

# 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  
F a l l 2 0 2 0

## GOING VIRAL

by Tom Ciotti

Now that a virus has captured our attention, what better time for an article about marine viruses. WARNING: if you are a germophobe or harbor even the slightest hope that the ocean is virus-free, STOP READING IMMEDIATELY!

### Viruses 101

Human awareness and study of viruses began in the late 19th century, and that of marine viruses only more recently. There is much we do not know about viruses, particularly marine viruses.

The word “virus” is Latin in origin and means slime or poison. That humans chose this name is not surprising since humans discovered viruses in the context of identifying the causes of diseases. Indeed, most of us likely view viruses as universally malevolent and are unaware of the important essential roles they have played and continue to play in the ecology of our planet, especially the ocean.

Viruses are biological entities. Most are composed of nucleic acid (either DNA or RNA) and protein, two of the chemicals essential to life as we know it. The nucleic acid forms the virus’s genome and the protein forms a protective coat, called a capsid, around the nucleic acid. Harking back to the disrepute in which viruses are commonly held, one researcher referred to this structure as “bad news wrapped in a protein.” Viruses are generally not considered to be “alive” because they lack the ability to reproduce autonomously—a hallmark of life as currently defined. In order to reproduce or replicate, a virus must first infect a living host cell and then hijack

the metabolic processes of the infected host cell to synthesize nucleic acid and protein and assemble those chemicals into copies of the virus. The reproductive cycle of most viruses is less than a day. The infection process involves the virus binding to the host cell’s surface and injecting its nucleic acid into

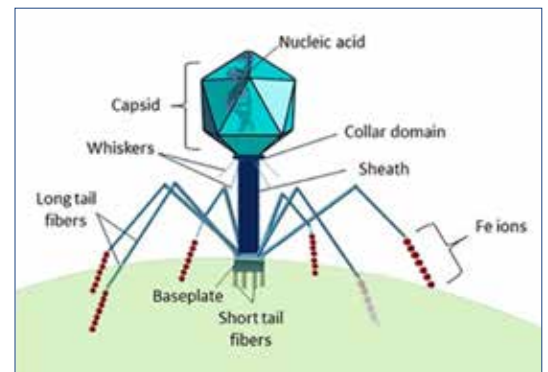
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*Viruses that can infect multiple host species can cause horizontal gene transfer between species.*

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the cell’s interior. Once inside, the nucleic acid can begin the replication process or integrate into the host cell’s genome, causing what is called a horizontal gene transfer (HGT) with the host. Viruses that can infect multiple host species can cause HGT between species. As many of us have recently learned, in some instances virus infection can result in significant harm or even death to the host.

Viruses come in a variety of shapes and sizes. One shape commonly found in the ocean looks like a miniature lunar lander. Others have geometric shapes. Most viruses are submicroscopic, which is why they remained unidentified by humans until just over a hundred years ago. Their average size is about 100 nm (1 nm = .000000039 in). In comparison, bacteria are microscopic and about



Structure of a typical virus

Credit: Wikipedia.org

Link: [https://en.wikipedia.org/wiki/Marine\\_viruses](https://en.wikipedia.org/wiki/Marine_viruses)

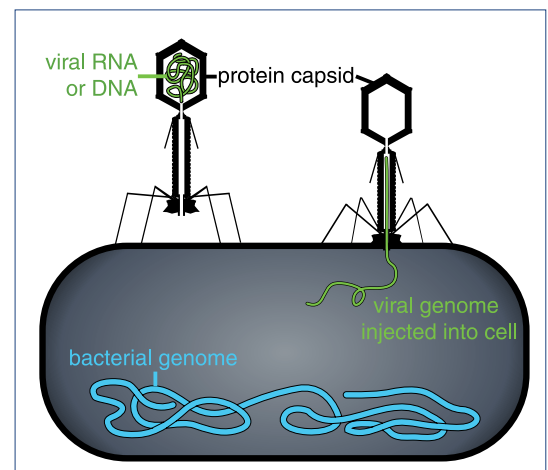


Diagram of how some bacteriophages infect bacterial cells (not to scale; bacteriophages are much smaller than bacteria)

Credit: Thomas Spletstoeser

Link: [https://commons.wikimedia.org/wiki/File:Phage\\_injecting\\_its\\_genome\\_into\\_bacteria.svg](https://commons.wikimedia.org/wiki/File:Phage_injecting_its_genome_into_bacteria.svg)

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## Friends of Fitzgerald Marine Reserve

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## Going Viral *continued from page 1*

10 to 100 times larger than most viruses. Recently, however, giant viruses which rival bacteria in size were discovered. These Godzillas of the virus world are, of course, found in the ocean. Didn't I tell you to stop reading??

Viral genomes are relatively small too. Viruses such as HIV which causes AIDS in humans have about 10 genes, viruses which infect marine bacteria have about 70 genes. Bacteria have about 3,000 genes. Humans have about 20,000 to 22,000 genes. Lest you get the impression that the number of genes an entity has correlates with biological superiority, I would add that bananas have about 32,000 genes. Humans do, however, have the longest and most complex genes of any organism.

Viruses are really old. They are at least as old as life on earth and perhaps even older. Since they require living hosts to continue to exist, most current thinking is that they originated simultaneously with or shortly after the advent of life. That puts them at having existed for about 4 billion years. In comparison our close ancestors originated about 6 million years ago and modern humans about 200,000 years ago. Yes, viruses have survived all the ice ages, asteroid strikes, mass extinctions, and every other catastrophe that earth has experienced. And yes, they are believed to have infected every earthly life form that has ever existed or will exist in the future. Not good news for those among us who think viruses will somehow magically disappear!

Viruses exist wherever life exists. That means they are everywhere on earth—in the atmosphere, the land, and all bodies of water, especially the ocean. They are part of the microbiomes of every living creature on earth. In the case of healthy humans, we comprise about  $10^{13}$  authentic human cells, and host in us or on us about  $10^{14}$  bacteria and 10 to 100 times more viruses than bacteria. “We” are literally more microbial and viral than we are human! What a mo-

ment of truth for those of us who sat around a campfire singing the ditty “There Ain't No Bugs on Me”! Since viruses have infected all of our ancestors and infect all of us, we and our ancestors have experienced a great deal of virus-caused HGT. So it is not surprising that roughly half the DNA present in the current human genome is estimated to be derived from viruses. Moreover, it is absolutely true that human well-being is dependent on the microbes, including the viruses, that we all host. The same can be said of every invertebrate, vertebrate, and alga we find in the tidepools at Fitzgerald Marine Reserve.

Here is some good news: viruses are very selective of the hosts they infect. Most viruses, including the vast majority of those found in the ocean, infect only a single host species. Only a minute fraction of the viruses found in the ocean infect humans and those that do were put there by us via careless waste disposal. So you can generally swim in the ocean, get your hands wet at the reserve, or even take a sip of seawater without fear of being infected by viruses.

## Viral Numbers and Math

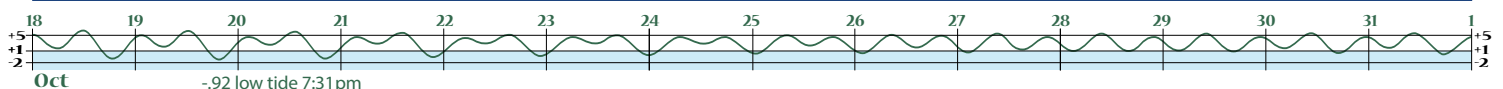
As intimated previously, there are an awful (no pun intended) lot of viruses on earth. So many it is hard to imagine. It is estimated there are way more viruses than there are stars in the sky. Marine virologists have measured the number of bacteria and viruses in seawater and have found that a milliliter (roughly a teaspoon) contains an average of 1 million bacteria and 10 million viruses. Curtis Suttle, a noted marine virologist from British Columbia who likes to play with numbers has, using the volume of water in the oceans, calculated there are an estimated  $10^{30}$  viruses in the ocean. That's a quadrillion quadrillion just in the ocean! Using an average size of 100 nm, Dr. Suttle calculates that if all the viruses in the ocean were lined up, the line would be about 7 million light years long. For reference, the closest galaxy to our Milky Way is about 25,000 light years away. So the line would easily reach many other galaxies in the universe. ➡

The graph displayed across the page bottoms shows tides for 10/18/20 to 3/7/21 at Princeton Harbor. 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. See: <http://www.fitzgeraldreserve.org/newffmr/site/lowtides/> and click on “Tides” for a more detailed tide chart.

*The winter afternoon low tides change to morning low tides in March. There are almost equally low tides several days before and several days after the noted low tide dates.*

The lowest tides this period at Princeton Harbor are:

-0.92	10/19	7:31 pm	-0.91	12/31	5:37 pm
-1.55	11/16	5:23 pm	-1.44	1/12/21	4:13 pm
		<i>fourth lowest tide of 2020</i>			<i>sixth lowest tide of 2021</i>
-0.63	12/02	5:53pm	-0.88	1/28	4:40 pm
-1.67	12/14	4:23 pm	-0.96	2/09	3:17 pm
		<i>second lowest tide of 2020</i>	-0.66	2/26	4:12 pm



➔ The majority of marine viruses are bacteriophages, a class of viruses that exclusively infect bacteria. The word bacteriophage means “bacteria eater.” Bacteriophages don’t actually eat bacteria, although it looked like they did to early researchers, and hence their name. Instead they cause the cell wall of their host bacteria to disintegrate and thus release the cell’s contents, a process called “lysis.” Dr. Suttle has estimated there are  $10^{23}$  viral infections of bacteria per second in the oceans and that roughly 80% of the ocean’s bacteria are infected at any given time. These high levels of infection produce an astronomical amount of HGT. This huge amount of HGT is the basis of ongoing evolution and change in both the host and the viral replicates resulting from the infections. He also estimates that a total of  $10^{27}$  lysis events occur daily, which releases huge amounts of organic material, including new viruses, into the ocean. Every day about 20% of the marine biomass is lysed by viruses. The number of virus particles present in a cell at lysis is called “burst size.” The average burst size for marine bacterial cells is about 25 virus particles per lysed cell. It is estimated that the rate of viral production in the ocean is in the range of  $2 \times 10^3$  to  $3 \times 10^6$  viruses per ml of seawater per hour. Viral production in the ocean varies and generally decreases from coastal waters to open waters. It is also estimated that the total marine virus population of the ocean turns over every one to six days. In comparison it takes an average of about seven years for most of the cells in the human body to be completely replaced, and the U.S. human population a current average of 80 or so years (current life expectancy) to turn over.

If the preceding paragraph is gobbledegook to you, the bottom line is that there is a humongous amount of viral infection and production of new viruses going on in the ocean every second.

### Diversity and Distribution

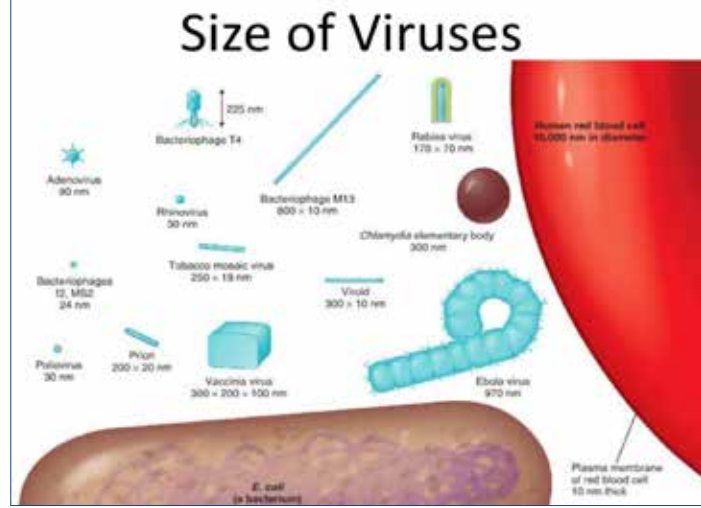
Research on the diversity and distribution of marine viruses began only about 20 years ago, so much about this aspect of marine virology has yet to be learned. Hundreds of thousands of marine virus phylotypes have already been identified in this short time. However it is likely there are many millions yet to be identified and we may never identify all of them. Since the presence of marine viruses is highly selective and dependent on the presence of their specific hosts, it follows that the diversity and distribution of marine viruses at a particular ocean location will correlate with the host diversity and distribution at that same location. A 2017 study done in the Indian Ocean analyzed a 250 ml sam-

ple of seawater and found 834 prokaryotic (infect prokaryotes), 346 eukaryotic (infect eukaryotes), and 254 unique (unidentified) virus phylotypes in the sample. The prokaryotic phylotypes were dominated by orders that infect Cyanobacteria whereas the eukaryotic phylotypes were dominated by orders that infect dinoflagellates. Analysis of microbial nucleic acid in the sample was consistent and showed the prokaryotic portion came from Cyanobacteria and the eukaryotic portion from dinoflagellates.

Other studies have shown that environmental factors such as nutrients, temperature, and acidity can affect the diversity and distribution of marine hosts and their viruses as well as the interaction between them. There have also been studies that investigated differences in diversity and distribution between coastal waters, deeper waters and ocean sediment as well as photic zone location and location in the water column. Those studies indicate that different groupings of viral phylotypes may congregate to form different viral communities dependent on temperate zone and water column location.

### Effects on Marine Ecology

Marine viruses, like human viruses, were first recognized and studied in the context of diseases adversely affecting commercially valuable marine organisms, particularly those that are grown using aquaculture. Thus, viruses have been identified with diseases in mollusks such as oysters, arthropods such as shrimp and crabs, sea cucumbers (cultured in Asia), and fish such as salmon, sea bass and cod. They have also been identified in diseases of animals that play important roles in marine ecology such as harbor seals and sea stars. In 1988 and 2002 thousands of harbor seals in Europe were killed by phocine distemper virus. ➔

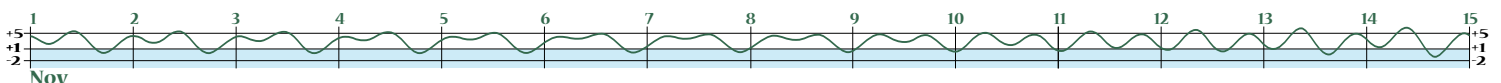


Credit: Rachel Belton, published in “Science,” 4-19-2014

*“We” are literally more microbial and viral than we are human!  
What a moment of truth for those of us who sat around a campfire singing the ditty  
“There Ain’t No Bugs on Me”!*



Sea star with wasting syndrome, days 1, 2 and 3, Guemes Island, WA, June 2014 Credit: Kit Harma



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*Because the DO (dissolved organic material) produced by lysis (disintegration of the host bacteria cell wall and thus release of the cell's contents) promotes growth of marine bacteria, many of which are photosynthetic, marine viruses contribute indirectly to the production of oxygen in the world.*

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➔ On the west coast of North America, including the Fitzgerald Marine Reserve, vast numbers of sea stars were killed in 2013–2014 by sea star wasting disease. Densovirus is believed to be involved in that disease although the complete etiology of the disease has not been established. The die-off of sea stars, a keystone species in the intertidal environment, has affected intertidal species diversity.

It was not until the 1990s that viruses were found to affect marine ecology beyond their role as pathogens of marine animals—that they profoundly affect global scale ocean productivity, bacterial diversity, biogeochemical cycles, and evolution.

As indicated previously, marine viruses cause a huge amount of lysis of marine bacteria. Scientists estimate that about 50% of bacterial mortality in the ocean is caused by lysis, with the other half being caused by grazing (other marine organisms consuming bacteria). Grazing causes the carbon and nutrients present in bacteria to be transferred up the marine food chain, whereas lysis releases such carbon and nutrients in the form of dissolved organic material (DOM) to the bottom of the marine food chain to stimulate growth of surviving bacteria. This latter downward transfer of carbon and nutrients is referred to as the “viral shunt.” Because the DOM produced by lysis promotes growth of marine bacteria, many of which are photosynthetic, marine viruses contribute indirectly to the production of oxygen in the world. Correlatively, viruses indirectly contribute to reducing the amount of carbon dioxide in the atmosphere. Photosynthetic marine bacteria consume carbon dioxide

in photosynthesis and reduce the amount of carbon dioxide by an estimated amount of 3 billion tons of carbon per year. Excess carbon dioxide in our atmosphere is, of course, one of the causes of global warming. In addition, it is also believed that marine viral activity enhances the sequestration of carbon in the deep ocean.

Grazing results in non-selective bacterial mortality and does not significantly affect bacterial diversity, whereas viral lysis, because of the selective infectivity of most bacteriophages, is selective and thus can affect bacterial diversity and prevent any one bacteria from becoming dominant.

Viruses are the main agents responsible for the demise of harmful algal blooms. Under favorable nutrient, light, and/or temperature conditions an alga can become opportunistic and rapidly multiply and dominate an ocean site forming what is called a “bloom.” The red tides we experience in the vicinity of the Fitzgerald Marine Reserve are examples of algal blooms.

In addition to causing water discoloration and sometimes an anaerobic environment, they often produce toxins that are harmful to marine life and humans. But with the enormous number of viruses floating around in the ocean, the relatively homogeneous algal population of the bloom is a prime target for viral infection and demise. Perhaps the most famous blooms are formed by the alga *Emiliania huxleyi*, which is armored with limestone plates. It is distributed globally and is well known for forming enormous blooms (they can often be seen from space) in coastal and open waters in temperate zones. Destruction of its blooms by viruses has created major limestone deposits such as the White Cliffs of Dover. Indeed, the milky waters seen near the end of blooms of this alga are not filled with healthy algal cells but with mostly dead and dying virally infected cells.

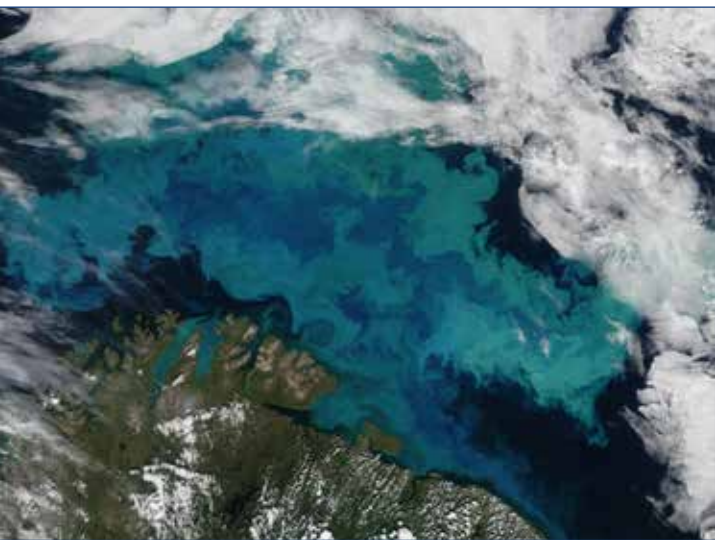
As indicated previously viral infection can result in HGT. The extent of HGT events in the ocean is still being studied and quantified. But it is expected to be enormous. It is known to be a primary mechanism of marine bacterial evolution—the way by which marine bacteria acquire new traits that enable them to cope relatively rapidly with environmental changes. Not surprisingly, virus-caused HGT is believed to be a driver of evolution in all living species, including humans.

## Closing Thoughts

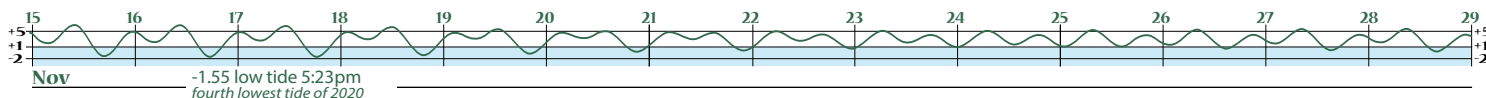
If the human race is ever fortunate enough to follow the seven million-light-years long line of viruses to distant stars and galaxies to discover, explore, and maybe colonize other planets, you can be sure the microbes and viruses we humans host will be along for that ride.

Finally, don't forget to get your flu shot and, hopefully, in a few months your Covid 19 shot.

Going...Going...Gone. ♦



*Algal Bloom in the Barents Sea, credit: Jeff Schmaltz, MODIS Rapid Response Team at NASA GSFC.*



Paul Gater

I joined the 2014 volunteer naturalist class run by the Friends of Fitzgerald Marine Reserve. I had always enjoyed visiting the reserve over the years though I can't claim to have been a regular visitor. But I was looking for opportunities and new interests as part of early planning for retirement. I'm a scientist (more later) and was drawn to Fitzgerald by the history, the biology and the need to protect the reserve for future generations. The course started well. But after a couple of classes I got the news that I have a rare blood cancer, multiple myeloma, and I dropped out of the class when I started treatment.

Happily, I recovered enough to attend the 2014 graduation party hosted by Tom and Linda Ciotti and, to my surprise, got a Volunteer Naturalist badge! This year I retook some of the classes as a refresher. And then the pandemic hit, which means I still haven't completed the second half of the course. I've discovered many other ways to volunteer at the reserve without the risk of a fourth grader exposing the deep holes in my knowledge of the tidepool critters.

How did someone from the middle of England end up in Half Moon Bay, California? I'm from the suburbs of Birmingham, which is the second largest city in England and 80 miles from the nearest stretch of English coastline. Not an obvious background for an interest in marine life, despite the stereotype of being from an island nation. While we had family holidays at the "seaside," I don't remember much of what you might

*How did someone from the middle of England end up in Half Moon Bay, California?*

call "nature," although I do recall interminable bus or car rides and then trying to dig to Australia on the beach. Then I left home to go to college in Portsmouth. Ahoy, the sea! This is a city rich in maritime history and is a major port for the British Navy. Admiral Nelson's ship from the battle of Trafalgar, the Victory, is a permanent exhibit. Henry VIII's warship, the Mary Rose, is now there too. I really didn't pay much attention to the local flora and fauna although I did meet others who got me into some hiking that included a brutal hike up and down the cliffs in Cornwall.

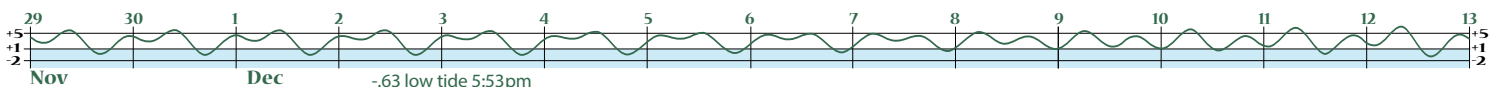
I graduated with a degree in pharmacology and moved to University College London to work as a research technician. This was the start of my career in science. I did enough research to write up a Master's thesis and then joined the pharmaceutical industry with Pfizer. Where are they based in the UK? By the sea in the old Cinque port town of Sandwich in Kent. The town is now several miles inland. Looking back, the weather reminds me of ours. I moved to Roche Pharmaceuticals a few years later and was then transferred to New Jersey in 1993. Thanks to reality TV, the Garden State may not be famous for its marine life, although there are some great places on the Jersey Shore like Cape May. I've been in the US ever since, moving to the Bay Area in 1997 and becoming a citizen in 2007. My wife and I decided to settle in Half Moon Bay in 1999 and so we bought a house in Frenchman's Creek. We wanted to be part of a small-town community. We wanted to live by the ocean and quickly discovered Fitzgerald along with the other coastside attractions like fog, tourists and traffic.

I retired in the summer of 2019 after a few years with Genentech. I wanted to give back to the community in retirement. I'm on the board of the Friends of Half Moon Bay Library and was volunteering in the kitchen at the Senior Coastside Center until the pandemic. I've found lots of ways to volunteer at Fitzgerald. I worked at the Visitor Center when my health improved and again earlier this year right before we had to shut down. I compile the Tide Tables that Susan Evans includes in the student training manual every year. I've been on the teams counting nudibranchs and sea stars. I like these citizen science projects. I'm also a member of the Sequoia Audubon Society and a frequent contributor to eBird, the huge database managed by the Cornell Laboratory of Ornithology. I suppose you can take me out of science but not science out of me. I'm pleased to help protect the harbor seal population and tidepools through blufftop monitoring while the reserve is closed. As I write this in early September, I'm looking forward to the day when we can open up the reserve to visitors again and help them enjoy this unique place. ♦



*While we had family holidays at the "seaside," I don't remember much of what you might call "nature," although I do recall interminable bus or car rides and then trying to dig to Australia on the beach.*

*I've found lots of ways to volunteer at Fitzgerald... I've been on the teams counting nudibranchs and sea stars. I like these citizen science projects.*



## Beach Watch 4-17

by Karen Madsen



*Beach Watch surveys provide a long-term database of information on the activities and uses of the beach by marine organisms and humans.*

Have you heard of the Beach Watch program? I am sure that many of you Fitzgerald Marine Reserve volunteers have heard of it or, perhaps, have even been (or are) a Beach Watch volunteer! But for those of you who aren't familiar

with it, this article will provide you with a little peek into this fantastic program.

### What is Beach Watch?

The Beach Watch program is a public-private partnership of the Greater Farallones National Marine Sanctuary (GFNMS) and the Greater Farallones Association (GFA). These two organizations have teamed together to study and protect the shoreline of the GFNMS and the northern portion of the Monterey Bay National Marine Sanctuary (MBNMS). I am proud to be a new Beach Watch volunteer; I was trained in the fall of 2019 and am excited to be part of the team and its important work.

Since 1993 (27 years!) Beach Watch has conducted shoreline surveys within and adjacent to the GFNMS and the MBNMS. The survey range currently spans 211 miles of California coastline from Año Nuevo State Reserve in San Mateo County to Manchester Beach (near Point Arena) in Mendocino County. These surveys provide a long-term database of information on the activities and uses of the beach by marine organisms and humans. Beach Watch is a certified MPA Watch partner in coastal central California. A good portion of Beach Watch's live human-use data is collected for the MPA Watch network.

Teams of surveyors monitor defined beach segments—there are 61 active segments and each segment is numbered. My beach is 4-17—beautiful Pescadero Beach in San Mateo County. Beach Watch surveyors conduct counts of live and dead marine animals and of human activities. Surveyors also document

oil and tarballs, oiled wildlife, relative abundance of beach wrack and seasonal changes relating to streams and lagoons. It is very rewarding to be part of such a long-term and important conservation citizen science project.

The most inspiring aspect of the program to me is how valuable the database is to oil spill monitoring and damage assessment of spills. Consistent monitoring protocols and the rigor of the database has provided a long-term data set against which to compare the mortality rates of species and species composition during known oil spills. The Beach Watch baseline data has helped to evaluate damages and determine legal settlements for four oil spills in the GFNMS, including the most recent Cosco Buscan spill in 2007 in San Francisco Bay, which resulted in a \$44 million settlement.

### What Type of Training is Required for Beach Watch Volunteers?

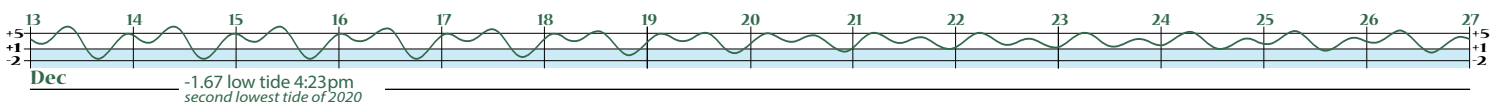
GFNMS and GFA conduct an excellent, rigorous training for new volunteers. The bulk of the training is focused on developing skills to identify live and dead marine birds and mammals. This is accomplished through many beach field trips and time spent at the California Academy of Sciences working with the Ornithology and Mammalogy Collection to gain in-depth learning with respect to ID skills. Surveyors must have very good ID skills to ensure the accuracy of the data set. The training also covers the purpose of the study, information about the overseeing organizations, a macro understanding of the survey areas, oil collection protocols, reporting procedures, and data collection and entry. My training consisted of about ten sessions, with both classroom and field-based work. It was fun to meet the other trainees and realize that I already knew some of them from the other volunteer activities that I participate in! I particularly enjoyed the bird ID field trips and working with the specimens at the Cal Academy.

### What Does a Typical Beach Survey Entail?

Each beach in the survey area is surveyed every two weeks by two separate survey teams



Credit: NOAA/GFNMS/BeachWatch



(i.e., each team surveys every four weeks). Teams consist of one to four people as the size and difficulty of each beach varies. Survey target dates are prescheduled and the survey must take place within two days before or after the target date. This schedule provides for data consistency.



On a typical survey day, the team meets at their assigned beach with all of their Beach Watch gear. Weather (winds, tides, temperature, visibility, etc.) is checked and documented. The team takes photographs documenting the view of their beach

and then begins their “Live” survey, which is a count of live organisms and human activity. After the “Live” survey is completed, a “Dead” survey of organisms is conducted. The survey also includes assessing the level of wrack on the beach, documenting the presence of any oil on the beach and reporting any stranded animals or sanctuary violations. My Beach 4-17 typically takes two to three hours to survey.

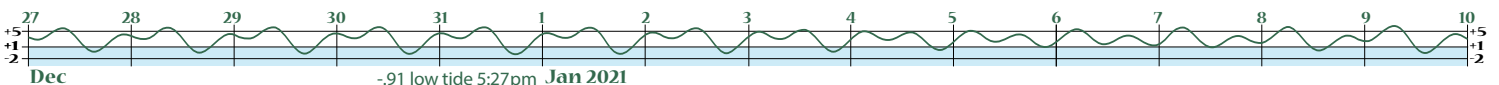
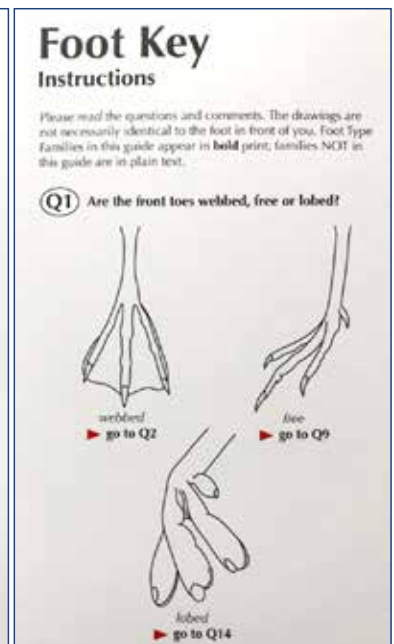
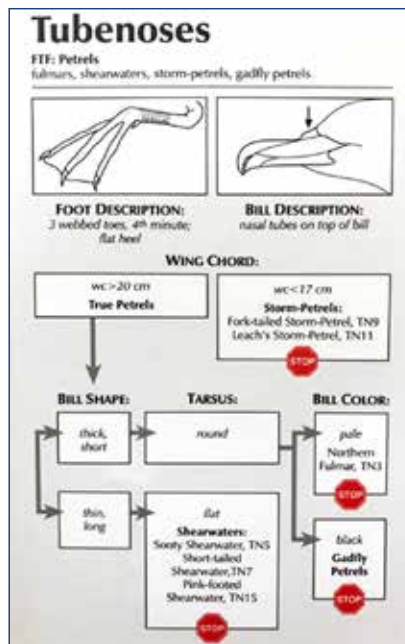
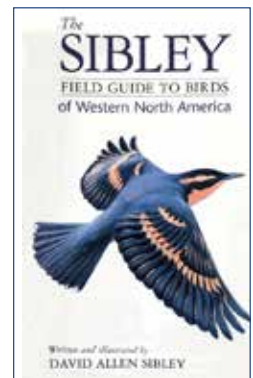
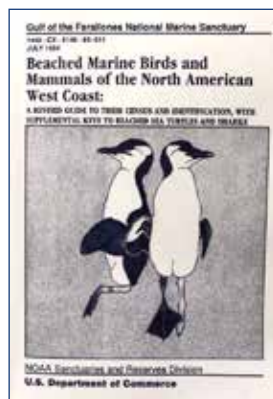
I work with a team of two and my partner has been surveying Beach 4-17 for more than 20 years! Being paired with such an experienced partner has been a real plus for me in my learning curve. I am amazed at how many Beach Watch volunteers have served more than 20 years with the program and I think that says a lot about how satisfying the volunteers find the work.

For me, learning to identify the various species of gulls (and their ages!) has been my greatest challenge. Because I am a long-time volunteer at Año Nuevo State Park and volunteered for several years at the Marine Mammal Center, I came to Beach Watch with some good ID skills regarding marine mammals, but learning to identify marine birds has been a stretch for me. I find it particularly tricky as most dead birds found on the beach are not much more than a few feathers and bones. As a Beach Watch surveyor, you quickly learn to use your resource books and start to focus on key identifiers like bills (check out what tubenoses look like) or feet (check out lobed feet vs. webbed feet). Dead animals are documented with photos and reviewed by Beach Watch experts for ID

*continued on page 9*

Karen never stops seeking out a new opportunity to serve her community. She has been a busy volunteer as evidenced here:

- Greater Farallones Association—Beach Watch
- California State Parks—Ano Nuevo State Park, leads hikes and tours as a docent; wildlife interpretation
- Peninsula Open Space Trust (POST)--Skyline Committee, donor outreach events, Ambassadors, leads hikes on POST protected properties.
- San Mateo County Parks—Fitzgerald Marine Reserve, leads tours at tide pools, Jr. Naturalist Camp leader
- Friends of Fitzgerald Marine Reserve, Board of Directors
- San Mateo County Sheriff's Activities League Moonridge Reading Stars Program, assists first graders with reading skills
- Pigeon Point Light Station (past), led hikes and tours as a docent; wildlife interpretation
- Half Moon Bay State Park (past), led hikes and tours as a docent; wildlife interpretation
- Marine Mammal Center (past), Education docent
- Coastside State Parks Association (past), Board of Directors



# See You on the Dark Side of the Reserve

With the tide pools closed, it's a great time to explore the thriving terrestrial life of FMR, under the shade of the cypress trees.

by Karen Kalumuc

photos by Karen Kalumuck



Have you ever noticed, really looked at, the plants on the FMR grounds? We are always in a hurry to get our tour groups, friends, or even ourselves down to the magic of the rocky intertidal, that except for (maybe) the Canary Palms (*Phoenix canariensis*) and Monterey Cypress (*Hesperocyparis macrocarpa*) trees, the land is a green and brown background blur. But that “blur” contains a whole lot of biodiversity and history, I have come to learn.

## Down the Rabbit Hole

Since April of 2019, I have gone down the rabbit hole of identifying and cataloguing the terrestrial plants of FMR. I needed a capstone project to earn my certification as a California Naturalist (more info: [http://calnat.ucanr.edu/Take\\_a\\_class/](http://calnat.ucanr.edu/Take_a_class/)), and wanted it to be something useful for visitors to the reserve. Tom Ciotti, then President of FFMR, suggested that I develop a plant guide, and my project was born!

More than a year later, I am not yet finished, but am very close. I knew that it would require at least a year to complete the project—to observe the seasonal plants, find ones in bloom (helpful for identification) or simply to capture a great photo. Nearly every time I go out to observe, I find a plant that I haven't noticed before! As of today (September 13, 2020) I am still waiting for a type of “horseweed” to flower so that I can perhaps identify it to species level; they have been growing for months and still haven't flowered! Argh!

What follows are a few insights I've learned (or relearned) from conducting this project, and a few tidbits about the plants themselves.

## What's in a Name? The Need for Latin

Have you heard of the plant “goat's foot”? How about African wood-sorrel, Cape sorrel, English weed, soursob, sourgrass, Bermuda buttercup? They are all synonyms of the very common plant with the bright yellow flowers, with

the scientific moniker *Oxalis pes-caprae*, what we call “oxalis.” Without a universally accepted reference name, it would be impossible to be sure that all of the common names refer to the same plant.



*Oxalis*

## A Weed is Just a Wildflower Out of its Place

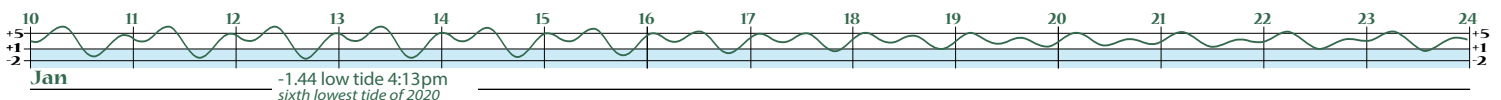
Take the example of Catchweed Bedstraw, *Galium aparine*, (aka cleavers, cleaverwort, goosegrass, stickwilly, scarthgrass, and white hedge). It has been showing up in my yard for years, a vine-like plant that rapidly grows atop other plants; as I weed, it annoyingly clings to shirt, pants, and shoes. The small hooked hairs that grow along the stem and leaves allow it to “catch” onto surfaces, and it was said to be used as mattress filling, hence the name “catchweed bedstraw.” Turns out that it is a native plant. Its root was used by native people to make a red dye, and its extract was used for medicinal purposes. Weed or wildflower, indeed!

## An “Unnatural” Environment

The Mediterranean climate of the area (cool, dry summers, wet, warmish winters) has provided the perfect environment for many non-native, introduced plants to thrive. Of the 100-plus species that I have identified, just under half are native. Prior to introduction of foreign



*Horseweed*





➔ plants, the land of FMR would have looked a lot like the restored areas of Pillar Point bluffs—a “coastal scrub” environment. The planting of the Cypress trees, in particular, have altered the native environment ever since.

The County Parks Department has been doing an excellent job of cultivating more native plants at FMR and removing invasive non-natives. I was thrilled recently to find Coast Tarweed, *Madia sativa*, along the trail. The plant is only a few inches tall, and the flowers about 2 mm in circumference, so very easy to miss! This plant provided copious amounts of seeds to Native Americans, who used them as an abundant food source. It’s so great to see it at the reserve!

### What’s Next?

When I have finished my cataloguing of the plants (which no doubt will be incomplete), I hope to make it available to anyone who would enjoy it (I am not quite sure how, yet). In the spring, I hope to lead folks on some tours of the wonders found in the dark side of the reserve.

Invaluable sources that helped me identify plants:

- iNaturalist—<https://www.inaturalist.org>
- Calflora—<https://www.calflora.org/>
- Jepson Herbarium—<https://ucjeps.berkeley.edu/eflora/> ♦



Tarweed



Tarweed seeds

Credit: Native Foods Nursery

## Beach Watch *continued from page 8*

accuracy—it can be very exciting and rewarding to find your bird or mammal IDs were correct! I was particularly proud of my first ID of a dead Pacific Loon, as there are a couple of types of loons in our area and sometimes they are confused with grebes (hint—check out those feet!)

One of my favorite parts of surveying Beach 4-17 is observing endangered Snowy Plovers. I have noticed that many of the Snowy Plovers on Beach 4-17 are banded and, as Beach Watch surveyors, we record the band colors on each bird. Re-sighting and reporting color-banded birds provides critical information on species survival and movement patterns and helps scientists learn how to better manage these threatened populations. Snowy Plovers are typically banded with two plastic color bands on each leg and we record the color combinations by leg.

I have thoroughly enjoyed conducting my first several Beach Watch surveys. Unfortunately, Beach Watch surveys were suspended mid-March with the Shelter-in-Place orders. Surveys began again in August (solo or same household teams only) but my team’s August survey date ended up being cancelled due to wildfire! I am crossing my fingers that our September survey of Beach 4-17

goes forward—I am missing getting to know my beach.

To learn more or sign up for future trainings, please see <https://beachwatch.farallones.org/>

Acknowledgments: Beach Watch Training Manual (NOAA/GFNMS/BeachWatch) ♦



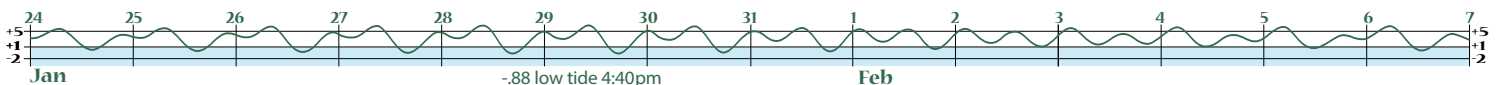
Credit: NOAA/GFNMS/BeachWatch



Credit: NOAA/GFNMS/BeachWatch



Credit: Mike Baird





# 2020 Student Scholarships

Each year Friends of Fitzgerald Marine Reserve awards \$5000 Bob Breen Scholarships to three Half Moon Bay High School students who plan to pursue studies in science. The 2020 scholarship recipients are:

- Audrey Booher. Audrey will be attending UC Berkeley in their natural resources program this Fall.
- Julia Race. Julia will be attending community college this year and transferring to the University of Colorado, Boulder in 2021.
- Roman Rodriguez. Roman will be attending the College of San Mateo next year and then plans to transfer to UC Berkeley.

Here are two students' responses.

Kelly Mubar,

I am so incredibly thankful for this generous scholarship. Fitzgerald Marine Reserve holds a very special place in my heart. Since I was a little girl, I remember visiting the tide pools with my family and listening to the seals in the distance. For my AP Biology project this year, I went out to the tide pools in search of cnidaria and echinoderms to photograph. I love talking with the park rangers, whom are always so interesting and passionate about what they do! My family is friends with Rob Calar; we had met him years ago while visiting Fitzgerald.

Fitzgerald Marine Reserve has already gifted me so much, and to receive a scholarship means the world. It warms my heart how much Bob Breen cared about our community and Half Moon Bay High School students. This scholarship, that continues to honor Bob Breen, is a wonderful and deeply appreciated gift.

I will be using this scholarship next year when I attend UC Berkeley's Rausser College of Natural Resources, majoring in environmental economics and policy. I hope to give back to our community and our environment. Thank you again for your incredible generosity and the investment in our community's future, both through our highschool graduates and all you do at Fitzgerald Marine Reserve.

Sincerely,  
Audrey Booher

Hello, my name is Roman Rodriguez. I received the Bob Breen Memorial Scholarship and I would like to thank you from the bottom of my heart for this very generous scholarship. I promise that it will not go to waste. I will be attending the College of San Mateo this upcoming Fall with intentions to transfer after two years to UC Berkeley.



*Fifth grade me with the carapaces of dead Dungeness crabs.*

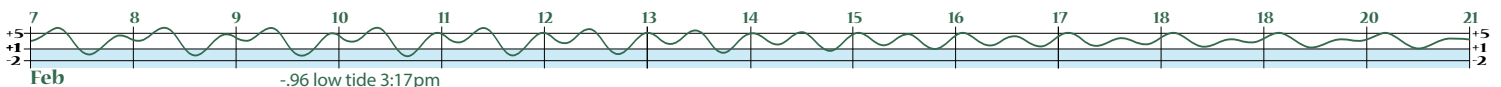
Ever since I moved to Miramar from Palm Springs, the ocean has caught my attention. As a little kid, I was always watching ocean documentaries and wanted to learn all about it. As a fifth grader from the Desert, it was a whole new world to me. Something that I had really only seen in movies was now in my backyard and mine to explore. My little brothers and I would find organisms that had washed up on the beach and I gave myself the job to find out exactly what these things were, from moon jellies and sand dollars to veleva veleva and sand worms. We called these experiences "Sea Life 101" because we would learn so much.

When we moved again, I was sad because we weren't as close to the beach, but little did I know that this was going to be even more of an adventure! Moss Beach had a hidden gem just off of the coast! The Fitzgerald Marine Reserve was straight out of a documentary with organisms like anemones, ochre stars, and nudibranchs.

As I became older, I was finally able to take the Marine Ecology class at the high school and explore the reserve more with guides and a goal of learning in mind. This is by far my favorite class ever as I got to learn even more about the ocean. I even got the opportunity to teach fifth graders about the ocean.

So for me, I think that this has all come full-circle. I was able to teach kids who were my age when I first found my interest in the ocean the things that I was wondering about at the time. I think that the ocean is the world's largest classroom and that we will never run out of things to find out. Thank you so much for helping me in my journey in an ever-so changing world. I will never forget what the Fitzgerald Marine Reserve has done for me and the experiences that I have had there. Once again, I am very grateful to be receiving this scholarship and to help remember the life of Mr. Breen.

Best,  
Joseph



# Abalone, The Remarkable History and Uncertain Future of California's Iconic Shellfish

by Ann Vileisis, reviewed by Julia Bott

When I first heard about the book *Abalone, The Remarkable History and Uncertain Future of California's Iconic Shellfish*, my mind went back to the many locally harvested feasts I had enjoyed while living on the Mendocino coast during the late 1970s and 1980s. After a few pages, I realized this book is a feast for the mind. At least once during every chapter I thought, "Friends of Fitzgerald docents would love this book." Though the first reference doesn't occur until halfway through the book, Fitzgerald Marine Reserve is mentioned three times.

Within the first month of moving to the southern Oregon coast, I attended a Kalmiopsis Audubon Society presentation on shorebirds. The presenter was Ann Vileisis, and she was articulate, caring, funny, genuine, and knowledgeable. So, I assumed *Abalone* would be well done, and it is. It is beautifully written and aesthetically pleasing. Vileisis is an evocative writer and her words stir emotion even when the subject is public meetings or research methods. She also includes the technical terms for many common words (handy for those of you who play Scrabble) and for a bonus, she offers the pronunciation, too. Her style leaves the reader with unanswered questions and a desire to read the next section or chapter. The general layout, the font, the illustrations, and the photos make it very easy on the eyes.

*Abalone* provides rich detail about the numerous species of *Haliotis*. Information includes their habitats, life cycles, and relationship with other marine species. She also describes threats to them and their recoveries (or not), and their importance to and use by humans. She ponders about the unknown effects of climate change on the giant slug's future.

By sharing engaging first-person stories and with her skilled interviews, Vileisis captures the intertwined life of humans and abalone over time. The book is professionally written and based on extensive research with 45 pages of acknowledgements, notes, and citations. She even includes a section describing how she found her sources. This, in itself, is a helpful guide on how to conduct research.

The book is divided into five parts. The first part, called "Before the Written Word," offers a look at the importance of the abalone's meat and shell in the lives of indigenous people. The presence of shells far from the coastal zone shows their importance in trade and commerce. The varied use of shells to adorn tools, structures, clothes, and people provides insight that different classes have existed in civilizations for a long time.

She spends the next two chapters on the thing that most people think about when they think of abalone—the iconic shell. In "The Anatomy of Iridescence," she goes into detail about how the shell's form and microstructure influ-

ence what we, and marine predators, see. Here, she took what could have been dry and difficult material and made it engaging and understandable. Her skill in doing that is in part due to her ability to distill and present information and in part from her commitment to learn thoroughly from knowledgeable people. In this case, she notes in the acknowledgements, "...Byran Grummon helped me understand the optics of abalone iridescence."

Part Two, "The Abalone Century" is chapters four to six and brings the reader back to the lives of the many who harvested, processed, sold, and ate abalone. The mollusks were generally bountiful, though not always at the same place. The many stories she uses to cover the period from 1850 to 1962 offer a wide and interesting variety of human relationships with abalone. But the decline of the abalone becomes more obvious as the chapters progress. She hones in on this in Part 3, "The Decline," which covers 1939 to 1985, overlapping some of the previous part's time period, highlighting how potential problems are easily ignored.

Parts Four and Five of the book, "Crisis" and "Imperiled," cover the years of 1980 to 2019. These chapters include interesting information from scientific studies, and also the many times science-based recommendations were ignored. The politics and the efforts of many, on all sides, to save something they hold dear are both maddening and inspiring.

Very near the end of the book the author describes a feast in the redwoods with friends who had harvested abalone earlier in the day. This personal memory was what first interested me in this book. While I learned so much from *Abalone*, her experience brought back the feelings of those moments. While the dinners were delicious, it was the connection with the ocean and gratitude for being able to enjoy its bounty that I really remember. This was pivotal in moving me to become a conservationist. I know I've experienced something special and for that I'm grateful.

In the book's concluding chapter, "Poised at the Brink," Vileisis thinks about the abalone's future and the role we play in it. Spoiler alert, especially with the unknown threat of climate change, prospects aren't great for the giant but beautiful slug. However, the author ends with an optimistic possibility that depends on a challenge: "Now these modest animals need for us to give something back. No matter what has come before, the future of abalone depends on our adopting a conservation ethic that emphasizes not what we can get from these animals, but rather, what they need from us to thrive."

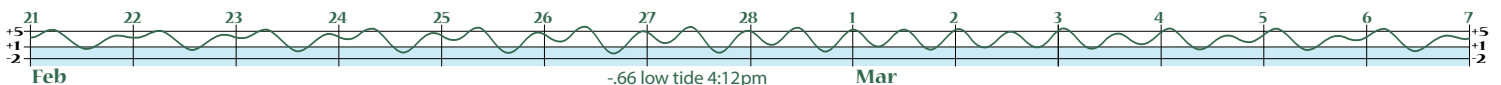
I think Ann Vileisis would take solace and be inspired by FFMR docents. ♦



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*While the dinners were delicious, it was the connection with the ocean and gratitude for being able to enjoy its bounty that I really remember. This was pivotal in moving me to become a conservationist.*

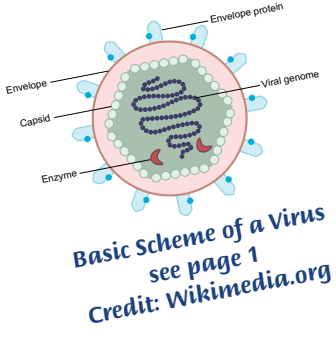
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## Teacher Survey

In light of the closure of the reserve and the suspension of school tours for an unknown period of time, FFMR Board members Jeanette Hyer (chair), Elaine Reade, Joseph Centoni and Roger Hoppes are surveying teachers who had planned to come to the reserve or had visited in recent years to assess their interest in virtual tours of FMR and online resources related to tide pools. The hope is to find ways to bridge the gap until visits to the reserve resume. Partnerships with San Mateo County Parks Department and local organizations doing similar outreach to local schools are being explored. Roger Hoppes is updating and enhancing FFMR's listing of online resources for teachers and others. The updated version will be available on the website soon. ◆

*Students tidepooling 2017*



## Friends of Fitzgerald Marine Reserve

Donation Chair, P.O. Box 669, Moss Beach, CA 94038, or through our website: [www.fitzgeraldreserve.org](http://www.fitzgeraldreserve.org)

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