OceanBights

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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.

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El Niño?

Last year we had warm temperatures and no El Niño weather pattern. This year there were strong El Niño indicators but our rainfall, as of this writing, appears to be that corresponding to a typical winter of past decades. In the words of one of my colleagues, **Mother Nature bats last**.■

Mariculture and aquaculture in Southern California

CMS President Jim Updike and I visited a white sea bass grow-out pen in Newport Beach last month. Hubbs-Seaworld runs a program that develops seafood resources, especially white sea bass for California. We described the white sea bass development in a previous issue of *OceanBights*. Essentially, wild-caught stock is bred, and the eventual fingerlings are allowed to grow in volunteer-maintained pens situated in open waters such as the one we visited in Newport Bay. When deemed large enough to fend for themselves, the sea bass are freed into the ocean to provide meals for anglers and free-diving spear fishermen.

Our visit got me thinking about marine aquaculture. Many people believe that aquaculture (sometimes called mariculture when done in the sea) will be a significant part of the solution to the problems of feeding a growing population (or a static population with a growing appetite, or an increasing wealthy population with gourmand tendencies). Nearly 17% of the world's protein comes in the form of seafood and that percentage is increasing.

There is little aquaculture in California, especially in the ocean, but this may be changing. Certainly in my lifetime, seafood mongers have trended from selling only wild caught items to mostly farmed items, including shrimp and salmon. There is no doubt that this trend will continue. Aquaculture has a place in the sustainable seafood industry, espe-

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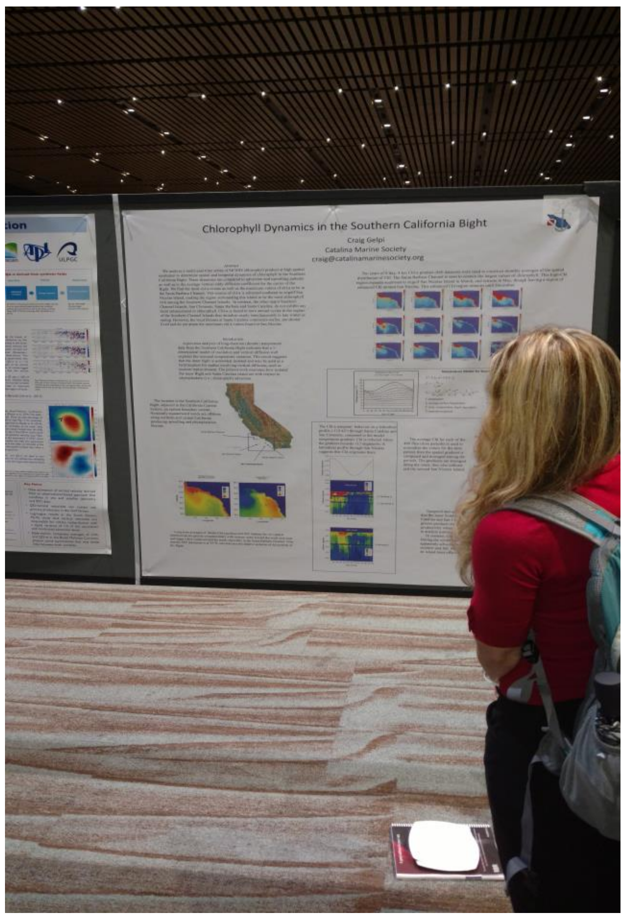
cially freshwater products (is there such a concept as freshwater seafood) that can be grown using agricultural crops or detritus as nourishment for the aquacultural crops. However, for mariculture, where the nourishments come from and where they end up may be defining issues for the future of the industry.

There is a continuum in aquaculture practices between two extreme types: totally closed, artificial environments where everything necessary for growth is explicitly brought into the system; and mostly natural environments that take advantage of the aquatic commons. An example of a totally artificial system is raising tilapia (a fish of African origins) in ponds located in Southern California deserts. Of course, there is nothing natural about this arrangement, with perhaps the exception of the water (unless it, too, is imported from Northern California). The fish feed and wastes must be actively managed and all inputs and outputs rigorously thought about and explicitly handled.

The other extreme is to extract as much as possible from the natural, environmental commons. ➔*See Aquaculture pg 12*



Scientist views CMS poster.

CMS presents at Ocean Sciences 2016

We presented a poster at the 2016 Ocean Sciences Meeting in New Orleans last February. The topic was the seasonal and spatial distribution of chlorophyll in the Southern California Bight, that region of the ocean between Point Conception and the Mexican border and includes Santa Catalina Island. This study is a continuation of our efforts to understand the processes that affect the Channel islands and their ecology. In particular, the study investigates how the physical dynamics CMS has previously elucidated may relate to basic marine biology including net primary production in the area.

We used chlorophyll estimates made with the Modis instrument on an earth observing satellite. **This chlorophyll product is obtained essentially by noting how "green" the ocean appears**. You can notice this during your next trip to the islands. Chlorophyll is normally much higher near the coast then around Santa Catalina, so note the color of the water as you approach the mainland from the island. When your eyes are atuned to the colors you can readily see the enhanced chlorophyll as you approach harbor.

The amount of chlorophyll corresponds to the amount of phytoplankton and therefore can be used as a proxy for where phytoplankton growth and nutrient availability.■

The Plight of the California Sea Lion

by Mary Ann Wilson

On a Sunday morning in March 2013, I spotted three dead California sea lion pups and two dying pups on the beach just south-east of the cliffs in Point Dume, Malibu. I called the Marine Mammal Care Center for help but they were overwhelmed and could not assist the pups. Two years later in April of 2015, I saw two dying sea lion pups just north-west of the cliffs. Someone called the CA Wildlife Center, and a representative came and put up signs that warned people to stay away and then left, saying there was no room for them.

During both years the National Oceanic and Atmospheric Administration (NOAA) declared an Unusual Mortality Event (UME) for California sea lions (*Zalophus californianus*). In 2013, more than 1600 California sea lions were stranded alive along the Southern California coastline and admitted to rehabilitation facilities in January, February, March, and April. Seeing some strandings is normal, particularly from mid-April to mid-May, when most pups are weaned and begin foraging on their own. Pups remain with their mothers for the first 10-11 months of their life and become independent around May of the year after their birth. This coincides with the peak upwelling period in the California Current System (CCS) when primary productivity is at its maximum. If the upwelling fails, we may witness

Mary Ann Wilson.

an UME. That's what happened in 2009—a huge mortality event took place between May and August, a period characterized by the strongest negative upwelling observed in 40 years, resulting in uncharacteristically warm sea surface temperatures. But 2013 was unique because most of the strandings occurred in the first four months of the year and were located mainly in Southern California (see Figure 1, next page).

This pattern not only repeated itself in 2015, but worsened. The strandings in 2015 occurred along the same stretch of coastline as they did in 2013, mostly from Santa Barbara through San Diego Counties. But the total strandings during the first five months of 2015 totaled 3340 (see Figure 2, page 5), more than doubling the 1262 strandings during the same period in 2013. Moreover, the strandings in 2015 was more than ten times the average stranding level for the same five-month period from 2004 to 2012.

The UME status allowed for the establishment of a panel of experts to determine the cause of the mortality. What the investigation found in both years was "a change in the availability of sea lion prey, especially sardines, which are a high-value food source for nursing mothers. Sardine spawning grounds shifted further offshore in 2012 and 2013, and while other prey were available (market squid and rockfish), these may not have provided adequate nutrition in the milk of sea lion mothers supporting pups or for newly-weaned pups foraging on their own."

Mark Lowry, a NOAA biologist, has collected sea lion scat from San Nicolas and San Clemente islands each season since 1981. Through the years, he has identified 133 different species, seven of which are commonly found in sea lions' diets. The common prey are market squid and six kinds of fish—anchovies, sardines, two different kinds of mackerel, short belly rockfish, and Pacific hake.

Of these forage, sardine and anchovy are fat- and calorie-rich while rockfish and squid are fat- and calorie-poor.

Lowry, who has completed his analyses of 2013 samples as well as the 2015 winter and spring samples, said in February 2016 that in 2013 and 2015, anchovy and sardine pretty much dropped out of their diet. As a result, the sea lions' diet became incredibly diversified. Evidence of common items includes market squid, some hake—though hake is also down from what they normally eat, and short belly rockfish. "But mostly they're targeting a group of non-common squid and octopus and non-common fish," Lowry said. The spring 2015 samples showed the highest levels of non-common cephalopod—squid and octopus—and non-common fish he had seen in a long time.

Of the 127 non-common species found in their diet, 40-60 different species were seen in samples taken from San Nicholas Island in 2015. At San Clemente Island, where Lowry collects fewer samples, 40-45 non-common species were found. Two kinds of mackerel, Jack and Pacific, have increased at San Clemente but not at San Nicholas Island.

In April 2015, Lowry told the Los Angeles Times that he had found "mystery stuff — gooey bits of substance you'd expect from a diet of jellyfish or tube worms." Though yet to be verified, his analysis now shows they were pyrosomes—free-floating colonial tunicates which are closely related to salp. "That's very unusual," Lowry said. "It's the first time I've ever seen those. What that says is that sea lions can't find what they normally eat, so they're eating whatever they come across."

In a report to be published by Royal Society Open Science, Sam McClatchie, Supervisory Oceanographer for Southwest Fisheries Science Center, predicted the temporal sequence of pup weights between 2004 and 2013 based on two variables: the relative abundance of sardine and anchovy, and the relative abundances of rockfish and squid. When rockfish and squid are more abundant than sardine and anchovy, sea lion mortality increases. The six most common items in their diet are shown below (see the table, next page) with their corresponding calorie and fat content.

Sharon Melin, a wildlife biologist with the NOAA Fisheries National Marine Mammal Laboratory, tracks sea lion pups' weight gain and growth, and correlates them with inferred diet of mothers. From an analysis of scats from females collected from breeding sites between June and September over eight years, she defined four different diet types and what years the types were dominant. Diet 1 has low percentage of market squid and a high percentage of Pacific sardine (2002, 2005). Diet 2 is dominated by market squid and Pacific hake (2000, 2001, 2010, 2011). Diet 3 is comprised

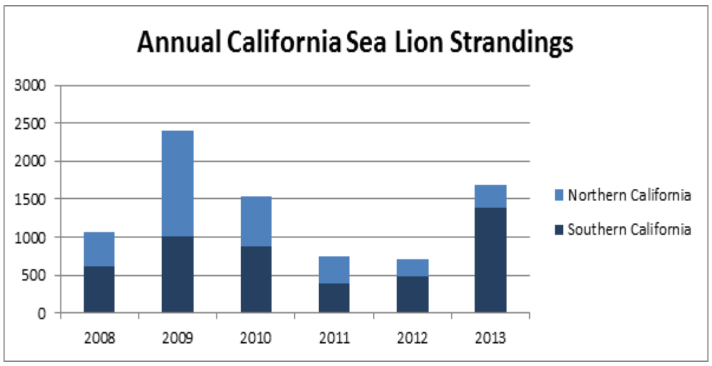


Figure 1.

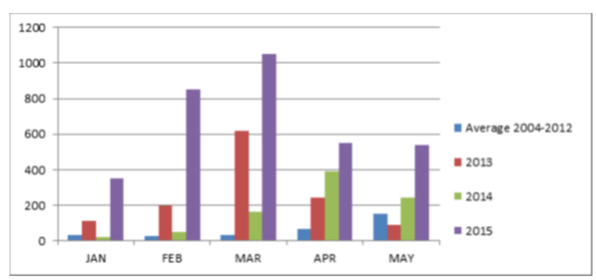


Figure 2.

mostly of northern anchovy and Pacific sardine (2003) and Diet 4 is dominated by market squid and rockfish (2009, 2012).

Average pup weights tended to be heavier in years represented by Diets 1 and 3, average in years with Diet 2, and the lightest pups occurred in 2009 and 2012 with Diet 4.

During three weeks of fieldwork on San Miguel Island in April 2015, Melin observed the sea lions traveling farther and diving deeper to find food. That's generally not a problem for males since they can go wherever the food is. After the breeding season, some males migrate north as far as Alaska. But a mother is tied to the rookery island until her pup is weaned almost a year later. Females generally remain within 90 miles (150 km) of the breeding rookeries.

California sea lion females give birth to a single pup between May and June in large rookeries on offshore islands along California and Baja Mexico. The main US breeding rookeries are located on the Channel Islands and California sea lion pups are born on the islands of San Miguel, San Clemente, San Nicholas and Santa Barbara. Once a mother begins foraging for food, a sea lion pup will usually nurse, on average, every third day. While she's away collecting food, she produces milk while her pup waits on shore and fasts. When she returns, she locates her pups with a "pup attraction call," which is established shortly after birth when the mother and pup call to one another and the pup imprints on its mother's distinct call. They also recognize each other by scent.

Taxa	Calories/gram	Fat/gram
Pacific sardine	2.17	0.124
Northern anchovy	1.31	0.048
Rockfish	0.94	0.016
Market squid	0.92	0.014
Pacific hake	0.90	0.013
Pacific mackerel	0.64	0.078

Forage food quality.

Lactating female California sea lions consume approximately 11% of their body mass in food per day. In addition, because lactating females are usually also pregnant during nine months of the 11-month lactation period, a diet that is insufficient to support both lactation and gestation may result in the resorption of the fetus or a premature birth.

In December 2014, Melin's team satellite tagged twelve adult female-pup pairs. What they found was while many stayed around the island through much of December, by January they started seeing females taking off and not returning, which was indicative of their pups dying. So out of the original twelve, by March only six were still coming to San Miguel Island, and they were consistently diving to 400, 500 or 600 meters.

This diving requires extraordinary physiology. To dive this deep, sea lions' lungs collapse at about 225 meters down and then re-expand at the same depth upon ascent. This technique not only staves off decompression sickness, by keeping nitrogen out of the bloodstream, but also reduces the amount of oxygen delivered from their lungs to their bloodstream—preserving the oxygen within the sea lion's upper airways. When they head back to the surface, the preserved oxygen re-expands into the lungs and prevents the sea lion from blacking out in the shallows.

"To have half of our sample diving into those kind of depths is unusual," Melin said in a NOAA Fisheries podcast last April by which time only four females-pup pairs remained. "These females that were doing this deep diving, they were going very deep and they were going out into very deep water. They were also the four females whose pups are still alive, and we were able to capture their pups. And although their pups were not giant, healthy pups, they were alive."

Lowry's 2015 winter and spring findings concur. Short belly rockfish, one of the common fish showing up in his samples, are generally found deeper in the water column than anchovies, sardines, and mackerel. Furthermore, a lot of the non-common fish that were found live on or near the bottom of the ocean, like flat fish and different species of rock fish, as well as cusk eels—a group of marine bony fishes.

A downward trend for sardine abundance has been going on for a decade, and over a large area (five degrees of latitude). McClatchie's report, which uses data from the Southwest Fisheries Science Center's Rockfish Recruitment and Ecosystem Assessment Survey (RREAS), shows that during the decade from 2004 to 2014, market squid and rockfish increased, while sardine and anchovy fell to very low numbers off central and southern California, and around San Miguel Island in the northern Channel Islands where sea lions breed.

According to the Pacific Fishery Management Council (PFMC), which develops regulations for fisheries in the U.S. off the West Coast, the sardine biomass (the estimated weight of a stock of fish) reached a peak of 1.3 million metric tons in 2006, then dropped to an estimated 97,000 metric tons in 2015**, a decline of more than 90%** and significantly below the 150,000 metric ton threshold for this directed fishery. In April of 2015, the Pacific Fishery Management Council announced the closure of the 2015-16 U.S. Pacific sardine fishery, beginning July 1.

Sardine populations rise and fall naturally, cycling as ocean temperatures shift. But, says Tim Essington, a University of Washington professor of aquatic and fishery sciences, "Fishing makes the troughs deeper." In a paper published in March, Essington showed that overfishing worsens the magnitude and frequency of the cyclical declines of sardines and other forage fish, such as anchovies.

His March 2015 study showed for the first time that fishing likely worsens population collapses in species of forage fish, including herring, anchovies and sardines. To prevent complete collapse, the study recommended the use of risk-based management tools that would track a fishery's numbers and halt fishing when they dipped too low. This strategy has the potential to not only ensure more fish for the sea lions, but long-term stability in the fishing industry. Using simulations of this management

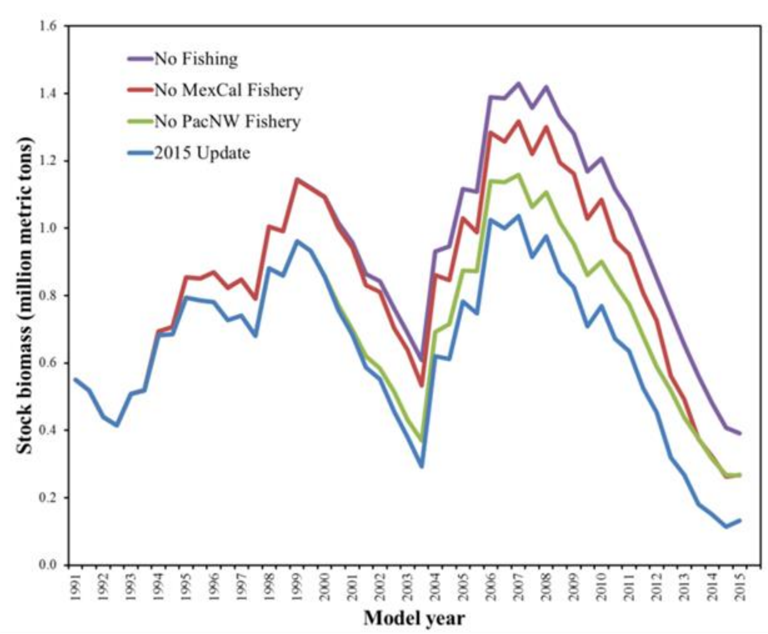


Figure 3.

strategy, researchers determined that by suspending fishing when a population falls below half of its long-term average, 64 percent of collapses could be prevented and average catch would be reduced by only two percent in the long term. Based on scientific recommendations by the Lenfest Forage Fish Task Force, Oceana suggests increasing the threshold for Pacific sardines from 150,000 metric tons to at least 640,000 metric tons.

At the April 2015 PFMC meeting, assessment author Dr. Kevin Hill presented a Southwest Fisheries Science Center analysis of what the sardine population might look like in the absence of fishing (see Figure 3). While it is clear that, with the lack of recruitment, the population would have declined greatly even in the absence of fishing, Hill's analysis showed the population would have been four times higher in 2015 without fishing; that is, approximately 400,000 metric tons (purple line, 'no fishing') versus the current estimated 96,688 metric tons (blue line '2015 update'). Moreover, sardine harvests exceeded Maximum Sustainable Yield levels during the decline.

Emaciated pup. Image by D. Gordon Kelly.

The U.S. population of California sea lions is currently estimated to be **300,000 animals**, all on the Pacific coast. From an estimated population of about 10,000 animals in the 1950s, their numbers have grown rapidly since 1972 when the Marine Mammal Protection Act was implemented. Lowry, who also conducts annual aerial surveys of California's pinniped populations, told the LA Times that the sea lion population is increasing at a rate of about 5.1% per year.

Unfortunately, we now have a large sea lion population coupled with a decline in food quality near breeding colonies. Until high-quality food increases again in the Southern California Bight, pup emaciation may become the norm. ■ *Mary Ann Wilson is a frequent contributor to* ***OceanBights***.

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.

California Morays Keep the Kelp Forest Community Healthy

By Lora Johansen

Catalina divers find California moray eels *Gymnothorax mordax* both exciting and scary. Scary, for like all morays, they breathe by repeatedly opening and closing their mouth and display their needle-like teeth that give them their menacing reputation. Exciting, because divers are unlikely to encounter one, even if they go looking for eels. These elusive fish hide in rock crevices and only venture out during the cover of night to hunt. Perhaps because they are cryptic, little is known about the California moray.

Although California moray eels live along the coast from Santa Barbara in Central California to Santa Maria Bay in Baja California, the morays are not commercially or recreationally harvested. Hence, landings, a valuable data source for many species is completely absent for these fish. Our knowledge of the eel is limited not only by the paucity of catch data, but also the few studies performed on California morays may be unreliable because they employed SCUBA transects or visual counts. As nocturnal fish, morays are a shy species. With slender, limbless bodies, they easily hide in rock crevices during the day, usually with only their head protruding. They quickly recoil into their den if they feel threatened and may be easily missed by SCUBA divers during the day.

Lora Johansen.

While information regarding the basic life history of California morays is missing, an abundance of information exists on their tropical cousins. Studies on morays in tropical communities show that they are top predators that influence the community structure of the reef with their eating habits. With this knowledge in mind, scientists suspect that California morays to have a similar ecological role in the kelp forest and this is a topic of interest for researchers. Ben Higgins, a Ph.D. candidate at the University of California at Santa Cruz, is documenting local morays distribution, diet, and diet limitations. By knowing where the eels are and what they eat, we can find out if they affect stability and health of the kelp-forest community.

Operating from the University of Southern California's Wrigley Institute for Environmental Studies, on Santa Catalina Island, Higgins and his team investigate the ecological role of the morays in four coves near Two Harbors: Cherry, 4th of July, Isthmus, and Little Fisherman. By researching how many morays there are, which type of habitat they prefer, and what they can and cannot eat, he aims to understand what influence they have on their kelp-forest home. Although his research is still in progress, Higgins already discovered that there are at least 18-30 times more morays (per square meter) on Catalina than studies have previously shown! By using two-chambered wire-mesh traps baited with anchovies, Higgins eliminates the biases associated with SCUBA surveys and gains a more accurate eel count. Typically, the team members deploy four baited traps in each of the four coves in the evening. The next morning, the team anxiously recovers the traps. They carefully sedate the eels by tactically transferring them into a bucket of salt water laced with fish anesthetic. Then the team measures and tags each moray, ensuring that no eel is counted twice. After the eels regain consciousness, the team releases them near their capture site. Over the last four summers, Higgins' team trapped and tagged a total of 789 different morays in Two Harbors. Only one eel got away, but left a story.

Trapped moray. From Ben Higgins.

Two years ago, Higgins was routinely pulling up eel traps when he spotted one flopping around on the deck of the boat. Acting quickly, he grabbed a towel and threw it over the fish. Like most morays, it bit the towel and began to knot itself, a typical behavior accompanying feeding or self-defense. When Higgins grabbed the towel to place it in the bucket of anesthetic, the moray's head slipped out and bit him on the finger. The eel escaped and Higgins went to the Catalina Island Medical Center in Avalon for eight stitches.

But that experience didn't stop Higgins from interacting with morays; he still handles their cages and dives in their coves regularly. In order to better understand their distribution, Higgins and his team are surveying the reef to predict which habitats will have more eels. Because morays tend to hide in crevices, Higgins predicts there are more morays in a permeable habitat. To test this hypothesis, the divers measure the rugosity, or complexity of the seafloor, around each eel trap. Using cardinal headings from the trap, the divers set four 10m transects and record the rugosity (on a scale of 1 to 3) of the habitat directly beneath each 0.5 m. So far, the team has logged over 150 dives collecting these data.

In addition to habitat, Higgins is investigating diet and diet limitations. By looking at gut contents in comparison to the relative abundance of prey items in the kelp forest, determined by multiple SCUBA transects, Higgins can ascertain if California morays are generalist predators. While they are sedated, Higgins manually palpates the eels to collect the gut contents in a non-invasive manner. So far, the data support the idea that California morays are generalists. From the stomachs of 49 eels, Higgins found ten different species including many different fish, shrimp, octopus, lobsters, crabs, snails, and even mantis shrimp.

The form of a morays skull and teeth can also indicate prey specialization. On the deceased morays, Higgins measures tooth number and tooth size to calculate bite force and see if the jaw indicates a dietary limitation. So far, these data also support the generalist hypothesis, by suggesting that larger morays still consume small prey often, even though their jaw size allows them to consume large prey.

This research indicates the role that California morays play. Although they are not

Habitat measurement. From Ben Higgins.

black and white like the zebra moray, they may as well be wearing stripes. Higgins calls them the "referees of the reef". By eating all types of animals they come across, the eels are keeping competitively dominate organisms at bay, and giving the others a fighting chance. By maintaining diversity, morays could be contributing to the stability of the reef in many ways. With many more species around, community roles that are usually filled by one species are now filled by several. These redundancies make the kelp forest more resistant to disturbances and help the community heal quickly if it is disturbed.

Measuring an eel. From Ben Higgins.

Not only do the California morays level the playing field for fish and invertebrates, but they could be stabilizing the kelp. As Higgins has shown, California morays prey upon crabs and fish that feed on kelp. By keeping those herbivorous populations in check, morays are maintaining the kelp and all the animals that depend on it.

Although Higgins has obtained some answers about California morays, his work continually inspires new questions. During his quest for California moray information, Higgins realized that no research has been conducted on reproduction of these eels. The only literature on the subject hypothesizes that cold water hinders the formation of gametes in morays living in southern California, preventing reproduction altogether. Since the local eels cannot produce babies, this population is unique. Possibly reproductive California morays living in Baja periodically repopulate southern California areas during El Niño years. As larvae, morays live in the open water for the first several months of their lives. When the California current relaxes during an El Niño event, there is an opportunity for larva from Baja to drift up the coast. This hypothesis could be tested by analyzing the correspondence of age groupings of morays on Catalina Island with physical oceanographic data indicating transportation of larva from Baja. If this theory is true, then southern California morays could be sexually activated by warm water events. With temperatures on the rise and predictions of more warm water on the way, the population of California morays could expand up the coast, past the historical limits of the species, in the near future.

Measuring the business end.

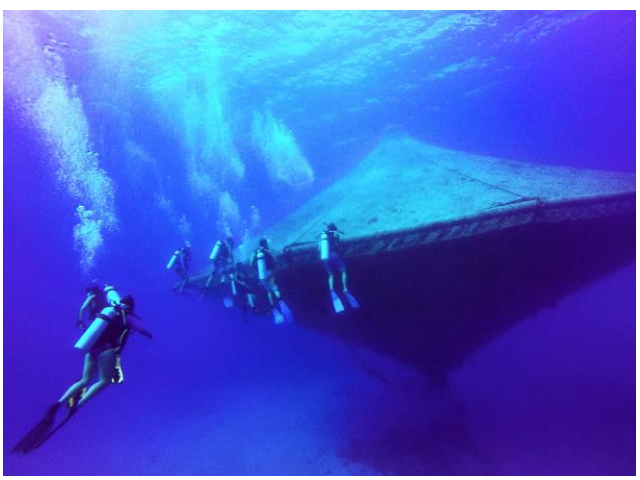
From Ben Higgins.

If the morays expand their geographic limits their interaction with other habitats may result in many possible outcomes. While Higgins research shows they support the kelp-forest community, the effects of eels on other California habitats is unknown. Their interaction with prey may threaten or strengthen the community structure of their new habitats in ways we cannot predict. California morays demonstrate our gaps in basic knowledge of our own backyard. In Ben Higgins' words, "It's still amazing that we can find things we know virtually nothing about in a place we've studied so well. Just goes to show that you can't take anything for granted!"■

Lora Johansen is a recent UC Santa Cruz graduate, who is currently working as a marine biologist on Sea Goddess Whale Watching tours in Moss Landing and striving to attend graduate school in the fall of 2016.

Aquaculture ➔

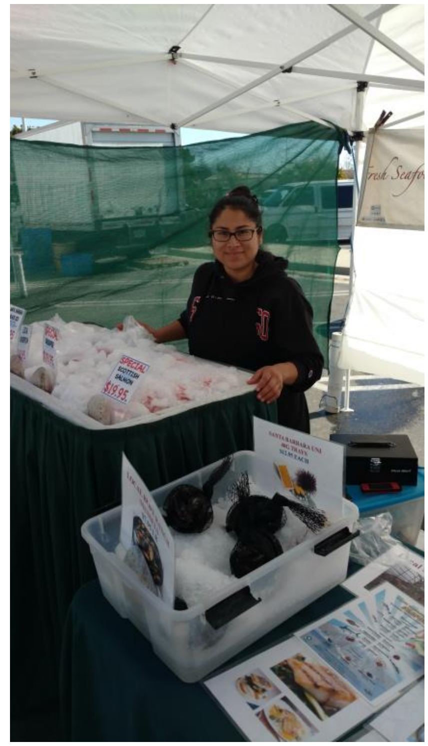
This can include salting the oceans or enclosed oceanic spaces with larvae or young, that use materials in the ocean to grow, then retrieving the product through harvest or catch. It is this latter extreme system that is of interest to CMS, where the ocean beckons with it large area and phyto-



Fish cage, Bahamas, from NOAA site.

planktonic soup. One example is shellfish farming, where the shellfish feed on the plankton or macroscopic algae (think abalone) that naturally occurs in the ocean. Indeed, the shellfish also extract calcium carbonate to build their shells. However, there is another noteworthy example between these two extreme types of aquaculture.

The wild salmon industry is close to collapse in California, as habitat and water quality have diminished greatly. The diminishment of natural stocks have opened an opportunity for farmed salmon product in our groceries and I bet there are few people who have not eaten farmed salmon, either purchasing it directly or having it served to them at a catered event. Much of our farmed salmon comes from British Columbia. Farm-raised salmon has enabled many people to enjoy this healthy treat. Salmon are typically raised in open-sea pens, often near rivers that natural salmon use for breeding. Unfortunately, there have been a number of problems with salmon farming, most stemming from the density of fish in the



California maricultured mussels for sale in Malibu.

pen. The farms use the ocean to provide the chemical environment required by the fish, as well as to dilute and distribute the wastes produce by the crop. However, this "urban fish environment" is conducive to diseases and other maladies, such as sea lice. And natural populations can be affected by these problems as individuals come near the farming pens. Sea lice may attack young wild fish, decimating the young of year. This can also happen when farm fish escape into the wild, a problem not restricted to ocean farming locations. Fish can escape from supposedly closed systems, such as those raising tilapia, and is one reason tilapia farming is restricted to SoCal deserts. And, if the farm-salmon have been unnaturally modified (perhaps through selective breeding), then escapees interacting with the wild population could produce deleterious effects on the natural population. The genetic makeup of a fish in captivity is probably not the optimum for a wild fish.

Sphere the fish, from NOAA Aquaculture office.

The other resource the salmon use is feed. Farmed-salmon feed is produced by processing smaller fish such as anchovies, etc. After all, salmon are carnivores and naturally eat these prey. For the same process that applies to the ratio of grain to cattle beef, much more oceanic fish biomass is destroyed than produced, making salmon-fish farms abusive on the ocean.

Finally, the pens are a hazard to marine mammals, who may get entrapped in the netting as they try to catch these apparently ready prey. Also, the fish waste is concentrated as the fish are, enhancing the nitrate concentration that may promote algal blooms and in general make an unhealthy environment.

So, in a sense, the farming of salmon is equivalent to the raising of cattle, perhaps worse, as cattle are natural grazers not carnivores. These are reasons to be concerned with California mariculture.

That said, I know of only 3 practicing or seriously planned mariculture projects in SoCal. An ongoing concern is Hope Ranch, the brand of the Santa Barbara Mariculture company. The other two operations are threatening to produce seafood.

Hope Ranch is a brand of mussels produced off the coast of Santa Barbara. It is actually in operation, producing a non-native mussel for foodies in the Santa Barbara area. Hope Ranch is reported to be 25 acres located off Santa Barbara where the seabed is at depth of 80 ft. The mussels are grown on lines or bags suspended below the surface. They extract minerals and food from the ocean waters that flow through them, such as calcium carbonate to build shells and plankton for nourishment. Bivalve waste is not considered a problem and, indeed, the bivalves are thought to provide an ecological service by consuming phytoplankton and cleaning the water. Of course, this begs the question of who would consume the plankton if the bivalves didn't. Raising bivalves in SoCal does not appear to be environmentally threatening, as we have not heard of problems with oyster farming off the northern coast of the state, including Tamales Bay and the former Drake Estero's operations. However, the SoCal operations would/are in open waters, not estuaries, and have to withstand the wild surf that we occasionally get. The Santa Barbara Mariculture Company can grow 120,000 lbs of mussels per year. But this is a small operation compared to the proposed Catalina Sea Ranch.

Catalina Sea Ranch doesn't produce anything, yet, being stuck in permitting hell. Rumor has it that the Catalina Sea Ranch developed plans to grow mussels after consulting with the Santa Barbara Mariculture Company people regarding techniques. The ranch operation is planned to be so large that it attracted great scrutiny from regulatory agencies, who are now also looking more closely at little Hope Ranch. No good deed goes unpunished.

Catalina Sea Ranch plans to operate offshore Huntington Beach, not too distant from the oil platforms familiar to SCUBA divers. Hence, it would be seen from boaters going to Santa Catalina and possibly from the island (the rigs are visible, especially on a clear night from the hills surrounding Avalon). The operation would look somewhat like the Hope Ranch operation in the mechanics of immersing mussels in the sea; however, it is planned to be much larger (raising a couple of million pounds of mussels) and would be located near the shelf break, which presumably aids in directing nutrient rich water towards the bivalves. They also have oysters and scallops on a future menu.

One interesting aspect of the Catalina Sea Ranch is a data gathering system that involves buoys, Remotely Operated Vehicles (ROVs) and a real-time internet feed to constantly monitor the operation remotely. These data are probably required to meet regulatory requirements. The data measurement system is so sophisticated that it has generated patents and its own business. What data would be measured? One would think that water quality would be monitored for such items as harmful algal blooms generating domoic acid, or petroleum spills, and perhaps dissolved oxygen, pH and temperature, i.e., the same parameters CMS measures at Santa Catalina. They would also have to surveil for entrapped mammals, structure-destroying flotsam, dysfunctional navigational markers, structural integrity, or the lack thereof that may produce flotsam, etc. as well as mussel predators, such as sea stars (remember them?).

The other planned operation is that of Rose Canyon Fisheries. They hope to raise fish 4 miles off San Diego. They seem to leverage the Hubbs-Seaworld Research Institute (HSRI) model for growing seabass described above and elsewhere. I write this because they are in cahoots with HSRI to raise white sea bass. They also intend to produce tuna. When we reported on the HSRI effort a couple of years ago (*OceanBights* Vol 3, No. 2), we described the process of producing sea bass but were not attuned to this process being aquaculture. But we understand how the HSRI work can address many of the weaknesses of the salmon farming discussed earlier. One of the pluses for the HSRI work is that their fish are spawned from wild-caught fish; hence, there is no genetic modification. While in captivity, the fish are fed a specially developed algae-based food, eliminating the need to feed the carnivorous fish, well, fish. However, after the sea bass reach a more-defensible size, they are released to pillage the ocean and grow large like white sea bass. Hence there is still this biomass loss as small fish become fodder for the up-the-food-chain sea bass. Clearly, the Rose Canyon Fisheries would not release fish into the wild. So problems stemming from a large number of fish in a small enclosure have to be dealt with. How the sea bass raising process works for tuna, we do not know.

Fish farm, from NOAA Aquaculture Office.

Rose Canyon Fisheries, Inc. is a partnership between HSRI and Cuna del Mar, LP, a company that owns and develops mariculture in a variety of locations. It is not a mom-and-pop operation, nor is Catalina Sea Ranch. The National Oceanic and Atmospheric Administration (NOAA) which runs the National Marine Fisheries Services, is encouraging mariculture in federal waters, so we can expect to hear of many other proposed mariculture operations in the future.

But the process to get up and going is not an easy one and requires deep pockets (i.e., those of large corporations). Permits are required from many agencies, including: NOAA; the U.S. Coast Guard; the U.S. Army Corps of Engineers; the U.S. Environmental Protection Agency; the California Department of Fish and Wildlife; and, the California Coastal Commission. Good luck with that.■

Volunteer for our Depth-Profiling Program

Can you deploy a 7-lb instrument from a boat or kayak? CMS has an active program to measure ocean chemistry around Santa Catalina Island and we could use your help. Contact us for more information.

Ocean Sciences Whirlwind

One of the most remarkable scientific conferences in the world is the Ocean Sciences Meeting, which is sponsored through a collaboration of 3 scientific societies dedicated to studying the earth and especially the ocean. The Ocean Sciences Meeting brings together all aspects of science related to the ocean, including marine biology, physical oceanography, government agencies, data providers, data organizers, policy, education and outreach, and, of course, vendors of instruments and books, as well as recruiters for universities.

This year in New Orleans there were approximately 5,000 attendees, listening to over 1,500 orals presentations and viewing about 3,500 poster presentations, with one poster contributed by CMS. I am always amazed at what people are working on, what they think is important, and the techniques they use to investigate their issues.

Watering hole in poster hall.

However, with so many presentations occurring simultaneously, people are frustrated at not being able to see all that interest them: ocean acidification; primary production; internal waves and mixing; climate change effects; coral bleaching; California currents; …

What were some of the highlights? Well, one plenary session described an experiment related to mining the seabed. The experiment scraped the bed repeatedly in the deep ocean and then returned every few years to see how the seabed reacted. Sadly, the seabed did not recover after more than 20 years.

And amazingly, we saw plans for re-engineering the Mississippi River to keep its delta sustainable. This would be terraforming, on a massive scale, the river flowing within a few hundred meters of the meeting.■

Upcoming Meetings

Southern California Academy of Sciences, May 6-7, at USC.

9th California Island Symposium, Oct 3-7, Ventura, CA.

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