established by Dr. John Pearse, who remains the Scientific Advisor for the program. He developed the program as a professor at UC Santa Cruz and "gave it" to the national marine sanctuaries when he retired.

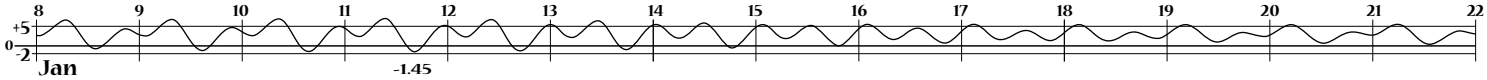
FMR became a LiMPETS partner in 2006. Roberta Chisam from St. Francis High School in Mountain View has been monitoring with her students at FMR from the beginning. Recently, after a day of monitoring in May 2012, she reported on the value of the program for her students: "My students find the data collection invaluable; they get excited about research and see first hand what it entails. It allows me to follow up and have a discussion with students about what is happening along our coasts."

Getting up close and personal with the rocky shore inhabitants, touching slimy algae and squishy anemones, taking careful and accurate measurements, is not for everyone. Some students report that they expect the monitoring experience to be "dirty, uncomfortable, and boring." But afterwards, almost every student reports a changed, more positive attitude about the process of science. Students say the experience was "awesome, amazing, hella fun." They want to come back and do it again—an unquestionably good outcome in itself.

Beyond the educational value of the LiMPETS program, the power of the LiMPETS network lies in the large quantity of data that is being collected



LiMPETS data are being used to help determine how effective the new system of state Marine Protected Areas (MPAs) is in protecting fish, invertebrates, birds, and other natural resources.



for California's national marine sanctuaries at more than 60 sites and over 600 miles of coastline. LiMPETS teachers and students go through rigorous training, and they are able to collect a large amount of data, cheaply. Annually, thousands of students and citizens compile baseline data against which future observations will be compared. By monitoring, students become eyes and ears for our coastal beaches and rocky shores, detecting changes and possible problems, often before anyone else. Most notably, LiMPETS data are being used to help determine how effective the new system of state Marine Protected Areas (MPAs) is in protecting fish, invertebrates, birds, and other natural resources. LiMPETS data will, along with other scientific studies, establish a baseline of data for sandy beach and rocky intertidal areas within the MPAs between Pigeon Point and Point Arena. For example, owl limpets are often illegally collected for food. Generally, it is the largest individuals that are preferentially taken for consumption. This size-selective harvesting has led to a widespread decline in body size of owl limpets along the coast of California. We count and measure this species in a large, permanent area to detect changes in abundance and size over time.

At Fitzgerald, LiMPETS students conduct 5-10 surveys per year. After six years, we are beginning to detect some possible trends. Between 2006-2011, owl limpet counts had remained stable, presumably because of FMR's status as a reserve. This year, however, student data show that their numbers have declined. I have done the counts myself. Owl limpets have indeed declined by approximately 30% in 2012. Our data from other local sites outside of reserves show similar declines.

Another method used for LiMPETS includes monitoring selected algae and invertebrates using randomly placed quadrats inside a permanent area. By doing this, we can determine statistically robust estimates of abundance that can be compared over time. At Fitzgerald, our modest dataset of 6 years shows that purple sea urchins and coralline algae have declined steadily in our study area.

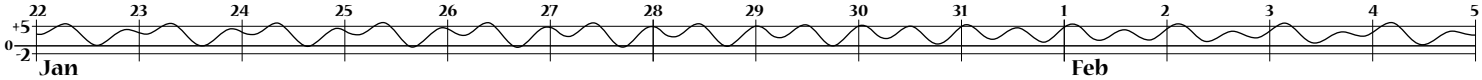
Dr. John Pearse, Scientific Advisor for the program, sets up a study site.

If all goes well, before long we will know much more about the status of many of the amazing creatures living in the intertidal. Ultimately LiMPETS data, along with data from other organizations, will help to protect these diverse, rich ecosystems. And yielding more than just data, LiMPETS brings science alive for students in a way that they think is "amazing".

Want to know more? Please visit the LiMPETS website at http://limpetsmonitoring.org. All data is available online for query and download. Look for our NEW LiMPETS Field Guide, funded by the Friends of Fitzgerald Marine Reserve, available on our website on October 1st, 2012. ◆

Owl limpets

Students from El Camino High School, left, and Lighthouse Community Charter School, right, use reference charts to identify species.



Julie Walters Conducts Survey of Future Ocean Stewards

On Sunday, August 12, Julie Walters ventured out to Fitzgerald Marine Reserve to inventory the minds of young visitors.

Sam age 5 1/2 and Nathan age 8 from Pleasanton and San Jose:

What was your favorite thing that you saw today? "A mussel shell that still had both halves. My mom likes the seals. I liked the creek and climbing over the rocks."

Chloe age 8 from Milpitas:

Have you been here before? "Yes on a field trip for my summer camp called Follow the Children." *Did you learn anything new today?* "Yes, that the tides are strong and that the moss is slippery."

Cole age 4 1/2 from Atherton:

Have you ever been here before? No, my mom found it online. *Did you learn anything today?* "The best place to see octopus the next time I visit."

Charlotte, age 9 from Bernal Heights, San Francisco:

What was your favorite thing that you saw today? "Hermit crab" *Have you been here before?* "Yes, for my 7th birthday party." *Why did you decide to come here today?* " It was my dad's idea." Dad: "It was foggy and gray in the city and we wanted to get outside."

Lucca age 5 from San Francisco shown here imitating a shark:

Did you learn anything new today? "Yes, that trash is bad for the ocean."

Lily from Manteca:

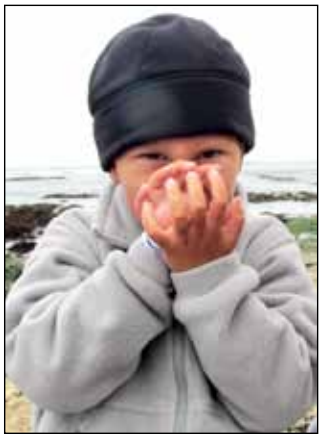
What was your favorite thing that you saw today? "Starfish and seals" *Why did you decide to come here today?* Dad: "To escape the heat, it was 103 degrees in Manteca."

Cole

Lily

Sam and Nathan

Chloe



Lucca, imitating a shark

Charlotte