OceanBights

The Magazine of the Catalina Marine Society

Summer 2015

Volume 6, Number 1

Contents

Catalina Marine Society
15954 Leadwell St
Van Nuys, CA 91406
www.catalinamarinesociety.org

Publication Committee
Michael Doran
Karen Norris
Craig Gelpi

Interim Editor
Craig Gelpi

OceanBights is published by the Catalina Marine Society. It is distributed free of charge to those interested in the Society's activities. The Society holds copyright to all articles within and they cannot be reproduced without the written permission of the Society.

The Catalina Marine Society is a nonprofit membership corporation founded in 2009 in Los Angeles to marshal volunteer resources to study the marine environment of Santa Catalina Island and the Southern California Bight.

Submissions. The magazine may publish submitted articles that pertain to our mission statement. Contact the e-mail address below for more information.

Letters to the editor should be sent via e-mail to the address below.
information@catalinamarinesociety.org

Ecological Disruption

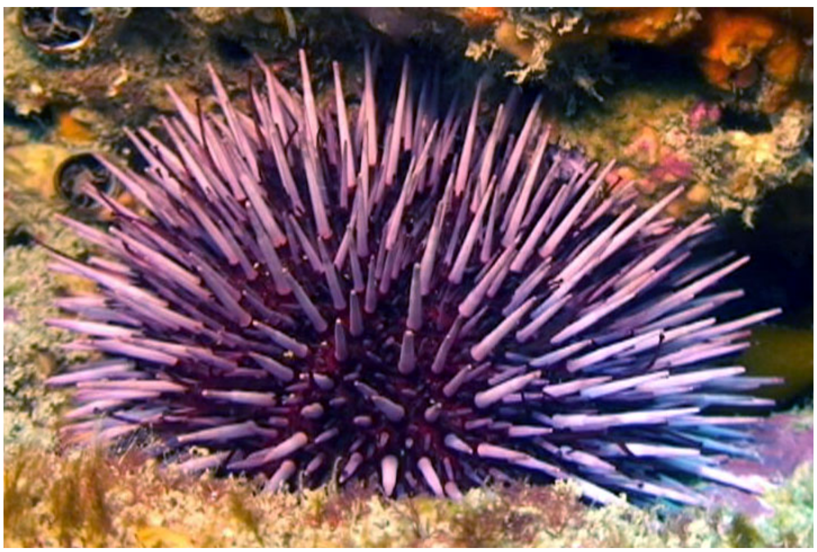
After we read the collected articles for an *OceanBights'* issue, we begin to see unplanned themes develop. Two themes occur here. First, is the importance of the purple urchin *Strongylocentrotus purpuratus*; and, second is the phenomenon of ecological disruption. The urchin finds itself: the object of intense study for its genome; a guinea pig for desalination brine-disposal studies; and starving for lack of kelp at Santa Catalina. These issues appear in the series of articles below.

Although not emphasized, the current drought is producing terrestrial ecological disruption as natural lakes dry up, dispersing the endemic inhabitants. This is occurring simultaneously with a local marine ecological disruption signified by the loss of kelp and the spread of sargassum. Perhaps both the terrestrial and marine phenomena are abetted by climate change. If so, then the speed of the effects is frightening, occurring over just a few years. Entertain yourself with the thoughts and I hope you read the entire issue.■

Consider the Urchins

Consider the humble sea urchin. Porcupine-like with spines and sea-star-like with tube feet, our attention was directed toward the urchin when an analysis was made of the 22-year time series of urchin counts collected by the Catalina Conservancy Divers (see the previous issue of *OceanBights* and the poster presentation made at the Southern California Academy of Sciences meeting). There was a cursory indication that crown urchins responded to the 1997-98 El Nino with larger numbers. What could be the mechanism? Does the warm water induce additional spawning in the crown; do higher temperatures reduce crown predation, or lessen competition for food? Good science requires that the literature be understood so it was searched. Although the initial observation may have been spurious, we learned that the relation between urchin and temperature is not clear cut and, indeed, the literature is often contradictory on this subject. We will not add to the cacophony here but rather will discuss how interesting we found the urchins to be after we studied some of what is known of them. Specifically, we are concentrating on the purple urchin, *Strongylocentrotus purpuratus*, and we relate a little on the animal's form and their natural history before getting to the really good stuff.

The urchin is an invertebrate consisting of an exoskeleton called a test from which emanates many sharp spines interspersed with fewer tube feet. The name urchin refers to the hedgehog, a spiny mammal. Urchins exhibit 5-fold symmetry, which is a common trait of echinoderms but is a completely different body plan than what terrestrial animals have (and therefore echinoderms are put into a separate phylum). Indeed, there are no examples of terrestrial or fresh water echinoderms. An urchin's mouth is on the bottom side and the anus on top, so they can mow algae down as they move, expelling waste as a locomotive expels smoke. At the mouth they have five teeth, reflecting the 5-fold symmetry, and an eating apparatus named Aristotle's lantern, as Aristotle described the creature as looking like a lantern. The purple urchin has relatively short spines, which enables it to get closer to the surf zone than crown urchins, whose longer spines would not do well in turbulent water. They primarily eat algae, but can be carnivorous if necessary. They move about to forage but usually not very far (meters?). And, they can go into a starvation mode, eating very little or nothing for long periods of time (years) if food is not available. They are long-lived, perhaps reaching 100 years of age, as determined from chemical analysis of their tests. The tests are made of calcium carbonate and so are expected to be susceptible to ocean acidification as described in a previous *OceanBights'* article. Sea urchins calcium carbonate test fossilize well, providing an evolutionary history that supplements and complements other studies of the urchin.



A stunning *Strongylocentrotus purpuratus*
by permission of Dr. Bill Bushing
©Star Thrower Educational Multimedia

The animals exhibit separate sexes, and release eggs and sperm through opening surrounding the anus. These fertilized eggs develop bilateral symmetry and have other similarities to vertebrates like us before they form mobile larvae that then bifurcate (quintfurcate?) into the famous 5-fold pattern, unlike us.

But what really is interesting about the purple urchins is that genetically, they are very complex critters. So interesting are the urchin's genetics, in fact, that their genome has been sequenced. That's a lot of work. Perhaps you remember the human genome sequencing effort and the dual government and private efforts to produce the first blueprint for mankind. Well, there has been an equivalent Sea Urchin Genome Project (SUGP). Why sequence the urchin?

Although, the animals appear to be simply constructed, genetically they are amazing. They have about 23,000 genes (humans have about 30,000), and exhibit surprising genetic diversity. One would expect that over the large geographic range of urchins, from Baja to British Columbia, there would be geographic pockets of genetic homogeneity that distinguishes the local population. However, the genetic diversity of urchins at a specific location matches that found across the entire range of habitation, implying there is considerable gene flow amongst the regions.

The 23,000 genes are quite a lot for such a simple animal. And the genes are surprisingly arrayed. Apparently there are many genes related to sensory properties, including vision, even though the animal has neither head nor eyes. Its genes code for opsin, a photorecepting protein that is the foundation of imaging eyes for animals. Also, there are many genes related to an immune system. The long-lived sea urchin exhibits an unprecedented complexity in the numbers and types of genes associated with immunity in vertebrates. For many gene families it has ten times the number of immunity-related genes when compared to vertebrates (is that why it lives so long?).

The urchin is a model system for studying intercellular recognition mediated by cell surface macromolecules. Or, to write plainly, the broadcasting sexual habits of urchins present many opportunities for the sperm of one species to meet with the eggs of another (ban the thought, purples and reds hybridizing?) Our purple urchin sperm must spurn the red's eggs (and everything else in the ocean) and seek its own species, mechanically modify itself to attach to the egg and complete fertilization. Much of this process is, surprisingly, the same in mammals, and by studying the urchin's process, we can learn more about our own development. What makes the urchin useful in this regard is that it has a large wild population, is easy to catch, spawning is easily induced and abundant (a female can release over 1 million eggs), gametes and larvae are plentiful and easily cared for. And its initial development mimics those of vertebrates. They are distantly, but importantly related to vertebrates and hence studies on urchins can yield results pertinent to ourselves. And, it has been sequenced, allowing gene expression to be studied well.

By the way, much of the research on purple urchins is done on Newport Bay at the California Institute of Technology Kerckhoff Marine Lab in Corona del Mar.

How has this genetic diversity benefitted the urchin? Well, they appear to be able to handle anticipated ocean acidification. For those urchins living along the Northern California Coast, upwelling is common and results in water with higher acidity than normal. Being exposed to higher acidity may have prepared the urchin genetically to handle it. They may be able to regulate their internal pH to counter the ambient pH, by expressing particular genes. The commonality of the genome suggests that all *S. purpuratus* may live well in more acidic seas. They can also handle temperature variation well.

However, the species survivability provided by their genetic diversity may be severely tested. As reported in the last issue of *OceanBights*, sea stars are being decimated by densovirus. Sea stars are a major predator of urchins, and with the stars laid low, the urchins are said to be

Adopt-A-Thermograph Program

The CMS is seeking donors and site managers for its Adopt-A-Thermograph program. These sponsors will extend and complete the Continental Thermograph Array that is currently under development. Adopt-A-Thermograph is directed by David Tsao. For more details, contact David at david@catalinamarinesociety.org or Craig at craig@catalinamarinesociety.org.

massing in Northern California. But in Southern California, the word is that urchins are disappearing, perhaps due to the same wasting disease that is attacking the stars. More food for thought.

So the next time you place your gloved hand on an urchin and its spines prick your finger, and the resulting wound takes longer than a year to heal and you just want to smash them and eat their gonads (I'm not too bitter), calm yourself by thinking about the amazing life form that this ugly animal represents.■

Future of our Giant Kelp

Our winter diving in the Avalon Dive park has been less than satisfactory for the last few years. Indeed, on two occasions, I have limited my dives to 1 per day. The reason is *Sargassum horneri*, or the Devil Weed. This brown algae starts growing during the fall (the specimen shown on page 6 was gathered in late September) and dies away late in the spring. It forms dense pygmy forests on the shallow seabed, often blocking view of the substrate where many of the interesting marine creatures live. Sargassum-saturated areas can be difficult to dive. Whereas a diver can usually swim through stands of kelp, weaving one's way through the sargassum is nearly impossible. It also doesn't feel good against one's wet suit and, unlike our giant kelp *Macrocystis pyrifera*, it can be hard to pull out or break apart.

Sargassum horneri is an alga native to Japan but invasive to the California Coast. It was first noted in Long Beach Harbor in 2003 during a biological survey. Three years later, it was spotted near the USC marine lab's seawater intake pipes near Two Harbors, a cherished landmark to scientific researchers. Then, within 3 weeks, it was noted at nearby Cherry Cove and Emerald Bay. Now it has been seen off the mainland, including Shaw's Cove. On a recent walk along the beach at Balboa Peninsula, I saw some washed up sargassum that may have been *horneri*.

Off Japan, the sargassum fills the ecological role of our giant kelp. However, its life history is significantly different. As mentioned above, Devil Weed is an annual, recruiting in the fall, maturing and dying in the spring. This cycle is in contrast to that of our giant kelp, which can live several years. During its short cycle, the Japanese invasive reaches 2 meters in height and is held aloft by small air-filled bladders called vesicles. In contrast, our kelp can reach 30 m in length and is buoyed by larger air bladders. *S. horneri*, like our kelp, can self-fertilize.

This has been a particularly bad year for our giant kelp.

Sargassum horneri
Images from Dr. Bill Bushing
©Star Thrower Educational Multimedia

Ocean temperatures have been unseasonably high everywhere, including Santa Catalina. We have seen many divers in the park without hoods, and thinner than normal 3-mil wetsuits were acceptable and even desirable. Additionally, there has been unusual and forceful storm activity. Storms have attacked Santa Catalina, resulting in two deaths in Avalon Harbor and severe damage to many boats that lost their moorings. Both of these phenomena are harmful to our kelp.

High temperature near the surface produce a stable "cap" in that the stratified upper layers inhibit nutrient diffusion from the depths to the surface photic zone, where they are required for photosynthetic growth. With fewer nutrients, kelp growth is reduced or stifled. Storms up-holdfast kelp, ripping it from the seabed. Although the un-anchored kelp may not be dead, it cannot contribute to the nearshore ecology. The lessened nutrients and growth reduce the capability for the kelp beds to repair damage they sustained during the storms, resulting in much less kelp. Storms and warm water are a "one-two punch", knocking our kelp forest down. Indeed the dive park has been almost completely devoid of kelp this winter. This ecological disruption may encourage or enable the Japanese sargassum to succeed in the spaces that were formerly occupied by our giant kelp. When the kelp is absent, there is less competition for space and light, permitting the sargassum, to get a hold(fast).

In a strange twist, *S. horneri* is vanishing from its Japanese home waters and warming ocean temperatures have been suggested as the cause. Interestingly, subtropical sargassum species are replacing temperate sargassum species, such as *S. horneri*, off Japan.

Close up of portion of a young *S. horneri*

Scientists have noted the phenomena that when warm kuroshiro-current (the Asian equivalent of our Gulf Stream) waters invade temperate regions of sargassum habitat, the sargassum dies, inducing another ecological disruption on the other side of the Pacific Ocean. This is consistent with our observations on Catalina in that the Devil Weed succumbs as the temperature increases. With rising ocean temperatures *S. horneri* can be expected to diminish in its native habitat. This is of particular concern to the Japanese, as *S. horneri* is a mariculture crop used for food. Also, *S. horneri* is thought to have medical applications by some researchers, providing another reason to grow it.

Besides being used in mariculture, we should note that **a vibrant ecology is based on *S. horneri* off Japan**. This sargassum provides spawning beds for fish, nurseries for juveniles and food for abalone. This ecology appears to be very similar to the one supported off California by *M. pyrifera*. However, our local ecology has not adapted to the Devil Weed, so we should not expect to receive any of the ecological benefits that *S. horneri* provides in Asia.

Is *S. horneri* likely to last? Will we get our magnificent kelp forest back? There is much to understand before a credible prediction can be made. However, we can report on the fate of other algal invasives. Stated simply, we have seen other invasives come, and we have seen them go.

Invasive seaweeds have been reported with increasing frequency in California, both Alta and Baja, and as of 2011, a total of 29 species have been tabulated. Some of the species have been ephemeral, providing just one specimen that enabled verification that, indeed, it was an invasive. Some of the non-natives have settled into the local ecology and are now a familiar scene in the landscape, and some are so small that they are hardly noticed, while others have disappeared. Only one, *Caulerpa Taxafolio*, has been intentionally eradicated. Hence, from our modern perspective, the invasives have not been an ecological catastrophe.

But there are concerns that changing environmental conditions may enhance the ability of invasives to colonize our shores, and hence future invasives may fare differently than past invaders. Climate change realizations, such as ocean acidification, temperature increases, and additional storm activity can be expected to disrupt the local ecology routinely and perhaps permanently. Indeed, the conditions that we have observed over the last year and noted as unusual may become typical.

Perhaps this is the reason invasives have been reported with increasing frequency over the last 30 years. But there are other reasons. There could be more possibilities for transporting them to our shores, as shipping traffic has definitely increased, or our colleges and universities produce more knowledgeable observers that are out and about providing more opportunities to recognize unusual flora. Or, **conditions may be becoming more appropriate for some invasives to propagate to the extent that they are more easily observed**.

Whatever the reason, the outbreak of *S. horneri* off Santa Catalina may turn out to be really serious business. The Dive Park is famous because of its environment, particularly its kelp forest. The economy of Avalon is certainly enhanced by the number of divers who buy ferry tickets, fill tanks, rent gear, eat and entertain themselves after diving. Without the forest, it will be less attractive as a dive site. Perhaps tellingly, kayaking outside the park recently I noted the surrounding area of the steps divers use to enter the park, and on a Saturday morning, there were no divers to be seen.

Perhaps *S. horneri* can be removed or isolated. Unfortunately, it is fairly widespread now. I understand much money was spent to eradicate *C. Taxafolia*, which was reasonably contained in a few local harbors that could be worked, but the effort to reduce the Devil Weed may have to be significantly larger if it is to succeed.

I hope I do not become one of those old salts that remember the good ole days when Casino Point had kelp. That would be really, really sad.■

Water, Water Everywhere

We are going through our fourth year of drought, so we decided to look at the numbers as they pertain to water usage and the amount of water we bring to California, and how that may affect our local ocean.

First, how much water do we use? Although usage varies tremendously throughout the state, the per capita amount of water we use per day for municipal and industrial purposes is 180 gallons or 0.68 cubic meters. Municipal and industrial uses include all household water, landscaping, firefighting, and of course, water used for manufacturing. A cubic meter (m^3) is a magic number in oceanography, and it weighs 1 ton. (Image a cube 3 ft by 3 ft by 3 ft and you have a good idea of a cubic meter).

Hence, in one year our state uses 10 cubic kilometers or, for a visual, the area of California flooded to 1 foot. Another visualization of 10 cubic kilometers, imagine Santa Catalina Island as a vessel that can hold water up to its highest point, Mt. Orizaba (2100 ft), easily seen from the mainland on a clear day. The volume represented by the footprint of Catalina to the top of Mt Orizaba is 124 cubic kilometers. Ten cubic kilometers is roughly that part of the imaginary vessel that would be northwest of Two Harbors. That doesn't seem like that much water. Let's calculate how we can get it.

The Los Angeles Aqueduct can carry almost 12 m^3 of water per second. Hence, in one year it could transport, assuming it operated continuously, a measly 0.38 km^3. Or, if we could find the source in the Sierra, 26 LA aqueducts would be needed to supply the 10 km^3 of water. That is a lot of aqueducts which makes it seem like a lot of water. But there is no water in the Sierra and the wet Northwest is not so wet this year, so aqueducts to the nearest watering-hole would be much longer than the 450-mile LA aqueduct. Of course, if we found a suitable hole there are many other details, such as how is the water distributed around the state, etc. And, I will not touch the legal issues with a 3.048-m pole.

Desal plant in Carlsbad under construction. Note the landmark stack of the power plant and the beautiful ocean swell.

Now compare the volume (northwest of Two Harbors to the height of Mt Orizaba, to the volume in the ocean. The deepest depth of the ocean between the mainland and Catalina is about 3,000 ft (deep as the island is tall) and the island is 40 km away and roughly 40 km long. Clearly there is vastly more water between the mainland and Catalina than what the entire state uses in a year. Let's say it is 1000 km^3.

Our drought situation would significantly improve if we could increase the water supply by a paltry 10% or 1 km^3, or 0.1% of the water between Palos Verdes and Santa Catalina. The cost of tier 1 water in LA (the cheapest water) is \$1.70/m^3, i.e., \$0.0068/gallon, yes, that is less than 1 penny per gallon. Compare that to the cost of bottled water or a gallon of gasoline! If we need a billion m^3 (i.e., 1 km^3), then it is worth about 1.7 billion dollars at LA rates. That doesn't appear to be much money in the scheme of things.

There are other options for obtaining water. Water can be desalinated and desalination may be in our future. We recently took a dive trip on a live-aboard where fresh water was made onboard, so, in effect, there was infinite water for showering after diving. Making fresh water from the ocean is possible. In some locations, desalination provides a significant amount of drinking water, about 40% in Israel, and also on Santa Catalina Island, where it satisfies about 80% of the needs of the permanent residents. So, desalination is practical under some circumstances.

The current technology for desalination is reverse osmosis. Osmosis works with a semi-permeable membrane which lets water flow through it but does not let salt pass. If the membrane separates containers of fresh and salt water, molecules of fresh water will pass through the membrane to dilute the saltwater. This will increase the pressure on the saltwater side of the membrane, until the higher pressure prevents additional water dilution. If we mechanically increase the saltwater side's pressure beyond the osmotic pressure, water will flow from the saltwater side to the freshwater side, increasing the amount of freshwater and leaving concentrated brine on the saltwater side.

Desal plant near Avalon
Stolen from internet.

One m^3 of seawater contains 1,000 kg of fresh water and 35 kg (70 lbs) of salt (doesn't that seen like a lot? This is often measured as 35 parts per thousand, or ppt. For comparison 1 m^3 of Mono Lake water, which does not support fish life, contains about 180 lbs of salt). So 1 km^3 of ocean water contains 35 billion kg of salt. See how numbers increase rapidly when cubed? One good thing about being a scientist is that you are unfazed by fantastically large numbers that have no intuitive meaning to you, and you can just mechanically do the math.

So, there are some difficulties with desalinated water. First, it produces much salt; second, it is expensive. Using our example, desalination for California means removing **35 billion kg of salt**, which has to be put somewhere, every year. The salt must be disposed of, back into the ocean, of course, as it would be much too much to use for seasoning. If this concentrated brine were simply dumped into the ocean it would likely kill marine fauna that could not tolerate the high salinity levels. Hence it would have to be diffused into the deep ocean to limit pools of concentration so marine life could survive, or discharged where there is sufficient natural mixing to quickly reduce the salt concentration. The plant near Avalon does not release very much concentrated brine, only water with a salinity 44 ppt or so. The relatively small amount is mixed into the ocean by tidal and surf action. This discharge was determined to have no effect on the only species studied, *S. purpuratus*, the subject of another article in this issue.

The second difficulty is the added cost of producing desalinated water. We are a civilization built upon cheap oil and cheap water. We use vast quantities of both to build stuff, transport our necessities and transport our waste.
The 50-million-gallon-per-day desalination plant being built in Carlsbad will only supply 6% of the perturbation we are talking about. The claim is that the cost will be about $2,000 per acre ft or about $1.62/cubic meter, comparable to the DWP numbers. In addition to the marginal cost, the investment has to be capitalized. Unfortunately, I cannot report on a cost of desalinated water that I believe in as I could not find a consistent set of numbers. Many reports indicate that the water is obtained for a cheaper price than what the LA DWP reports on their website (and quoted above). The major component of the cost to produce fresh water is

Northrop Grumman supports CMS with Community Service Grant.

energy, and the local cost of energy varies significantly.

Another difficulty is that during years of plentiful rain and snowfall, desalination is not needed. So the capital investment in a desalination plant does not provide a return on investment during these times. And, when drought returns, there is a call for upgrading to new technology developed during the years of plenty with an additional capitalization cost. A fourth issue has been raised, that of marine life (especially phytoplankton) being sucked into a desalination plant. As phytoplankton inhabits the surface zone, a deep intake may limit loss of plankton, but at any rate, it doesn't seem to be a significant amount.

There are other ways to increase our water supply and, of course, there is increased conservation of the water we use. Increasing the water supply could be accomplished by recycling the water we use, diverting it from agricultural to municipal and industrial use, or taking more from the environment. Of all the water in California, 50% is for the environment, 40% is for agriculture and 10% is for municipalities and industry. We could conserve water by designing manufacturing processes to use less, fighting fires with chemicals, and of course, landscaping with water-stingy plants.

But now, we need the water. The problems we are grappling with during this drought are appearing elsewhere and will increasingly confront areas covering the planet. But because California is rich in brains and money, I suspect we may lead the path to stable and sustainable water for the globe.■

Marine Fauna Identification classes

Mike Doran

Fish, invertebrate and algae identification classes, sponsored by Catalina Marine Society and presented by REEF.ORG at the Long Beach Aquarium of the Pacific, took place in June and July, 2015. The ID programs, which were conducted by REEF volunteer Gerald Winkel, prepare volunteer divers to take part in underwater survey and data collection programs.

REEF has survey programs that are ongoing around the world, but the ID programs sponsored by CMS were specifically tailored to species likely to be seen in Southern California waters. For more information about the survey programs, visit www.reef.org.

The June program focused on identification of fish species, with the follow up program in July related to invertebrate and algae species. The Long Beach Aquarium of the Pacific, without whose generous support the classes would not have been possible, made class room facilities available for the programs. 20 attendees were able to partic-

Students eager for fish ID from Gerald. Photo by M. Doran ipate in the fish ID class, and 12 attended the invertebrate ID class.

Catalina Marine Society supports volunteer programs related to ocean science, such as the REEF survey, but also is generally supportive of programs that educate divers and the public alike regarding the marine life that is characteristic of the Southern California environment. CMS expects to sponsor additional REEF fish and invertebrate/algae ID classes in 2016.

If you are interested in these ID classes or have an idea for another class, please let us know.■

Budget Exercise Revealing

The first detailed in-kind budget analysis of CMS activities indicates we are on track to receive $45,000 in diving, boating, writing and professional services for 2015. Wow. **All that and a good time, too.**

This giving in-kind is one of the reasons we founded the Society. We realized that the professional services that could be rendered by volunteers are of tremendous value. We just needed an institutional mechanism to organize, focus and capture this bounty.

Please contact us to find out more about our activities and how you may contribute and get into the fun(d).■

Society News

The Society held its annual meeting at the Aquarium of the Pacific in May. The Board of Directors were presented with the state of the Society, both financial and otherwise and the various projects were elaborated on.

Organizationally, the structure and people remain the same as last year, with Jim Updike being the president, Karen Norris the secretary and Craig Gelpi the CFO. All nine board members were re-elected.

Awards were presented to **Jon Davies and Shawn Broes for their outstanding work producing the YouTube video describing work on the Continental Thermograph Array. It can be found at** http://youtu.be/0XWThEaDL90 or from a link on the CMS web site. **Ted Sharshan received an award for outstanding field work**. Ted maintains a CTA site and also organizes boat trips to Santa Catalina for our depth-profiling program. Ted is our Go-To guy!

Other happenings are that the urchin study described in the previous issue of *OceanBights* was presented in poster form at the Southern California Academy of Sciences Annual Meeting in May by Mike Doran. A paper presented at the 8th California Islands Symposium describing the physical forcing of internal waves observed near Two Harbors was published as part of the monograph of the Symposium Proceedings by the Western North American Naturalist.

Of course, the end of the meeting provided an opportunity to have wine and get together with old and new friends.■

Island Chlorophyll Study Continued

One of our "on the patio" projects is to understand primary production in the ocean surrounding Santa Catalina Island. Primary production is the uptake of carbon from the atmosphere or ocean and its incorporation into new life, usually in the form of phytoplankton, which is colored green by chlorophyll. Our main datasets will consist of satellite observations of essentially the color of the ocean and how it changes with the seasons. Using empirical relations of ocean color and chlorophyll content, we also hope to compare satellite results to our own island chlorophyll measurements.■

Upcoming Meetings

CalCOFI Monterey Bay Aquarium Research Institute (MBARI) Moss Landing, CA 14-16 December, 2015

Ocean Sciences meeting 2016: 21-26 February 2016 New Orleans. *Faire le bon temp roulez.*

Catalina Marine Society Membership

Catalina Marine Society Members support the goals of the Society through their dues and also elect the Society's directors. Membership is described in the bylaws and is granted to those who: 1) agree with the mission statement; 2) pay the annual dues (currently $20); and, 3) submit an application that is approved by the board. An e-application is available on

http://www.catalinamarinesociety.org/CMSMembership.html

Manual Membership Application

Please send the following required information to the Catalina Marine Society via e-mail or post to the address below.

Name, e-mail address, postal address, reason you wish to join the Society, and that you agree with our mission statement.

Dues can be paid through the "Donate" link or checks made payable to the "Catalina Marine Society" sent to the following address:

Catalina Marine Society
15954 Leadwell Street
Lake Balboa, CA 91406

If you are interested in contributing to the work of the Society in other ways, please let us know. Categories and examples of needed volunteer work are listed below.

Lab

Data analysis
GIS
Programming

Field

Boating
Diving
Instrument calibration
Hardware/Equipment fabrication and mounting

Office

Web design/programming
Graphics
Photography/Videography

Magazine/newsletter

Reporting
Publishing
Editing
Departments

Fund raising

Event planning
Event volunteer
Grant writing

Press/publicity

Public speaking
Newspaper articles