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Pacific Coast Science and Learning Center
Point Reyes National Seashore

Parks for Science

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In Search of the Great White Shark

Few predators conjure images as iconic as the great white shark (*Carcharodon carcharias*). But as it turns out, the idea most of us have of these sharks—as aimless wanderers blindly trolling the ocean, ready to sink rows of jagged teeth into anything that moves—doesn't hold much water.

The lives of white sharks are a lot more complex than once thought, but it's not entirely clear what drives their sophisticated behavior. Scientists do know that every fall, many of these top predators swim to the coast of northern California in pursuit of their favorite prey—the elephant seals, sea lions, and harbor seals that haul out on the region's beaches. And as long as the weather cooperates, each day during "shark season," from October to December, graduate student Taylor Chapple of the University of California, Davis, and his assistants patrol the coastal waters off Tomales Point at Point Reyes National Seashore in search of the giant fish.

Chapple is part of a large team that includes collaborators based at UC Davis, Stanford University, the Monterey Bay Aquarium, and the Pelagic Shark Research Foundation. They gather data on white sharks from Point Reyes to Año Nuevo and the Farallon Islands west of San Francisco to the Hawaiian Islands.

"In the northern Pacific, we don't have any population estimates and only limited data on large-scale movements and habitat use," says Chapple, "so that's basically what the project's looking to do."

To attract sharks, the team uses a simple decoy made of carpet that floats at the surface and is shaped like a seal. Often, the animals can't resist investigating, even without the use of chum and massive amounts of bait in the water—a trick which can induce the violent behavior featured in television specials and movie cameos.

© Taylor Chapple

Drawn to the seal-shaped silhouette, a shark cautiously checks to find out whether this decoy might make a good meal. Long seen as mindless eating machines, research has shown that white sharks are more complex than once thought.

"We don't need all that," Chapple says. Rather, the idea is to take advantage of the animals' natural curiosity. "We're trying to get the animals up so that we can get data from them," he adds. Typically, just the shark's dorsal and caudal (tail) fins appear, knifing through the surface as it nudges or circles the decoy. But Chapple has seen sharks thrash the carpet seal to pieces or dive with it in their mouths.

At the first sign of a great white, someone yells, "Shark up!" and the crew surges into action. One researcher begins firing pictures with a digital camera. "The dorsal fin—the trailing edge of it—is basically like a fingerprint," Chapple says, and they compare the photographs taken here at Tomales Point with the ones their collaborators take, for example, at the Farallons, tipping the researchers off to where sharks are going and if they're moving in any sort of pattern.

Meanwhile, another assistant reels in the decoy to draw the shark closer to the boat,

Feature Articles

and they drop a video camera attached to a pole into the water to look for any distinguishing markings and to determine the animal's sex. If it gets close enough, Chapple uses a long metal rod to attach one of two types of small tracking tags to the shark just behind the dorsal fin.

Satellite tags give the team information about "transoceanic movements," which involve forays thousands of miles into the middle of the Pacific.

The other type, called an acoustic tag, helps researchers determine which sharks are in a particular area and provides information about their movements on a smaller scale. A receiver with a lead like a micro-phone that hangs from the boat into the water picks up the unique code from each acoustic tag attached to a shark and spits out a number on a digital readout. This signal alerts the crew to the presence of a particular shark in the vicinity of the boat, even if there's no activity at the surface.

Acoustic tags are also used by other researchers to study everything from sea turtles to whales. Because the technology is based on a similar platform, a tag attached to a salmon can "talk" to Chapple's receiver. Or, one of the sharks he tagged might ping the receiver of someone studying sturgeon. This overlap vastly expands the pool of potential collaborators, he says, and bolsters research that incorporates information about not only sharks, but other important species living in the sea.

With each day on the water, Chapple and his colleagues learn more about this famous, but poorly understood predator. Swimming at the pinnacle of the food chain, the great white exerts a sweeping influence over the ecosystem, but many scientists believe the species is in trouble. As the ocean changes in the wake of shifting climate conditions, overfishing, and other human-induced effects, the importance of understanding shark ecology grows exponentially. From this shark's-eye view of the marine environment, we can begin to understand what's going on in the ocean—not as we see it from our distant vantage point, but as its inhabitants do.

For more information, visit http://www.topp.org/species/white_shark.

Sea Change in Tomales Bay:

In late October 2008, the Giacomini wetlands in the Golden Gate National Recreation Area filled with the high tide for the first time in more than 60 years, marking an important milestone in rehabilitating the Tomales Bay watershed.

"This is an incredible moment in history," says Don Neubacher, superintendent of Point Reyes National Seashore, which manages the project. "The community has created 560 acres of wetlands to enhance the long-term health of Tomales Bay and all of its inhabitants. This gives me hope for the future." This project restores 12 percent of the outer coastal wetlands in central California.

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On October 25, 2008, the old Giacomini dairy ranch sat as it has for six decades—sheltered from the tides.

A sizable chunk of this critical wetland complex was lost around the beginning of the 20th century, when a levee was constructed across the mouths of Bear Valley and Olema Creeks to create a road. Then in 1944, the Giacomini family purchased the land to increase milk production for the wartime effort, later constructing levees around some of the remaining wetlands. These modifications halted the dynamic system that supported large wildlife and plant communities and fundamentally transformed what was once one of the largest tidal marshlands in Tomales Bay.

For more than 50 years, these once-rich wetlands supported a dairy farm. Then in 2000, the Giacomini family sold the ranch to the National Park Service so that the wetlands could be restored. To ensure the most successful and beneficial restora-tion possible, the project involved years of scientific analysis and careful planning. Timed to coincide with the levee breach, the majority of the construction work has been completed. In the past year, dedicated workers have been removing levees, stabilizing creek banks, removing agricultural structures, realigning Tomasini creek, creating tidal channels, and establishing high tide refuges for endangered species. Restoration biologists predict that once the habitats are restored, native plants and animals will naturally come back and repopulate the wetlands.

An unanticipated breaching of the levees by an unusually high tide in July offered just such a glimpse of what's in store as natural processes begin to exert their influence on this area once again. Bat rays and leopard sharks were washed over the barriers to be among the first to reclaim this new territory. And pickleweed, an important plant in salt marsh ecology, began to reestablish from just this one occurrence. This resurgence of native species suggests that the ecosystem is highly resilient and should improve quickly.

The newly restored Giacomini wet-lands will create habitat for many endangered or threatened species. Fish, such as coho salmon, steelhead trout, and green sturgeon; birds, including the California clapper rail; and mammals, such as the southwestern river otter, are all expected to take up residence. The wetlands will also provide an important stopover for migratory waterfowl and shorebirds, and will create a nursery and foraging area for the likes of seals, sharks, and rays.

The Giacomini Wetlands Restoration

"The opportunity to return full function to this dynamic and beautiful place is a true privilege," says Brannon Ketcham, a hydrologist at the Seashore.

In addition to improving the biology of Tomales Bay, hydrologists also predict that the Giacomini wetlands will improve the bay's water quality. Previously, levees funneled the flow and pollutants directly to the Bay, causing excess sediment, pathogens, nutrients, and mercury to enter the water.

Now, with the levee removal and restoration, the wetlands will act as a sieve the pollution entering the bay. The blossoming saltwater, brackish, and freshwater marsh communities will begin to filter out pollutants in the coming years.

The Seashore also strives to make the Giacomini project a tool for teaching the importance of wetlands. Seashore staff and other scientists have held monthly seminars detailing aspects of the restoration. During the levee breach at the end of October, park staff hosted a viewing of the tides with spotting scopes, a walk out into the area, and an open house, attended by about 500 people.

The reintroduction of the tides is merely the beginning of the story. Myriad changes will take place in the years to come, allowing the area to continue to serve as a natural classroom.

"We have helped to bring back something truly special," says Lorraine Parsons, who managed the project and is based at Point Reyes National Seashore. The Giacomini project is "something that will make Tomales Bay a better place for both people and wildlife," she adds.

To learn more about the story of the Giacomini Wetlands, visit http://www.nps.gov/pore/parkmgmt/planning_giacomini_wrp. htm

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On October 26, after the final levee was removed, the high tide filled the East Pasture, beginning a transformation that will increase the outer coastal wetlands in central California by 12 percent.

Coho Salmon Monitoring in Redwood Creek

The population of endangered coho salmon (*Oncorhynchus kisutch*) along the West Coast of the United States is only about 1 percent of historic levels. Scientists attribute this decline to introduced diseases, overfishing, dam construction, and habitat loss. Large-scale weather patterns that change ocean dynamics such as El Niño also affect salmon survival. Since 1997, National Park Service biologists have monitored coho salmon throughout their entire life cycle in Redwood Creek.

Adult coho build gravel nests called redds in freshwater streams and lay their eggs where the water moves quickly enough to provide oxygen. After nearly six weeks, the eggs hatch, and tiny, bug-eyed coho called alevin that emerge live off their attached egg sacs for another six weeks.

It's only once this food source is exhausted that they leave their gravelly homes in the spring as juveniles, still lingering in shallow, near-shore areas where they live among tree roots, woody debris, and rocks in the shady parts of the stream.

Young coho ply the stream's waters until the next spring when they undergo a process known as smolting when a host of changes occur—including the way their gills and kidneys function—so they can live in saltwater. Then, the transformed coho migrate out to the ocean to mature into adults for another 18 months or so before returning to the stream where they were born, ready to spawn and begin the cycle again. Unlike their cousins, the steelhead trout, which can make several runs to and from the ocean in a single lifetime, coho salmon reproduce only once before they die.

Because female coho are three years old when they spawn, each three-year cycle represents a distinct population—what scientists refer to as a year class ("Status of Redwood Creek Coho Salmon" on page 4). While each of the three salmon year classes in Redwood Creek shows a distinct population trend, the 2007 and 2008 counts have declined markedly from previous years.

© Richard James

Plucked temporarily from its watery lair, this coho smolt is set to be weighed and measured, providing biologists with valuable information about the health of the salmon population, before returning to Redwood creek.

An Internship at Point Reyes National Seashore *By Eli Gross*

At the beginning of the summer, I was looking for an internship of some sort, but I wasn't sure what type of work I wanted to do. I decided to look for something with the National Park Service, and with the help of a friend, I found out about an opportunity to intern in the fisheries office at Point Reyes National Seashore. It sounded like a great opportunity, and I decided to take the internship.

A levee at the Giacomini Wetlands site breached in July 2008, and the receding tide trapped dozens of animals. Park Service volunteers and biologists came to the rescue, capturing trapped sharks and rays in the flooded wetland and releasing them in Lagunitas Creek to return to their homes in Tomales Bay.

Even though I had no previous experience with fish, I quickly came to enjoy the work I was doing. I spent all of my time doing fieldwork, much of it spent with the Giacomini Wetlands Restoration Project. We had to remove endangered tidewater gobies trapped in the ditches of an old dairy ranch that the Seashore is now restoring to natural wetlands.

However, during my first week, a levee surrounding the ranch broke, leaving the pastures flooded. It also stranded leopard sharks, as they were unable to get out of the flooded ranch after the tide dropped. As a result, I spent a 12-hour day rescuing leopard sharks and returning them to Lagunitas Creek, which borders Giacomini Ranch. The chance to save these sharks was one of the highlights of my time at Point Reyes.

After the excitement of rescuing the sharks, the real work began, and I ended up doing something I haven't done since I was young: playing in mud. I spent many a day up to my chest in thick mud during my time clearing the ditches of gobies.

My other work involved monitoring the coho salmon and steelhead populations of the Pine Gulch watershed. This was accomplished through electro-fishing, which works by attracting fish to an electric probe that briefly stuns the fish, allowing netters to snag them. The fish are then measured and weighed before being released back into the creeks unharmed.

By the end of the summer, I had become quite good at netting fish, and I had learned how to handle fish as well. Over the course of my time at Point Reyes, I gained a sense of what certain types of fieldwork entail and how often plans have to be changed completely on the fly. Overall, it was a great experience, and I was very fortunate to have had the opportunity.

Eli Gross is a junior at Lick-Wilmerding High School in San Francisco.

Status of Redwood Creek Coho Salmon

Year class 1: Born 1998, 2001, 2004, 2007

Numbers of adults and redds (nests) have been fairly steady over the past four generations of this year class. But those numbers dipped by 50 percent between the winters of 2003–2004 and 2006–2007. The 2007 juvenile estimate was higher than the previous generation, but smolt counts in 2008 showed that fewer juveniles than expected survived the winter, probably due to low stream flows.

Year class 2: Born 1999, 2002, 2005, 2008

Historically, this year class has been strong but highly variable. The number of adults counted in the winter of 2004–2005 (born in 2002) was the highest in the history of National Park Service surveys. No adults were seen returning in the winter of 2007–2008 even though the 2008 year class started with record numbers of juveniles and smolts. However, fry were caught during spring smolt trapping in 2008, proving that at least one pair of coho had returned to Redwood Creek. More broadly, 73 percent fewer coho spawners returned along the California and Oregon coasts during this same period, likely due to unfavorable ocean conditions.

Year class 3: Born 2000, 2003, 2006, 2009

This cohort is now the smallest of the three year classes in Redwood Creek, but as recently as the 1996–1997 spawning run, it was the largest. A large-scale El Niño event that year caused high winter stream flows that decreased juvenile survival rates, and that disruption still affects population numbers today.

Take a virtual trip to Redwood Creek via the Natural Laboratory Podcast at www.nps.gov/pore/photosmultimedia

Coastal Biophysical Inventory

With the Coastal Biophysical Inventory, park scientists have an important tool to better study and manage the coast of Point Reyes and beyond. Researchers classify segments of the shoreline based on the physical habitat and catalogs the species living in each part of this diverse environment.

The Coastal Biophysical Inventory is a rapid assessment of the coastline in the intertidal zone at the Point Reyes National Seashore and Golden Gate National Recreation Area. The National Park Service manages this baseline inventory of coastal resources between Bodega Bay and Half Moon Bay.

As part of the inventory, the coastline is broken up into sections based on the shape and type of bottom cover—or substrate—that occurs in the zone created by the high and low tides. Researchers use the type of material covering the floor—for example, large boulders, rounded cobbles, coarse sand, or pebbles—to classify each distinct habitat. Then, they create transects that begin at the low tide zone and stretch to dry land, keeping track of the organisms encountered along the way. In addition to biology data collected in each unique area, many other types of measurements, observations, and photos of the coast are made. In June, they completed the inventory of more than 161 kilometers of coastline.

Members of the team then organize the collection of measurements, observations, and images into a database. With all of this information in one place, a list of the species residing in the intertidal zone and a description of the local environment can be constructed for any piece of the coastline. This tool is an invaluable resource for ongoing management planning, as well as the protection or restoration of habitat in the event of a catastrophe such as an oil spill, as it was when the Cosco Busan ran aground in 2007.

All observations were also mapped and correlated to photos, allowing biologists and ecologists to retrieve a rich bundle of information about a single location. They can also identify all the locations that meet a specific set of criteria.

The project is managed by the Pacific Coast Science and Learning Center and through a collaboration with the staff of the Partnership for Interdisciplinary Studies of Coastal Oceans based at the University of California, Santa Cruz. The Oil Spill Prevention and Response agency of the California Department of Fish and Game also partially funded this project.

For more information, contact Joseph Kinyon, GIS & Biodiversity Database Manager at Joseph_Kinyon@partner.nps.gov.

Pacific Coast Science and Learning Center (PCLSC) Partners with Universities

In a continuing effort to promote the highest quality science at the San Francisco Bay Area National Parks, the PCSLC is helping to fund 12 research projects, many of which will help inform management and conservation decisions facing the park. The PCSLC also hosted over 2,000 researcher-nights at the Tomales Bay Marine Station in 2008, and supports scientists working on many of the more than 90 research projects that are conducted in the park each year. Funded 2008 projects include:

UC Berkeley

- Variation in tanoak resistance to Sudden Oak Death, *Katy Hayden*
- Restoration of overwintering habitat: impacts on coho salmon populations, *Justin Lawrence*
- The ecohydrology of coastal sand dunes in Mediterranean climates, *Allison Green*
- Insect phylogeography and conservation of coastal sand dunes, *Matthew van Dam*
- Tule elk and human interactions at Tomales Point, *Christopher Moi*

UC Davis

- The effect of elasmobranches on habitat use of the invasive European green crab in Tomales Bay, *Caitlin Coleman-Hulburt*
- White shark movements at Point Reyes, *Taylor Chapple*
- Population dynamics of high intertidal isopods, *Renate Eberl*
- Linking oceanographic conditions and recruitment of invasive species in Tomales Bay, *Andy Chang*

UC Santa Cruz

- Demographic status of the Point Reyes elephant seal colony and predictions for future growth, *Ramona Zeno*

Washington University in Saint Louis

- Causes of rarity and invasiveness in thistles and lupines, *Steve Kroiss*

State University of New York - Stony Brook

- Current and future status of pine pitch canker in a bishop pine forest at Point Reyes, *Emily Thompson*

For more information on PCSLC research and science communication programs, go to http://www.nps.gov/pore and click on PCSLC.

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Parks for Science showcases creative and collaborative science, science education, research, and natural resource management supporting science-informed decision making within the national park system and associated academic institutions and partners. The Pacific Coast Science and Learning Center is a part of the San Francisco Bay Area Network of Parks and is located at Point Reyes National Seashore.

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Parks for Science was edited and produced by John C. Cannon.

Point Reyes Home to New Species of Lichen

In July, lichenologist Kerry Knudsen discovered *Lecanora simeonensis* (pictured at right), a species of the symbiotic organism composed of algae and fungi that was previously unknown to science. Knudsen was participating in a lichen-collecting field trip to the Seashore that preceded a meeting of the International Society of Lichenologists, and he found the specimen on a fence near the Bear Valley Visitor Center.

This new discovery will add to the growing database of knowledge being gathered by the National Park Service's All Taxa Biodiversity Inventories.

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Read more at http://www.nps.gov/pore/parknews/newsreleases.htm.

Newsletter Subscription

To be placed on the mailing list for Parks for Science, write to Jessica_Luo@partner.nps.gov, and let us know whether you would prefer a PDF or a print copy.

Internships

If you would like to be considered for an internship with the Pacific Coast Science and Learning Center, please contact Ben Becker with a cover letter and résumé: Ben_Becker@nps.gov.