

Ocean Wise Rockfish Abundance Survey Report 2020



A juvenile quillback rockfish resting on a glass sponge. Photo credit: Ocean Wise.

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A Brief History of Rockfish in British Columbia

Rockfish populations experienced severe depletion in coastal British Columbia (B.C.) waters through the early 1990s, when a historic low was reached. Black and Bocaccio rockfish were extirpated¹ in Howe Sound in the 1960s through the use of downrigger weights on salmon flashers (*pers. comm.* Jeff Marliave). Reef by reef, serial depletion of rockfish occurred during the 1980s. In 1986, the first licenses were issued for live-market fisheries of rockfish (Yamanaka and Logan 2010). Prior to this, there were no restrictions or management actions in place to protect populations of rockfish in B.C. Rockfish landings quadrupled between 1986 and 1990 with the advent of rockfish fishing licenses (Yamanaka and Logan 2010). It was not until 1996 that total allowable catches (TACs) were defined at the species level for rockfish. Prior to this, TACs were based on groups of rockfish, such as the 'red rockfish', which were a collection of five different species targeted for harvest, or 'other rockfish' (Yamanaka and Lacko 2001). Due to the unique life span of each species – ranging from a couple of decades to over 110 years – grouping rockfish species together can easily lead to declines in the longest-lived species, as was the case with the 'red rockfish' – which included yelloweye rockfish – during the 1980s (Yamanaka and Lacko 2001).

Through extensive consultation with scientists and the public, a rockfish conservation strategy was put forward in 2002 that would see the establishment of rockfish refuges (Yamanaka and Logan 2010). In 2007, Fisheries and Oceans Canada (DFO) finalized 164 Rockfish Conservation Areas (RCAs) ranging from Haida Gwaii in northern B.C., to the southern Strait of Georgia. These 164 RCAs represent 20% of rockfish habitat along the B.C. coast. In addition to RCA closures, all hook-and-line fishing for groundfish (lingcod and rockfish) in area 28 and area 29 were banned in the summer of 2007. Between 2009 and 2011, Haggarty et al. (2016) examined the effectiveness of these RCAs and showed that habitat relief and depth influenced rockfish density but designation as an RCA did not. It is believed that recreational fishing compliance within the designated conservation areas is an issue limiting RCA effectiveness (Haggarty et al. 2013). However, it is important to consider the life span of some species of rockfish – yelloweye rockfish have been aged to over 100 years old – meaning detectable recovery would not necessarily be expected on the order of a few years or even a decade. For example, during the last century in B.C., dominant year-classes occurred for yelloweye only in 1917, 1952 and 1982, and for quillback only in 1926, 1946 and 1968 (*pers. comm.* Lynne Yamanaka).

Rockfish can be found year-round at depths reachable by scuba; however, recent studies by Ocean Wise's Ocean Biodiversity Research Program have found that some rockfish 'hide' during the winter, making them more difficult to see. This behavior can be observed from as early as October and as late as the end of May, during which period rockfish live deep within multi-layered rock piles. Over the peak winter hiding period (December to March), divers have observed an average of 18 rockfish for a population known to be home to over 250 individuals. As a result, dives conducted during this time may yield lower than expected counts. Thus, it is suggested that participants of the Rockfish Abundance Survey (RAS) primarily conduct their surveys between August and October, to maximize the likelihood of observations.

¹ Extirpated - A wildlife species that no longer exists in the wild in Canada, but exists elsewhere.

Dives logged during the annual RAS are performed by divers from the community as well as Ocean Wise staff. Divers are enlisted through a variety of sources including dive organizations, stores, charters, magazines, and personal contacts. Ocean Wise staff survey efforts are generally limited to Howe Sound.

Biology of Rockfish

There are 37 species of rockfish along the B.C. coast, five of which are considered inshore rockfish, primarily found in rocky reef habitats. Each species can be distinguished based on a variety of characteristics including colour/colour pattern, shape and size, and sometimes depth (Love et al. 2002). RCAs, defined in 2007 by DFO, are intended to protect the five inshore rockfish species: yelloweye, quillback, copper, China and tiger rockfish. Quillback rockfish are listed as threatened² by COSEWIC³, while yelloweye rockfish are listed as special concern⁴.



Adult Tiger Rockfish. Photo by Charlie Gibbs

Rockfish are typically long-lived species, some with a lifespan exceeding a century. These species take longer to mature and reproduce. They mate in the fall and give birth to free-swimming larvae that eventually settle on rocky reefs. Inshore rockfish do not typically

stray far from their home (Hannah and Rankin 2011), making them an easy target in sport fisheries and highly susceptible to overfishing. Mature, large female rockfish give birth to larger babies with the greatest chance of survival (Berkley et al. 2004). As a result, overfishing of large rockfish can have a severe impact on the success of the next generation. Rockfish are also uniquely impacted by catch-and-release practices; during rapid ascent to the surface, their gas-filled swim bladder quickly expands, greatly reducing their likelihood of survival after such barotrauma (Rummer and Bennett 2005).

² Threatened - A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

³ COSEWIC - The Committee on the Status of Endangered Wildlife in Canada

⁴ Special concern - A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Survey Instructions

2020 marked the 16th annual Rockfish Abundance Survey (RAS) conducted by Ocean Wise. The survey was initiated in 2005 prior to the 2007 introduction of the 164 RCAs in B.C. The survey enlists the help of divers from the community to census rockfish populations both inside and outside conservation areas in order to examine the effectiveness of RCAs in protecting inshore rockfish as well as to track the recovery of rockfish from the historic low reached in the 1990s. The RAS occurs over a three-month period (August to October inclusive) to account for rockfish 'hiding', and to avoid low visibility during springtime blooms. During hiding, rockfish can be hard to see as they hide deep within rock piles in winter months, making it difficult to get an accurate estimate of abundance.

The purpose of this survey is to estimate rockfish abundance using a count per unit effort (CPUE) measure in a given area by having divers count the number of rockfish, noting the species and size (age, adult vs. juvenile vs. young of year) during the dive. Bottom time⁵, average depth and maximum depth are also recorded (via the diver's dive computer). With this information, the abundance of rockfish in the given area is calculated using a CPUE, which is the number of rockfish counted per hour diving. This index provides an estimate of the relative abundance of rockfish populations and indicates how populations are changing over time (Haggarty and King 2006). Alternatively, divers can take videos of their dive and use the footage to count and identify the rockfish after the dive. An instruction package outlining all the pertinent information for divers can be found on Ocean Wise's annual rockfish abundance survey website: research.ocean.org/project/rockfish-survey

Sample dive slate:

| Date | General Location | Specific Location | Bottom Time (min) | Max Depth (ft) | Average Depth (ft) | # of adult Copper Rockfish | *Adult Copper Rockfish CPUE |
|----------|------------------|-------------------|-------------------|----------------|--------------------|----------------------------|-----------------------------|
| 09/06/16 | Howe Sound | Porteau Cove | 32 | 50 | 40 | 67 | 60*67/32 =126 |
| 09/07/16 | Howe Sound | Whytecliff Park | 53 | 75 | 47 | 23 | 60*23/53 =26 |

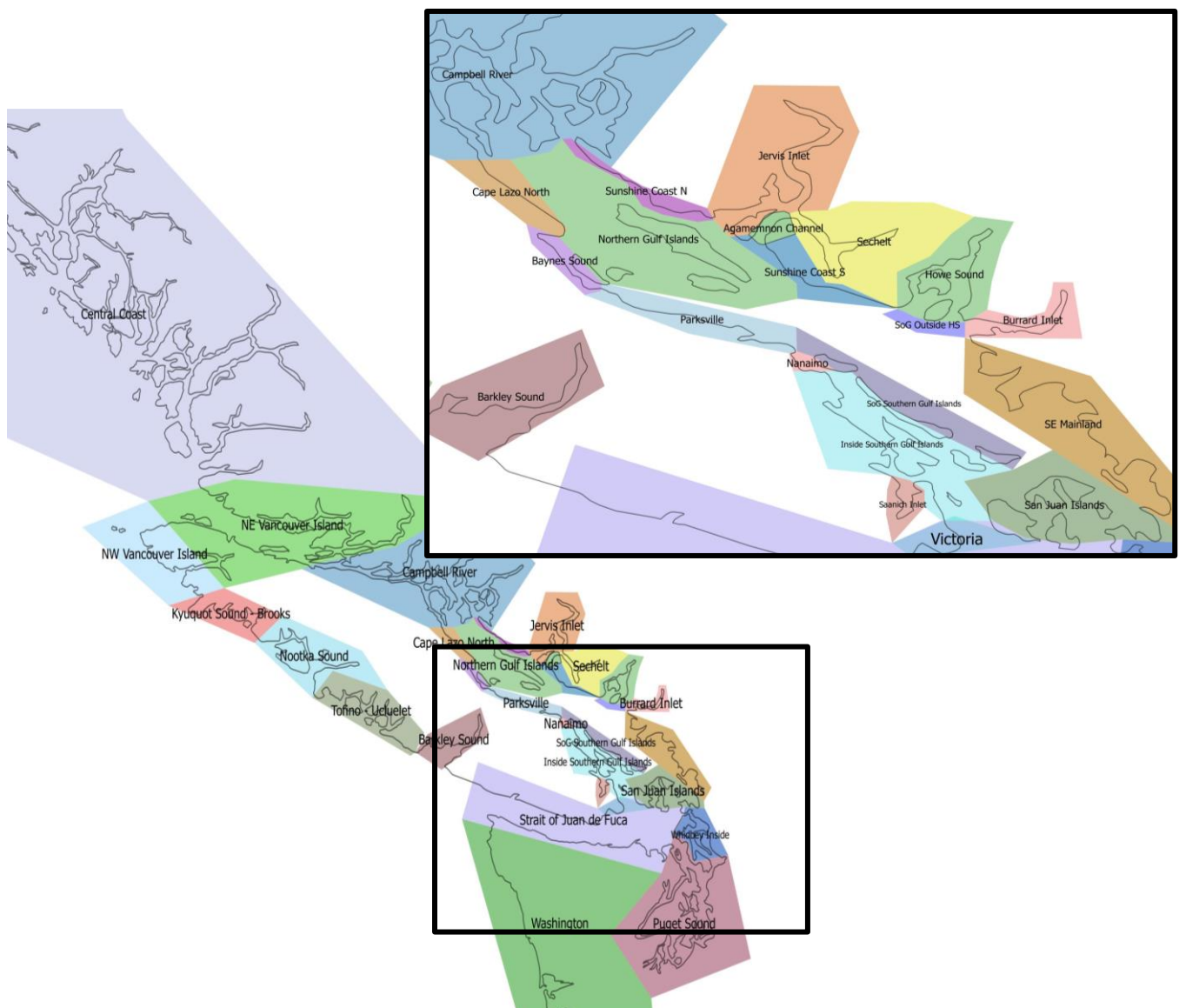
*calculated by Ocean Wise after data collation (60min x # fish/#minutes = # fish per h)

All data are sent to Ocean Wise or entered online through the survey website. Once the data are sorted the index of abundance i.e., the CPUE is calculated. The CPUE is the number of rockfish of an individual species and age sighted per hour. It is calculated by multiplying the number of rockfish by 60, divided by the bottom time.

⁵ Bottom time - The total time, in minutes, from the beginning of a descent to the beginning of an ascent.

Results and Discussion

The 16th annual RAS was conducted between August and October 2020. Participants from around B.C. and Ocean Wise staff undertook a total of 127 dives equivalent to almost 116 hours underwater. Despite the challenges of COVID-19 preventing dive charters and some divers from conducting surveys this year, the number of submissions received were the second highest ever. Areas surveyed in 2020 included Barkley Sound to Victoria to NE Vancouver Island and across the Strait of Georgia (Table 1). In all, there were fourteen species of rockfish identified, from newly settled young of year widow rockfish, schools of yellowtail rockfish and decades old yelloweye rockfish. The abundance of rockfish, based on geographic area as defined by pre-existing biodiversity patterns (Map 1), varied widely again in 2020.



Map 1. Geographic area breakdown for British Columbia south coast and Washington.

Table 1. Summary of rockfish counts in 2020, by area, including the seven most commonly seen rockfish, total rockfish abundance, number of survey submissions (dives) and total underwater survey time. Each CPUE is rounded to the nearest whole number.

| Area | # of Dives | Total time (min) | *Total Rockfish CPUE | Copper CPUE | Quillback CPUE | Puget Sound CPUE | Tiger CPUE | Yellowtail CPUE | Black CPUE | Brown CPUE |
|------------------------------|------------|------------------|----------------------|-------------|----------------|------------------|------------|-----------------|------------|------------|
| Grand Total | 127 | 6944 | 372 | 74 | 15 | 27 | 1 | 56 | 18 | 12 |
| Howe Sound | 23 | 1016 | 125 | 15 | 17 | 7 | 1 | 85 | 0 | 0 |
| Barkley Sound | 14 | 742 | 711 | 25 | 10 | 124 | 4 | 234 | 44 | 0 |
| Burrard Inlet | 1 | 58 | 31 | 2 | 3 | 0 | 0 | 0 | 0 | 26 |
| Campbell River | 12 | 679 | 74 | 35 | 33 | 0 | 1 | 4 | 0 | 0 |
| Inside Southern Gulf Islands | 11 | 697 | 301 | 173 | 10 | 0 | 0 | 33 | 0 | 84 |
| Nanaimo | 2 | 117 | 20 | 8 | 9 | 0 | 0 | 0 | 0 | 0 |
| NE Vancouver Island | 9 | 498 | 2097 | 24 | 48 | 6 | 0 | 34 | 161 | 0 |
| Parksville | 15 | 1034 | 241 | 207 | 27 | 1 | 1 | 1 | 0 | 1 |
| Saanich Inlet | 22 | 1146 | 107 | 43 | 1 | 1 | 0 | 54 | 0 | 8 |
| Sechelt | 4 | 198 | 224 | 220 | 1 | 0 | 0 | 0 | 0 | 0 |
| SoG Southern Gulf Islands | 2 | 120 | 39 | 26 | 4 | 0 | 0 | 0 | 0 | 9 |
| Strait of Juan de Fuca | 1 | 5 | 1752 | 0 | 72 | 0 | 0 | 0 | 1680 | 0 |
| Sunshine Coast S | 1 | 120 | 320 | 318 | 0 | 0 | 0 | 0 | 0 | 0 |
| Victoria | 10 | 514 | 287 | 32 | 2 | 156 | 1 | 71 | 4 | 0 |

*This includes all stages of rockfish (YOY, juvenile and adult), representing the total number of rockfish a diver encountered per 60min of diving.

Data for North East (NE) Vancouver Island was submitted for the first time this year, while five other areas were surveyed after a few years of no submitted observations (Strait of Juan de Fuca [3 years], Strait of Georgia (SoG) Southern Gulf Islands [2 years], Burrard Inlet [3 years], Sunshine Coast S [11 years] and Sechelt [7 years]).

In eight areas, five or more dives occurred (Table 1). Since 2018, Campbell River has been the only area where a minimum of five dives has shown an average abundance count below 100 rockfish, a trend continued in the 2020 survey (Table 1). The highest abundance of rockfish was observed in NE Vancouver Island (2097 rockfish per 60-min survey), with nine dives. Barkley Sound, with 14 dives, had an average abundance of 711 rockfish (Figure 1), an increase of more than 400 rockfish per 60-minute dive since the 2019 survey (Figure 2), primarily due to an increase in yellowtail, widow and Puget Sound rockfish. In fact, every species recorded in Barkley Sound had a higher abundance than that observed in 2019.

In the Strait of Juan de Fuca, a single freedive of five minutes duration was conducted, where 146 rockfish were observed. When the CPUE is calculated, this gives an abundance of 1752 rockfish per 60-min survey. However, a single five-minute survey is not a sufficient sample size. More surveys are needed in this area in the future to assess if the rockfish abundance seen at this site is representative of the whole area.

Additionally, anecdotal reports from citizen science divers noted “swarms” of young of year widow rockfish in 2020, which they stated “dwarfed” the recruitment of yellowtail rockfish observed in 2017/2018. This is the first time since the start of the RAS that widow rockfish have been observed in large numbers, indicating the presence of a year class for this species.

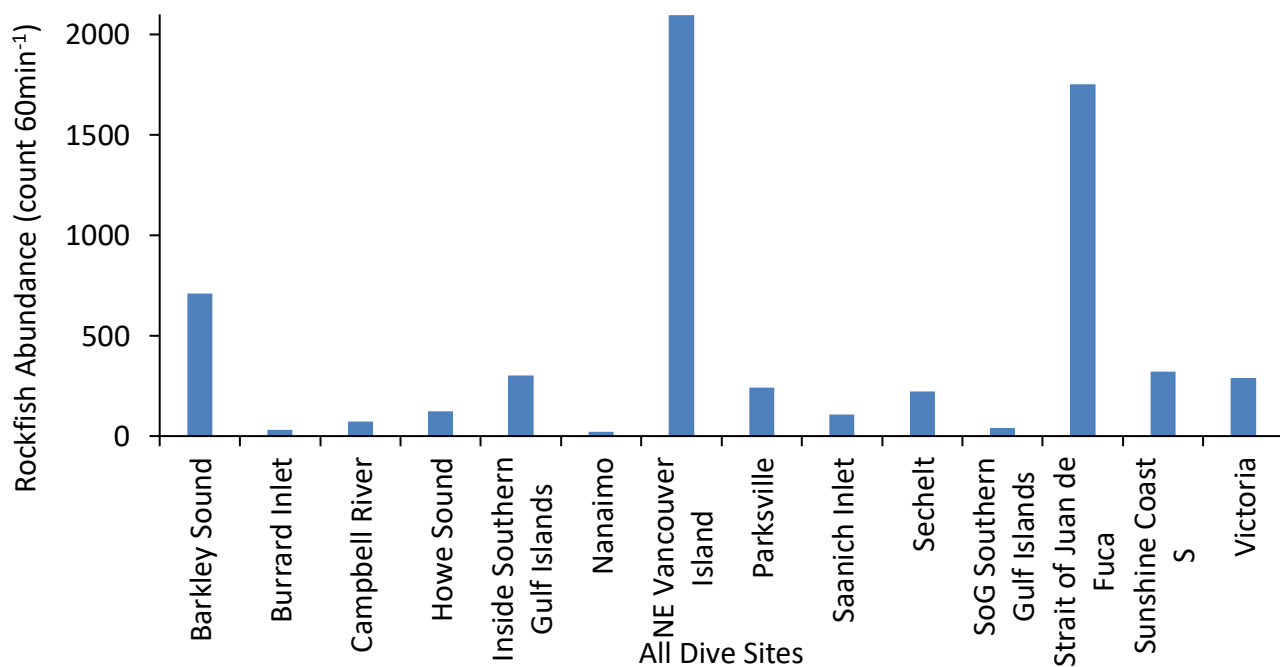


Figure 1. Total rockfish abundance (count per unit effort – 60min) for each dive area surveyed in 2020. Results compiled from 127 scuba dive surveys. Refer to Map 1 for areas.

The abundance of rockfish in the Inside Southern Gulf Islands was almost triple the abundance observed each year since this site was included in the survey (Figure 2), mainly due to an increase in copper and brown rockfish. In contrast, rockfish abundance in Victoria and Howe Sound declined by more than 200 and 500 rockfish per 60-minute survey, respectively. Puget Sound rockfish were the main driver of the decline seen in Victoria, with abundance dropping by half from the previous year. The decline observed in Howe Sound is likely attributable to a lack of data. In 2019 there was only one survey conducted in Howe Sound which does not provide a clear representation of the rockfish abundance for that area. However, when comparing 2020 to 2018 abundances in Howe Sound, there is a decline seen in yellowtail and copper rockfish. Total and species level abundance of rockfish did not change considerably in Parksville or Saanich Inlet. There is considerable variation within some sites between years.

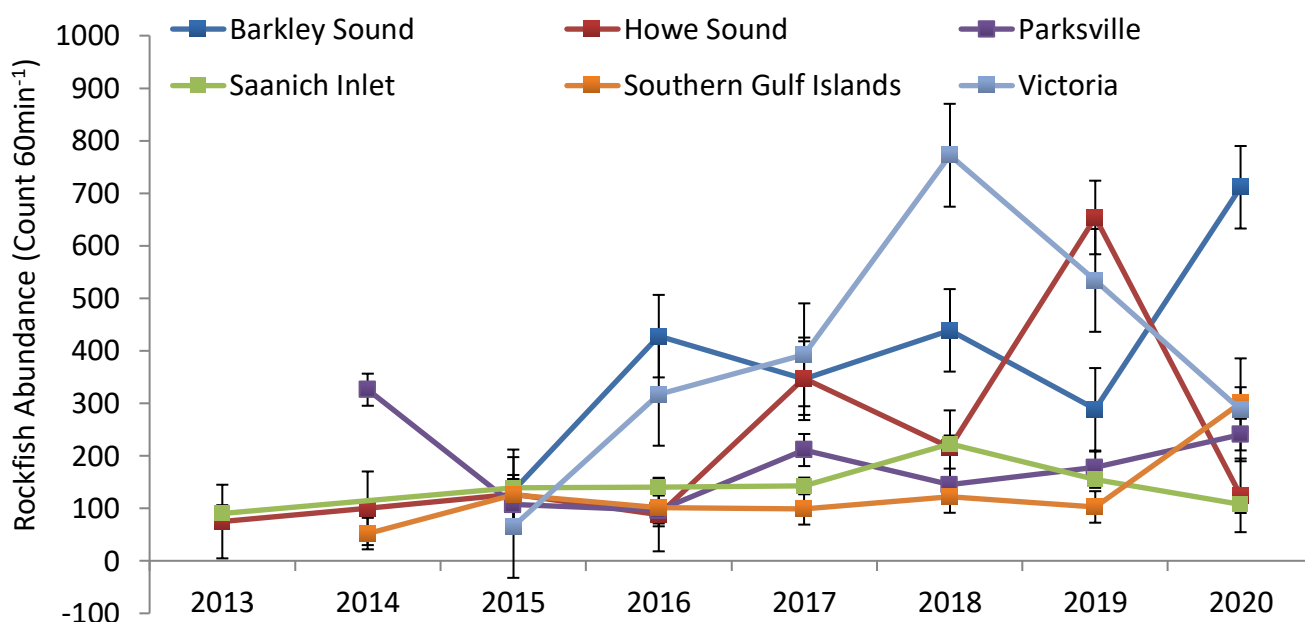


Figure 2. Abundance of rockfish (count per 60-min survey effort) for six Geographic Areas since 2013. The black vertical lines are error bars, indicating the variability in abundance.

In line with expectations, adult-age rockfish were most frequently observed in most areas surveyed. A notable exception was NE Vancouver Island, with an abundance of 1712 young of year rockfish per 60-minute dive (Figure 3). Of these young of year rockfish, 99% were widow rockfish. Areas with juvenile rockfish exceeding 100 rockfish per 60-minute survey included Barkley Sound, NE Vancouver Island, Parksville, Sechart and Sunshine Coast S. The largest abundance in adult and juvenile rockfish was observed in the Strait of Juan de Fuca; however, as noted earlier, this area only had one survey submitted and may not be an accurate representation of rockfish abundance for this area.

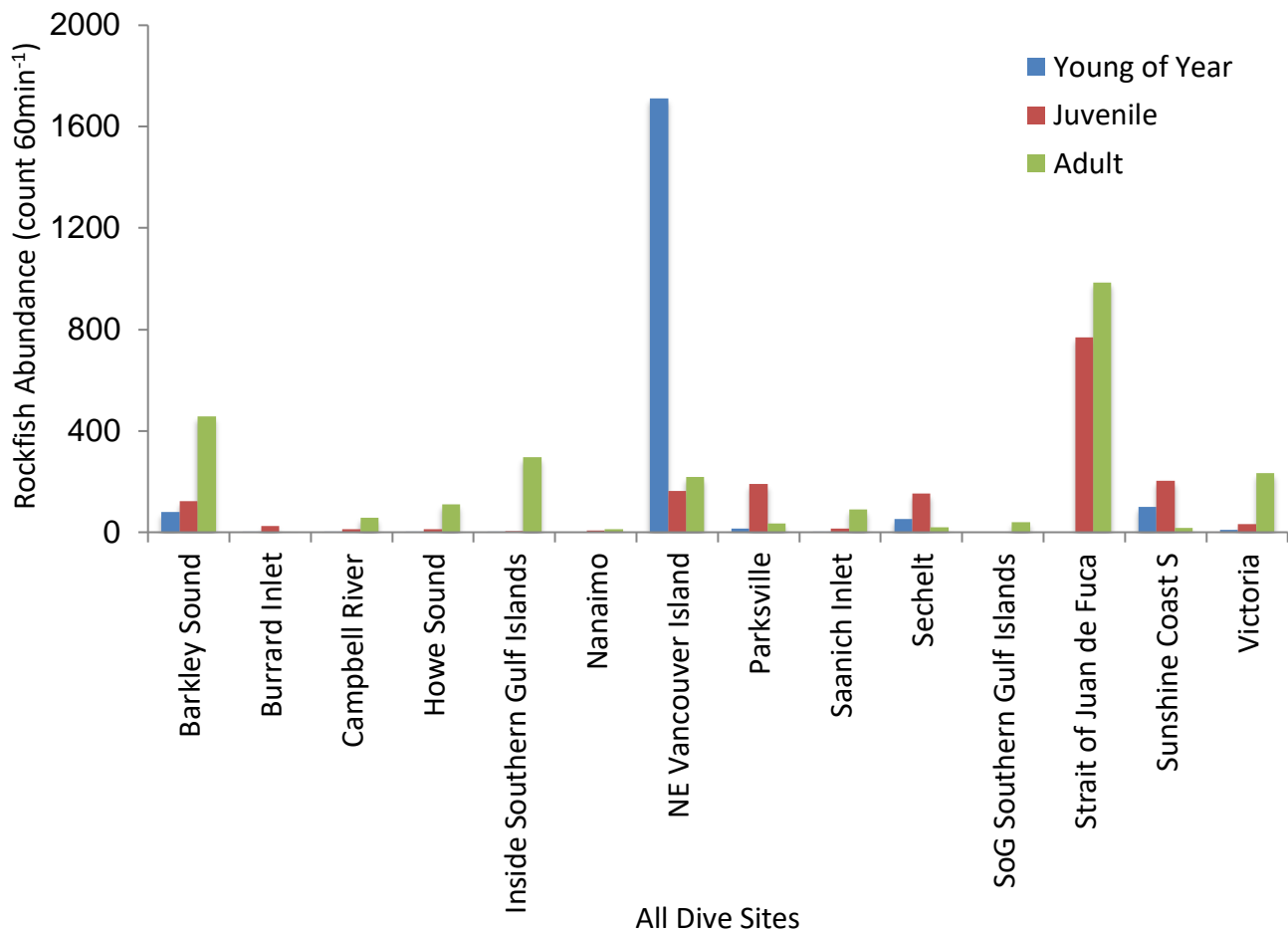


Figure 3. Rockfish abundance broken down by age category for each area in 2020. Results compiled from 127 scuba dive surveys. Refer to Map 1 for areas.

Selected Sites

Rockfish tend to have a small home range (Hannah and Rankin 2011). As such, we focused on a small geographic scale to identify site-by-site changes in rockfish abundance by selecting six sites that have been consistently surveyed over the past 13 years to see how rockfish abundance has changed since 2007 (Figure 4).

In 2020, rockfish abundance at Renate Reef in Barkley Sound increased to 1187 rockfish per 60-minute survey effort, similar to abundance levels observed in 2016 (1195) and almost double the abundance observed in 2017 and 2018. In both 2016 and 2020, there was an increase in yellowtail rockfish; however, this year, adults comprised the majority of observations, unlike in 2016, which was comprised mostly of juvenile rockfish. These numbers are considerably higher than that observed when Renate Reef was first surveyed in 2011 and 2013 (rockfish abundance of 219 and 309, respectively).

Madrona Point in Parksville saw an increase of nearly 400 more rockfish per 60-minute survey compared to 2019. The presence of juvenile copper rockfish was the main contributor to the increase in abundance at this site. These most recent numbers are far higher than that first observed in 2009 and 2012 (rockfish abundance of 33 and 24, respectively).

Overall, rockfish abundance declined at the three other sites examined. At Ogden Point in Victoria, this has been due to a continuous decline in Puget Sound rockfish and yellowtail rockfish populations since 2018. At Whytecliff in Howe Sound, declining abundance is due to lower observations of yellowtail rockfish. A declining trend has been observed at Henderson Point in Saanich Inlet since 2018. Unfortunately, due to COVID-19, Maude Reef was not surveyed this year, nor did we receive any survey data from the Northern Gulf Islands area.

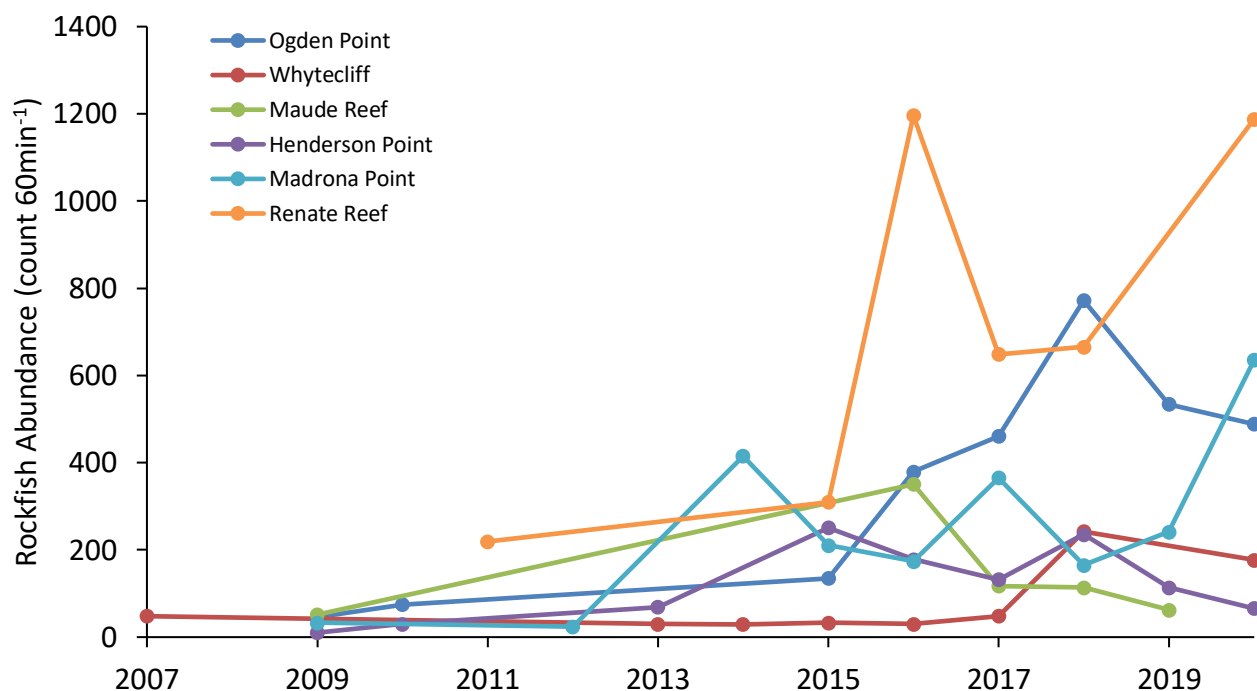


Figure 4. Rockfish abundance, a count per 60-min survey effort, at selected sites since 2007.

It is only through repeated, year-over-year surveys at the same sites that we can effectively track the health of individual rockfish populations and map out where events, such as a widow rockfish year class, occur. This information can also be informative when evaluating the effectiveness of protected areas such as RCAs or marine protected areas (MPA). However, there is much interannual variation observed at many sites, another reason why long-term data collection such as that provided by the RAS is critical.

Threats

The main threat to rockfish populations along the B.C. coast is bycatch, particularly in the Strait of Georgia where stocks have been greatly reduced. A recent study (Haggarty et al. 2016)

examining the effectiveness of RCAs showed that there is a problem with lack of compliance in regard to fishing regulations in these areas, which may be related to a lack of knowledge on the part of the fishermen. By including the boundaries of RCAs on digital GPS charts, it could make it easier for a fisherman to see when they are within an RCA, hopefully improving compliance. As a long-lived species, recovery of rockfish populations is expected to be a long-term process, but protected areas that allow for populations to stabilize and have multiple successful year classes will lead to healthier populations of rockfish in B.C.

Solutions

Provided that the aim of RCAs was to rebuild depleted stocks that can then replenish neighbouring, unprotected areas, the first solution to fishing pressure on rockfish should be to increase compliance by making resources visually available in GPS systems on board fishing vessels (Haggarty et al. 2016). An increase in resources for enforcement of existing regulations would also likely contribute to a reduction in fishing pressure.

A recent assessment on critical fish stocks in Howe Sound suggested the establishment of citizen enforcement officers who are granted limited powers such as checking catch size and handing out fines for infringements (Miller et al. 2020). This may further ensure compliance and deter illegal fishing activity.

The Galiano Conservancy has also achieved rockfish conservation success by increasing awareness through community-based education. Fisherman awareness of RCA boundaries increased from 32% in 2015 to 60% in 2019. Additionally, their study using shore-mounted trail cameras monitoring RCAs and fishing activity found that the overall percentage of fishing within RCAs largely decreased from 2015 to 2019 (Galiano Conservancy Association, 2020). Public education, awareness and monitoring are effective when utilized properly and is a strategy that should continue to be used to protect rockfish.

How can you help?

The Rockfish Abundance Survey is a citizen science-driven project that heavily relies on the public's contributions to survey efforts. Over the past seven years, citizen scientists have contributed over 50% of survey reports. By participating in this survey, divers can aid our efforts to track the long-term trends in rockfish abundance in B.C.

Not a diver? You can still contribute to rockfish conservation by following [local fishing regulations](#) and reporting any violations to DFO.

The Rockfish Abundance Survey is not the only fish census conducted by the Ocean Biodiversity Research Team (formerly the Howe Sound Research Program) at Ocean Wise. During a five-week period centering on late February, Ocean Wise researchers census

spawning lingcod populations along the B.C. coast. The Lingcod Egg Mass Survey (LEMS) was launched in 1994 by the Marine Life Sanctuaries Society (MLSS). Since 1996, Ocean Wise has promoted and collated the data for this survey. These two annual surveys provide our team with the ability to inform government decision-making on which areas afford the best protection for inshore rockfish and lingcod populations.

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