OceanBights

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Contents

Catalina Marine Society
15954 Leadwell St
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www.catalinamarinesociety.org

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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

Editorial: Dumbing Down the Earth

After attending a few conferences and reading a few books, I was sufficiently exposed to new ideas that I was emboldened to hazard thinking on my own. My concern du jour is the dumbing down of our earth. I am not referring to the educational and intelligence quota of the human population declining, though on a per capita basis that could be scary. I am referring to the ability of life on earth to solve problems. Life has continually solved problems since its inception; the problems of living in a hard world. Its solutions have included developing sophistications, complications and combinations needed to deal with exploiting niches on a brutal physical planet. Life has done this by developing and using a large and diversified gene pool that can respond to harsh environments of pressure, temperature, chemistry, competition and predation.

The bioplanet's intelligence is its genetic diversity. It combines its genes through sex or mutations to extend its vitality to new environments be they spatially removed or simply dynamic. The result has been the colonizing of the air, deep earth, thermal pools and wildlife adapting to urban environments. We have imperfectly recognized this intelligence and have tried to incorporate it into some of our decision-making algorithms, such as neural networks and genetic programming. And, we have formalized its study through the field of metagenomics, the study of the gene pool of the environment without the intermediaries of the organisms.

Continued on page 5➔

Oceanography at JPL

La Canada-Flintridge is home to one of the most unique oceanographic organizations on the planet, the Jet Propulsion Laboratory. Hmm, oceanography and JPL? There are many questions that come instantly to mind, as there is nothing in JPL's name which relates it to oceanography. Do they even own a boat?

There are approximately 200 people involved in oceanography at JPL, making it one of the largest oceanographic institutions in Southern California. How did an organization noted for intra-planetary robotic exploration come to be an oceanography powerhouse? I posed this question to JPL and was directed to Eric Conway, a historian, who has researched this connection and provided his material.

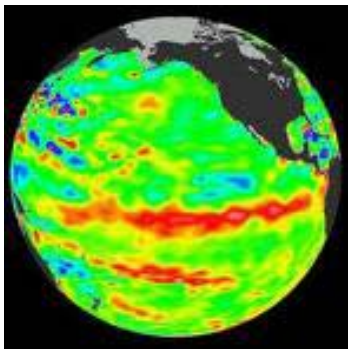
During the early days of the space program, astronauts saw oceanographic and atmospheric features from space that indicated the large-scale motions of geophysical phenomena. Yes, not too long

ago there were no global images of the planet. The astronauts also saw that the oceanic motions were clearly related to the atmospheric ones. This set in motion programs for oceanography-dedicated satellites that could measure these phenomena. And JPL, being a premier space-vehicle organization, won the contract for Seasat-A, the first oceanography-dedicated satellite. Seasat-A hosted an ocean altimeter, synthetic aperture radar, microwave scatterometer, microwave radiometer, and an optical/near infrared radiometer to measure sea surface temperature and clouds. We'll discuss these more later.

Seasat-A, the first oceanographic satellite.

Seasat-A was launched and collected data for approximately 3 months before it failed. It died sooner than anticipated and left money originally allocated for satellite operations available for other activities. As anyone in an engineering organization knows there is usually lots of money to engineer new experiments but very little money to analyze the data they collect. As sensors and data collectors become more varied and efficient, the percentage of data that is seriously analyzed decreases. Fortunately, an enlightened recommendation was made that the money originally allocated for the operation of the now defunct satellite be switched to the analysis of the data it collected. Additionally, the data would be made available to the public, bucking the trend among scientists to hold onto their federally-funded data until they got a chance to publish. Needless to say, but we will, the CMS is a strong supporter of open access to government-collected data.

JPL has been involved in all NASA's oceanographic satellites since Seasat. To get some perspective on the technical history, we spoke with JPL oceanographer Dr. Bill Patzert, who has been at the institution for over 30 years. We asked Bill what was JPL's greatest success in oceanography and he said it was the development and operation of satellite ocean altimeters. We are sure, to the non-physical oceanographer, the concept of a satellite ocean altimeter is a bit puzzling. The altimeter measures the altitude of the sensor. For aircraft, it is used to avoid crashing. In the case of satellites, it is to determine where the surface is, as the position of the spacecraft is known very well. The ocean surface is dynamic and affected by many processes as well as the local gravity. Indeed, currents, in cooperation with the rotating earth, produce surface-height signatures, some as large as a meter (e.g., the Gulf Stream) but usually only a couple of tens of centimeters. Measuring the changes in signatures and inferring the corresponding current changes has given us a global view of the currents and processes that affect our world. The most



El Nino signatures.

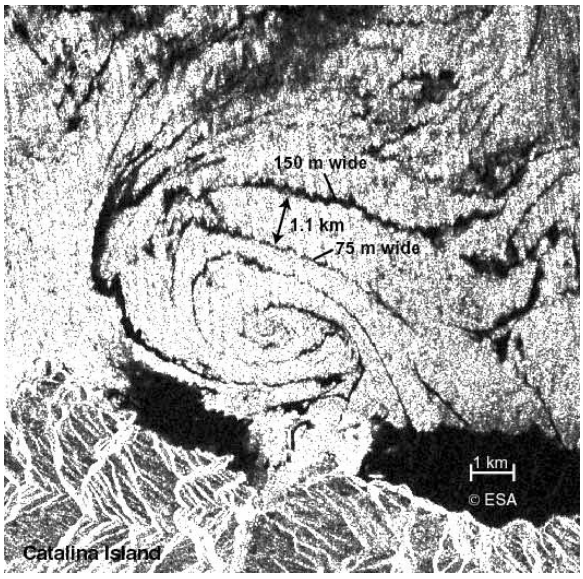
famous of these is the El Nino/La Nina signal found in the western Pacific Ocean.

Images of the ocean surface-height anomaly and the corresponding El Nino predictions have become part of the public's consciousness and are one of the greater success stories of satellite oceanography. Bill has heard that over 2 billion people have seen the classic El Nino sea height images produced by JPL. Before the height was measured directly via altimeter, it was inferred from ocean chemistry in a laborious procedure that involved collecting a depth profile of water properties, including salinity and temperature, determining the water's density as a function of depth and integrating the water's weight in the water column. This process is repeated for a series of locations. In this way, relative surface-height differences could be measured and large-scale, stable currents, that are way too small to measure directly, can be inferred. The satellite altimeter makes life much easier. It can be used globally and has done much to increase our understanding of the earth's processes.

An important component of interpreting the altimeter data is knowledge of where the surface would be if there were no currents, a position largely controlled by the local gravity. Altimetry is so important that it help begat the Gravity Recovery and Climate Experiment, managed by JPL. GRACE employs two satellites flying in formation to measure the fine structure of the earth's gravity field. These measurements are used to construct the geoid used by the satellite ocean altimeters to measure ocean sea level as discussed above. Because the gravity measurements are made repeatedly, temporal changes in the field, due to movements of mass, including changing currents, glaciers and aquifers can also be measured. The two spacecraft fly 220 km apart in a polar orbit 500 km high. The distance between the satellites is continuously measured. As the first satellite encounters gravity modulations, it moves farther or closer to the second one, which itself encounters the same modulations a half minute later. These changes in velocity between the two satellites can be used to compute the gravity anomaly. If the anomaly is static, its measurement leads to refinement of models for earth's gravity which, in turn, lead to more accurate altimetric measurements.

Other instruments associated with JPL include the radar scatterometer and passive radiometer. The scatterometer measures radar backscatter over a large range of angles and retrieves the surface wind velocity, while the radiometer measures the radiation emanating from the surface and derives the sea surface temperature, or SST. The CMS has employed all these products in its studies.

By its very nature, satellite oceanography provides data that addresses global issues and supports earth system science. However, JPL does work issues closer to home.



SAR image of spiral eddy next to Two Harbors, Catalina

Looking for local work, we talked to Dr. Ben Holt. We were familiar with Ben's work in the analysis of eddies in the Santa Monica Bay. Book a port window seat for your next flight from LAX and if the sea is calm, you may see eddies in the bay as spiral patterns of slicks. Dr. Holt used images made from synthetic aperture radar hosted on a satellite to study these signals. Radar is particularly sensitive to surface roughness and easily detects slicks, day or night. How these spirals form and dissipate can be important clues in how the ocean is mixing. By the way, **Santa Catalina Island appears to be a major player in the formation of these eddies**. Why this is so is not understood; however, the general flow of currents through the Bight is thought to interact with the island to generate vortices

Other local work has included support of the Orange County Sanitation District far-outfall closure. Outfalls are where sewers or drains discharge into the ocean. The District was closing a 5-mile outfall and diverting the drainage to one near-shore. JPL performed the satellite analysis of current flows using SST and chlorophyll measurements to determine the location of the drainage. SST was provided by the ASTER instrument with an amazing 15-m resolution. The use of the nearer outfall did not produce much of a noticeable signal, which in this case is good.

What we consider to be one of the greatest JPL contributions to oceanography is the availability of physical oceanographic data through the PO.DAAC. This is the Physical Oceanography Data Active Archive Center. (No, I don't know why they put a period after the O.) PO.DAAC's mission is to preserve NASA's ocean and climate data and make these universally accessible and meaningful. Since the launch of NASA's first ocean-observing satellite, Seasat, in 1978, PO.DAAC has become the premier data center for measurements focused on ocean surface topography (OST), sea surface temperature (SST), ocean winds, sea surface salinity (SSS, see a previous issue, Vol. 2, No. 2 of *OceanBights* for more information) gravity, ocean circulation and sea ice. It is the facility from which organizations, such as the CMS, can access data acquired from sophisticated instruments orbiting the earth.■

Editorial, cont.

➔ However, anthropogenic actions may be destroying the earth's collective intelligence. For example, eutrophication removes the problem of finding nutrients, and takes away the advantage of intelligence or genetic diversity, leaving simple life forms to dominate. Similarly, introduction of invasive plants and animals and monoculture farming reduces the diversity of species and genes. Population bottlenecks produced by expirations and reduced habitat lead to reduced gene pools and mitigated ability to respond to new external pressures, including global warming or an environment recently shaped significantly by man.

Advances in the field of bioinformatics suggest that the current, collected intelligence of the planet can be digitally stored, or even regenerated if lost. However, the engineering proof for this path has not been demonstrated and therefore there is a risk that it may not be possible. Besides conservation, I do not know the solution to the dumbing earth, but I do believe that intelligence is a terrible thing to waste. ■

Continental Thermograph Array nears fulfillment

The Continental Thermograph Array, supported by our Adopt-A-Thermograph program and several diving organizations, has reached our coverage goal with multiple sensors deployed off Laguna Beach, Crystal Cove, Palos Verdes and Malibu. Although the array has reached the planned size, there is plenty of room for additional volunteers and instruments to compensate for expected losses over time and achieve the redundancy

necessary to insure continuous data collection. Ted Sharshan and Dirk Burcham manage a Laguna Beach array and **Dive Tribe** both sponsors and manages the Crystal Cove site. Jon Davies (CMS board member) manages two site arrays off Palos Verdes. Staff divers of the **Aquarium of the Pacific** manage a site. The **Antelope Valley Desert Divers** both sponsors and manages a sensor off Deer Creek. In Malibu, Dave Bentley and David Tsao (the D&D array) sponsor and manage a site with two instruments.

If you are interested in participating in the CTA program, please contact us.■

Spotlight on: Hubbs SeaWorld

Perhaps on a visit to SeaWorld in San Diego you drove alongside Hubbs-SeaWorld Research Institute (HSWRI). I naturally thought the institute would have an emphasis on stuff pertaining directly to SeaWorld, such animal husbandry, veterinary care and animal training. However, the institute has a much wider purview and grander outlook.

HSWRI is a public, non-profit charity, similar to the CMS. Their scientists apply sophisticated technologies to seek solutions that protect and conserve marine animals while benefiting humans and our reliance on marine resources.

The institute, founded by the founders of SeaWorld, was renamed for the famous ichthyologist Carl Hubbs and his wife Laura. The institute embraces research, conservation and education through an eclectic mix of work in ecology, bioacoustics, physiology and aquaculture.

HSWRI's aquaculture program addresses issues in fishery resources regarding sustainably feeding a hungry planet while maintaining a healthy ocean. They wish to provide more fish in the wild as well as captive marketable fish. Some of HSWRI efforts, specifically their work with white seabass, aka WSB, (*Atractoscion nobilis*), may be known to our readers from KCET's Huell Howser's show on the hatchery that aired several years ago. The sea bass program involves many volunteers and touches many aspects of Southern California ocean activities so we will describe it in some detail. Because it is such a popular sport and eating fish, WSB were chosen for aquaculture to supplement the dwindling wild population.

Volunteer Rich Ford at the Redondo Beach facility. Courtesy of Jon Davies.

Potential broodstock is captured with hook and line, particularly at Catalina Island. They are held in netpens at Cat harbor until they can be transported to the HSWRI facility in Carlsbad by volunteer boaters. There, they are treated for parasites and quarantined for 45 days. An identification tag (a passive internal transponder, or PIT tag, same as used with abalone, see the Vol. 1 No. 1 issue of *OceanBights*) is inserted with a numerical identifier. The fish are sexed, their DNA sampled and they are given a health checkup before induction into the broodstock program.

In the hatchery the fish are induced to spawn by manipulating water temperature and lighting conditions to simulate springtime conditions, the natural spawning time for WSB. In this manner, the fish may spawn several times a year. Fertilized eggs collected from the broodstock tanks are placed into larval rearing tanks. Here they are fed live Artemis (brine shrimp) until they are 2 inches

long. They are moved into other tanks with different feed until they are 4 inches long. A 1-mm long wire with a code printed on it is placed in the cheek muscle of each fish before it is moved out of the hatchery to the grow-out facilities. Each tag contains the spawning date and location of the fish.

There are 13 grow-out facilities located on Catalina at, Newport Bay, and at King Harbor and other marina and estuaries. They are operated by volunteer groups, such as angler clubs, who raise the fish until they are approved for release by a Department of Fish and Game fish pathologist. Some fish may be released directly from the grow-out containers while others are transported around the state to balance the distribution of releases.

The Redondo Beach facility, located on land leased at a nominal rate from power company AEG, is staffed by a team of 32 volunteers. Each volunteer spends at least one hour a month cleaning the pens, feeding the fish and assessing their condition.

Rich Ford, who heads the volunteer team in Redondo, said he's proud of the program's success in replenishing the stocks of white sea bass, one of the most sought-after sport fish in California. "I'm a big fisherman and it's extremely gratifying to be able to give something back," he says.

In the wild, the fish presumably follow the natural routine of a wild seabass, eating, growing and being preyed upon. Part of that routine is occasionally being caught by people who want to eat it. If you catch or shoot a white seabass, the Department of Fish and Game requests that you bring them the head of the fish, presumably the only part that remains after you eat it. There is a list of many CDFG offices and local bait & tackle shops (with freezers!) that accept the heads. Check the CDFG web site for locations. The returned heads are checked for the cheek tags. Retrieved tags provide information about growth rates, migratory routes, survivorship, predation and mating patterns.

According to the HSWRI aquaculture newsletter, over 1.8 million sea bass have been released with tags. Of these, 177 tags have been recovered; that is, 1 tagged fish for every 500 heads scanned. The record sea bass release-to-capture distance is held by the fish that was caught 630 km from its release point, with the next longest distance being about 250 km.

HSWRI scientists tagging elephant seals on San Miguel. Courtesy of HSWRI.

Besides WSB, HSWRI is working with other species of fish in its aquaculture program. Although not as advanced as the WSB program, other efforts involve yellow tail (*Seriola lalandi*), California halibut (*Paralichthys californicus*), and California rockfish and striped bass. Interestingly, they procure the halibut from local fishing derbies. However, obtaining rockfish is not so easy and may

require travel to distant offshore rocky habitat to trap these rare fish.

Obviously, raising fish requires much specialized knowledge, from catching, to breeding and feeding. One of the significant issues for fish farming is how to feed the fish. The large fish that we eat naturally eat other fish. If the growers have to catch wild fish to feed their cultured fish, then aquaculture would not relieve fishing pressure on our stocks, but could increase it. One solution is to replace fish-source fish feed with other protein sources, particularly plant-based protein. HSWRI performs much work to find substitutes for fish meal and fish oil.

HSWRI has a many-faceted program in bioacoustics, or the production, reception and scattering of sound by animals. Their scientists are interested in all aspects of sound and its relation to animals. Of course acoustic communication is very important, especially in the marine environment. HSWRI bioacousticians are working to understand how noise, such as the Navy's sonar, affects marine mammals and how these effects can be mitigated. HSWRI staff also believe bioacoustics studies with whales and dolphins may lead to resolving conflicts between fisheries and marine mammals.

The HSWRI ecology program seeks to understand how marine animals live and how they are affected by biological and physical forces. Southern California waters support growing populations of four species of pinnipeds (seals and sea lions). These robust and recovering populations are expanding into habitats that are now mostly occupied by humans. Humans and marine mammals are linked by their dependence on the ocean, particularly the coastal zone, for places to live, find food, reproduce, and raise their young. Pinnipeds share beaches and coastal waters with humans, and they eat some of the same fish and invertebrate species that we enjoy. Pinnipeds may serve as reservoirs for diseases that can have substantial effects on humans, pets, and domesticated food animals. Conversely, the term "pathogen pollution" has been coined to describe the harmful impacts of human sewage outfalls on marine ecosystem health. Studying the impacts of environmental change and fluctuations in food quantity or quality on pinniped populations may help us predict and evaluate the potential implications of these changes for human health.

The only way to effectively manage the resource and health conflicts inherent in the tremendous growth of these populations is through a clear understanding of the population ecology of seals and sea lions. Therefore studies that address the health of marine mammals in an ecosystem context are increasingly important. HSWRI employees Drs. Brent Stewart and Pam Yochem have been working on the Channel Islands since the late-1970's studying

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.

Participants will donate the minimum cost for a single thermograph setup, currently totaling $150. The Catalina Marine Society will supply the sensors and associated mounting hardware and will perform QA and calibration procedures on the sensors before they are deployed and when they are retrieved. The sponsors, if they desire, may also be the site manager, providing the resources for deploying and retrieving the thermograph, or have the CMS arrange for the diving.

The Adopt-A-Thermograph is directed by David Tsao. For more details, contact David at david@catalinamarinesociety.org or Craig at craig@catalinamarinesociety.org.

changes in seal and sea lion populations and attempting to identify the biological and physical factors that influence them. They conduct annual surveys and censuses at colonies at San Nicolas and San Miguel islands, extending a 30-year database on patterns of pinniped abundance and distribution. They also are documenting the foraging behavior of various life stages of seals and sea lions to understand their dietary preferences and habitat needs. Using instruments that record not only the location of the animals, but also the depths at which they are foraging and temperature of the water at those depths, they are tracking the geographical and vertical use of marine habitats by these top-level predators. This information, along with the census effort, will aid in the development of predictive models that can be used to establish proactive conservation and management strategies for California pinnipeds throughout the North Pacific. These mammals are serving as an early warning system of the increasing pressures facing the world's oceans.

HSWRI has laboratories adjacent to SeaWorld on Mission Bay in San Diego. It also operates a hatchery in Carlsbad and a marine mammal ecology lab in Florida. The facility near SeaWorld employs approximately 50 staff, and, of course, lots of volunteers.■

Scientific Mooring Deployments at WIES

By Mike Doran

Catalina Marine Society, in conjunction with Catalina Conservancy Divers and the USC Wrigley Institute for Environmental Studies, has embarked upon the 9th deployment of an YSI instrument sonde at Catalina Island. The deployment campaign, which began in December, 2010, is now entering its third year. The sonde is deployed at a depth of 60 feet on a deep-mooring line at Big Fisherman Cove within the Wrigley Marine Reserve. The instrument is recording temperature, conductivity, chlorophyll and pH data for the water at depth.

CMS has expanded its instrument deployment on the mooring line at Big Fisherman Cove by adding thermograph sensors at 30, 60, and 80 feet. Additionally, a depth sensor has been deployed at 20 feet at the base of a pier piling to record depth changes to support tidal fluctuations studies (see page 15).

These additional sensors are primarily designed to measure internal waves driven by the tide and assist in the interpretation of the temporal behavior of the sonde data. ■

Data Portal Developed

The CMS web site has been expanded to enable access to the Society's growing collection of data sets. These sets include those collected at its scientific mooring near Two Harbors, the more recent Catalina Conservancy Divers temperature data and also newly collected data from the CMS Continental Thermograph array.

The portal can be reached through the "Data Portal" link on our home page. Data can be downloaded via Excel spreadsheets, permitting widespread utility. Please check it out, report problems and send us comments on how to improve it.

As additional data are collected they will be linked to the web site for public access. Researchers who wish to employ data obtained from the site are urged to contact the CMS regarding data details, including specifications and collection procedures.■

Need a speaker for your next club meeting or event?

Contact us and we can discuss possible CMS presentations appropriate for your group.

Chasing Elusive Harmful Algal Blooms

By Erica Seubert

Living in southern California it is hard to ignore our closest neighbor - the Pacific Ocean. The beaches offer us a weekend getaway from cluttered cubicles and hectic schedules. Maintaining and caring for our beaches have become a source of pride for some seaside towns with organized beach cleanups, the banning of plastic bags and other wasteful materials. While these bans and cleanups are beneficial, please remember that a healthy ocean relies on more than just the items we humans are able to see. The microscopic organisms living in our water have a major influence on the ecology of the oceans and our impact on them is often not readily noticeable. However, their impact on us is noticeable when one species suddenly dominates or some microbial constituents produce toxins that affect marine life. These episodes of stimulated productivity are termed harmful algal blooms or HABs.

Microscopic organisms tend to get a bad reputation. Clever advertising has spurred obsessions over unseen bacteria and viruses that may threaten our loved ones' health, boosting the sales of anything labeled "anti-bacterial" or "anti-microbial". However, the ocean food web is anchored by a host of harmless microbes, and the production of thousands of protists, bacteria and viruses ultimately determine the success of our fisheries. The interaction among these three groups is termed the "microbial loop" as their associations are not linear but tightly coupled to one another.

Erica Seubert

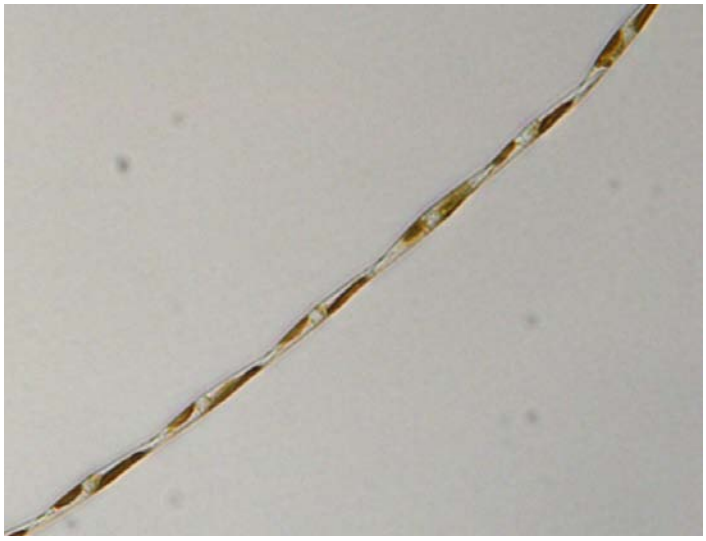
The term protist refers to microscopic eukaryotic single-celled organisms. Eukaryotic cells are typified by the presence of a nucleus and other membrane organelles and the ability to reproduce sexually. Within the protistan group there are autotrophic organisms, also known as phytoplankton and unicellular algae, which utilize photosynthesis to produce their own food, heterotrophic organisms that consume autotrophs, and mixotrophic organisms that can switch between autotrophy and heterotrophy depending on conditions. The work performed in Dave Caron's laboratory at the University of Southern California is focused on understanding the complex ecological interactions present in the protistan fraction of the microbial loop.

The growth of the protistan community can be stimulated in multiple ways. Direct nutrient input will stimulate photosynthesis, thereby increasing the number of organisms capable of autotrophy. Stimulation of the portion of the protistan community capable of heterotrophy is a bit more complicated as the preferred prey item will need to be stimulated first. Heterotrophs that consume bacteria will flourish when bacterial production is increased and heterotrophs consuming other protists will follow any increase in abundance of their prey.

The normal protistan community will host a myriad of different species at any given time, with the dominant members changing as the input of nutrients, light availability and prey abundance fluctuates over time. **Harmful algal blooms (HABs) occur when the microbial loop is somehow disrupted.** In a water body that had

previously hosted a few hundred species of protists simultaneously, one species suddenly dominates and will come close to comprising 100% of the protistan community present.

The autotrophic diatom, *Pseudo-nitzschia*, produces a neurotoxin called domoic acid (DA) that is capable of causing illness in higher animals. When ingested by humans via contaminated seafood, DA causes a syndrome termed amnesic shellfish poisoning with symptoms ranging from nausea to loss of memory and even death. Thanks to successful monitoring of seafood products by state health departments DA has not caused a human death since the first identified outbreak in Prince Edward Island, Canada, in which 3 people died and over 100 were sickened in 1987. DA amounts within cells are low compared to the concentrations necessary to sicken humans or wildlife; it becomes a health threat when it is concentrated by bioaccumulation through the food web. A single cell containing DA cannot sicken us, but when shellfish and fish capable of consuming *Pseudo-nitzschia* feed, they concentrate the toxin in their bodies. When marine birds and mammals consume the concentrated toxin, they become ill. The effect of this toxin on marine food webs plays out almost every spring on our television sets when the local news reports increases in the amount of California sea lion strandings and in marine bird illnesses. The negative impacts DA production has on the local ecosystem led to classification of *Pseudo-nitzschia* as a HAB organism. Unlike other HAB organisms that may reach significantly high cell densities and compose almost the entire protistan community, *Pseudo-nitzschia* does not have to be a dominant member of the community to pose a risk.



Chain-forming *Pseudo-nitzschia*
Courtesy of the author.

Most HAB research has been limited to describing an event once it has begun, that is, after reports of discolored water or sickened animals have reached scientists. However, identifying conditions conducive to HAB development is essential for understanding HABs. *Pseudo-nitzschia* is a common member of the protistan community in southern California and it is present for most of the year, but DA is typically only detected in the spring. **Stimulation of *Pseudo-nitzschia* growth does not necessarily stimulate DA production.** The work I have performed at USC in completion of my doctoral thesis has dealt with understanding DA production by *Pseudo-nitzschia* in southern California. We use a combination of laboratory experiments and open-ocean sampling to investigate the factors that lead to DA generation. Experiments with laboratory cultures can help determine which factors are important to DA production and subsequently impact the design of expensive open-ocean sampling and HAB monitoring programs in our area.

DA is a small molecule, 33% of which is composed of nitrogen. Nitrogen availability directly impacts an organism's growth; it is a component of

many essential molecules (i.e., amino acids) and is needed for basic cell metabolism. Nitrogen availability is one of the main factors that can limit autotrophic growth in the ocean.

When *Pseudo-nitzschia* uses available nitrogen to make DA, that nitrogen is not available for other cell functions. To sustain autotrophic growth, the availability of carbon, nitrogen, phosphate and silicate must be present in a molar ratio of 106 carbon: 16 nitrogen: 1 phosphorus: 16 silicate (Redfield ratios). When nitrogen is in short supply, the nitrogen to phosphate ratio will be under 16:1 and nitrogen is said to be the limiting nutrient. Once nitrogen availability has been increased and the ratio of nitrogen to phosphorous is 16:1, neither is limiting.

The first hypothesis behind DA production concerned nitrogen availability in excess of concentrations necessary for growth, hence ratios of nitrogen to phosphorous will be higher than 16:1 and nitrogen to silicate ratios higher than 1:1. Phosphorous and silicate concentrations would be the elements limiting *Pseudo-nitzschia* growth in this situation. Laboratory experiments confirmed that in times of phosphate and silicate limitation DA production increased, and the amount of increase in DA production differed according to the nitrogen source available.

However, ocean samples we collected in the Los Angeles area in which DA was measurable did not correspond to limited phosphate and silicate concentrations. In 2008 our laboratory at USC joined four other universities in southern California as a part of the Southern California Coastal Ocean Observing System (SCCOOS) HAB monitoring program. Weekly samples are collected from Newport Pier and analyzed for protistan community composition, chlorophyll concentrations (which are a measure of total autotrophic protist growth), nutrient and DA concentrations. The dataset of weekly samples analyzed for DA over the course of a few years for one location **showed a pattern of DA presence corresponding to upwelling events**.

Upwelling is a phenomenon in which deep water is brought to the surface. The process occurs when persistent downcoast winds move surface waters offshore, away from the coast. Deep, cold, nutrient-rich waters from offshore replace the surface waters. The combination of persistent downcoast winds and a sharp decrease in coastal water temperature help scientists identify an upwelling event. In the week prior to an upwelling event DA was undetectable although *Pseudo-nitzschia* was present in the Newport Pier sample. However, DA was detectable after an upwelling event.

Correlation of upwelling events and DA detection at Newport Pier is important, but the primary research goal is to identify specific conditions that stimulate DA production. We are now exploring the component that drives the correspondence of upwelling events and the presence of DA – is it the introduction of nutrients in upwelled water that stimulates *Pseudo-nitzschia* to produce DA or are DA-producing *Pseudo-nitzschia* cells present in the upwelled water? Upwelled water will have nutrients proportioned close to the ideal Redfield ratio. Answering these questions require us to monitor not only what is occurring at coastal locations such as Newport Pier but also analysis of samples taken offshore, below the surface, where the upwelled water originates.

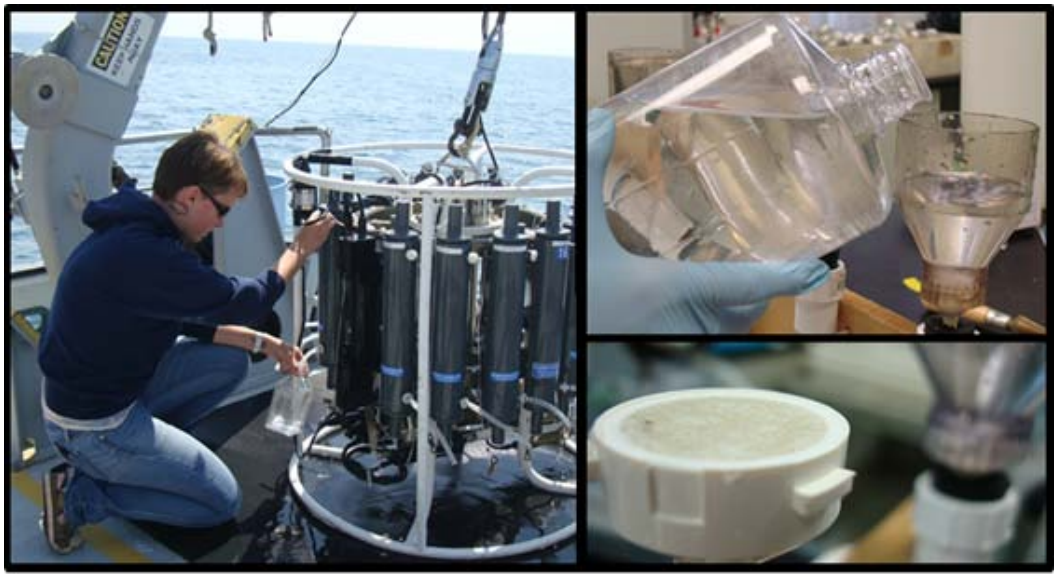
The primary oceanographic tool for sampling offshore and at specific depths is a CTD rosette. It is an instrument in which a carousel of bottles is placed in a circle around a series of sensors on the interior. The majority of rosettes are outfitted with Conductivity, Temperature and Depth (CTD) sensors that inform scientists in near-real time of temperature, salinity (derived from the conductivity and temperature), and depth of the water as the carousel is lowered. A sensor for chlorophyll fluorescence (such

as the CMS maintains at Two Harbors) can also be included on the CTD, allowing scientists on the boat to see the relative chlorophyll concentration present in the water column as the rosette travels down. Chlorophyll concentration is a proxy for autotrophic protistan abundance and since *Pseudo-nitzschia* is autotrophic it will most likely be present in locations where autotrophic cell abundance is high. Elevated chlorophyll concentrations are used to identify sample locations ideal for our research objective. As the rosette is brought back aboard the ship it will pause at the depth identified during the downcast as an area with high chlorophyll concentration and one or more bottles will sample water from that depth. Niskin bottles are plastic tubes in which the top and bottom of the bottle can be pulled open by a rope. The top and bottom are left open as the rosette of bottles is lowered through the water column. A scientist on board the ship can press a button that releases the hold on the rope closes the bottle. The now closed Niskin bottle contains water from the specific depth we suspect the *Pseudo-nitzschia* inhabits. Once on board the sample is collected and filtered onto glass-fiber filters for analysis.

Times in which upwelling events are likely to occur can be identified by weather forecasts and there are specific seasons in which upwelling favorable winds can occur. In the southern California area, upwelling events are most likely to occur in spring; this is helpful for scheduling the sampling but there are still several months over which to spread the data collection effort.

The time and monetary commitment involved in maintaining consistent monitoring and sampling programs is prohibitive and heavily impacts the number and location of samples collected. Narrowing down the specific time period in which the offshore sampling is most effective allows scientists to focus their efforts (and money) to the collection and analysis of samples that will be best able to meet their research objective.

In 2011, the SCCOOS sponsored the development of a Community HAB Watch Program with additional support from the Centers for Ocean Sciences Education Excellence (COSEE) West and scientific expertise from our laboratory at USC. The program involves eleven informal science centers in southern California, spanning the coast from the Ocean Institute in Dana Point to the Ty Warner Sea Center in Santa Barbara and including sites far offshore such as Anacapa Island, maintained by the Channel Islands National



Shipboard sampling for *Pseudo-nitzshia*. Courtesy of the author.

Marine Sanctuary. Each of the centers was provided with training HAB monitoring. The development of this program allowed for a stronger connection between university researchers and the science centers, armed the centers with current and comprehensive information on HABs present in southern California for them to pass on to visitors and provided researchers with priceless information crucial to expanding our knowledge of the timing and spatial components of HABs. Expanding the coverage of coastline monitoring sites and community involvement becomes implicitly important and essential to assisting scientists in meeting their research goals. It allows information to be collected in more areas than the scientists can realistically visit on a regular basis and provides comparative data on the spatial component of blooms. For example, in 2011 there was a significant bloom of the dinoflagellate *Lingulodinium polyedrum* identified in Dana Point by the Ocean Institute and reported to USC researchers through the Community HABWatch program. At Newport pier, the monitoring location maintained by USC, *Lingulodinium* was not present and we would not have known about the bloom just a short distance away at Dana Point without the Community HABWatch program. Results from the HABWatch program can be obtained from www.sccoos.org.

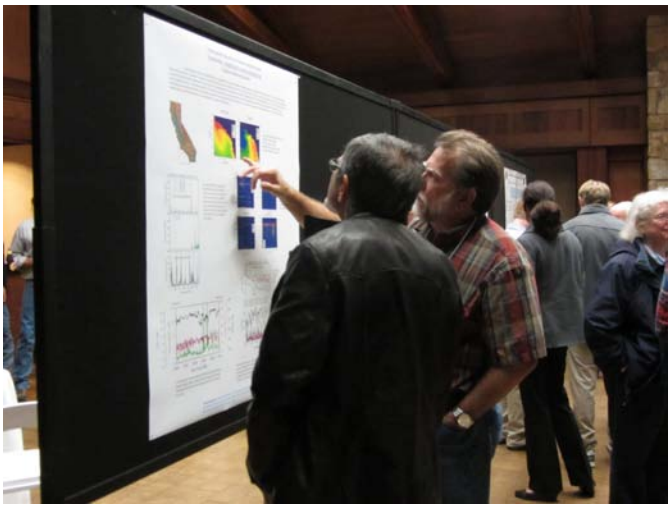
Erica Seubert is working on HABs for her doctorate at USC. ■

CMS Technical Presentations

The CMS made presentations at the Eighth California Island Symposium in Ventura, and the CalCOFI Conference in Pacific Grove.

The Island Symposium is an eclectic mix of science related to the California islands, including archeology, geology, botany and marine biology. We made an oral presentation at the symposium describing internal waves at WIES. Almost a decade before, Karen Norris (now secretary of the CMS) gave an oral presentation at the same symposium describing the analysis of ocean temperature as measured by the Catalina Conservancy Divers. This was the first presentation to a professional audience from what would become the Catalina Marine Society. The latest work combines CCD data with government data sets in an effort **to under-stand the active internal wave environment at WIES**.

At the California Cooperative Oceanic Fisheries Investigation (CalCOFI) Conference we presented a poster **describing chlorophyll dynamics at Santa Catalina** Island and comparing it to dynamics at other Channel islands. The chlorophyll was measured from satellite and at the CMS mooring near WIES.



Craig Gelpi, right, discusses chlorophyll dynamics with Tony Koslow of the Scripps Institution of Oceanography

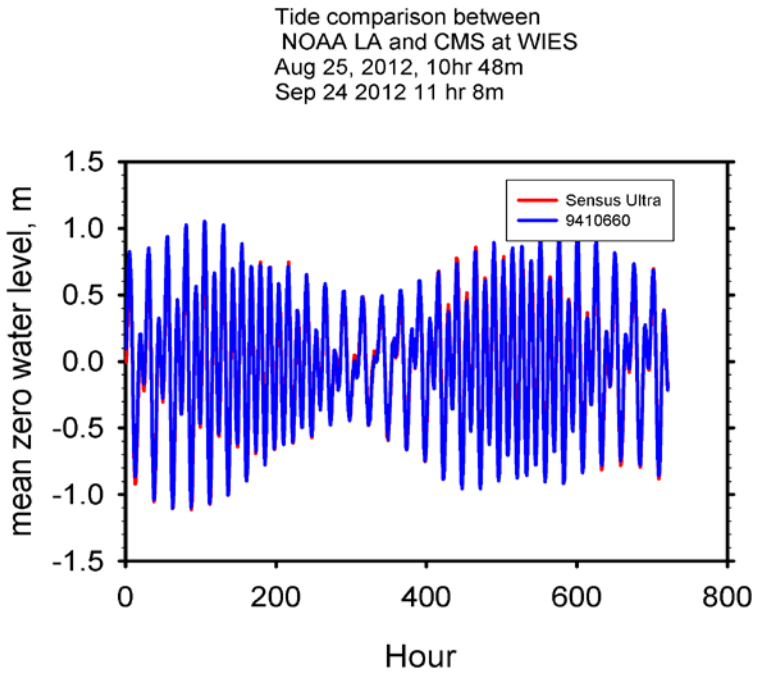
By comparing satellite measurements of chlorophyll among the various Channel Islands, we concluded that Santa Catalina is not a hotbed for chlorophyll generation. ■

Tide measurements made at Catalina

For the first time in decades, tide measurements have been made at Santa Catalina Island. Sea-level measurements are routinely made along the coast, including locations such as Los Angeles Harbor, San Diego and Santa Barbara. But there have been limited data taken at Santa Catalina until the CMS effort. Although local tide tables are adequate for most applications, there are phenomena that may produce differing water-level modulations among the continental sites and the offshore islands. These phenomena include **storms, Santa Ana winds and tsunamis**.

To make tide measurements economically, the CMS chose a SCUBA-diver depth-logging device. However, because the logger would have to be deployed for long periods of time, it was enclosed in a housing that could equalize pressure with the ambient ocean yet protect the sensor from biofouling and sediments that could clog its ports and distort measurements.

The experimental setup was deployed at the WIES pier. After 3 months, the sensor was retrieved and its data downloaded and compared to the NOAA tide data for the harbors at Los Angeles and San Diego. The tidal data for the three data sets were virtually indistinguishable.



A sampling of data from the pressure gauge.

The intent of the instrumentation is to determine tidal phenomenology at the island. To this end, more instrumentation will have to be added to measure atmospheric pressure and provide redundant water-level measurements to increase confidence in small signals. However, the data obtained so far indicate a promising start and that the project can be accomplished both technically and economically.

Instrumentation sponsors and volunteers for data analysis are always welcome. Contact the CMS if you are interested. ■

Upcoming Meetings

CalCOFI Conference
December, 2013 in La Jolla

Southern California Academy of Sciences Annual meeting, May 3-4, 2013, California State University, Long Beach

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 $100); 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