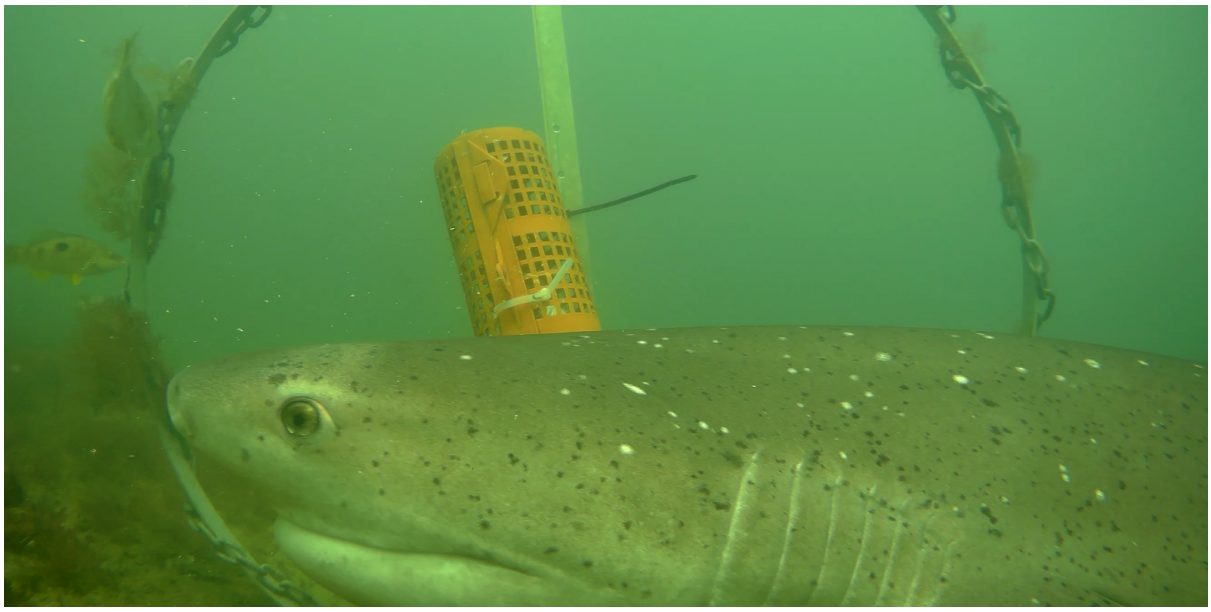
Otago Participatory Science Platform 2020

Shark Spy, Monitoring Otago Sharks



Report prepared by

Rob Lewis, Sally Carson

For the purpose of partial fulfilment to the Otago Museum Trust Board ("OMTB") OSPS General funding agreement to the New Zealand Marine Studies Centre, University of Otago in 2019.

Main contributing schools / groups:

Bayfield High School, John McGlashan College, MacAndrew Bay School, Kaikorai Valley College, Hinds High School, South Otago High School, Catlins Area School, and Waitaki Girls High School.

Table of Contents

Introduction

There are multiple shark species that inhabit coastal ecosystems around New Zealand that lack demographic data (e.g. abundances, seasonality, age structure, sex ratio; Ford et al., 2018). Sharks play an important role as apex or meso-predators by shaping coastal food webs via consumptive and non-consumptive effects (Heithaus, 2005; Estes et al., 2011; Heithaus et al., 2012). The Otago region has a rich marine diversity including multiple shark species. Previous research has indicated that several species of shark frequent the coastal waters around Dunedin including but not limited to:

- Great white shark, *Carcharodon carcharias*
- Sevengill shark, *Notorynchus cepedianus*
- Porbeagle shark, *Lamna nasus*
- Blue shark, *Prionace glauca*
- Thresher shark, *Alopias vulpinus*
- School shark, *Galeorhinus galeus*
- Rig shark, *Mustelus lenticulatus*
- Spiney dogfish, *Squalus acanthias*
- Carpet shark, *Cephaloscyllium isabellum*

(Graham, 1938; Anderson et al., 1998; Roberts et al., 2008; Housiaux et al., 2018; Bill Dickson pers. comm.)

Unfortunately, the lack of demographic information on many species limits conservation, management and policy initiatives. Sharks are however, a captivating and enigmatic group of marine animals and people are often enthusiastic to learn more about them. This presents an opportunity for the wider community to be involved in collecting data (connecting the community to science and the environment) while increasing our understanding of shark demographics.

The same rich marine diversity that attracts sharks has also made the Otago region a hotspot for ocean activities including commercial and recreational fishing, spearfishing, kayaking, surfing, windsurfing, swimming and diving. A spate of attacks which occurred between 1964 and 1970 resulted in a fearful reputation of sharks locally, with shark nets being installed at

St Kilda and St Claire beaches to reduce the shark population. It is no surprise then, given their fearful reputation that some believe 'the only good shark, is a dead shark'. Luckily the perception of sharks has been slowly changing in the last two decades, and while there is still a fear for safety, people have also fostered genuine interest in knowing more about sharks in general.

For these reasons and more there have been numerous occasions that local people or groups have contacted the Marine Studies Centre expressed interest to about knowing more about sharks in the Otago region. Consultation with a wide range of community groups in early 2019 provided a range of observations and questions about the local shark populations. Recreational fishers' have reported novel feeding behaviours and have concerns about the condition local shark populations are in. Speardivers, divers, swimmers, surfers and free-divers tended to want to avoid large sharks and were interesting in their abundance patterns (i.e., when and where are they more likely of running into a shark?). Most of the information on sharks local to Otago comes from commercial catch data (dead specimens) which has its own set of biases such as fishing gear selectivity, or not fishing in the same areas as where people dive or surf. Shark Spy sought to address the questions and concerns of the local community while increasing our scientific understanding of local shark demographics for better conservation purposes.

As sharks are subtidal, wide ranging, and relatively large and long-lived species, studying them has its challenges. To collect information about seasonal distribution, relative abundances and some demographic structure of shark populations, searching for and sighting sharks at different times of the year is required. Baited underwater videos (BUVs) have become a popular option to collect this information in recent years owing to their cost-efficiency and ease of use. They are non-invasive and have been used effectively in monitoring sharks in the past (Marshall & Pierce, 2012; Santana-Garcon et al., 2014). BUV's can provide information about species diversity, seasonality and abundance of sharks and their prey species when used as systematic surveys. Sightings can also be reported by any member of the community that happens to come across a shark. Reporting opportunistic encounters of sharks by the wider community (divers, surfers, fishers, boat users etc.) provides incidental occurrence data which can identify seasonality and distribution.

Aims and Objectives:

The purpose of Shark Spy was to explore the abundance and demographics of shark, ray, skate, and chimera populations along the Otago coast while involving the wider community in the process of data collection, data analysis and discussion of the results. The specific objectives were to:

- Gain understanding of the species composition, relative abundance, and demographic parameters of shark populations in coastal Otago (including North and South coasts) using underwater baited video.
- Gain understanding of the distributions of local shark species along coastal Otago via incidental reporting of shark observations by the wider community.
- Record occurrence of shark and skate egg cases along the Otago Coastline.
- Educate the Otago community about local shark ecology and behaviour.

About this project

This project was conducted in collaboration with the New Zealand Marine Studies Centre, the University of Otago, schools and the wider community. The BRUV footage was collected and analysed with classes of students from seven secondary schools and one primary school from Dunedin, Balclutha, Catlins and Oamaru. Individual students from a range of schools and the wider community were also involved through the NZMSC science extension and enrichment programmes. Community shark sightings came from a range of people within the Otago region and the egg case survey data was carried out in conjunction with Sustainable Coastlines, a nationwide beach litter survey project. Shark egg cases found on their surveys are reported directly to iNaturalist but have encompasses numerous Otago beaches.

This project was funding through the Otago Participatory Science Platform (MBIE Curious Minds).

Methods

Shark Spy employed three methods of data collection which included systematic surveys using BRUV , reporting of incidental sightings by the public, and reporting chondrichthyan egg case sightings using beach clean-up days and incidental reports.

Baited underwater video (BUV)

Study site

The area of sampling for Shark Spy included the Otago harbour and the adjacent coastal areas, Oamaru Harbour and the Catlins Estuary. The maximum depth of the sample areas was 30m, minimum was 5m. Substrate varied depending on location but generally fell into mud/sand or mud/cobble. Sample site locations are displayed in figure 1 and figure 2.

Figure 1. Map of all sampled locations using BUV's in 2020/21 along the entire Otago coastline. Sites were concentrated in Dunedin, Oamaru, and the Catlins.

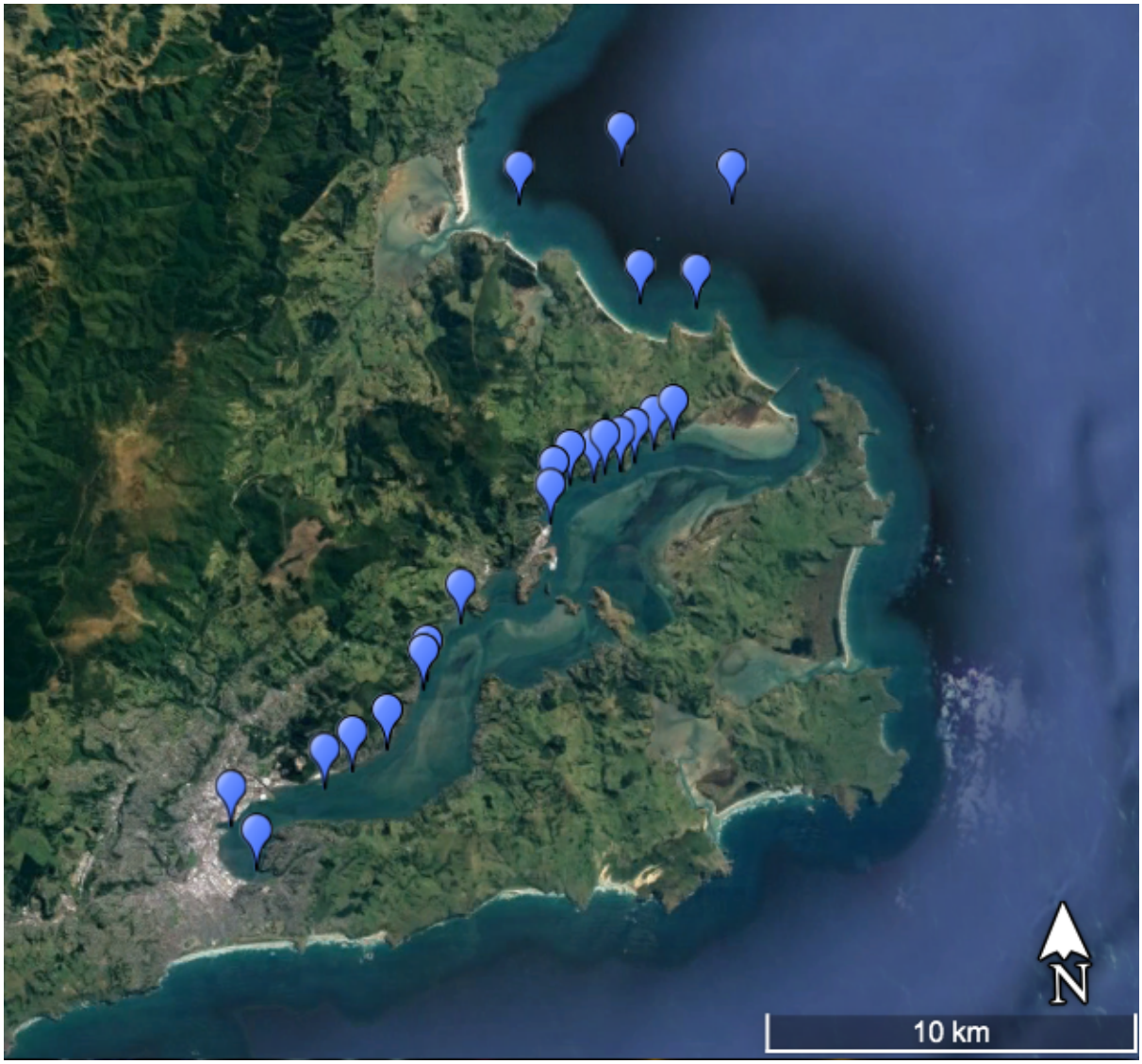


Figure 2. Map of all sampled locations using BUV's in 2020/21 in the Dunedin area.

Video images were obtained using a downward-facing baited underwater video (BUV) system equipped with a single waterproof SJcam SJ5000X mounted in a stainless-steel frame which could be deployed to depths of up to 30m. The base of the BUV was 1m in diameter with a bait box fixed in the centre (figure 3). To bring sharks to the camera the bait box was filled with 500g of broken up pilchard and sardine. Attached to the arm of the BUV was an incompressible float for the purpose of relocation and retrieval.

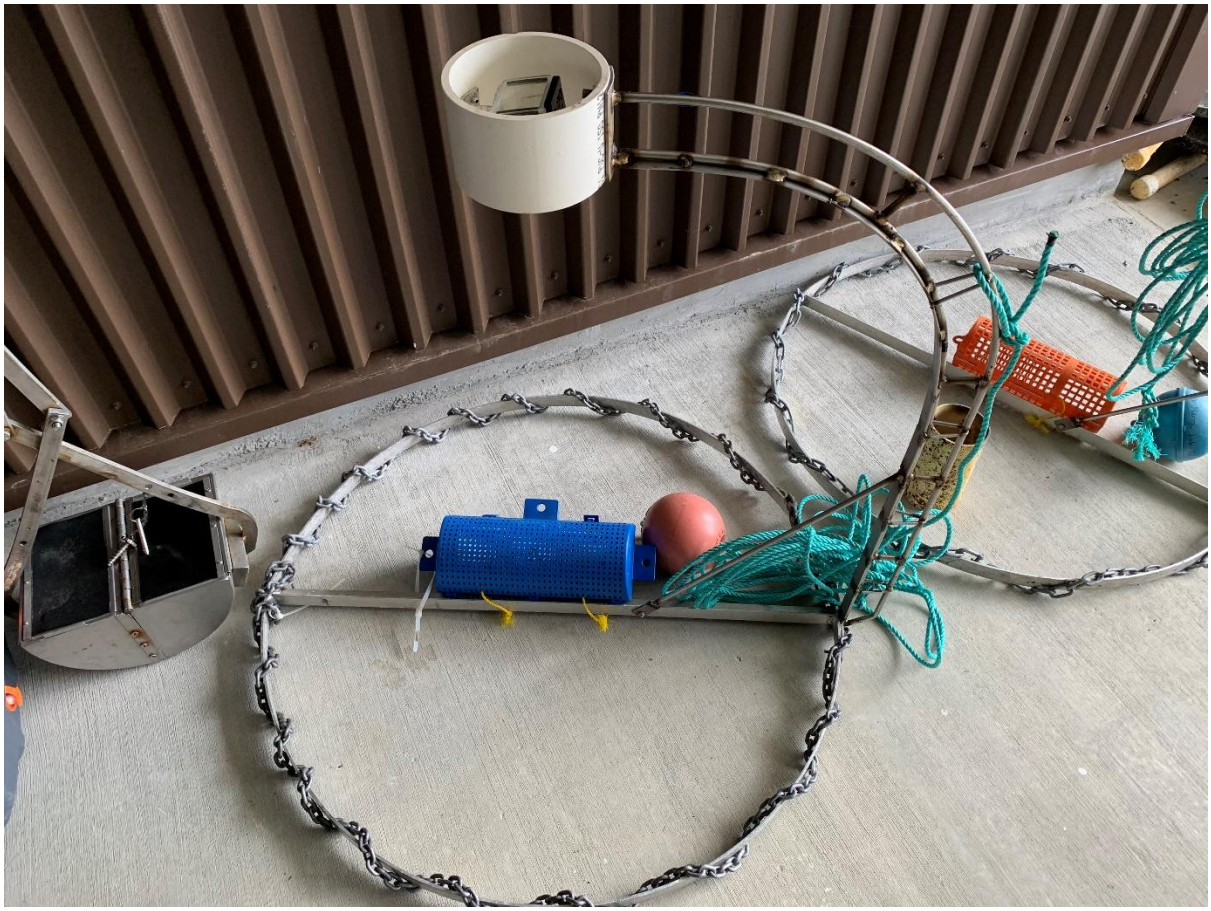


Figure 3. Baited underwater video frame used for Shark Spy underwater video data collection.

Deployments were focused on winter and summer as monthly sampling from 2019 had indicated that this would be of more value. All trips were conducted between 10am and 2pm in Beaufort sea-state <6 and swell height <3m. Before deployment of the BUV the camera was turned on and recording initiated. The BUVs were deployed from the side of the vessel and lowered to rest on the seafloor (the camera sits approx. 1m from the seafloor). Recording lasted for an hour before the camera would shut down from low battery. The BUV's were then recollected. The video data was downloaded, and the first 30 mins separated for the purpose of analysis following the same protocols as what the department of conservation have outlined for their BUV research (see Haggit et al., 2014).

Data analysis

Videos were analysed in the classroom by students ranging from years 6-12. Only the first 30 minutes of each video was used for analysis to ensure that the species sampled were present in the area to start with, rather than being attracted from larger distances as the bait plume extends. Any sharks that were captured by the camera were identified to species level, sexed

if possible, and potential prey species were identified. 'Max N' (maximum number) counts are a straightforward method of estimating relative abundances of the species seen on the footage and is a standardized method in the literature (Willis & Babcock, 2000). To aid in completing the analysis faster in the classroom the 30 minutes of footage was broken down into three-minute segments which could be shared to separate groups. The students were asked to produce a species list of all the animals seen in a video as well as a count of the maximum observable number of a single species in a single frame. The data was then compiled producing species richness, relative abundance and biodiversity information for each deployment.

Incidental sightings of sharks

Members of the public and water user groups such as divers, fishers, boat users, were encouraged to get involved and register shark sightings to Shark Spy. Sightings were asked to include a photo for ID, a location, and a date. In order to store these sightings as well as make them available to the communities that helped to collect them it was decided to use iNaturalist as a platform. iNaturalist is a global image sharing network seeking sightings of all animal and plant species. It is well established and allows for the data from projects to be downloaded for free by anyone. Members of the community could send sightings to Shark Spy, or upload their sightings directly to iNaturalist via the website or a mobile app.

Beach surveys for egg cases

Some species of sharks, skates and chimera lay eggs, which often wash up on beaches. Recording the sightings of these egg cases provides insight about the seasonality and occurrence of egg laying chondrichthyan species. Different species have unique designs in egg cases so any that were found can identified to species. A separate iNaturalist Project was created to catalogue community finding of these egg cases alongside live shark sightings. Systematic surveys in a 100m section along the high tide zone were conducted at six different locations along the Otago coastline (figure 3) alongside beach litter surveys conducted by the Sustainable Coastlines project citizen science project.

Data Analysis

Data on species, location and seasonality was exported from iNaturalist for the purpose of analysis. As there are limited sightings only exploratory data analysis was conducted.

Results

Dedicated surveys

Table 1 outlines the species list of Chondrichthyes found during the BUV surveys for Shark Spy 2020.

Table 1. Species list of all Chondrichthyan species recorded on the BUVs and which months they were seen in.

Species name	Common name	Season found	Location
Notorynchus cepedianus	Sevengill Shark	Summer	Otago Harbour
Galeorhinus galeus	School shark	Winter	Otago Harbour
Squalus acanthias	Spiny dogfish	Summer	Dunedin Coast
Alopias vulpinus	Thresher shark	Summer	Dunedin Coast
Cephaloscyllium Isabella	Carpet Shark	Summer	Oamaru Harbour

Species richness and seasonality

During the winter and early spring months dedicated surveys at all sites yielded low elasmobranch species. The only place Elasmobranch species were caught on the BUV footage during this time was a school shark in the Otago Harbour.

Summer sampling was busier with multiple sightings of sevengill and school sharks in the Otago Harbour, thresher sharks and spiny dogfish on the Dunedin Coast and carpet sharks in the Oamaru Harbour.

Incidental sightings

Incidental sightings reported to Shark Spy resulted in 21 sightings of juvenile/adult sharks and two egg case sightings from around all of New Zealand (Table 2 and table 3 respectively).

Table 2. Species and number of reported sightings of juvenile/adult sharks from Otago.

Species name	Common name	Number of reports
Notorynchus cepedianus	Broadnose sevengill shark	8
Lamna nasus	Porbeagle shark	1
Cephaloscyllium isabellum	Carpet Shark	7
Mustelus lenticulatus	Rig Shark	2
Galeorhinus galeus	School shark	1
Zearaja nasuta	Rough skate	3

Egg cases were reported for elephant fish and rough skate but no carpet sharks. Kakanui Beach was identified as a particularly abundant beach for collecting egg cases from with over 50 egg cases being recorded on a beach count.

Table 3. Species and number of reported sightings of chondrichthyan egg cases around all of New Zealand.

Species name	Common name	Number of reports
Cephaloscyllium isabellum	Carpet Shark	1
Callorhinchus milii	Elephant Fish	50+

Broadnose sevengills were the most commonly reported species and are the one species with enough sightings to plot a tentative seasonality (figure 6). Broadnose sevengills are reported between October and March (late spring – early autumn).

Synthesis of all data

Combining all collected data presents some information on seasonal species richness in the Otago region (figure 7). Winter contained considerably less sightings of chondrichthyans from both BUV surveys and community sightings again reinforcing a strong summer seasonality for a majority of species.

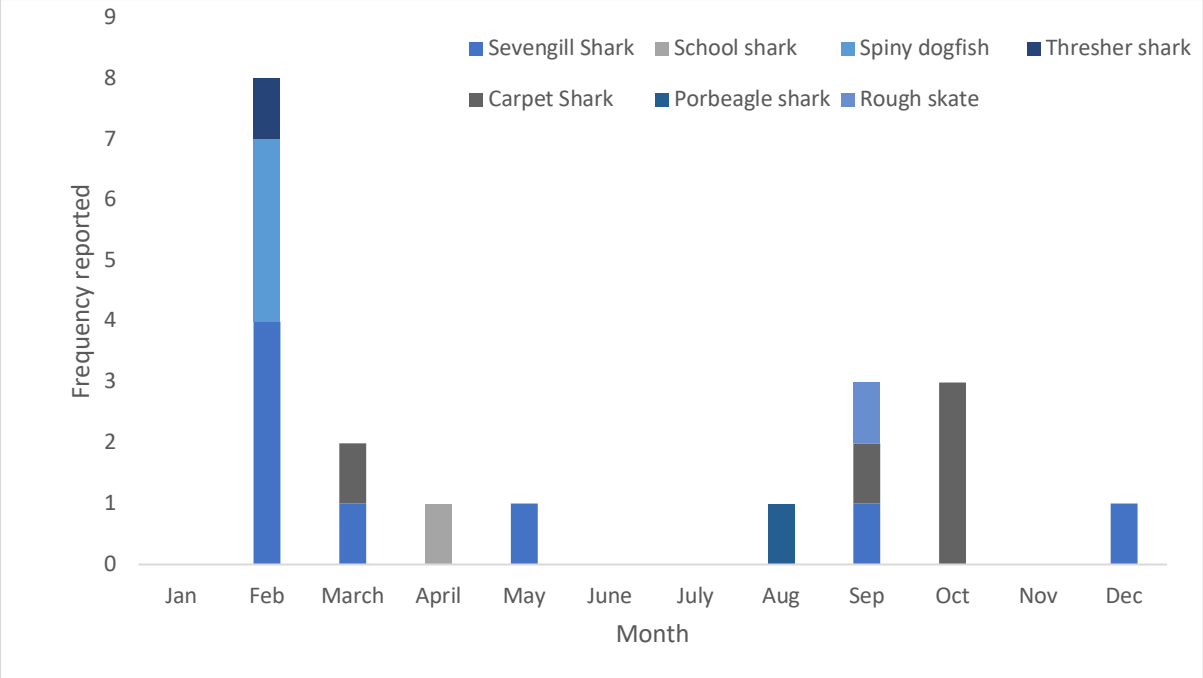


Figure 4. Collective results for all live sighting of all species from both observation methods (BUV and incidental sightings).

Using the total data available from both sightings and BUV data from the entirety of the projects length the species that have the most sightings are carpet sharks (n =19) and broadnose sevengill sharks (n = 15). Figures 5 and 6 outline the apparent seasonality of these species (respectively) based on observations reported to iNaturalist from mid 2019 to mid 2021.

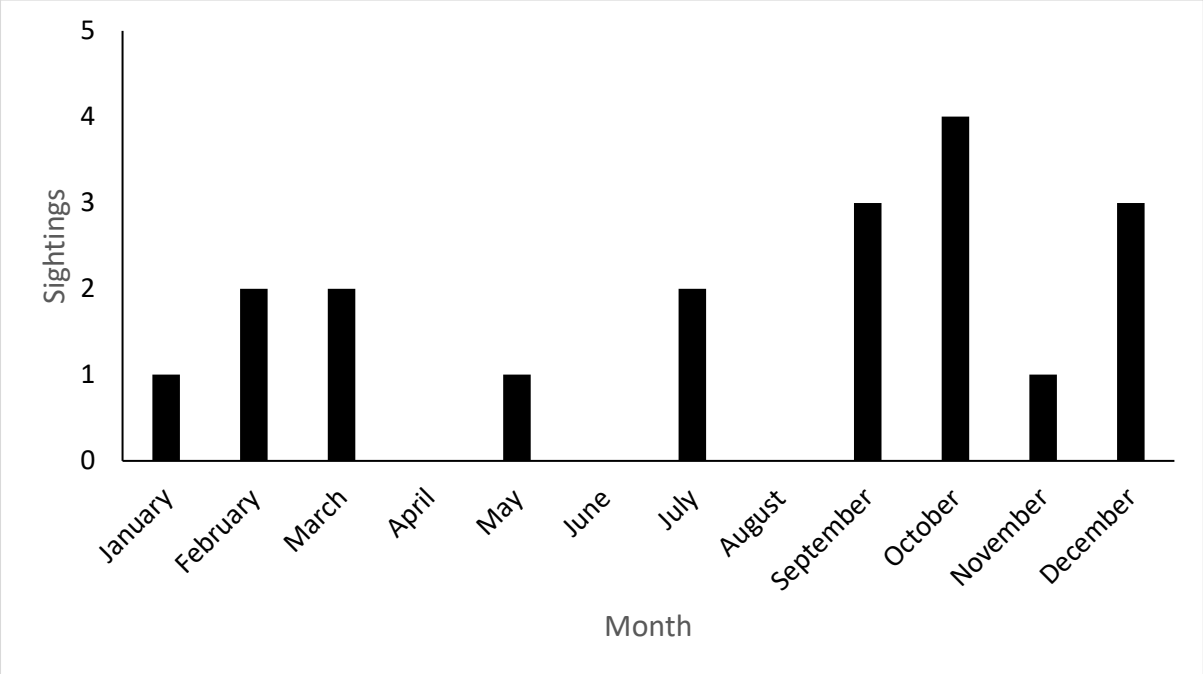


Figure 5. Seasonality based on reported sightings for carpet sharks in the Otago region from mid 2019 to mid 2021.

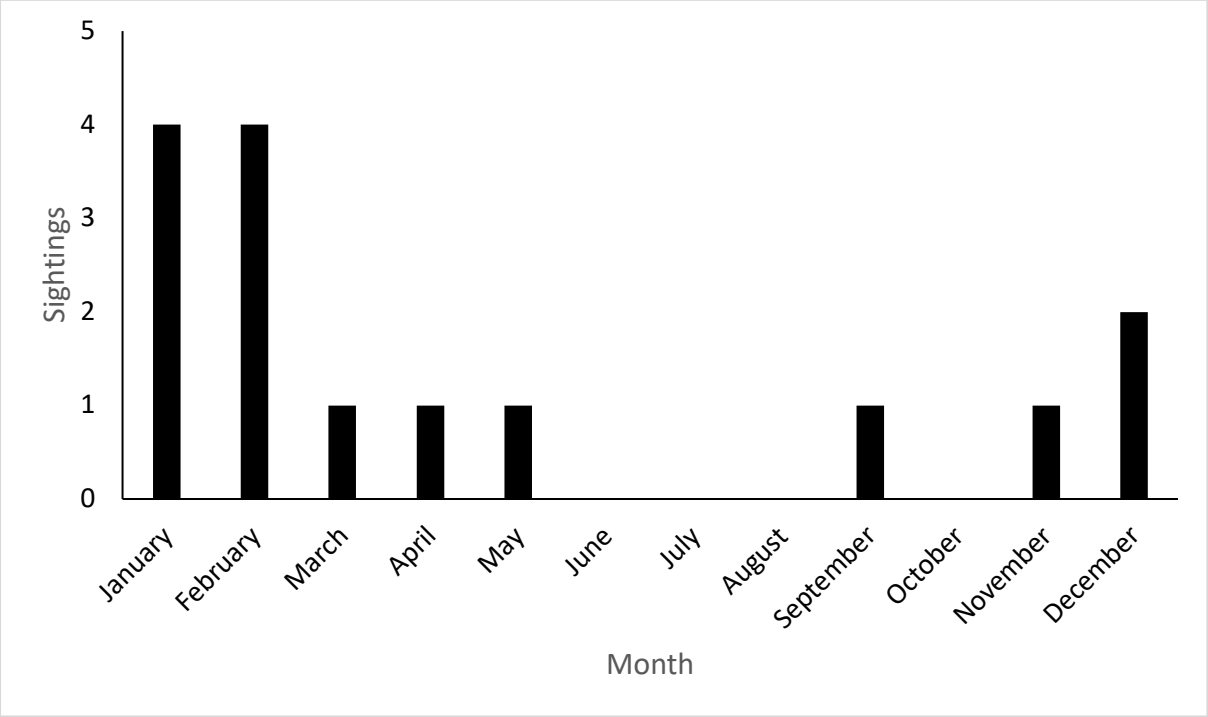


Figure 6. Seasonality based on reported sightings for broadnose sevengill sharks in the Otago region from mid 2019 to mid 2021.

Discussion

As the project continues to collect information on shark sightings in the Dunedin area a picture of distribution and seasonality is starting to form. The total collected data by the project is not enough to stand on its own however and is best used in conjunction with other larger fishing or research datasets. Given enough time this may change, for now what we can draw from the data is a species richness and rough outline of the seasonality for some of the species that make use of the Otago coastline.

In particular the species that have the most sightings and that we can draw some idea of seasonality from are the carpet shark and the broadnose sevengill shark. Within the Shark Spy project for the Otago region carpet sharks have been sighted from just north of the Waitaki river down to Dunedin (both inside the harbour and out). Beyond this they have been sighted in Steward Island/Rakiura meaning logically we could assume that they are present in South Otago but have not been reported yet. Sightings for carpet sharks did not

appear to have any strong or apparent seasonality (see figure 5) being sighted throughout the year at a reasonably consistent rate. A study by Horn (2016) reflected this finding for other regions of New Zealand also indicating no or weak seasonal shifts in carpet shark for breeding purposes.

Conversely the broadnose sevengill sharks do show seasonal differences in their presence around the Otago region. In terms of distribution this species has been sighted along the entirety of the Otago coastline, but seems greatly reduced or entirely absent in winter months from May to September. This same pattern of seasonality has been shown in research on sevengills from several locations in Southern New Zealand including Dunedin (Housiaux et al., 2018), Stewart Island (Lewis et al., 2020) and Fiordland (Michael Heldsinger, pers. comm.). The reason for this seasonality is suggested to be driven by temperature (Housiaux et al, 2018) as the presence of sevengills in Northern New Zealand appears opposite to the South, with sevengills anecdotally becoming more frequent in Northern waters during winter. This requires further sampling to confirm, however.

It should be noted that the observations that display these seasonality's for carpet sharks and broadnosed sevengill sharks we majority from community observations which carries with it an inherit bias of human behaviour. During winter when the water is cold there are likely less community members making use of the Otago coastline resulting in skewed search effort. The seasonality seen in sevengills for instance may be due to a lack of 'eyes on the water' more so than actual seasonality despite closely matching the seasonality seen other southern coastlines. This also applies to the carpet shark observations, that although some were sighted in winter there were still more consistent sightings during the warmer months of the year. The major way to deal with this is an intensified strategy of baited underwater video deployments which can not only confirm the presence of sharks, but also their absence.

In totality, the project data continues to become more useful as time goes on and more sightings are added to the iNaturalist database. As previously stated, the data will not be able to stand on its own (at least not for at least 3 more years), but it is a starting point for new research as well as complimenting existing research. As more people become aware of the research as well as continuing relationships with individuals who consistently report shark sightings the rate of sightings will also hopefully increase.

Looking towards the future, a next big step would be to equip communities with monitoring equipment and training. This would allow the active collection of data by the community on more than an incidental level, as well as confirming when sharks are not found.

References

Anderson, O. F., Bagley, N. W., Hurst, R. J., Francis, M. P., Clark, M. R., & McMillan, P. J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. *NIWA Technical Report 42*.

Barnett, A., Abrantes, K. G., Stevens, J. D., Semmens, J. M. (2011). Site fidelity and sex-specific migration in a mobile apex predator: Implications for conservation and ecosystem dynamics. *Animal Behaviour*, *81*(5), 1039–1048.

Ebert, D. A. (1989). Life history of the sevengill shark, *Notorynchus cepedianus* peron, in two northern California bays. *California Fish and Game*, *75*(2), 102–112.

Ebert, D. A. (1996). Biology of the sevengill shark *Notorynchus cepedianus* (Peron, 1807) in the temperate coastal waters of southern Africa. *South African Journal of Marine Science*, *17*(1), 93–103.

Ford, R. B., Francis, M. P., Holland, L., Clark, M. R., Duffy, C. A. J., Dunn, M., Jones, E., Wells, R. (2018). Qualitative (Level 1) risk assessment of the impact of commercial fishing on New Zealand chondrichthyans: an update for 2017. *New Zealand Aquatic Environment and Biodiversity Report No. 201*.

Graham, D.H. (1938). Fishes of Otago Harbour and Adjacent Seas with Additions to Previous Records. *Transactions and Proceedings of the Royal Society of New Zealand*.

Haggitt, T.; Freeman, D.; Lilley, C. 2014: Baited remote underwater video guidelines. Prepared by eCoast for the Department of Conservation, Wellington. 82 p. (doccm-1395189)

Heagney, E. C., Lynch, T. P., Babcock, R. C., Suthers, I. M. (2007). Pelagic fish assemblages assessed using mid-water baited video: Standardising fish counts using bait plume size. *Marine Ecology Progress Series*, *350*, 255–266.

Horn, P.L. (2016). Biology of the New Zealand Carpet Shark *Cephaloscyllium isabellum* (Scyliorhinidae). *Journal of Ichthyology, 56*(3), 336–347.

Housiaux, J. A., Hepburn, C. D., Rayment, W. J.(2018). Seasonal variation in occurrence of the sevengill shark , *Notorynchus cepedianus* , in two inshore habitats of southern New Zealand. *New Zealand Journal of Zoology*, *46*(1), 48-60.

Marshall, A. D., Pierce, S. J. (2012). The use and abuse of photographic identification in sharks and rays. *Journal of Fish Biology*, *80*(5), 1361–1379.

Roberts, C., Stewart A.L., Struthers, C.D. (2008) Fishes of New Zealand. *Te Papa Press, Wellington, New Zealand.*

Santana-Garcon, J., Braccini, M., Langlois, T. J., Newman, S. J., Mcauley, R. B., Harvey, E. S. (2014). Calibration of pelagic stereo-BRUVs and scientific longline surveys for sampling sharks. *Methods in Ecology and Evolution*, *5*(8), 824–833.

Stehfest, K. M., Patterson, T. A., Barnett, A., Semmens, J. M. (2014). Intraspecific differences in movement, dive behaviour and vertical habitat preferences of a key marine apex predator. *Marine Ecology Progress Series*, *495*, 249–262.

Taylor, M. D., Baker, J., Suthers, I. M. (2013). Tidal currents, sampling effort and baited remote underwater video (BRUV) surveys: Are we drawing the right conclusions? *Fisheries Research*, *140*, 96–104.

Williams, G. D., Andrews, K. S., Farrer, D. A., Bargmann, G. G., Levin, P. S. (2011). Occurrence and biological characteristics of broadnose sevengill sharks (*Notorynchus cepedianus*) in Pacific Northwest coastal estuaries. *Environmental Biology of Fishes*, *91*(4), 379–388.