

BETWEEN the TIDES

F r i e n d s o f F i t z g e r a l d M a r i n e R e s e r v e
S e p t e m b e r 2 0 1 6

Friends of Fitzgerald Marine Reserve Never Disappoint

Newly graduated naturalists joined forces with seasoned marchers to represent FFMR in the 2016 Half Moon Bay Annual Fourth of July parade. King Neptune skipped into the lead followed by an array of costumed naturalists: jellies, an oyster catcher, sea anemones, a mermaid and a walking tidepool. Others wore FFMR jackets and donned crab hats. As always salt-water taffy was tossed to watching children as we moved along. Three dogs joined us; two wore sea stars and another a seal. The

beagle evoked laughter from the observers when he insisted on rolling on his back for several minutes.

We left with our second-place red ribbon and a feeling of exhilaration. It is always a delight to be cheered on by an enthusiastic community. Why not join us next year and share this joyful experience. A huge thanks to Kris and Michael Liang for organizing the event again this year. ♦



Three dogs joined us; two wore sea stars and another a seal. The beagle evoked laughter from the observers when he insisted on rolling on his back for several minutes.



Friends of Fitzgerald Marine Reserve

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Moss Beach, CA 94038
Phone: 650.728.3584
www.fitzgeraldreserve.org

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Our Mission:

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

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REGISTRATION FOR 2017 FFMR VOLUNTEER NATURALIST TRAINING CLASS

The 2017 FFMR Volunteer Training Class consists of 10 Saturday classes, plus six additional hours spent at the reserve with a mentor. The classes will be held on the coastside near the reserve and at the reserve. The schedule for 2017 is: January 7, 14, 21, 28; February 4, 11, 25; March 4, 11, 18. There is no class February 18 (President's Day holiday weekend). FFMR will host a graduation party on March 25, so please include that in your schedule of classes. The times of the classes has yet to be determined.

Volunteer naturalists must be physically capable of navigating the rocks and reef and must be over 17 years old.

Volunteer Naturalists are required to volunteer a minimum of 6 hours per month during the busy season-January through June-and 4 hours per month July through December.

Space is Limited — Your Registration Form and Fee must be received prior to the deadline to hold a space. Registration Deadline is December 15, 2016

Mail the completed Registration Form with \$65 check made payable to FFMR to:

FFMR Training Class
P.O. Box 669
Moss Beach CA 94038

For more information please email Karen Madsen at kmadsen728@gmail.com before December 1, or Susan Evans at susanmtnvw@aol.com from Dec. 1 to Jan. 7.

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone: _____

Email: _____

How did you hear about FFMR's Training Class?

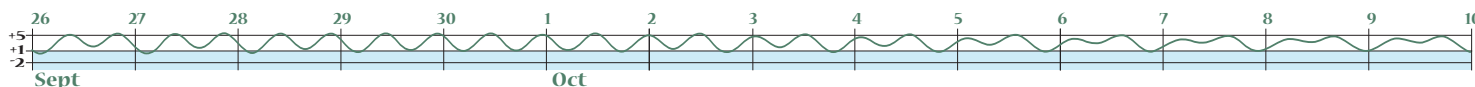
For more information email: volunteer@fitzgeraldreserve.org or check our web site: www.fitzgeraldreserve.org

The graph displayed across the page bottoms shows tides for 9/26/16 to 2/12/17. Where the date appears is midnight. The reefs are accessible for exploring during low tides—at least +1 or below. This area is shaded light blue. Some low tides aren't listed if they appear during the night. See: <http://fitzgeraldreserve.org/resources> and click on "Tides" for a more detailed tide chart.

Beginning in September, the summer morning tides change to afternoon/evening tides. There are almost equally low tides several days before and several days after the noted low tide dates.

The lowest tides this period are:

-0.82	10/18	7:09 pm
-1.43	11/15	5:03pm
4th lowest tide of 2016		
-0.44	12/1	5:44 pm
-1.59	12/14	4:50pm
2nd lowest tide of 2016		
-0.58	12/30	5:24 pm
-1.35	1/12/17	4:38pm
5th lowest tide of 2017		





Green lined shore crab: *Pachygrapsus crassipes* ♦ WENDY KWOK



Purple sea urchin:
Strongylocentrotus purpuratus
♦ WENDY KWOK



Red beaded anemone:
Urticina coriacea ♦ BARBARA DYE



Blenny eel with black turban snail:
Tegula funebris ♦ BARBARA DYE

We Want Your Photos

We thank these wonderful photo enthusiasts for sharing their photos with the BTT community. We would like to continue highlighting a page of color photos so please send your submissions to:
<http://jpelinka2@yahoo.com>
We welcome photos from everyone: kids, amateurs and professionals!



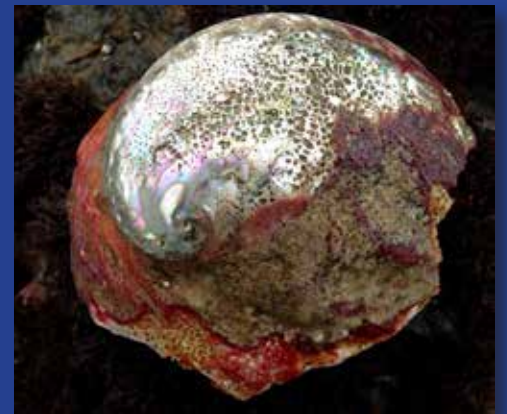
Nudibranch: *Aeolidiella oliviae*
♦ TOM NIESEN



Harbor seals – *Phoca vitulina*
♦ JULIE WALTERS



Cormorants ♦ JULIE WALTERS

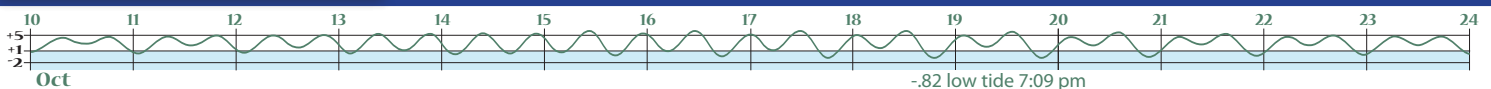


Red abalone – *Haliotis rufescens*
♦ JULIE WALTERS



Sea palms: *Postelsia palmaeformis*
♦ MARTIE BATESON SAUTTER

Ochre sea stars: *Pisaster ochraceus*
♦ TOM NIESEN



The Case of Jellyfish Blooms

by Janet Pelinka

“Jellyfish are taking over the seas and it might be too late to stop them.”

As early as 2001 and as recently as this spring, jellyfish blooms have made sensational news with headlines like “Jellyfish are taking over the seas and it might be too late to stop them,” “Jellyfish taking over oceans, experts warn,” and simply, “They’re taking over!”

These headlines have been prompted by harmful incidents attributed to jellyfish blooms. In Sweden, a moon jellyfish invasion clogged the cooling system of a nuclear reactor and forced its shutdown, and they have disrupted power generation in several other countries including the United States. The fishing industry has also been

tween the size of summer jellyfish blooms and subsequent adult salmon returns.

There are claims that tourism has taken a hit, too. In July the Telegraph News reported that the Marine Conservation Society found the number of jellyfish blooms are on the rise in coastal waters. Vacationers in the Mediterranean and the British Isles have been warned to be cautious when on the beaches there. Once relegated to Southern Oceans off Australia, the deadly box jelly now populates Thailand, Japan, Israel... and the Florida Straits, with recent alarming swarms up and down the Atlantic Coast of Florida.

A February 2012 study authored by 17 scientists titled, “Questioning the Rise of Gelatinous Zooplankton in the World’s Oceans,” refutes the idea that there is a drastic and dangerous rise in the jellyfish population, and offers possible explanations for such perceptions.

Some scientific literature has supported these claims and links the rise to the human impacts that have caused a deterioration in our ocean systems and its occupants (Yet the authors acknowledge that they lack the data needed to test these claims). This idea appears reasonable to some people because gelatinous zooplankton (jellyfish) have survived for over 500 million years, through catastrophic global events. And the fact that their oxygen demand is low and they can survive in eutrophied waters (rich in nutrients but low in oxygen), adds fuel to the thought that jellyfish are positioned to take over the seas while other oceanic populations decline.

In her book *Stung! On Jellyfish Blooms and the Future of the Ocean*, biologist Lisa-Ann Gershwin links jellyfish blooms to ocean degradation due to human factors, saying “...jellyfish populations are exploding into superabundances and exploiting these changes in ways that we could never have imagined...and in some cases driving them.” Yet she too is careful to admit that there is a lack of scientific data on jellyfish and jellyfish blooms.

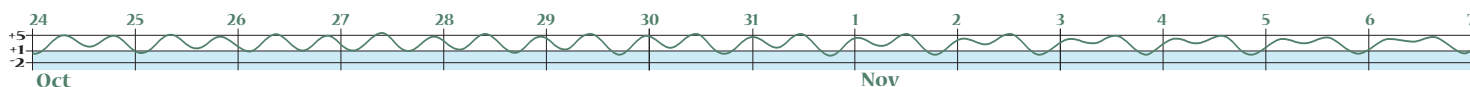
An interest in observing marine ecosystems is increasing greatly, so it is possible that newly reported blooms may have existed in the past but just were not reported. Many personal



Nomura's Jellyfish (Nemopilema nomurai) can grow up to 2 m (6.6 ft) in diameter and weigh up to 200 kg (440 lbs). They reside primarily in the waters between China and Japan (Source: Wikipedia: Giant Jellyfish clog fishing nets in Japan. Photo credit: Shin-ichi Uye)

affected. Japan’s fishermen have been plagued with burst nets and clogged trawl lines. Nomura, which can grow to weigh 440 pounds, capsized and sank a ten-ton trawler when they tried to haul up a net full of them.

Another headline in the journal *Ecosphere* states, “Evidence that summer jellyfish blooms impact Pacific Northwest salmon production.” The article’s authors, scientists from Oregon State University and NOAA, believe there is growing evidence that there are negative correlations be-



experiences are reported on blogs that may not be credible but gain a global audience. And the media and some scientific literature tend to expand their reporting more when there are exciting events like jellyfish blooms, and less when jellyfish are at low levels. When Chloe McCardel's bid for a record swim from Cuba to the United States was thwarted by multiple painful jellyfish stings the incident made international headlines.

As the February study explains, "News reports on gelatinous zooplankton have also increased in number dramatically—by over 500%—in the past two decades and the headlines are often alarmist. In contrast, scientific publications on jellyfish outbreaks, although they increase in a manner proportional to that of media reports, are outnumbered by public media reports by a factor of ten. This could be because scientific reports lag behind media reports in general, yet the trend holds when the above numbers of jellyfish reports are standardized against a different topic, fish. Fish-related publications also grew over time, but the relevant growth rates of both scientific publications and media reports are comparable. This normalization shows that scientific publications about jellyfish and salps have not changed appreciably over time, whereas media reports have increased in number and are potentially driving public perception."

The study explains further that the public notion of an increased presence of gelatinous zooplankton can be attributed to the lack of a defined baseline. There is little long-term data that jellyfish blooms are on the rise. It states that this "...results in a continuously sliding frame of reference, which refers only to the observer's immediate past and ignores reports of recurrent blooms in the more-distant past." In other words, lack of older data leads us to conclude that there is a new problem, even though there is paleontological and historical evidence in scientific literature that shows mass occurrences of jellyfish in the distant past.

There is wide recognition that more data must be collected and the authors of this study have created Jellyfish Database Initiative (JEDI), a global database of gelatinous zooplankton records collected by organizations and researchers around the world. It will provide baseline data for developing an understanding of future jellyfish blooms. A new website called JellyWatch

has been created where citizen scientists are encouraged to report jellyfish sightings that can help fill in research gaps. But studying jellyfish is very difficult: some explode when touched, some can be seen only with a microscope, making netting them difficult, and they have complicated and poorly understood life cycles, not to mention the danger that creatures like box jellies pose.

Over the past 16 years five International Jellyfish Blooms symposia have been convened in the United States, Australia, Argentina, Hiroshima and Barcelona. The International Jellyfish Bloom Symposium is the largest meeting of the world's jellyfish and other gelatinous species scientists. Its stated purpose is "...to bring together specialists from all over the world in order to share, learn and inspire current and future research on the topic, addressing questions in order to highlight key areas for future exploration." Topics of the most recent symposium ranged from spatio-temporal dynamics and population genetics to socio-economics and "citizen science." It also focused on science outreach, and a special session was organized where the general public and media were invited.

While the work of some scientists like Lucas Brotz from the University of British Columbia, and Lisa-Ann Gershwin suggest that human intervention may not work because the peculiar biology of jellyfish means that once their numbers surge, the tide may be impossible to turn, the truth may lie in the numbers. Collecting data and establishing a baseline is the first step. ♦

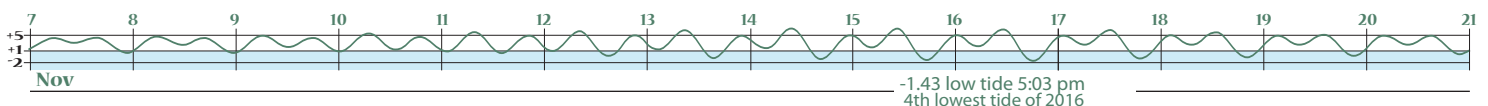


January 25, 2013: Jellyfish known as "sea tomatoes," washed ashore on Cable Beach in western Australia. (Photo: credit James Brown, source: Ocean Treasures Memorial Library)

When Chloe McCardel's bid for a record swim from Cuba to the United States was thwarted by multiple painful jellyfish stings the incident made international headlines.



Jellyfish for dinner anyone? In 2001, the annual global harvest of edible jellyfish was estimated to be around 321,000 metric tons. The most prominent countries involved in edible jellyfish production are Burma, China, Indonesia, Korea, Malaysia, the Philippines and Thailand. (source: Wikipedia, edible jellyfish prepared with sesame oil and chili sauce.)



Junior Naturalist Camp 2016

by Kathleen Hayes

It is said that the mark of a true professional is to make it look easy. A quick reflection on the past weeks of Olympic games jumps to the forefront of my mind, and I recall thinking how easy Simone Biles made it look to walk upon the thin expanse of the balance beam and how the sprinters in track and field never seemed out of breath as they crossed the finish line.

I know full well that none of these feats of athleticism are easy and that it took years of preparation, practice, and discipline to get to that point. And now, as I sit down to write about this year's Junior Naturalist Camp, I cannot help but reflect upon what went into the camp. When the campers arrived full of energy and anticipation on Day 1, the volunteers, like our Olympians, made it all flow so seamlessly and look so easy. So this year, I thought I would share some "behind the scenes" views with you to show you how the amazing and professional group of Friends of Fitzgerald Marine Reserve volunteers work behind the scenes to make this a special, magical week at the reserve for these young campers.

I am going to stick with my Olympics analogy and use the sport of the 4 Man Relay to talk about how this camp comes to fruition each year and this year in particular.

LAP 1:

Months before the camp is scheduled to start, I begin to write the content for the workbook. This is the backbone of the camp and it drives all the days' activities. Workbooks lay out each day for the camper, and are filled with facts, trivia, true/false questions, multiple choice, connect-the-dot and short-answer questions. Campers are encouraged to read the workbook passages aloud to each other as a group, and answers to questions are discovered in a collaborative fashion with lots of rowdy answers

and giggles. Campers have the opportunity to journal and sketch also. And, on Day 1, each camper gets to personalize their own tote, workbook, and journal with paints, jewels and stencils.

Lap 2:

Once the workbook is completed, the baton is passed to Linda Ciotti, who rallies her fabulous group of volunteers and encourages all those interested in making the Junior Naturalist Camp a magical experience to attend an information meeting. At this meeting we share what has been covered in the workbook. Our layout for camp this year was broken into five special themes:

Day 1: Tidepools

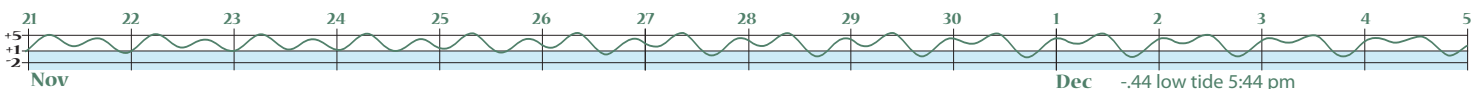
Day 2: Seaweed and Seals

Day 3: Whales

Day 4: Ohlone Indians

Day 5: Fun and Games – last day of camp

All of the volunteers at this meeting share feedback on the proposed workbook activities, arts and crafts ideas, science experiments and physical challenges focused around each theme. These are fun-filled brainstorming sessions that invariably end up in laughter and delight as new ideas are



brought forth. This year was special because we had a volunteer by the name of Marianne who was a talented guitar player and singer and brought the gift of music to our camp!

Lap 3:

Once Linda has organized the volunteers and assigned them each to specific days, tasks and duties, she passes the baton to volunteers who work on camp preparation. This is when the shopping starts. There is so much to do to prepare for camp! Supplies are purchased and assembled. Prep work is done on the arts and crafts projects. The workbooks are printed and assembled into binders. Then everything is organized by day and brought to the reserve in the order that items are to be used.

Lap 4:

We're about to cross the finish line. Excitement reaches fever pitch on the morning of camp. This year we offered a special treat to the Junior Naturalists—a pre-camp guided tour of the tidepools—because Mother Nature blessed us on this first day with an early low tide. Volunteers assemble to lead tours while other volunteers prepare the tables at the campsite. And yet another group of volunteers assemble binders, make name tags for the campers and lay out the camp supplies. Pens, papers, paintbrushes, pencils and erasers find a home on the table for eager campers to get to work personalizing their gear.

Soon the first camper arrives and the volunteers snap to attention. Ranger Katherine Wright is present and ready to sign the campers in. Parents are informed of the rules of engagement in camp. The Junior Naturalists are treated to the welcome video at the hut and the tour guides glide silently into the crowd of 24 children, divide them into equal groups, and lead them to their first activity with ease.

The Finish:

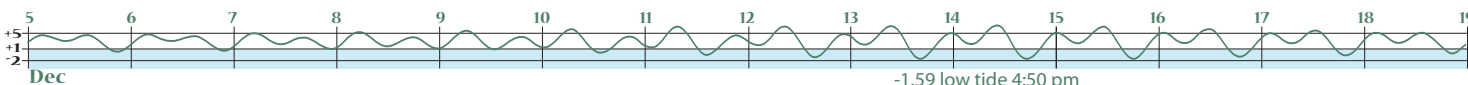
The laps have been run. The race has been won. And now it's time for fun. This year, as in years past, we were treated to a diverse group of campers not only from the Half Moon Bay area but from as far away as Ohio and the East Bay.

Special thanks goes out to Casey Passemore for volunteering to lead the camp each day. And we cannot write an article on Ju-

nior Naturalist Camp without giving special thanks to all of the rangers who shared their passion for Fitzgerald Reserve with these lucky campers. Thank you to each and every one of the volunteers who shared their knowledge and devotion to this special place we have all decided to preserve and protect. ♦

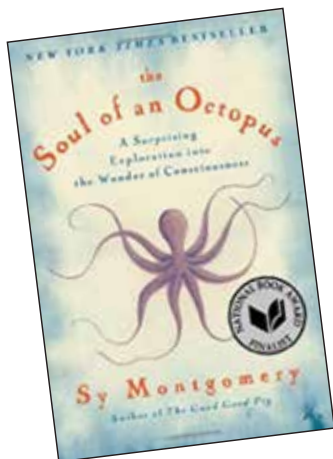


We're about to cross the finish line. Excitement reaches fever pitch on the morning of camp.



The Soul of an Octopus: A surprising exploration into the wonder of consciousness

by: Sy Montgomery reviewed by Steven Slomka



“Kali bobs her face to the surface... her pupils are dilated, like those of a person who’s newly in love.”

Animals have personalities. Their idiosyncrasies make them unique. Among domestic animals selective breeding has long been used to accentuate some physical or behavioral traits and repress others. But there are individual differences within a breed as well; one may be more athletic, another a voracious eater, a third may lack hunting ability. Anyone who’s gone for a leash or doctored a food dish takes this for granted. But when the subject of animal consciousness gets discussed, mollusks do not come to mind.

So, is it a stretch to think that advanced invertebrates like octopuses could have unique “personalities,” express emotion, initiate play? That’s Sy Montgomery’s thesis in *Soul of an Octopus: A Surprising Exploration into the Wonder of Consciousness*. This well-researched, well-written book is as close to a page-turner as the genre ever gets. The author is especially adept at describing interactions with the creatures—several generations of Giant Pacific Octopus, *Enteroctopus dofleini*, housed at Boston’s New England Aquarium where she is a docent.

Let’s review some octo-facts. The Giant Pacific Octopus has eight arms with two rows of suction cups on each. They eat by moving food to the mouth, suction cup by suction cup, until the future meal reaches the mouth and sharp beak where the animal breaks up its prey into digestible chunks, and swallows. The octopuses can instantaneously change their coloration to match their environment, to intimidate, sexually attract, flash messages, and express excitement or contentment. They have relatively small, donut-shaped brains and many ganglia throughout the body. They use their siphons to get around, escape predators and soak docents. Although the Giant Pacific Octopus averages 30 lbs with a 14-foot breadth, they can squeeze through any hole or crack that’s bigger than their beaks. They’re notorious escape artists and very smart.

Sy Montgomery suggests that the octopus brain has evolved to a highly functional level because the cephalopods have no physical protection, no shell, no skeleton. So to survive predation they have to be able to think fast.

The following descriptions are based on the author’s close observations of five aquarium individuals and maybe six creatures in the wild.

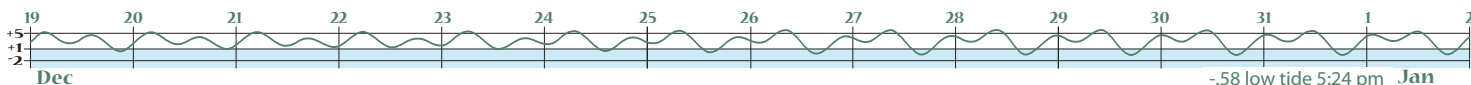
Basic Life. Most aquariums vary feeding times so that meals come randomly, just as they would in the ocean. The animals can be quite territorial, so individuals need to stay separated. One octopus had an ongoing territorial dispute with its sunflower star neighbor. The octopus eventually created a demilitarized zone from which the seastar launched occasional sorties, only to be repulsed. In the wild, the octopuses tend to live in dens between small crevices or under ledges.

Meeting the Cephalopods. The Giant Pacific Octopus at the aquarium recognizes individual people. The main feeder was allowed great intimacies, yet another docent was greeted every time with a siphon blast of cold water. The octopus explores human arms with its arms. It’s not clear how sensitive the tentacles are, the author thinks they can sense the presence of a bandaid. The cephalopods’ range of behaviors varies: they can try to drag a docent into the tank, squirt a torrent of near freezing water or bite a docent for no human-discernible reason. The octopuses come up to be scratched, to have their tentacles fondled, flash red when aroused but remain white when contentedly calm. The author describes an encounter:

Kali bobs her face to the surface and looks carefully into our eyes. Our hands respond as if summoned: We reach almost as one to stroke her head, which she seems to not merely permit, but to enjoy. She brings her eyes out of the water. Though the light is very bright, her pupils are dilated, like those of a person who’s newly in love.

Courtship to the Death. The Seattle Aquarium holds an annual Valentines Day event: The Octopus Blind Date. The mating of the Octopuses. It draws a lot of voyeuristic observers, and from Sy Montgomery’s depiction it’s easy to see why.

And now we can see Squirt [the bride] flowing toward us, bright red with excitement.



She crawls purposefully over the sandy bottom of the tank toward Rain. He has now turned from grayish to red but is still not moving. A bright white eyespot appears on Squirt's "forehead" as she stretches her second arm toward him, reaching within three feet of his closest arm...At her touch Rain pours down the side of the rock wall to meet the female on the bottom.

He races into her arms. She flips upside down, giving him her vulnerable, creamy white underside. They embrace mouth to mouth, thousands of glistening, exquisitely sensitive suckers tasting, pulling, sucking on each other. Both of them flush with excitement. Finally, Rain completely envelops Squirt with his interbrachial web, like a gentleman might cloak his lady with his coat on a cool night. Only a few of her suckers remain visible on the Plexiglas.

They do it again in an hour and a half. This time it's side by side, with Rain using his hectocotylized arm, the long one with the ligula on the tip, moving the stringy white spermatophore to his ligula then shooting it into Squirt's mantle. That pretty much knocks both of them out until about six hours after their first encounter, when they separate and head to opposite sides of the tank. The males don't die in the tanks, but in the wild they're much more vulnerable to attack and many males don't make it. The females get to lay the eggs.

Molluskan Motherhood. A female will lay her eggs regardless of fertilization. She can lay and intensively care for between 120,000 and 400,000 eggs. The female stops eating during this care and her life ends soon after the eggs hatch. The female drapes strands of rice-grain sized eggs around the den, circulating water and

dispersing algae and other growths. The New England Aquarium had a mature female who laid her eggs, even though she lived in captivity and never mated. She cared for the eggs for weeks until she eventually just gave up and ignored them. (It was after this time that Sy Montgomery had a homecoming experience with the adult female named Octavia. Although Sy had been traveling for six months, Octavia greeted her like a long lost friend, spending an especially long time fondling the author's arms.)

In the Wild. The Giant Pacific Octopus does not appear to be afraid of human scuba divers—much more curious than fearful. It usually takes a couple of interactions before the human diver and the octopus can get together. In most cases, the cephalopod takes the diver on a tour of the territory, usually demarked by crab, scallop or clam shells, then explores the diver with arms lined by suction cups.

During Montgomery's travel to Moorea, a South Pacific island, she visited an eight-sided church built in 1827 that honors the octopus. She explains, "To Moorea's seafaring people, the supernaturally strong, shape shifting octopus was their divine protector, its many reaching arms a symbol of unity and peace."

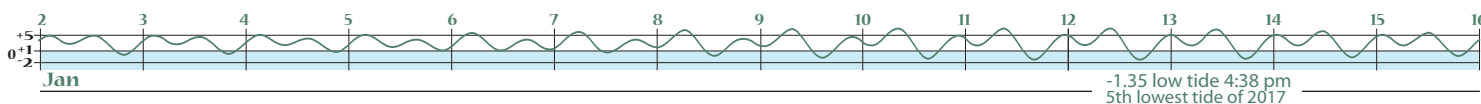
The author furthers her thesis with the following:

The desire to change our ordinary, everyday consciousness does not seize everyone, but it's a persistent theme in human culture. Expanding the mind beyond the self allows us to relieve our loneliness, to connect with what Jung called universal consciousness, the original, inherited shapes shared with all minds; unites us with what Plato called animus mundi, the all-extensive world soul shared by all of life. ♦

Sy Montgomery suggests that the octopus brain has evolved to a highly functional level because the cephalopods have no physical protection, no shell, no skeleton. So to survive predation they have to be able to think fast.

Top 8 Weird Facts About Octopus

1. A 50-pound octopus can squeeze through a hole only 2 inches in diameter. If their beak fits, they can get through.
2. Octopus are about 90 percent muscle.
3. An average female Giant Pacific Octopus in Alaska can lay 90,000 eggs.
4. Octopus frequently lose an arm to predators, but they grow back.
5. Giant Pacific Octopus are cannibals. They will happily kill and eat smaller octopus.
6. All species of octopus have venom. The venom of the Giant Pacific Octopus is not dangerous to humans, but Australia's blue-ringed octopus is known as one of the most poisonous marine animals—its venom is deadly to humans.
7. It is tempting to use "octopi" as the plural of "octopus," but DON'T DO IT. "Octopi" would be a proper Latin plural, but the word "octopus" has a Greek, rather than a Latin, root. The correct use is to use the word "octopus" to refer to one or several individuals of a single species; use the plural "octopuses" only when talking about multiple species.
8. An octopus has three hearts, nine brains, and blue blood.



Spotlight on Karen Kalumuck



Karen with a piece of the baleen from the whale that washed up at Bean Hollow State Beach in 2010.

The view from my front deck in Moss Beach is a beautiful peek of the ocean and cypress trees of the Fitzgerald Marine Reserve. It's a stark contrast to the belching smokestacks of the steel mills back in Youngstown, Ohio, where I grew up. Youngstown is nowhere near the ocean, and the first time I saw it—on a college “spring break” trip from Bowling Green State University to Daytona Beach—I ran across the sand and plunged into the water with all of my clothes on!

I earned a Bachelor's degree in microbiology and moved to Houston to attend graduate school at Rice University where I studied genetics. The Gulf of Mexico was only a 90-minute drive away, and I would go there as often as I could to commune with the ocean, and swim in the warm waves while dodging jellyfish and tar balls. After earning my Ph.D. I studied human molecular biology at Baylor College of Medicine, also in Houston, on a postdoctoral fellowship.

My career interests always included being a teacher, and I landed in Northfield, Minnesota where I was a Biology professor at St. Olaf College (alas, no longer close to the ocean). During my second summer there, I spent six weeks at the Hopkins Marine Station of Stanford University, in Pacific Grove, attending a course in Developmental Biology that used marine invertebrates as model organisms. We collected our own research subjects, so at 6am one June morning I had my first tidepooling experience along the rocky coast of Pacific Grove—I was utterly flabbergasted and totally smitten by the beauty and diversity of the tidepool organisms! In the lab, we artificially spawned the organisms, primarily sea urchins, and mixed eggs and sperm while watching through a microscope, being witness to new lives being formed! I was thoroughly hooked on this perfect blend of lab and marine sciences.

Over the next few years, I returned to Pacific Grove in the summers to continue my urchin research project. I also taught an off-campus course “Coastal Biology in California” using Hopkins as our base. I learned a lot about oceans and their inhabitants from prepping and teaching this course—a bonus was getting out of Minnesota in January!

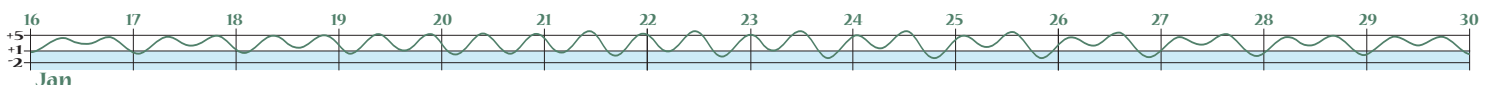
All of this time spent at Hopkins led to me meeting and marrying a researcher there, Dr. Rob Swezey. We got married on the beach at Hopkins and moved to the Coastsides when Rob took a job in biotech. After teaching at a few local community colleges, I landed what became my “dream job” at the Exploratorium. There, I developed and delivered the Exploratorium's Teacher Professional Development program in the Life Sciences, designed science demos, gave public presentations, wrote publications, and played the “in house expert” for a variety of live webcasts ranging from “Life on Mars” to “Microbes and Food”.

In 2010, when the pregnant blue whale washed up at Bean Hollow State Beach, I was able to obtain the permits to harvest a large piece of baleen from the whale for display and educational purposes at the Exploratorium. It was a huge honor to be able to preserve a piece of her, and her story. To keep the thirty-eight baleen plates intact, they soaked in a 60-gallon container of fixative, in my backyard, for many months. It's been gratifying to watch visitors interact with it at the Exploratorium.

Being laid off became a blessing, as I have been enjoying a much-needed, extended sabbatical. I had wanted to become an FMR docent for years, and in 2015, I finally had the time to do so. I am thrilled to be a member of such a knowledgeable, dedicated, and utterly fun group of people. I enjoy leading field trips as well as chatting with adults and families visiting the reserve, and delight in guiding visitors to observe closely, ask questions, and figure things out themselves, when possible...I definitely receive spurts of feel-good dopamine for every visitor's “WOW” moment!

In addition to FMR I also volunteer at San Francisco Animal Care and Control, working primarily as a dog adoption assistant and socializer. Rob and I have our own menagerie of three cats, two dogs and one guinea pig, and we love hanging out with them. We can often be found sea kayaking or hiking, and have had the good fortune to travel to many spectacular places including New Zealand, the Galapagos Islands, Easter Island, and Tasmania, and have enjoyed many visits to the Hawaiian Islands. No matter where we go, we are always pleased to come home to this spectacular place we call the Coastsides. ♦

I had my first tidepooling experience along the rocky coast of Pacific Grove—I was utterly flabbergasted and totally smitten by the beauty and diversity of the tidepool organisms!



Phytoplankton Rapidly Disappearing

by Sasha Greenawalt

The Science News article title read:

“Phytoplankton rapidly disappearing from the Indian Ocean.”

The header read:

“A rapid loss of phytoplankton threatens to turn the western Indian Ocean into an ‘ecological desert,’ a new study warns. The research reveals that phytoplankton populations in the region fell an alarming 50 per cent over the last 16 years.”

I thought, this sounds serious; I'd better check it out. I began with a brief review of phytoplankton. I discovered that in May of 2015 the first results of the Tara oceans expedition were published in *Science*. An international team of scientists had sailed aboard the research schooner Tara for four years and had sampled planktonic life from around the world. The team collected 35,000 samples and performed the largest DNA sequencing analysis ever done for ocean species, finding around 40 million genes, most of which are new to science.

Tara scientists reported surveys of existing communities, discovered new organisms and observed how the different planktonic organisms interact.

Helen Thompson, at smithsonian.com, says that “The [Tara] research confirms that climate change will have a huge impact on plankton, but scientists still don't know what exactly that impact will look like. On the plus side, now that researchers know what normal plankton communities look like, they'll be able to tell if something is out of whack in the future.”

“Phytoplankton” is a term that covers a very diverse group of organisms: from cyanobacteria (believed to be one of the oldest organisms on Earth) to silica-contained diatoms, to whip-tailed dinoflagellates, green algae, viruses and armor-plated coccolithophores. Most are single-celled and microscopic or very small. So small that a tablespoon of

sea water could contain hundreds of thousands of organisms. The photosynthetic bacteria were unknown until the 1970's when technology improved enough to make them visible.

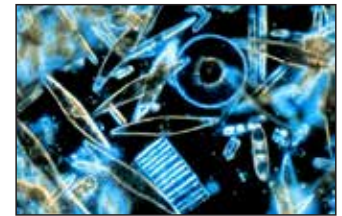
Otherwise known as microalgae, all phytoplankton are photosynthetic and most are buoyant and float in the upper part of the ocean (or in bodies of freshwater). There, like terrestrial plants, they use chlorophyll in photosynthesis, the process of converting sunlight and CO₂ into oxygen and energy (in the form of organic compounds such as proteins, fats and carbohydrates). For these compounds they require inorganic nutrients such as nitrates, phosphates and sulfur. They are said to provide “primary production.”

Phytoplankton produce about half of the oxygen generated on Earth (and are therefore responsible for about every second breath you breathe); they are also responsible for removing about half of all CO₂ from the atmosphere during photosynthesis. The carbon then ends up (in plants and animals that have died) deep in the ocean on the sea bed, safely isolated from the atmosphere. Clearly these organisms are important actors in the climate system and an essential part of the Earth's carbon cycle.

Phytoplankton also form the base of the food chain on which most marine life feeds, including many species of fish, some marine animals such as whales, manatees and sea lions, and birds such as pelicans. In the open ocean, they are the only source of primary production to sustain pelagic food webs. The effect of a substantial decline in the abundance of phytoplankton would cascade up the chain to affect many other higher species.

Several factors act on phytoplankton as a result of climate change, the major ones being:

1. warming ocean temperature
2. increasing atmospheric CO₂ ➔



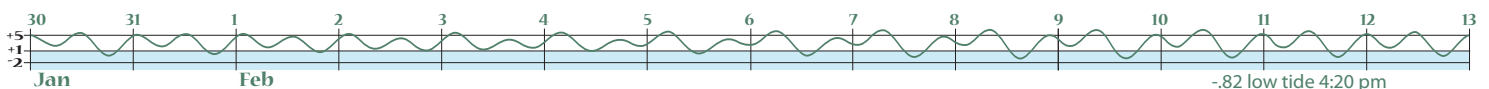
Top: Diatoms are one of the most common types of phytoplankton. Photo credit: Wikipedia.

Above: Phytoplankton come in many shapes and sizes. Photo credit: Wikipedia. Drawings not to scale.

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Collage adapted from drawings and micrographs by Sally Bensusen, NASA EOS Project Science Office. Drawings not to scale.





Check out our
new page of
Your Photos (p3).
Keep sending
them in!

Six Ray Star: Leptasterias sp.
◆ TOM NIELSEN

Phytoplankton *continued from page 11*

3. acidification of the oceans
4. decline or increase in ocean mixing due to warming surface waters, leading to a reduction or increase in available nutrients. (The mixing of the ocean's layers ferries nutrients from the sea's depths into the sunlit layers where the microalgae live.)
5. increased storm activity and extreme weather

As often happens in discussions of climate change, there is some disagreement on the impacts these factors have or will have, and sometimes some conflict between the results of field observations, laboratory studies and computer modeling.

Thus, estimates of oceanic phytoplankton change are highly variable.

Using six climate models, a large multi-university study of ocean ecosystems predicted a global increase in primary production of 0.7% to 8.1% by 2050. In contrast, a more recent multi-model study estimated that primary production would decline by 2–20% by 2100. One primary production study found a net increase in phytoplankton, judging by measured chlorophyll, comparing data from 1998–2002 with those from 1979–1986. Other studies, using the same database of measurements, concluded that both chlorophyll and primary production had declined over this same time interval.

Such discrepant results are understandable, as laboratory studies have to take into account and mimic the complex interactions between variables: increased CO₂, light, temperature, pH, etc., and also account for differing responses depending on the species of the organisms used. One process that finds broad interest is this: increasing atmospheric CO₂, leading to ocean acidification, might have an adverse effect on the calcifying phytoplankton species. At the same time increased CO₂ stimulates photosynthesis.

Experimental manipulations of pH in coccolithophore cultures have produced both reduced and enhanced calcification and growth.

A study done by Lothar Schluter held phytoplankton in seawater acidified by carbon dioxide and measured the calcification activity. After an initial drop in shell calcification the cultures mostly restored their nominal calcification rates within a year. But then as the experiment continued, the phytoplankton began making less and less shell material. So the duration of the experiment is important.

Then there are feedback mechanisms such as: enhanced CO₂ causes ocean surface warming, which lessens winter convection and nutrient availability, which diminishes primary production, which enhances atmospheric CO₂.

It's dizzying, it is far more complicated than this and we haven't even considered genetic adaptation.

Despite substantial variation in both the magnitude and spatial pattern of change, the majority of published studies predict that phytoplankton biomass and/or primary production will decline over the next century. What is needed is a more solid understanding of marine phytoplankton ecosystem responses to the multiple and interacting factors driving climate change and a better knowledge of the ability of marine microalgae to adapt genetically to the remarkably rapid pace of current climate change.

The Tara scientists have produced diagrams of planktonic interactions that give a picture of what normal communities look like around the world. As Jeroen Raes, a member of the Tara team, says, "This map [of planktonic interactions] is a first step towards a better understanding of the dynamics and structure of the global marine ecosystem and the impacts such things as climate are having on these tiny creatures." ◆

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