

Citizen Science and Sharks

Traditionally, academic science has used graduate students to collect data in many cases, but community science, the term by which *citizen science* is also known, has revolutionized the process by which large amounts of data can be collected accurately by large numbers of non-scientists under the training and mentorship of scientists. There has been some discussion in the scientific community about whether the data collected by citizen scientists is as scientifically valid as data collected by traditional methods and this is a fair question to ask.¹

In the world of marine science, citizen science has also been used to monitor the impact of invasive marine species in specific communities.² Several marine non-profit organizations, including Reef Environmental Education Foundation (REEF) and Reef Check California, have successfully collected and submitted data using citizen-science methods for use in coastal management and marine biology studies.^{3,4}

Comparatively fewer studies have been done with citizen science and sharks. One encouraging study has shown that data collected by citizen science divers on reef sharks has indicated that they are on par with that collected by automated methods, such as acoustic telemetry.⁵ Gabriel Vianna is quoted in Science Daily as saying, 'Our study shows that with a little bit of training and a good sampling design, recreational divers collect very useful data that can be used to monitor shark populations over long periods of time and across large spatial areas. Such programs have relatively small costs when compared with other methods currently used.'⁶

Citizen Science and Broadnose Sevengill Sharks

The San Diego-based non-profit Ocean Sanctuaries was founded in 2014 to create and provide support for marine citizen science projects. The Sevengill Shark Identification Project was one of its first citizen science projects, begun in 2010 in response to anecdotal evidence that divers were seeing increasing numbers Sevengill sharks off the coast of San Diego. This made the species an ideal candidate for a long-term (5-10 year) population study.

During this period, Ocean Sanctuaries partnered with information architect Jason Holmberg, who had helped design the original pattern recognition algorithm that had been used to identify Whale Sharks (*Rhincodon typus*).⁷ Holmberg later used this and another algorithm to create **Wildbook**, an open source software framework to support collaborative mark-recapture, molecular ecology, and social ecology studies, especially where citizen science data needs to be incorporated and managed.⁸

The Sevengill shark (*Notorynchus cepedianus*), named for having seven gill slits on either side of its body, as opposed to the normal 5 gills, reaches lengths of 3 m with an average length of 1.5 m. They weigh up to 107 kg and are known to live as long as 49 years.⁹

Sevengills are usually found over the continental shelves in shallow waters off the West Coast of the United States, Australia, New Zealand and South Africa. They are often sighted close inshore, in bays and estuaries, with larger individuals having ranges that include deeper waters offshore and deep channels in bays to 570 m. They are seen usually cruising slowly near the bottom, even in waters as shallow as a meter, and sometimes at the surface. Sevengills are known to hunt in packs and can attack at great speeds when pursuing prey. They prefer rocky bottom habitats although they commonly occur over sandy and muddy bottoms as well.⁹

Although this shark has a wide range, it is subject to intense fishing pressure as a result of being restricted to inshore waters. Currently the World Conservation Union (IUCN) lists the Sevengill shark as '*Data Deficient*.' It is currently assessed as '*Near Threatened*' in the eastern Pacific Ocean.”⁹

This provides an excellent reason for conducting a citizen science population study of this species in the Southern California.

Study Methodology

How does this citizen science project work? Divers do their normal dive and if they observe a Sevengill shark and can take a photograph of the lateral view of the head and gill area *without endangering their safety*, they do so and then upload that photograph to the '**Wildbook**' database at Sevengill Shark Sightings.

This study has now expanded to Cape Town, South Africa, as part of a citizen science partnership between Ocean Sanctuaries and the Two Oceans Aquarium in Cape Town, as part of an effort to include citizen science photographic documentation from False Bay, South Africa, another area where this species is commonly seen.¹⁰

Contained within **Wildbook** are *two pattern recognition algorithms*, which scan submitted photographs and analyze the black freckling pattern seen around the eyes and gill area of this species, which identify individuals in much the same way as a fingerprint does. In this way, photographs submitted over time in a single location can determine if and which sharks are returning to the same location from year-to-year. ¹¹

High definition photographic data collection methods are replacing the older diver identification method, because they are more accurate for species identification. The Sevengill project uses high definition photography which provides much more detail about encounters with this species.

Data Sets

Although this is an all-volunteer, citizen science project, Ocean Sanctuaries wants to keep the methodology as scientifically current and accurate as possible, while still keeping within the scope and means of a citizen science project. So, here is a summary of the databases and methods used in this long-term (5-10 year) populations dynamics study of the Sevengill Shark (*Notorynchus cepedianus*).

Ocean Sanctuaries is not set up for shark tagging, which is both expensive as well as labor intensive and usually requires boats, crew and an affiliation with a marine research institution and grant money to operate.

1. Database #1: Photographic Database: over 100 photographs, of varying quality, from poor to outstanding, taken over the past 4 years by local divers of Sevengills in the San Diego area. It is the best of these photographs are run through the pattern recognition algorithm to identify individual Sevengill sharks through the freckling pattern commonly seen on their front and dorsal sides, much as biologist Brad Norman did a few years ago to identify individual Whale sharks via the star-like patterns on their dorsal sides.

2. Database #2: Video Database: the video database of over 70, mostly high definition, high quality videos, also taken by local divers, is used also, to aid in determining gender and behavioral patterns observed, as well as bite marks and scratches, etc. They also will be

subjected to the pattern recognition algorithm.

3. Pattern Recognition Algorithm: **Wildbook**, mentioned above, uses two sophisticated pattern recognition algorithms, IS3 and SPOT, to identify individual Sevengill sharks via the unique freckling pattern that can be seen on their front and dorsal sides.¹²

Since this is a long-term population study spanning 5 or more years, we are still analyzing the data, but preliminary results with the algorithms have been promising and Ocean Sanctuaries plans to publish it's results within the citizen science community in the near future.

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