UC SANTA BARBARA

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# Scientists use drones to track white sharks along California beaches

The forecast at the beach today is cloudy, with a chance of sharks. At least, that's the forecast that researchers at UC Santa Barbara would like to be able to provide. They're leading a project to predict when and where great white sharks show up near a beach.

The goal is to develop forecasting tools that can help predict what times of year, what times of day, or what ocean conditions are likely to be more or less sharky. The team set out to understand what fine-scale factors affect shark behavior at all life stages. "Predicting when sharks will turn up is something of a holy grail in shark science," said Douglas McCauley, a professor in UCSB's Department of Ecology, Evolution, and Marine Biology. "But even initial insights can help us make better decisions: Is today a better day for surfing or beach volleyball?"

As of now, shark presence is still hard to predict. But some first steps toward that goal were shared in a report published in the Marine Ecology Progress Series, after a two year study at Padaro Beach in Carpinteria, Calif. Lead author McCauley and his team used aerial drones to observe how shark presence varied with different oceanographic conditions. Water temperature, season and time of day seemed to correlate most with shark density off the coast, they found. These insights may help inform shark conservation and beachgoer safety.

## A shark’s schedule

Some things in nature are easy to predict: The ebb and flow of the tides, the emergence of cicadas, the changing of the fall foliage. But white shark movement is hard.

Many factors influence the decisions of an animal as complex and intelligent as a shark, especially in an environment as dynamic as the ocean. Where sharks turn up is shaped by their life stage, the behavior of their food, oceanographic conditions and long-term patterns associated with climate change.

To assemble their forecasting model, the team used aerial drones to count the number of white sharks near the beach and then measured as many other features about the ocean as they could. This included temporal factors — like the time of day and season — as well as physical characteristics, like swell and wave height, water visibility, surface and seafloor temperatures. They also considered biological factors like the amount of plankton in the water (a proxy for the fertility of the food web these sharks rely on).

The drone aspect of this project was relatively novel. The group has used all kinds of methods to count sharks over the years: having divers tally them as they swim by, counting sharks by sonar, and marking them with tags. But for this study, the team sent out a drone to fly a pre-programmed, one-mile flight path just outside the surf line. “One of the strengths of this method is that you can cover a lot of ground in these surveys, and because the sharks have no idea there is a drone overhead, they are easier to count,” explained co-author Neil Nathan, a project scientist at UCSB’s Benioff Ocean Science Laboratory. “A disadvantage is that you can really only image the surface layer of the ocean.”

To fill in these blind spots, researchers at UC Santa Barbara have been collaborating with experts at Professor Chris Lowe’s Shark Lab at CSU Long Beach. Lowe’s team has studied white sharks in this region for years, providing additional data streams through tagging efforts and acoustic buoys. Pairing these visual and acoustic data provides a better picture of these population patterns over time, but it wasn’t a part of this particular study.

Finally, the authors combined shark sightings and oceanographic factors with mathematical models to see what combination of variables best predicted how many sharks there were at the beach on any given day.

## Warm waters for lil’ sharks

Ocean temperature and time of year were among the very few factors that seemed to correlate well with where and when sharks appeared. White sharks are actually somewhat warm-blooded; they can keep their core a little bit warmer than the water around them. But they still get chilly, especially the smaller ones, which lose heat faster. The researchers found that smaller white sharks tended to avoid colder temperatures close to the seafloor and were slightly more attracted by warmer surface waters.

There were also significantly more sharks in summer, fitting in nicely with the temperature findings. That said, they still observed some juveniles even in November and December. Before this, researchers had thought that the youngsters headed south to warmer climes for the winter.

Most of the individuals in Carpinteria were juveniles, indicating that the beach is an important nursery habitat for baby white sharks. But there are some older sharks out there as well. The largest sharks measured up to 15 feet.

The drones spotted more sharks near the surface in the late afternoon. That, again, may be because they are trying to warm up in these warmer surface waters. “Compared to water at depth, [the surface] feels like a jacuzzi to these sharks after the sun warms [... it] all day,” Nathan said. This is the same slice of ocean that we like to play, swim and surf in. Eight times more sharks were seen right at the surf break, versus farther out to sea, he added.

## Sharing the waves

This is a good time to be reminded that the people of California have experienced, on average, only three “shark incidents” per year since 1950. And the California Department of Fish and Wildlife defines an incident as “any documented case where

a shark approached and touched a person in the water.” It turns out sharks make pretty good neighbors.

McCauley grew up on the beaches of Southern California, but he doesn’t recall seeing a single shark from the shore or in the water throughout the decades of his youth. Glimpsing 10-15 in a day is a welcome sight; it means the state’s wildlife is recovering.

White shark populations were hit hard by gill nets for decades, as were seabirds and marine mammals. The state has slowly phased out many types of gillnets and is now considering potentially eliminating the last form of gill netting allowed. These policy changes — along with added protections for marine mammals — have done a lot to repair our coastal ecosystem. “One generation later, I was blown away to drop my kids off for their first days of surf camp in Carpinteria and see baby shark fins just outside the surf line,” McCauley said.

Californians are familiar with the importance of finding safe ways to share our mutual home with wildlife. What is happening in the surf is similar to how we use science to co-exist with predators on land, like mountain lions or bears. “Right now co-existence is largely going well, as people at these beaches seem to have much more interest in the sharks than vice versa,” McCauley said.

In fact, one of the most exciting things to come out of this project was the collaboration with the community. “Everyone was curious about the scientists flying a drone on the beach,” said Samantha Mladjov, lead SharkEye drone pilot and study co-author. “The one thing everyone wanted to know was, ‘What did you see: Are there a lot of sharks out there today? Should I go for a surf or a run?’”

As a result of the interest and curiosity, the team quickly spun up an automated text notification system that shared the results of the day's survey in real time. “We think data is empowering and helps us make safer, smarter decisions,” said Nathan. “Our goal in this program is to provide data that helps people fall more in love with the ocean. It helps them understand it better and feel and be safer, even though the probability of an incident with a shark is exceptionally low.”

The team welcomes community members to check out live data on SharkEye.org and sign up for free text notifications from the shark survey program. McCauley and Nathan also encourage people to follow the current conversations about reform to

the gillnet fishery, which can add to the momentum in wildlife recovery along our beaches and coasts.

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