Giant spider crab ecological assessment in Port Phillip Bay

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May 2023

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Spider Crab Research Highlight Video

Part 1. Project overview

Giant spider crabs (*Leptomithrax gaimardii*, also called Great spider crabs) are a charismatic, iconic species of Port Phillip Bay; yet little is known about their ecology and habitat use. They form massive gatherings (aggregations) in winter when they are coming together to moult (shed their shells in order to grow bigger).

Concerns have been raised regarding the environmental performance, sustainable use and social conflict issues associated with recreational fishing targeting the annual moulting aggregations of the Giant spider crab in shallow waters of Port Phillip Bay between May and July each year. The Department of Energy, Environment and Climate Action (DEECA) has approached Deakin University to further improve the understanding of the ecology of the Giant spider crab, and to ascertain the broader conservation, social and cultural values of the species to the Victorian community.

In 2022, Deakin University undertook an ecological and socio-economic assessment of the Giant spider crab (*Leptomithrax gaimardii*) in Port Phillip Bay. The program comprised three main projects: a citizen science project, a spider crab ecology project and a spider crab socio-economic project (separate report). The first project aimed to harness citizen science to obtain information on spider crab aggregations and ecology; the second project utilised traditional science to collect data on spider crab aggregations and their ecological significance in situ; the third project estimated some of the economic values of the species and their annual aggregation.

1.1 Revealing the habits of spider crabs through citizen science

Given the community's enthusiasm for spider crab aggregations, as well as the challenges associated with the monitoring of marine species such as spider crabs, involving the community through citizen science to inform the ecology of the species provides an opportunity to address knowledge gaps.

Using best practice application of citizen science, our research team implemented a new framework - Spider Crab Watch - to allow for on-going monitoring of spider crabs in Port Phillip Bay (and the rest of Australia) and increase the quantity and quality of spider crab data collected by citizen scientists. The following steps were taken: collect pre-existing data, set up an iNaturalist project for citizen scientists to log spider crab sightings and establish a Zooniverse project to allow citizen scientists to help our team analyse images obtained with timelapse cameras.

In 2022, 199 iNaturalist observations were logged by 63 citizen scientists (including both sightings for isolated crabs and for aggregations). Previous observations were retrieved from the Atlas of Living Australia and the Spider Crabs Melbourne Facebook page, leading to a total of 309 observations. This work helped inform traditional science activities, as well as generated new data on the locations, timing and durations of aggregations within the Bay and beyond.

Timelapse cameras were deployed during winter to monitor the spider crab season at Rye and Blairgowrie piers, as well as at St Leonards when the aggregation there was detected in June. This led to the collection of 66,000+ images including ~7,080 spider crab images. The images collected were uploaded onto a web portal allowing citizen scientists to view them and help collect information on spider crabs, other marine life, and human presence during spider crab season. As of January 2023, 2,770 volunteers have participated in the project, including analyses of images. In addition, regular interactions with citizen scientists took place with ~ 650 comments posted on the project's discussion boards.

Through community engagement and education, the project contributed to an increased interest in and appreciation for marine, and specifically spider crab research, and provided useful insights into Port Phillip Bay's unique natural assets.

1.2 Giant spider crab ecological assessment in Port Phillip Bay

Deakin established an acoustic listening station network (44 stations) and tagging program across Port Phillip Bay to better understand spider crab ecology and movements. The establishment of an acoustic network in Port Phillip Bay provides an open access acoustic network for use by government agencies, the university sector and not for profits to establish tagging projects in Port Phillip Bay.

The project also built on existing efforts in Port Phillip Bay for sustained monitoring to determine spider crab distribution and biomass across aggregation sites. Stereo baited remote underwater video (SBRUVS) has become a National standard for assessing fish diversity and provides opportunities in Port Phillip Bay to inform marine spatial planning and identification of high value areas of diversity and changes through time. From 127 successful BRUVs deployments, 93 fish taxa (5,679 individuals) and 14 invertebrate taxa (282 individuals) were identified.

Stereo diver operated video (DOVs) techniques allowed our team to survey the only confirmed spider crab aggregation in Port Phillip Bay in St Leonards on the Bellarine Peninsula in 2022. Specifically, we mapped the extent of the aggregation, we estimated spider crab abundance and predator occurrence. The latter will be compared to fish diversity data collected through BRUVS. The results from 25 transects suggested the aggregation size varied between 1773 and 2104 square meters and 31,012 and 50,729 spider crabs during surveys. The footage also helped train an algorithm to automatically detect spider crabs using machine learning to automate density estimates.

The team of divers deployed acoustic tags on 50 spider crabs (35 females, 15 males) post-moult, and took morphometric measurements from 550 individuals (mostly live, but also dead or moult discards) in Port Phillip Bay to increase our understanding of spider crab movements and biology, respectively. Morphometric measurements were also obtained from an additional 88 Museums Victoria's specimens. Data from listening stations were retrieved in January and February 2023; in total, there were 56,329 spider crab detections and 27 individual spider crabs were detected in the Southern part of Port Phillip Bay across 13 stations.

1.3 Socio-economic assessment of spider crab aggregation in Port Phillip Bay

A separate socio-economic study, briefly introduced below and the findings of which will be presented in a separate report, is being undertaken by Kym Whiteoak, Dr Sabiha Marine, Prof John Rolfe, and Dr Paul Carnell as part of the broader DEECA-funded spider crab research.

Spider crabs (*Leptomithrax gaimardii*) live across the Great Southern Reef of continental Australia and Tasmania, including in Port Phillip Bay where each winter they aggregate in huge numbers in shallow waters as they moult their shells. This spectacular event has become a spontaneous nature-based recreation activity, as people travel to the main aggregation to witness the event with snorkels or scuba equipment. The event also attracts recreational crabbers who use crab nets to catch crabs during this time for eating.

Little is known about the spider crabs' ecology, distribution and habitat use. Nor do we know much about the value that the community holds for the spider crabs and their annual moulting event. A socio-economic study undertaken concurrently to the research presented in this report focuses on estimating some of the economic values of the species and the annual aggregation. In particular, estimating the 'use value' produced from nature-based recreation during the aggregation event, and the 'non-use' value held by the broader community for the spider crabs and their annual aggregation. The potential for fostering a tourism and recreation event centred on the spider crab aggregation is also explored.

At time of writing this socio-economic study is being finalised and findings will be made available in a separate report.

Part 2. Revealing the habits of spider crabs through citizen science

Lead: Dr Elodie Camprasse
Project team: Prof. John Arnould, Assoc. Prof. Daniel Ierodiaconou

2.1 Methods

2.1.1 Collation of pre-existing data

Data was retrieved from the Spider Crabs Melbourne Facebook page in order to categorise information reported by community members on the page over the past few years (2018-2022). The information contained in these posts up until the 16th August 2022 was analysed.

The Atlas of Living Australia database was also queried to obtain all existing spider crab sightings available, with the final dataset retrieved on the 16th August 2022 (Figure 1). Duplicate records were omitted. Observations without images and/or without information available to determine whether the reports related to spider crab aggregations (e.g. mention of spider crab numbers and activity such as moulting in the notes) were filtered out.

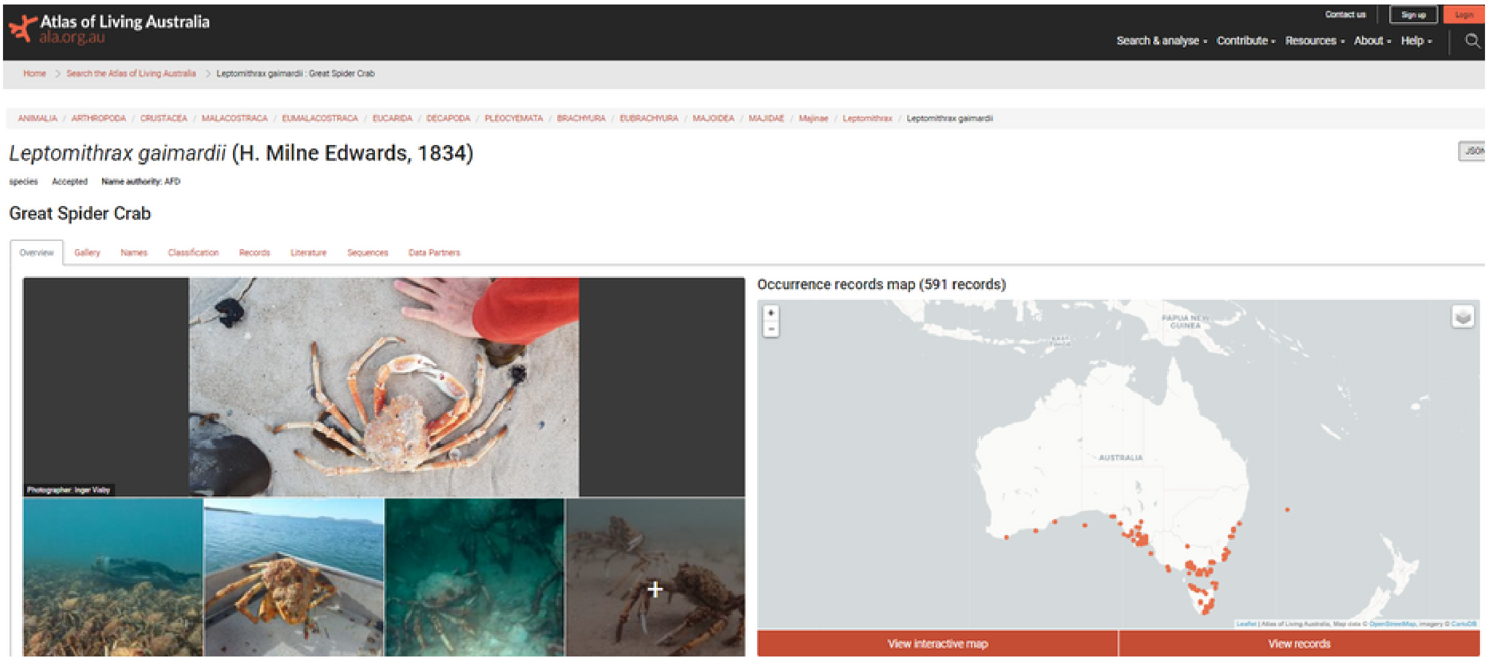


Figure 1: Atlas of Living Australia webpage, from which existing spider crab observations were retrieved (Copyright Atlas of Living Australia, licensed under CC BY 3.0)

2.1.2 iNaturalist

The iNaturalist Spider Crab Watch project was launched on the 30th March 2022, ahead of peak spider crab season (May-July). To keep all spider crab data from Australia in the same place, sightings prior to the launch of the project were manually added (either upon our request by the user who had submitted the sighting or by our team).

Unlike prior data collection, the iNaturalist project allowed us to collect necessary metadata on observations to detect when spider crab moulting was taking place, and how spider crab numbers were changing. Citizen scientists were prompted to submit current, as well as historical information to obtain a more holistic understanding of spider crab activity. Our outreach mainly focused on Port Phillip Bay, but information from other parts of the country were welcomed.

Citizen scientists were asked to submit spider crab sightings regardless of the number seen during an encounter, for dead spider crabs and/or spider crab moults. Logging absence data (i.e. when citizen scientists going for a dive or snorkel did not see any spider crabs) was also encouraged. To collect additional information on the ecological role of spider crab aggregations, citizen scientists were also prompted to submit photos of aggregating spider crabs and the predators present

in the environment at that time, as well as to submit photos showing the presence of or predation on Northern Pacific seastars. Lastly, after the St Leonards aggregations ended, we asked the community to keep an eye out for tagged spider crabs and submit reports if they saw any.

The information required to submit a sighting included the species (*Leptomithrax gaimardii*), the location, time and date of the observation (or lack thereof for absence data), whether the information reported was presence or absence, an estimate of the number of spider crabs sighted and what was observed (no spider crabs, dead spider crabs, live spider crabs, moult(s), dead spider crab(s) and moult(s), live spider crab(s) and moult(s)) (Figure 2). Additional optional information could be entered, including some notes (free text), the maximum depth of the encounter (or lack thereof) and the water temperature (usually obtained by citizen scientists from dive watches/computers).

Submitting photos along with this information was encouraged, though to avoid missing out on potential sightings and valuable information, submission without images was also possible. Because of concerns around revealing the location of spider crab aggregations expressed early during the community consultation process, the research team included three different levels of geoprivacy. Citizen scientists could choose from the following options when submitting information: “open” (exact location visible by everyone on iNaturalist), “obscured” (obscured location visible by everyone – the location appears as a random point in a given radius around the actual location), “private” (location information only accessible by project admins).

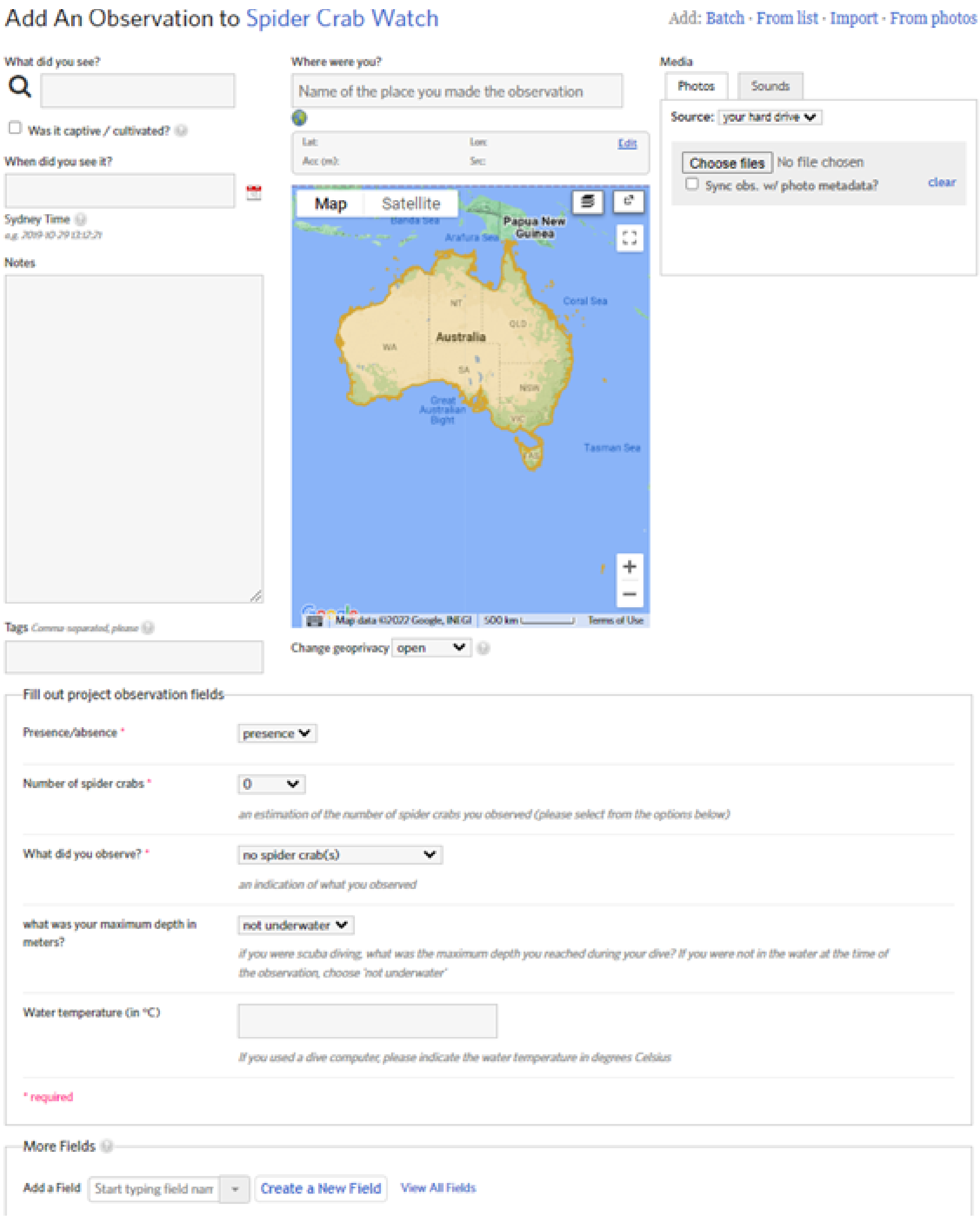


Figure 2: Layout of the Spider Crab Watch iNaturalist project (Copyright iNaturalist AU, used by permission)

2.1.3 Zooniverse

The research team deployed timelapse cameras at Blairgowrie pier (10th May - 13th July), at Rye pier (10th May - 18th June), and at St Leonards (16th June - 13th July). At the piers, the cameras were attached to the pylons using stainless steel strapping; at St Leonards, cameras were attached with cable ties to weighed upside-down crates resting on the sea floor.

A second component of Spider Crab Watch was created through Zooniverse, the world's largest and most popular online platform for people-powered research (Armstrong et al. 2021). The project underwent beta testing during a month (August 2022), and the feedback obtained during this phase from 55 volunteers allowed us to improve the project (Appendix 1). Following final approval from the Zooniverse team, the project (Figure 3) was launched on 6th September 2022 and citizen scientists across the country and beyond now have the opportunity to scan through and analyse the images through three workflows (one to identify and label spider crabs, one to identify other marine life present in the images and one to identify signs of human activity).

A field guide and tutorials for each task have been created to guide citizen scientists through the process of classifying the images, and a research section provides context on spider crab ecology and the broader spider crab research. Each image was being analysed by 15 different citizen scientists before being "retired" (i.e. not shown to more people) prior to the addition of a new rule on 17th December 2022. To address comments from citizen scientists highlighting that a high number of images did not contain any animal, leading to boredom, the project was modified so that "empty" images (i.e. no spider crabs, no other marine life, and no human activity in the respective workflows) would be "retired" after 5 classifications. Individual classifications will be aggregated for further analyses.

In addition, when the classifications from citizen scientists are finished, results obtained will be compared to expert classifications ("gold standard" classifications, outside the scope of DEECA-funded work) to assess the accuracy of citizen scientists' work and make adjustments for future work if necessary.

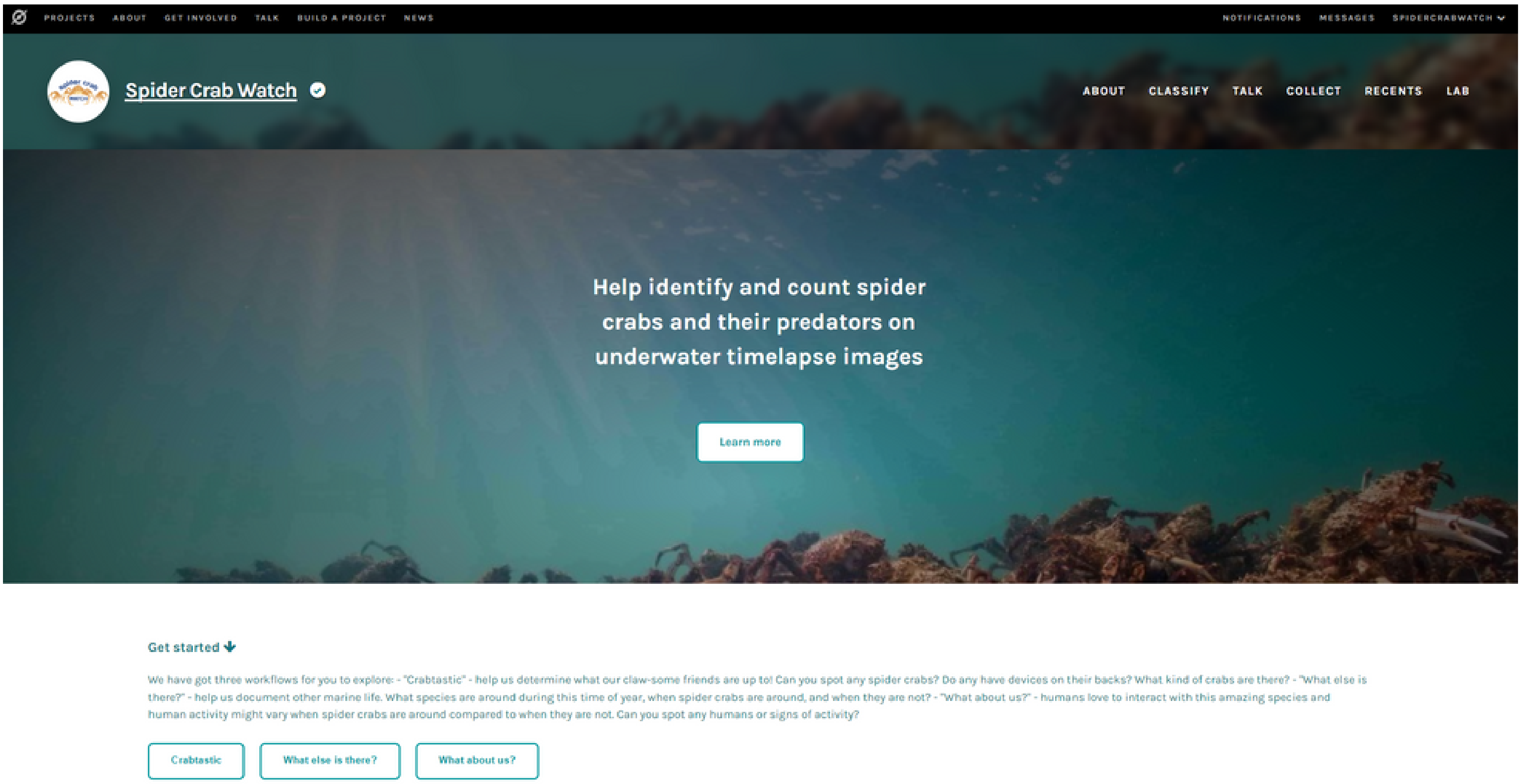


Figure 3: Layout of the Spider Crab Watch Zooniverse project

When ongoing classifications by citizen scientists are finished (estimated end of 2023), the data will be used to determine how long spider crabs were detected in the environment at the St Leonards aggregations and thus estimate the duration of the aggregation. The data could also help determine differences in predators and other marine life when spider crabs are detected in the environment as opposed to when they are not. The analysis of the images could allow the team to determine how long spider crab moults are detected in the environment after aggregations. The data could also allow us to characterise human activity (snorkelling/diving/swimming, fishing, etc) during spider crab aggregations. With this data, a machine learning algorithm could be trained to recognise individual spider crabs (including tagged spider crabs), other marine species including predators, and signs of human activity to facilitate the analysis of images obtained through the deployment of timelapse cameras in future years.

2.2 Results

2.2.1 Pre-existing data

All 1031 existing posts were retrieved from the Spider Crabs Melbourne Facebook page. Posts related to general information about spider crabs and their aggregations, photos and videos, and actual sightings (including dates, times and locations) of spider crabs alone or in groups. From 28th June 2018 to 9th May 2022, a total of 133 posts related to spider crab aggregations with the necessary information to determine the dates, times and locations of encounters were retrieved. The vast majority of aggregations were reported in Port Phillip Bay (131 posts), and specifically at Rye and Blairgowrie piers (126 posts).

We also obtained 544 unique spider crab observations from 15 different datasets on the Atlas of Living Australia, including 242 observations from iNaturalist. A total of 113 sightings of spider crab aggregations were retrieved. Combining the data from the Spider Crabs Melbourne Facebook page and the Atlas of Living Australia (including iNaturalist) provided a total of 245 usable observations spanning the years 2008 to 2022 (with observations in nine different years and from 13 locations (Figures 4 & 5)). A peak of spider crab observations (and thus inferred activity) was obvious in May-July (Figure 4). Sightings were available from Victoria and Tasmania (Figure 5).

The quality of the data available was lower than anticipated and some years only had a single or a few sightings; as community members reported most of this information (except for 2022) without being specifically prompted to report spider crab aggregations, it is sometimes difficult to ascertain when exactly the aggregations started and ended, complicating analyses to determine the duration and environmental triggers responsible for the aggregations.

Environmental data have been retrieved from the IMOS portal and analyses outside the scope of funded work are underway to correlate spider crab aggregation sightings with such variables in order to investigate the triggers of such aggregations. Although there is no published study on those triggers, it is commonly believed that temperature and moon phase influence the timing of the aggregations and/or the onset of moulting.

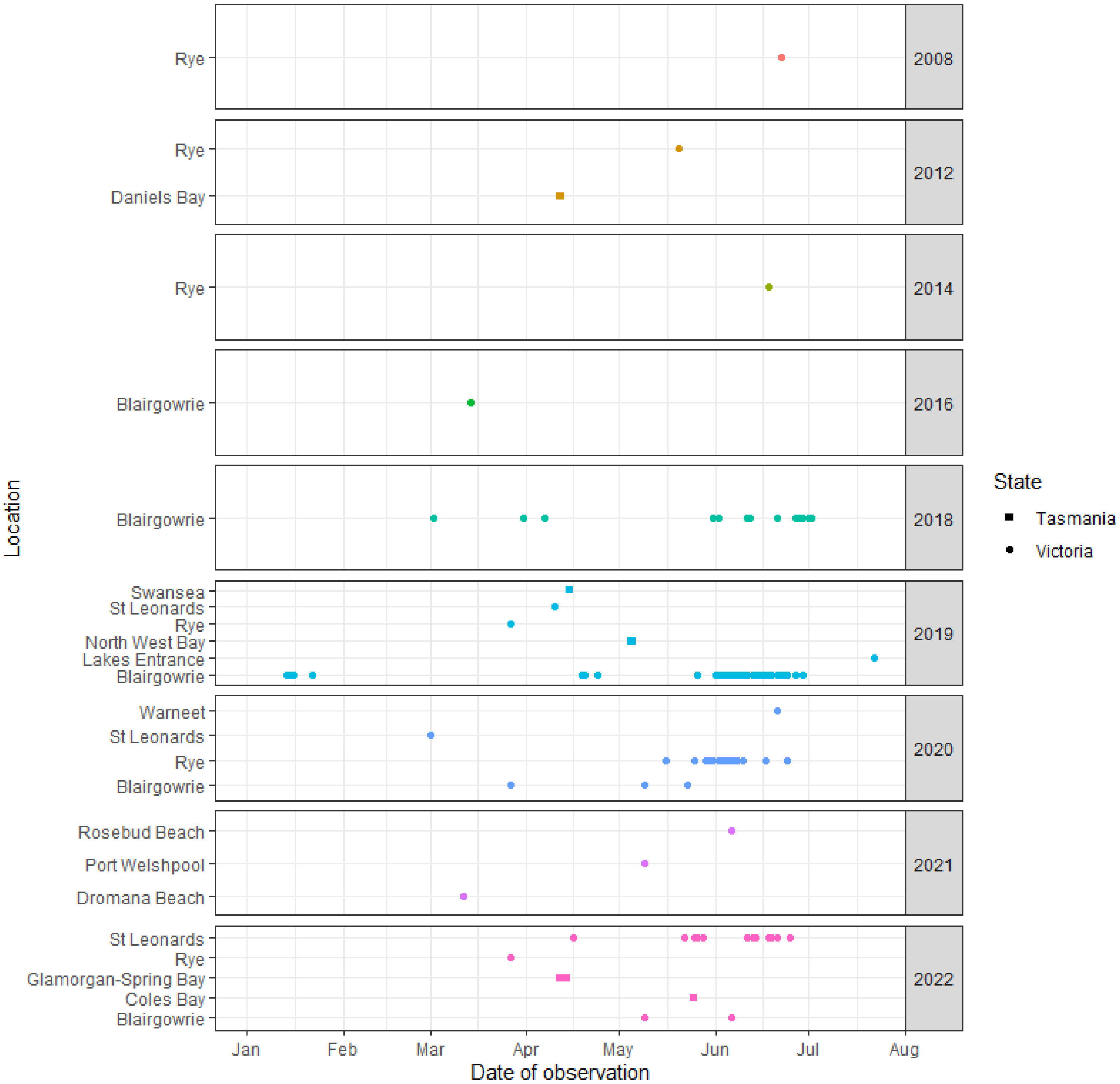


Figure 4: Dates of observations and locations for reports of spider crab aggregations available on the Spider Crabs Melbourne Facebook page and the Atlas of Living Australia database

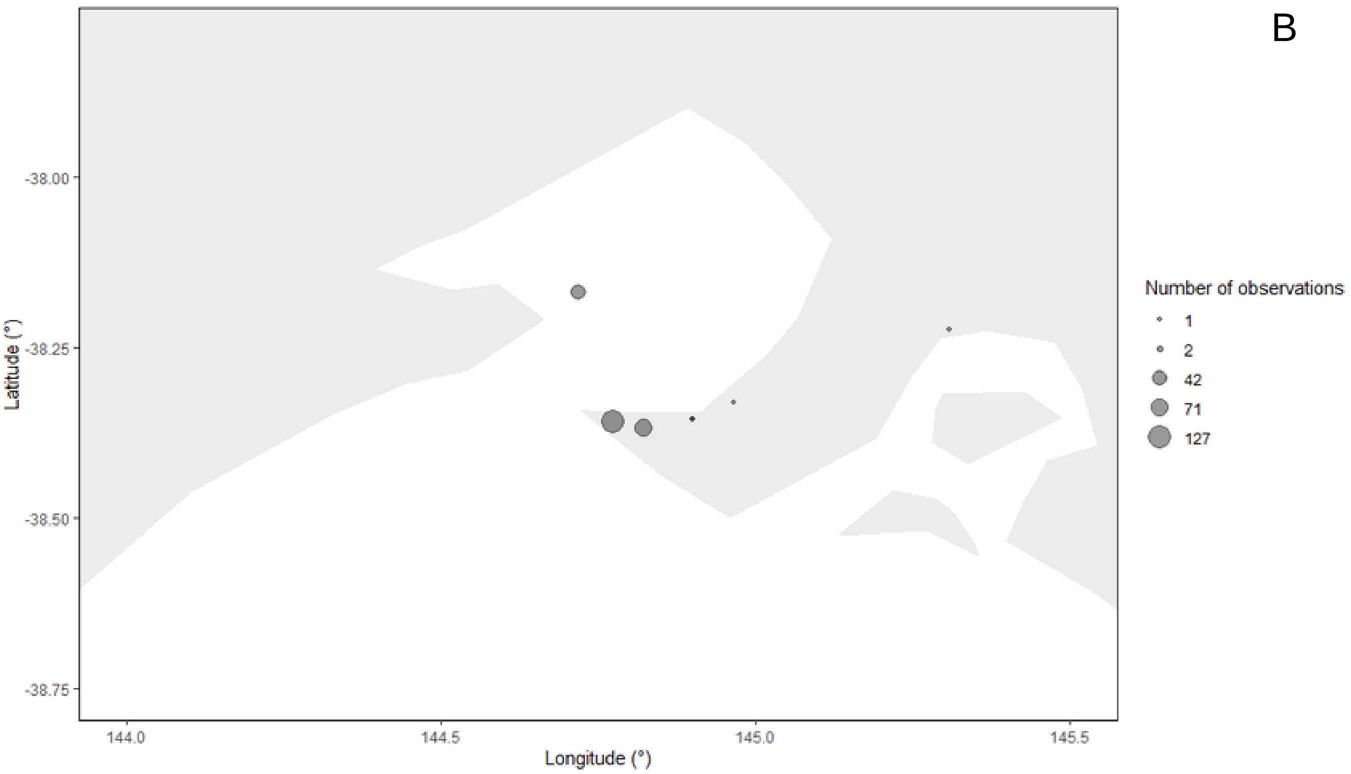


Figure 5: Locations and number of reports of spider crab aggregations available on the Spider Crabs Melbourne Facebook page and the Atlas of Living Australia database, A - in Australia, B - in Port Phillip Bay and Westernport

2.2.2 iNaturalist

As of the 30th January 2023, 86 members (people signed up to receive project updates) have joined the iNaturalist project, 321 observations were logged from 109 different contributors.

A total of 199 observations were logged in 2022 by 63 citizen scientists. That year, spider crab observations from St Leonards (the only confirmed aggregation in Port Phillip Bay that year) were logged on iNaturalist between 21st May and 20th June, with a gap in observations between 28th May and 11th June. Reports of moults were logged between 13th June and 25th June at the St Leonards aggregation.

Mean daily water temperatures were calculated from data recorded every half an hour by the nearest wave buoy at Indented Head (-38.1359° 144.7531°) (Figure 6); they varied between 10.3°C and 15.9°C, with an average of 13.0°C. Full moon happened before the first observations were reported (16th May 2022) and during the second lot of observations on 14th June 2022. The first evidence of moulting reported on iNaturalist was on 13th June 2022.

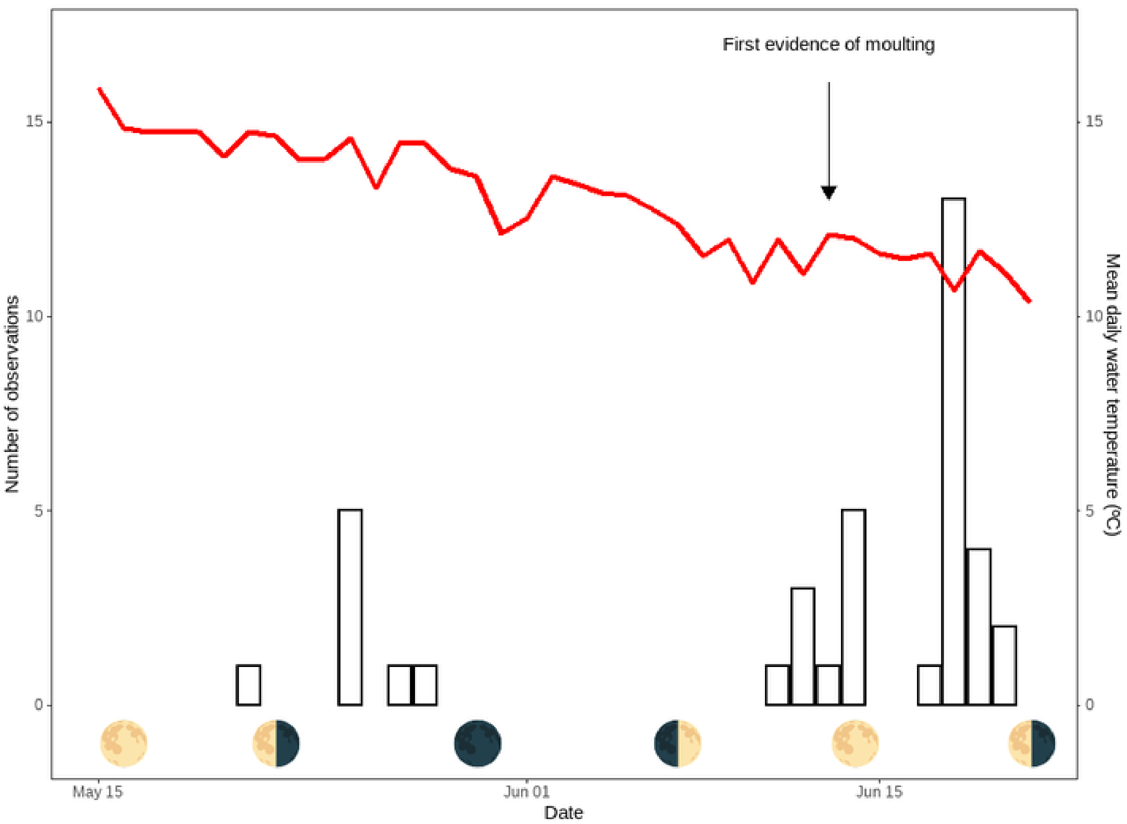


Figure 6: Number of observations per date during the 2022 St Leonards aggregations in relation to mean daily water temperature and moon phases

Whilst our outreach efforts focused on Port Phillip Bay and Victoria, reports of spider crab aggregations in South Australia, from which reports have been rare historically, have also been logged in 2022. Uptake for logging absence data (no spider crab sighted on a dive or a snorkel) was limited (17 observations were logged as absence data), showing that the importance of absence data needs to be communicated better and more broadly. About a third of 2022 reports were logged as “obscured” or “private” though some citizen scientists who had conversations with the research team reported waiting for after the aggregations were over to submit their sightings as “open” instead of using these options straight away.

Photos showing different types of predators were logged, including: a broadnose sevengill shark (*Notorynchus cepedianus*), smooth stingrays (*Bathytoshia brevicaudata*) and Melbourne skates (*Spiniraja whitleyi*) were submitted. No tagged spider crabs were reported on iNaturalist. In 2022, the number of spider crab sightings for Port Phillip Bay (most of which were directly added to the Spider Crab Watch project) increased significantly compared to previous years (Figure 7).

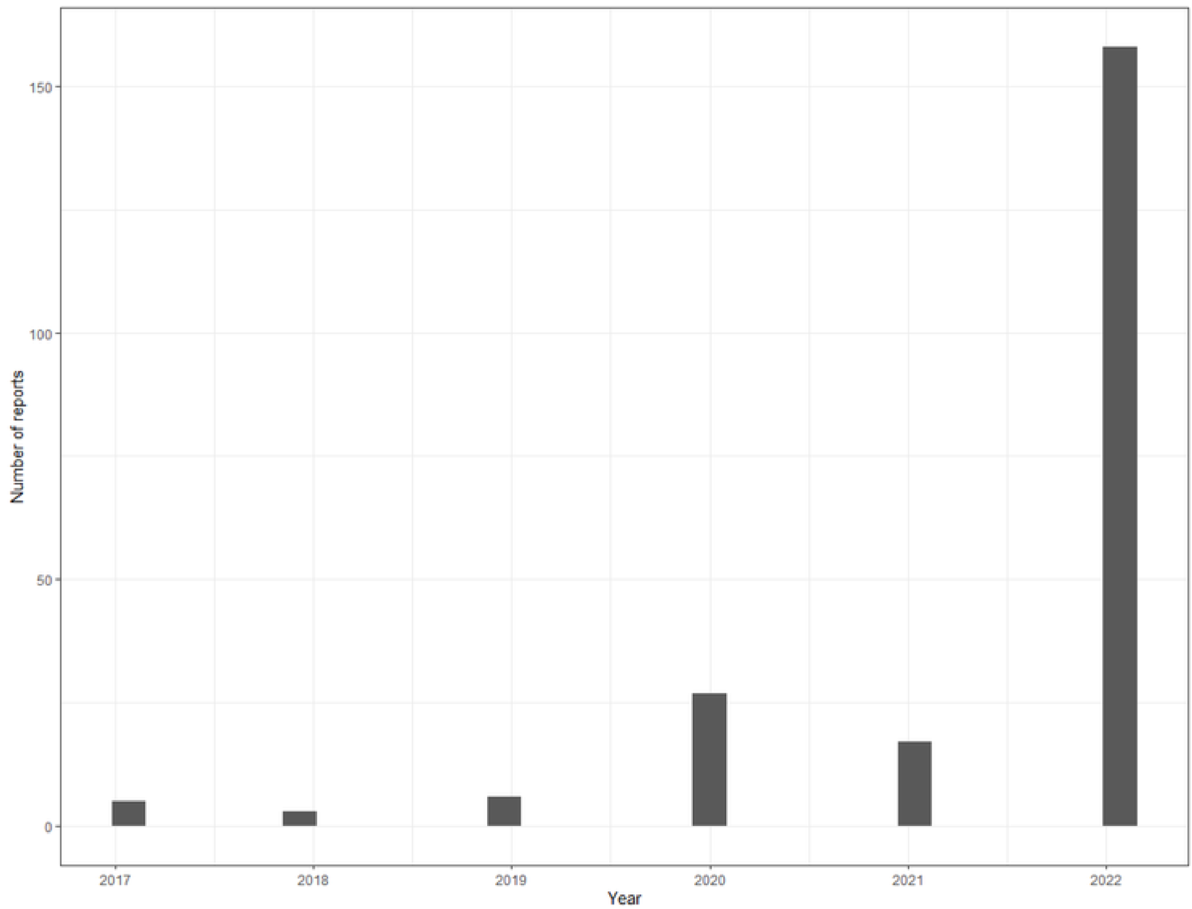


Figure 7: Number of spider crab reports logged on iNaturalist through time in Port Phillip Bay

2.2.3 Zooniverse

More than 66,000 images (Figure 8) were collected during the winter months thanks to the timelapse cameras deployed at Rye, Blairgowrie and St Leonards. A preliminary analysis of the images by the research team revealed that around 7,080 images had spider crabs in them (~8% of spider crab images at Blairgowrie contained only single crabs; <0.1% of spider crab images at Rye and ~82% of images at St Leonards). Cameras at St Leonards detected spider crabs between 16th June and 10th July, with images showing an active aggregation between 16th June and 22nd June.

As of 26th January 2023, 2,773 volunteers have completed 503,803 classifications (image reviews). In addition, the platform allowed regular interactions with citizen scientists posting comments (~650 comments received as of the 27th January) to check their identifications, ask questions, express curiosity or appreciation for spider crab aggregations and marine life.

Figure 8: Example of images obtained with the timelapse cameras deployed in Port Phillip Bay in May-July 2022

2.3 Community engagement

2.3.1 Consultation and outreach

Stakeholder consultation in early 2022 included meetings with existing partner organisations (Spider Crab Alliance, Victorian National Parks Association, Port Phillip Ecocentre) and new community groups (Rye Coastal Advisory Group, Blairgowrie Yacht Squadron) and informal conversations with citizen scientists involved in reporting spider crab information in previous years. This consultation involved reviewing past data collection (e.g. on the Spider Crabs Melbourne Facebook page and iNaturalist), exploring suggestions for improvement, and helped our research team design a new framework for the community to log spider crab sightings.

Extensive community outreach to introduce the research program, educate the community and recruit citizen scientists was conducted including 40 posts on social media, seven newsletters, 13 articles and features, 18 radio interviews, 19 events, 63 organisations reached and >111,000 people (Appendix 2). Fliers to advertise the project and invite community members to get involved in the research were distributed in sailing, fishing and diving clubs around Port Phillip Bay. As of 26th January 2023, 450+ people have signed up to the Spider Crab Watch newsletter curated by the research team; the newsletter has been well received with high open rates (see statistics in Table 2 in Appendix 2). Dr Elodie Camprasse also contributed expertise to build a virtual spider crab tour in collaboration with nature-connection charity Remember The Wild (not part of the DEECA grants, but the content creation was informed by our research team's work).

2.3.2 Evaluation

The team designed a survey to capture citizen scientists' satisfaction with Spider Crab Watch on iNaturalist, their motivations for getting involved and some socio-economic information. The online survey was approved by Deakin University's human ethics committee (reference number SEBE-2022-32) on 3rd August. Feedback for the Zooniverse project will be collected in the coming months.

Despite repeated call outs (on social media and through word of mouth), only 7 respondents took the survey. Half of them were previous iNaturalist users and half of them signed up as a result of their desire to participate in our research (one respondent did not indicate if they were already an iNaturalist user). Satisfaction for the project ranked from 2/5 to 5/5 (with 1 being worse and 5 being best) and averaged 3.7/5. Social media was the main source of awareness of the program (four respondents with one respondent hearing about it in the media and another through word of mouth and another through community presentations). The main activity which was performed by citizen scientists when viewing spider crabs was snorkelling/swimming/diving.

Sources of dissatisfaction included:

- “I usually have to log the information and go back after to add the attributes as it doesn't show as an option at the first place in the computer and doesn't show at all on my android phone.”
- “Location should be private for all recorded observations to protect the crabs from fisherman.”
- “New to iNaturalist so needed to learn the ropes. Fine once up and running”.
- “Figuring out how to log a sighting to a specific project was not straight forward intuitive. Needed some guidance.”

Suggestions provided by respondents to improve the program included:

- “do more advertisement”
- create a “guide on iNaturalist for beginners”
- “maybe need to ask to people with bad experience to show you why it is difficult”
- “sort images by sighting date”
- “additional background on project (how are our observations helping research outcomes?) and regular updates to those following”.
- “Once the process of logging something is understood it's working fine. Logging a sighting on the website can be confusing when adding project fields. The order of the fields is important for context. But that's not a particular problem of this project but a general design problem with the website”

Survey respondents rated that their involvement in the project related to the following benefits: contributing to scientific knowledge (average rating of 5/5), being encouraged to spent more time in nature (average rating of 3.3/5), learning about spider crabs and the marine environment (average rating of 4.6/5) and helping their future career (average rating of 1.6/5).

2.4 Challenges encountered

One of the main challenges for our research in 2022 was related to the location of the spider crab aggregations. Spider crab activity at the main sites where they have historically been sighted (e.g. Rye, Blairgowrie) was very low and no settled aggregation occurred there from our knowledge. Whilst there were sightings at Blairgowrie of a group of spider crabs in their thousands early in the season (early May), the location was inaccessible to citizen scientists reporting spider crab sightings (i.e. no-go zone at the entrance of a marina). As far as we know, no spider crab activity was reported at Rye pier. The only location that we know of where spider crabs aggregated in 2022 was at St Leonards, on the Bellarine Peninsula, where typically less divers and snorkelers explore the marine environment and where awareness of spider crab aggregations is lower than on the Mornington Peninsula.

The second main challenge was people's reticence to share any spider crab information because of concerns around fishing practices. Community members discussed this matter online (e.g. through Facebook pages), and the consensus was to avoid making any information on the spider crab whereabouts public. This was discussed during our regular meetings with DEECA and our position was to not reveal locations and encourage people to interact with the spider crabs and provide more information on their locations and activities. A few people let our team know (through informal conversations) that unless all locations on iNaturalist were made private (hidden to the general public), they would prefer not to participate; a preference for all locations to be made private was also mentioned in the evaluation survey. A few people also said that they would rather wait until aggregations were over to submit any sightings on the project.

Despite the number of observations available on iNaturalist, the Atlas of Living Australia, and on the Melbourne Spider Crabs Facebook page, some of the questions we expected to be able to answer at completion of this project haven't yet been answered. What environmental cues trigger spider crab aggregations needs to be explored further with more data. This is for the most part due to the low accuracy/specificity of the existing data (except for 2022), which was not collected with a specific framework to answer questions regarding spider crab ecology and aggregations. The potential importance of spider crab aggregations for regulating Northern Pacific seastars also remains to be determined as very numbers of this species of seastars were present at aggregation sites in 2022. However, the project helped us develop a good understanding of the 2022 spider crab aggregation, including its location, duration and the progression of the different phases, as well as the presence of predators.

Some confusion and/or frustration, as shown by comments on social media and reported to during regular catch-ups, existed as to what the team was trying to achieve and where funding was coming from. Some people expressed distrust in the research thinking the funding was coming from and intended to benefit fisheries.

2.5. Lessons learned and future work

Data quality prior to our program was poor and a lot of sightings could not be used (inability to determine whether they related to spider crab aggregations, spider crab numbers unclear, etc). Our project allowed us to increase both the quantity and quality of spider crab sightings compared to previous years, despite a challenging season, with spider crab activity being low at the main sites where people actively go and look for spider crabs and the community being reticent to log spider crab sightings because of fear of revealing locations of aggregations. The duration of the aggregations could be determined with much more accuracy than in previous years, and the collection of new information (number of spider crabs, presence of predators in the environment during aggregations, onset of moulting) was made possible. Standardised data collection is necessary to improve our understanding of understudied spider crab aggregations and Spider Crab Watch provided a portal to collect new information. Whilst the iNaturalist Spider Crab Watch project will remain accessible to the community, citizen science participation is expected to increase with ongoing engagement and communication with community members.

Through continued outreach, we can obtain more information in future years and hopefully ease some people's concerns about how the data can be used and is used for. The community was eager to gain information on the research and on spider crabs and the marine environment, as shown by survey results and by the high number of radio interviews, media features and presentations given throughout the project, which was much higher than anticipated.

The main issue with existing citizen science data (e.g. data logged in the past on iNaturalist, Atlas of Living Australia, on the Spider Crabs Melbourne Facebook page) lies in the majority of sightings being recorded anecdotally rather than with the aim of answering specific questions regarding spider crab ecology and

specifically, their aggregations, and/or being recorded without specific prompts. We built a framework that would allow such information to be recorded with more accuracy by asking people to answer specific questions. The project raised awareness for spider crab research, and received great formal and informal feedback from community members eager to participate in research that would inform the ecology of the species.

In order to answer questions revolving around the timing, duration and triggers of the aggregations and moulting as well as their ecological role long-term data collection will be required. Ideally, data collection will involve a mix of traditional and citizen science, capitalising on the work done by the research team as part of this project and the broader research funded through the Port Phillip Bay Fund. Citizen science and specifically iNaturalist reports were valuable to inform traditional science activities (including underwater surveys, tagging, morphometrics), as well as to collect new information. Ongoing community engagement is therefore desirable. As this project was a pilot, our team leveraged existing social media platforms with existing fan base and an interest in spider crabs and more broadly the marine environment in the region (e.g. Spider Crab Melbourne Facebook page, Spider Crab Alliance Facebook page, and the Victorian National Parks Association, Port Phillip Ecocentre and Great Southern Reef social media platforms and newsletters). Dedicated social media platforms for the project would complement the Spider Crab Watch newsletter and attract new supporters.

Information available on spider crabs and their aggregations are mostly from Blairgowrie, Rye and in 2022, from St Leonards, but we know that aggregations happen elsewhere in the Bay from anecdotal observations obtained through informal discussions with dive clubs and other Bay users. These aggregations seem to occur in locations which are not accessible by most divers, who do not have access to a boat and mostly dive at popular dive sites in very shallow water from the shore. Obtaining a more holistic understanding of the locations and durations of spider crab aggregations require engaging with people and organisations outside of the recreational diving and snorkelling community (e.g. sailing and angling clubs, commercial diver operators). Having a researcher leading community engagement being an active member of the diving and snorkelling community helped the project gained traction and alleviated some concerns around participating in the research. With more awareness for the project and time dedicated to community outreach, it will be possible to engage a more diverse audience; organisations in the fishing community have also expressed interest in partnering with our team to achieve research outcomes in the future.

Aggregations outside of peak season (May-July) have been reported in previous years. The purpose of these aggregations is unknown. Anecdotal information suggests that these aggregations are short-lived; therefore, citizen science is valuable to capture more information on aggregations outside of winter and engagement in the research through the year (as opposed to mainly during winter) is desirable.

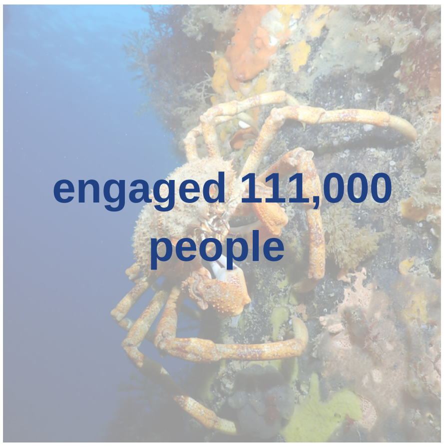
Some of the questions we put forward are not yet answered because of the 2022 conditions and/or the quality of existing data (what environmental variables trigger the aggregations and what is the potential of spider crab aggregations to regulate Northern Pacific seastars for example). Ongoing data collection will need to be performed to detect such trends. Determining the cues that trigger spider crab aggregations is still ongoing as data analyses is complicated by the nature of existing data; despite the fact that data over >5 years on spider crabs have been logged on various platforms, most often it was not possible to pinpoint the start and the end of past aggregations, making it challenging to correlate sightings with environmental variables with the required accuracy. The number of Northern Pacific seastars at suspected aggregation sites were very low, making it impossible to detect significant trends related to the impact of spider crabs on such introduced species. Instead, Northern Pacific seastars were monitored thanks to the timelapse cameras deployed at Rye, Blairgowrie and St Leonards (Coastcare grant GA-F26964-7317). Preliminary analysis of the images obtained with the cameras indeed revealed very low number of Northern Pacific seastars at Blairgowrie and none at Rye pier and St Leonards observed during the sampling period at site locations.

Low uptake for the reporting of spider crab absence data on our iNaturalist Spider Crab Watch was witnessed; such data can inform habitat suitability modelling for the species but better ways to collect this information needs to be considered (e.g. through a hashtag on social media) and/or the value of this data needs to be communicated better for ongoing data collection.

Community concerns around revealing spider crab locations need to be taken into account and ways to alleviate them need to be integrated to the project (e.g. other, additional ways to report the data and/or improved communication around options to obscure locations). Other avenues to involve citizen scientists were discussed with partners and the local community. For example, the organisation of community events to measure and sex moults in order to collect information on size, sex ratio, morphometrics and sexual dimorphism in spider crabs, which is important to understand the composition of the aggregations and potential changes linked with anthropogenic pressures. With contingency options to take into account concerns over revealing the location of aggregations (e.g. researchers collecting moults on site but holding community events in different locations), this kind of community engagement could be considered to increase community participation and as an additional opportunity to educate the community about our unique marine species and raise awareness for the research.

Responses to our survey seeking to understand citizen scientists' experience with Spider Crab Watch on iNaturalist have been low, indicating that other ways of obtaining this information should be investigated (e.g. one-of-one interview following methods from Sea Dragon Search, focus groups, most likely online, or offering incentives such as prizes when people take the survey). Nonetheless, suggestions which should be taken on board to improve citizen science's experience of and satisfaction with the project have been offered by participants (e.g. creating a guide for community members unfamiliar with iNaturalist, providing additional background on the project and regular updates to those following the project on iNaturalist, having conversations with people finding the process difficult, advertise the project more widely). Such suggestions will be implemented by the research team when funding is secured to continue this work.

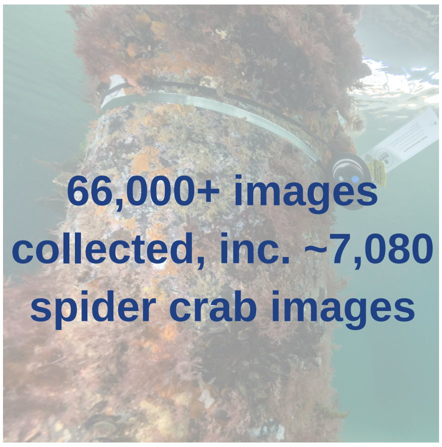
Revealing the habits of Port Phillip Bay's iconic spider crabs



199 iNaturalist observations, 63 citizen scientists

New online portals to collect spider crab data

Motivations: contributing to science, learning about spider crabs



3.7/5 satisfaction with Spider Crab Watch

Part 3. Giant spider crab ecological assessment

Lead: Assoc. Prof. Daniel Ierodiaconou
Project team: Dr Elodie Camprasse, Prof. John Arnould, Paul Tinkler, Darren Wong, Scott Gray, Dr Sasha Whitmarsh, Dr Mary Young, Darcy Cutter

The research team undertook an ecological assessment of giant spider crabs and their aggregations. Stereo baited remote underwater video (SBRUV) was used to assess fish diversity within Port Phillip Bay. Stereo diver operated video transects allowed us to map the extent of the 2022 St Leonards aggregation, estimate spider crab abundance and predator occurrence. Acoustic tagging was used to understand spider crab movements post aggregations. Finally, morphometric data were obtained to further our understanding of spider crab biology.

3.1 Baited remote underwater video (BRUVs)

3.1.1 Methods

For imagery acquisition we used Stereo baited camera systems where two high definition video cameras (GoPro Hero7 Black) were fitted on each SBRUV frame. The pairs of cameras were mounted 0.7 m apart and angled in at 8 degrees to allow for stereo imaging. Filming in stereo adds the capability for making accurate measurements of individual fish, informing estimates of biomass. Each SBRUV frame was calibrated in a pool prior to fieldwork commencing. SBRUVs were baited with one kilogram of pacific sardines (*Sardinops sagax*) to attract fish into the field of view for relative abundance and diversity estimates, and length measurements. They were left to soak on the seafloor for a minimum of 60 minutes.

Weights of individuals of each species were estimated using length-weight relationships obtained from Fishbase (Froese & Pauly 2010). Where length-weight relationships were not available for a species, that of a close relative was used. Total relative biomass was calculated as the sum of individual weights of each species, for each site. Where all individuals were not able to be measured at the MaxN, the mean weight of that species was assigned.

3.1.2 Summary of deployments

A total of 181 replicate deployments were made across Port Phillip Bay between 15th of February and 10th of April (Figure 9). Of these 181 replicates, 127 were considered successful, with 54 failures (Table 1). The failure replicates were due to poor visibility within some areas of the bay. BRUVS were targeted to sample across a range of habitats, depths, and site types, with anchor scar and dredge spoil sites recording high percentages of failures (Table 2).

3.1.3 Habitat types observed

Four major habitat types were sampled across the 127 deployments, circa and infra-littoral reefs, seagrass, and soft sediment habitats (Table 2). The deployments were conducted within 1–27 m and categorised into four depth bins for analysis (0–5, 5–10, 10–15, 15+). Infralittoral reef and soft sediment habitats were the dominant habitats sampled. The shallower sites sampled (<10 m) had higher percentage cover of macroalgae compared to the deeper sites (>10 m) which were more dominated by fine and coarse sand cover (Figure 10).

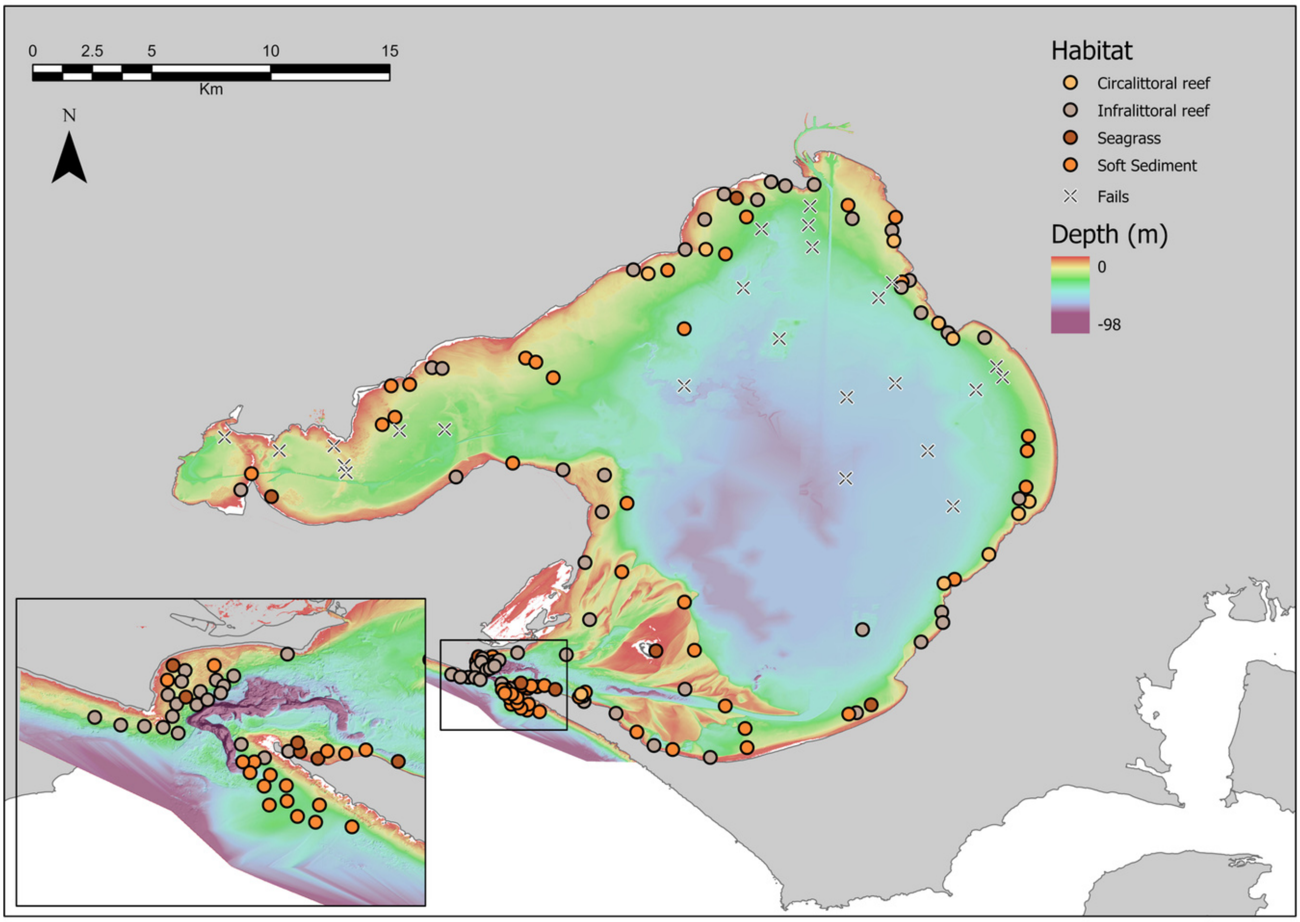


Figure 9: S-BRUV Port Phillip Survey extent in various habitats

Table 1: Summary of BRUVS deployments made across Port Phillip Bay in 2022 showing the original site type and whether the replicates was a success or failure.

Site type	Success	Fail	Total
Anchor Scar Sites	1	9	10
Deakin BRUVS	49	6	55
Dredge Spoil Sites	1	5	6
Drift algae net sites	6	7	13
Kade BRUVS	7	2	9
PPB ROV Sampling	24	7	31
RLS	12		12
Spider Crabs	5		5
Tim Seagrass Sites	3		3
TNC Shellfish Reefs	5	6	11
VFA Abalone	3		3
VFA Acoustic Receivers	6	12	18
VFA Seagrass	5		5
Total	**127**	**54**	**181**

Table 2: Summary of habitat types sampled by depth range for the BRUVS deployments in Port Phillip Bay. Categories in brackets denote biotopes defined according to the Combined Biotope Classification Scheme (CBiCS) as displayed for Victoria in the 'Biotope Atlas' on CoastKit

Habitat type / Depth (m)	Circalittoral reef (ba4)	Infralittoral reef (ba3)	Seagrass (ba5.8)	Soft sediment (ba5)	Total
0–5	1	25	4	12	42
5–10	7	25	5	13	50
10–15	2	6		16	24
15+		2	1	8	11
Total	**10**	**58**	**10**	**49**	**127**

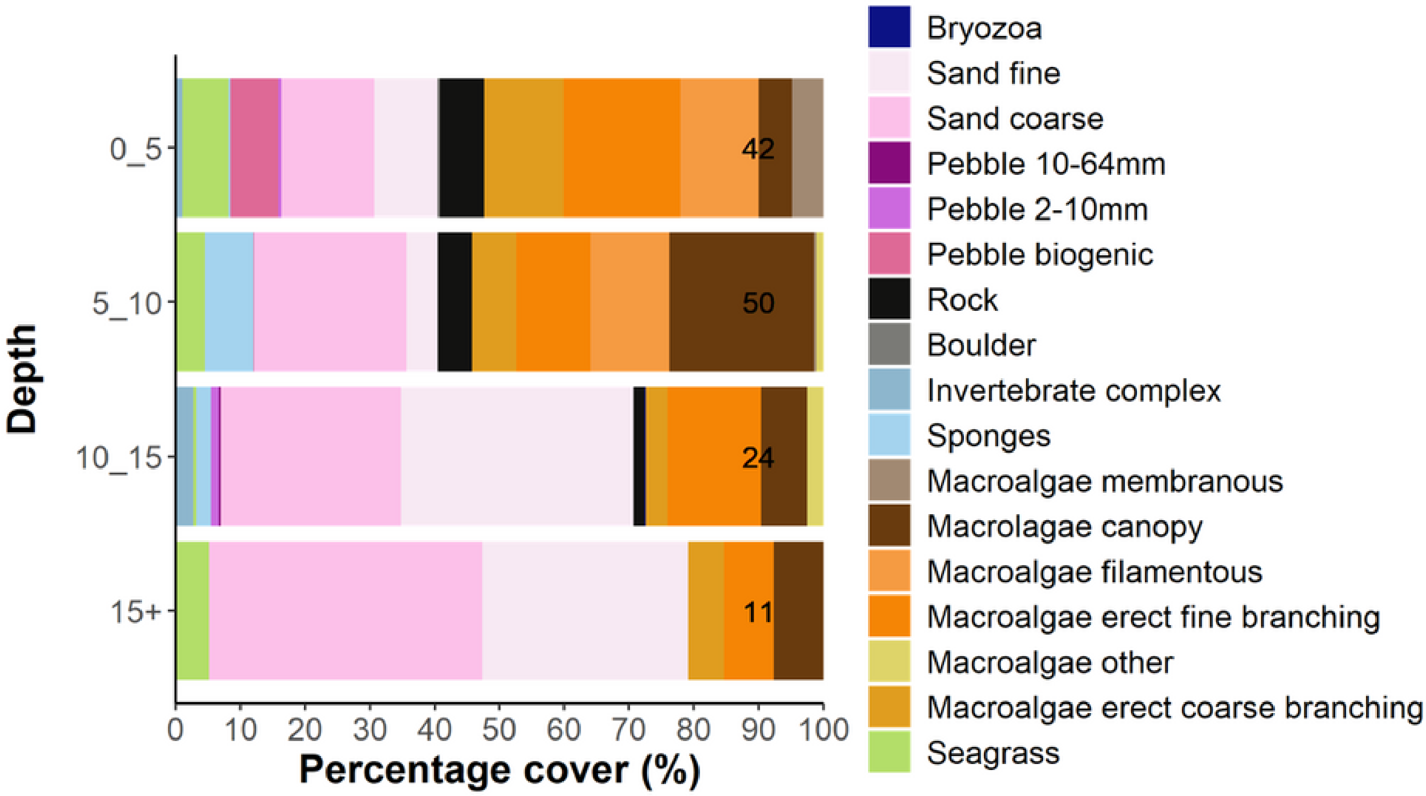


Figure 10: Percent cover of habitat from the BRUVS across the depth range sampled in Port Phillip Bay. The numbers in each bar show how many replicates were included in each depth category.

3.1.4 Fish assemblages of Port Phillip Bay in 2022

A total of 127 successful BRUVS were completed in Port Phillip Bay in 2022. From these BRUVS, 5,679 individual fishes were observed from 93 taxa, including 78 teleosts, 13 chondrichthyans, and two cephalopods (Appendix 3). Additionally, 14 invertebrate taxa across 282 individuals were observed, including six spider crabs, *Leptomithrax gaimardii*. All invertebrates except the cephalopods were excluded from further analysis.

The most abundant taxa were the schooling scads *Trachurus* spp., followed by snapper *Chrysophrys auratus*, and trevally *Pseudocaranx* spp. (Figure 11). Large rays were the top contributors to the biomass observed including smooth rays *Bathytoshia brevicaudata*, eagle rays *Myliobatis tenuicaudatus*, and fiddler rays *Trygonorrhina dumerilii* (Figure 11). Fiddler rays *T. dumerilii* were also by far the most widespread species observed appearing on 80% (102/127) of deployments, with the next most widespread species, snapper *C. auratus*, appearing on only 46% of deployments and goatfish *Upeneichthys vlamingii*, appearing on 45%. The total biomass, total abundance and species richness obtained are displayed in Figures 12-14.

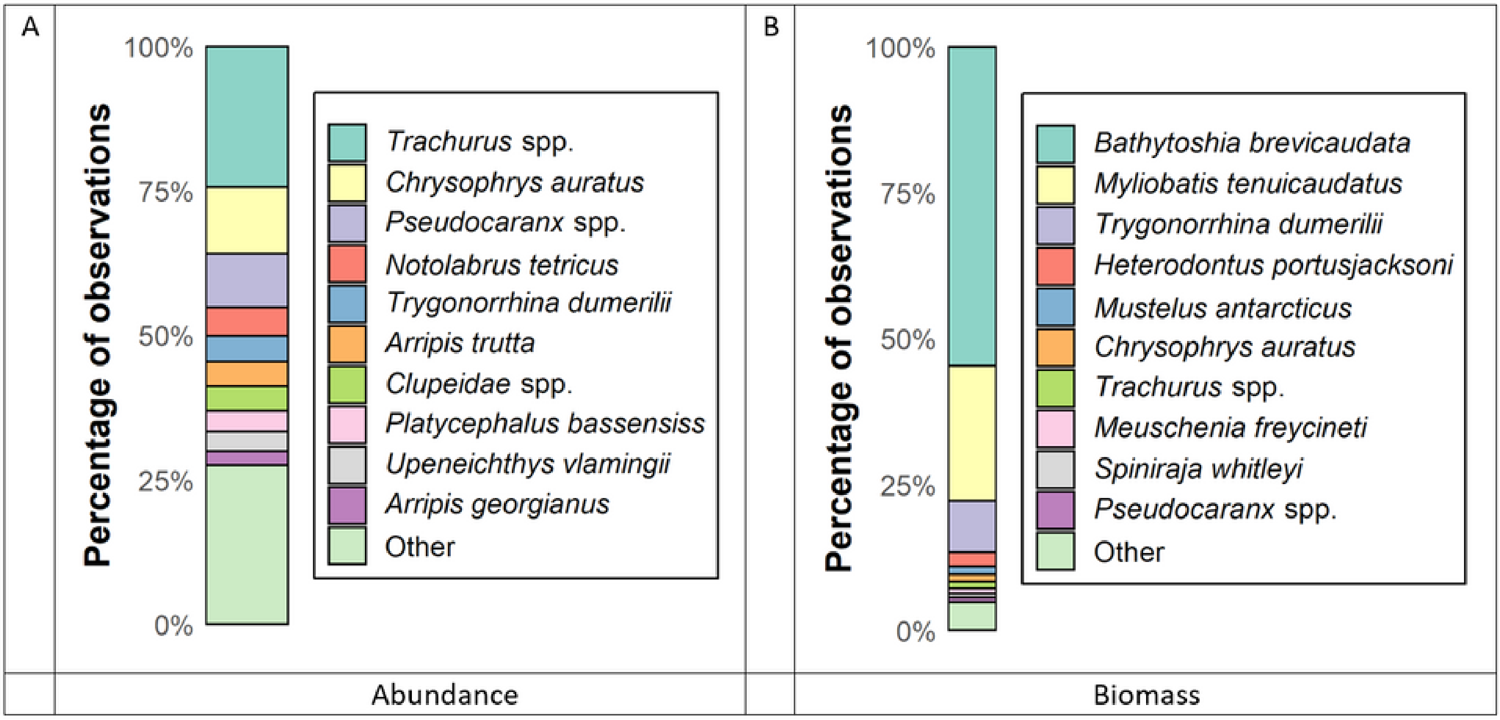


Figure 11: The top ten A) most abundant taxa and B) contributors to biomass shown as a % of overall observations

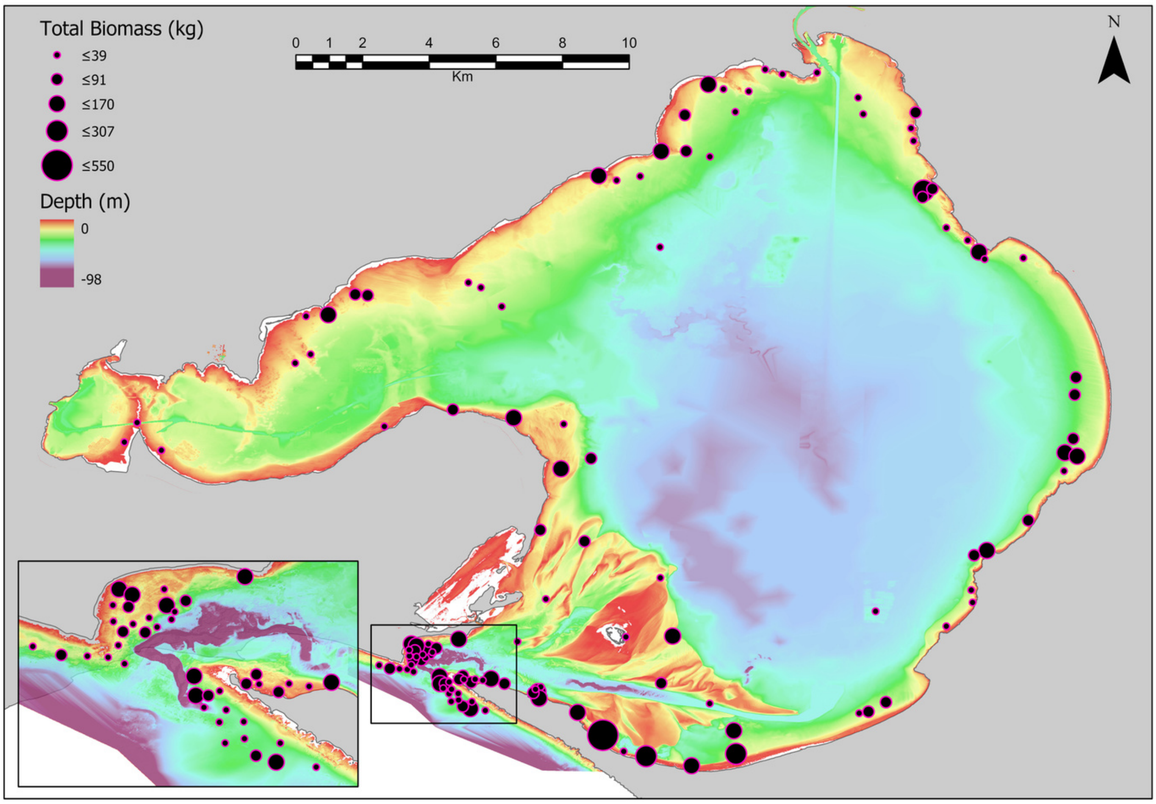


Figure 12: Total biomass (kg) for all species recorded from the BRUVs deployments

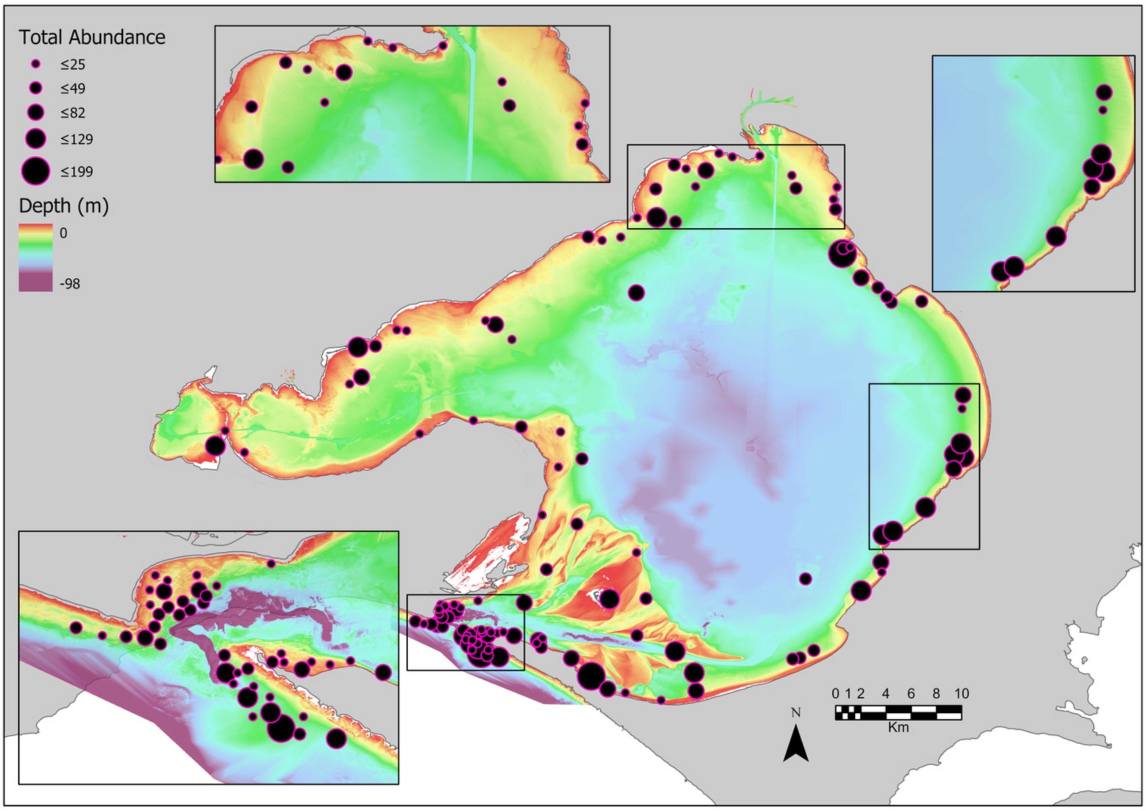


Figure 13: Total abundance for all species recorded from the BRUVs deployments

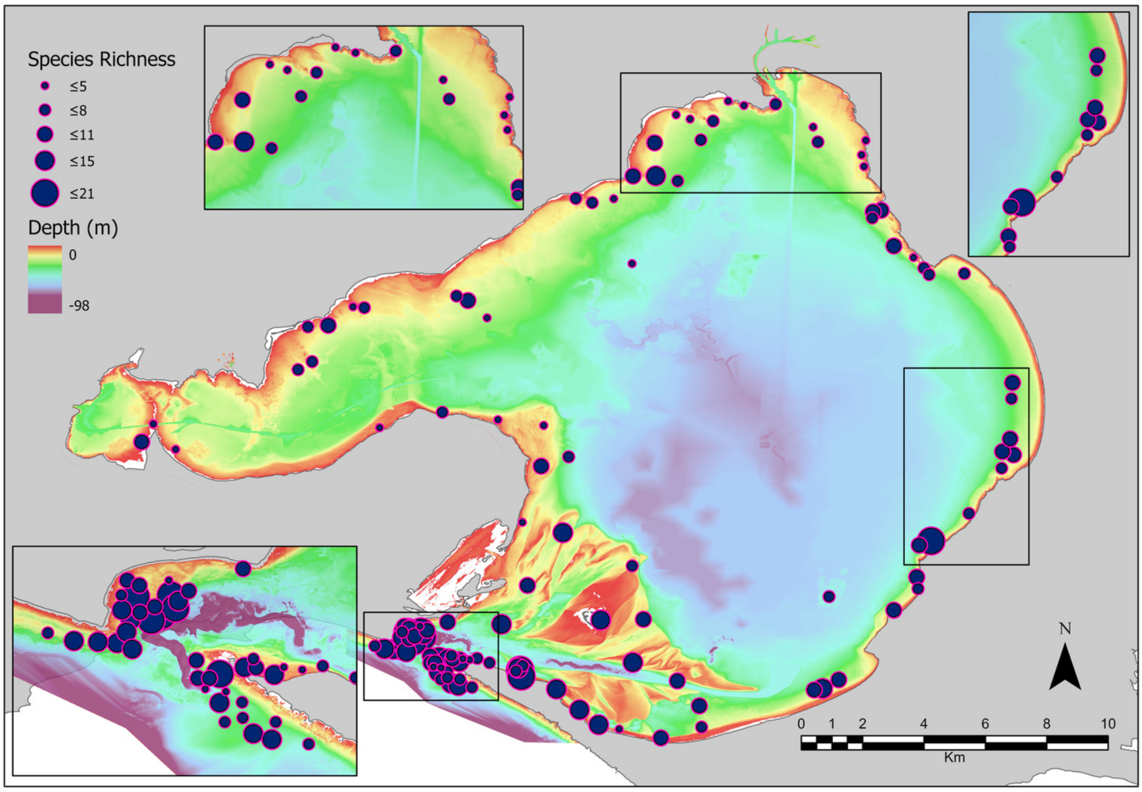
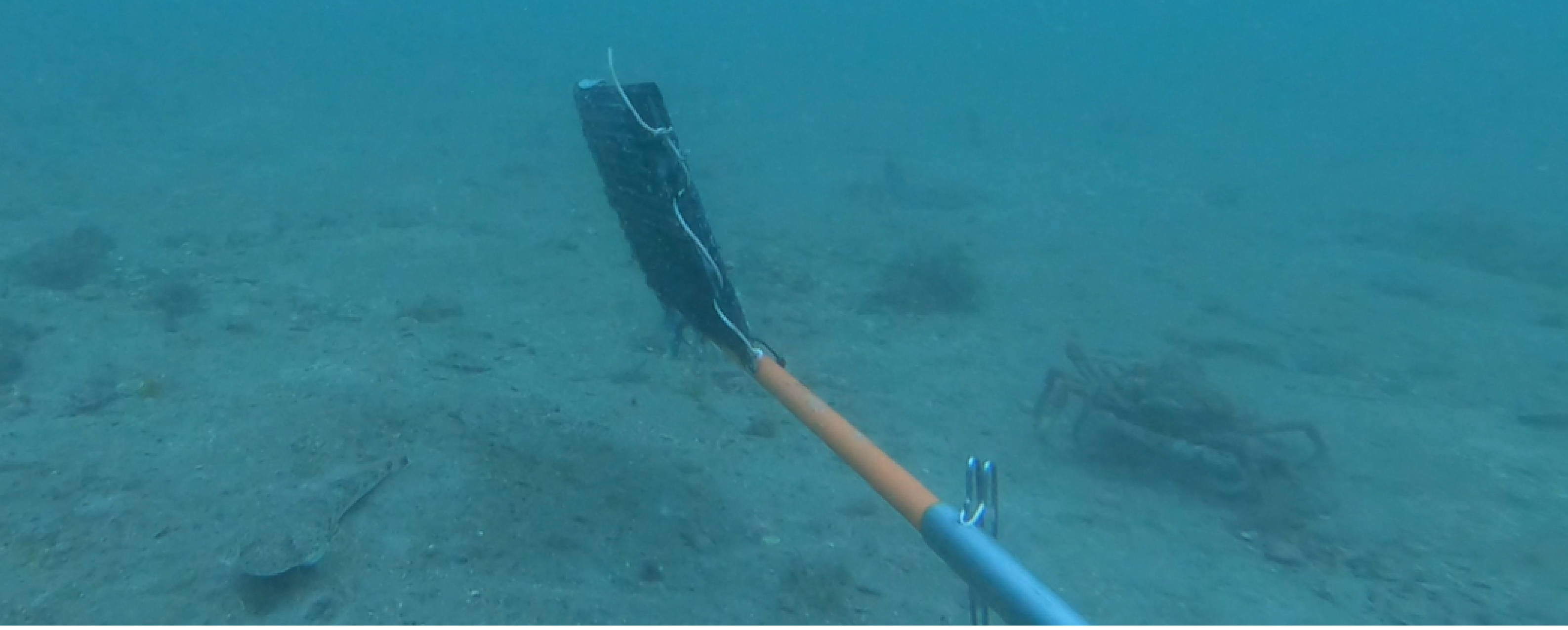


Figure 14: Species richness for all species recorded from the BRUVs deployments



3.1.5 Spider crabs observed from the BRUVS

Six individual *L. gaimardii* were observed across the 127 deployments, with only a singular crab on each deployment (Table 3, Figure 15). Five of the observations were from areas outside protected areas, with one in the Port Phillip Heads Marine Park. Five crabs were observed in soft sediment habitat and one in seagrass. No crabs were observed in dominant reef habitat. Crabs were observed across a wide depth range from 1–15 metres. The majority of the crabs were observed in February and crabs were observed across the daytime sampling hours. Two of the sites where spider crabs were observed were chosen due to them being known spider crab aggregation areas (PPB126, 117), however, at the other three historically known aggregation sites no spider crabs were observed (038, 052, 081).

*Table 3: Environmental variables for the six deployments in which spider crabs Leptomithrax gaimardii were observed within Port Phillip Bay in 2022. A * indicates a pre-determined spider crab aggregation site.*

Site	MPA Status	Latitude	Longitude	Habitat	Depth (m)	Temp (°C)	Date	Time deployed
PPB134	Unprotected	-38.30718	144.6884	Seagrass	15.7	19.1	15/02/2022	9:32:00 AM
PPB126*	Unprotected	-38.1455	144.750542	Soft Sediment	13.1	21.7	16/02/2022	1:09:00 PM
PPB117*	Unprotected	-38.34105	144.853219	Soft Sediment	11.4	20.7	1/03/2022	10:04:00 AM
PPB105	No Take	-38.30374	144.6788	Soft Sediment	10.4	19.0	15/02/2022	9:26:00 AM
PPB095	Unprotected	-38.20507	144.746	Soft Sediment	8.6	21.9	16/02/2022	4:17:00 PM
PPB003	Unprotected	-38.35936	144.790212	Soft Sediment	1.1	21.5	15/02/2022	3:24:00 PM

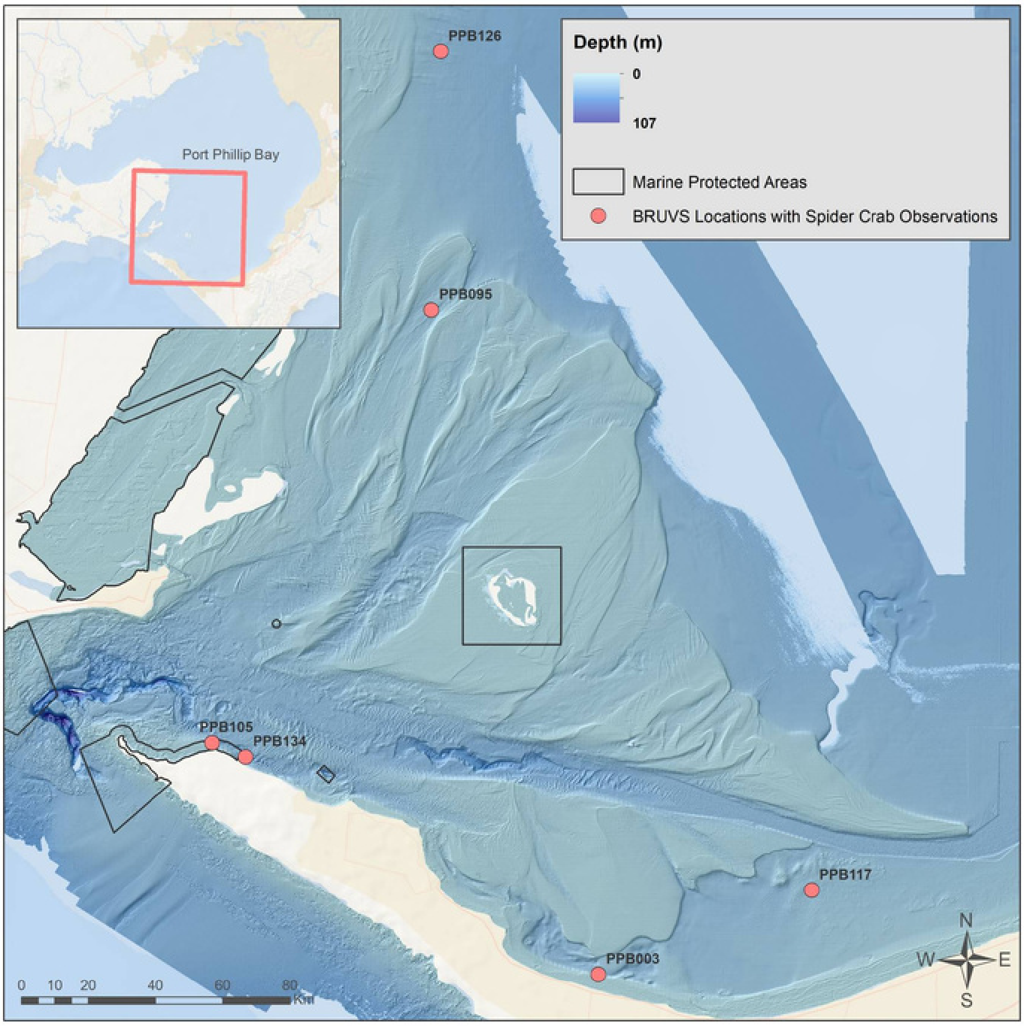


Figure 15: A map showing the locations of the spider crabs observed from the BRUVS deployments

3.1.6 Influence of habitat type on fish assemblages

Habitat had a significant effect on the fish assemblages observed across Port Phillip Bay (Pseudo-F = 5.54, P = 0.001; Figure 16). All habitat types differed significantly except for infralittoral reef and seagrass habitats (Table 4). Species influencing the difference between habitats included senator wrasse *Pictilabrus laticlavius*, blue throat wrasse *Notolabrus tetricus*, scalyfin *Parma victoriae*, and rough leatherjackets *Scobinichthys granulatus* for the infralittoral reef and seagrass habitats, flathead *Platycephalus bassensis* and scad *Trachurus* spp. in the soft sediment habitats, and snapper *Chrysophrys auratus* in the circalittoral reef habitats (Figure 17, Appendix 4). Species richness varied significantly by habitat type, with infralittoral reef habitats having significantly more diversity than soft sediment habitats (Figure 18). Total abundance and total biomass did not differ by habitat type.

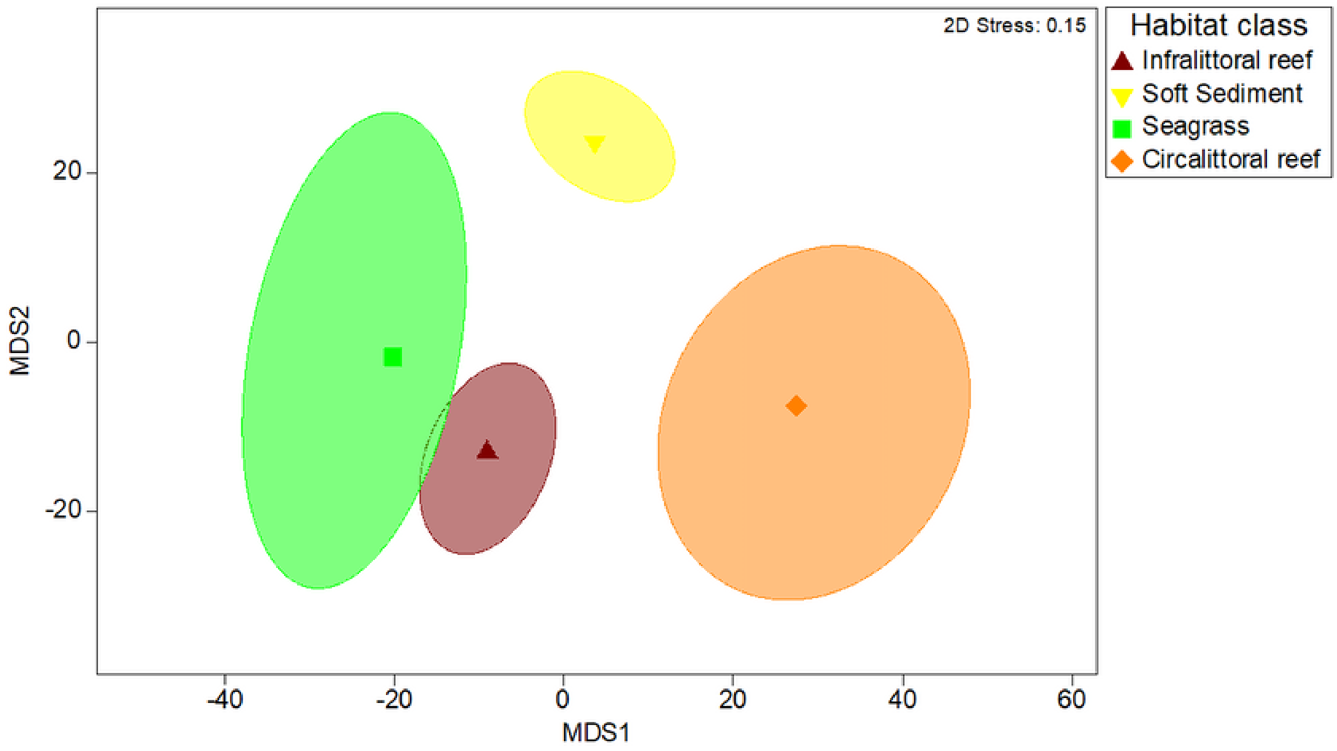


Figure 16: A metric MDS plot showing the bootstrap averages (N = 100) for habitat type of fish assemblages observed via BRUVS in Port Phillip Bay. The symbol indicates the average for that habitat type and the ellipses show 95% of the coverage of the bootstrapped values.

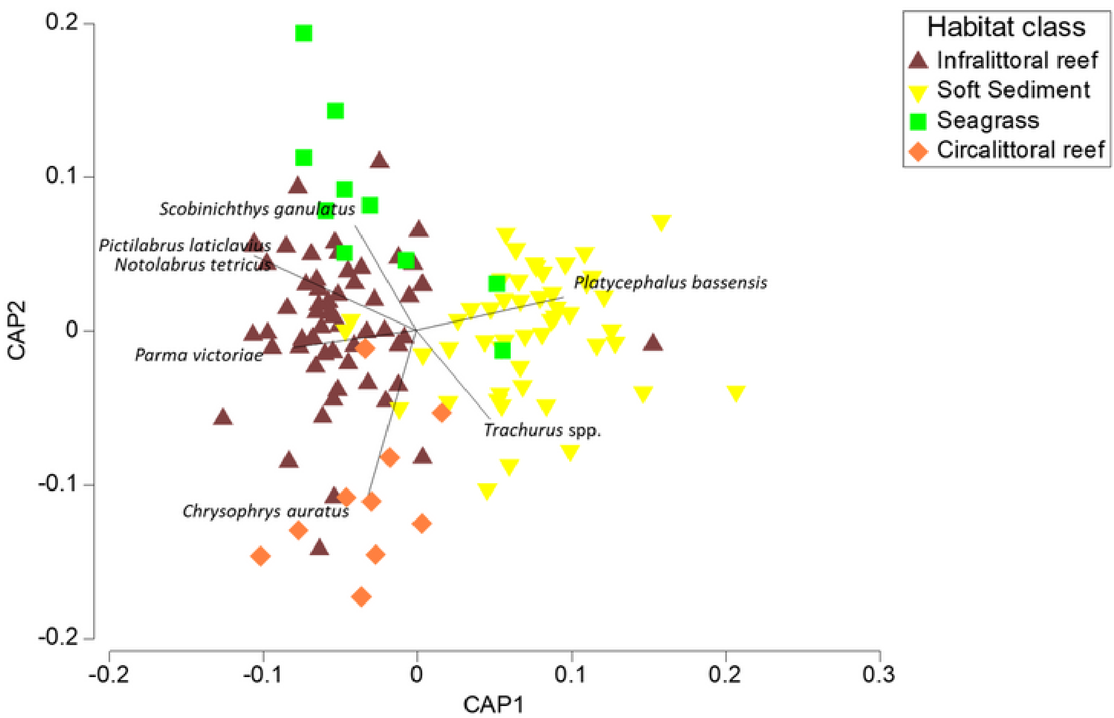


Figure 17: CAP ordination plot for habitat type showing the similarity between BRUVS deployments. Fish species correlated (>0.4) with the first two axes that are also contributors to within group similarity from SIMPER (Appendix 4) are shown in black.

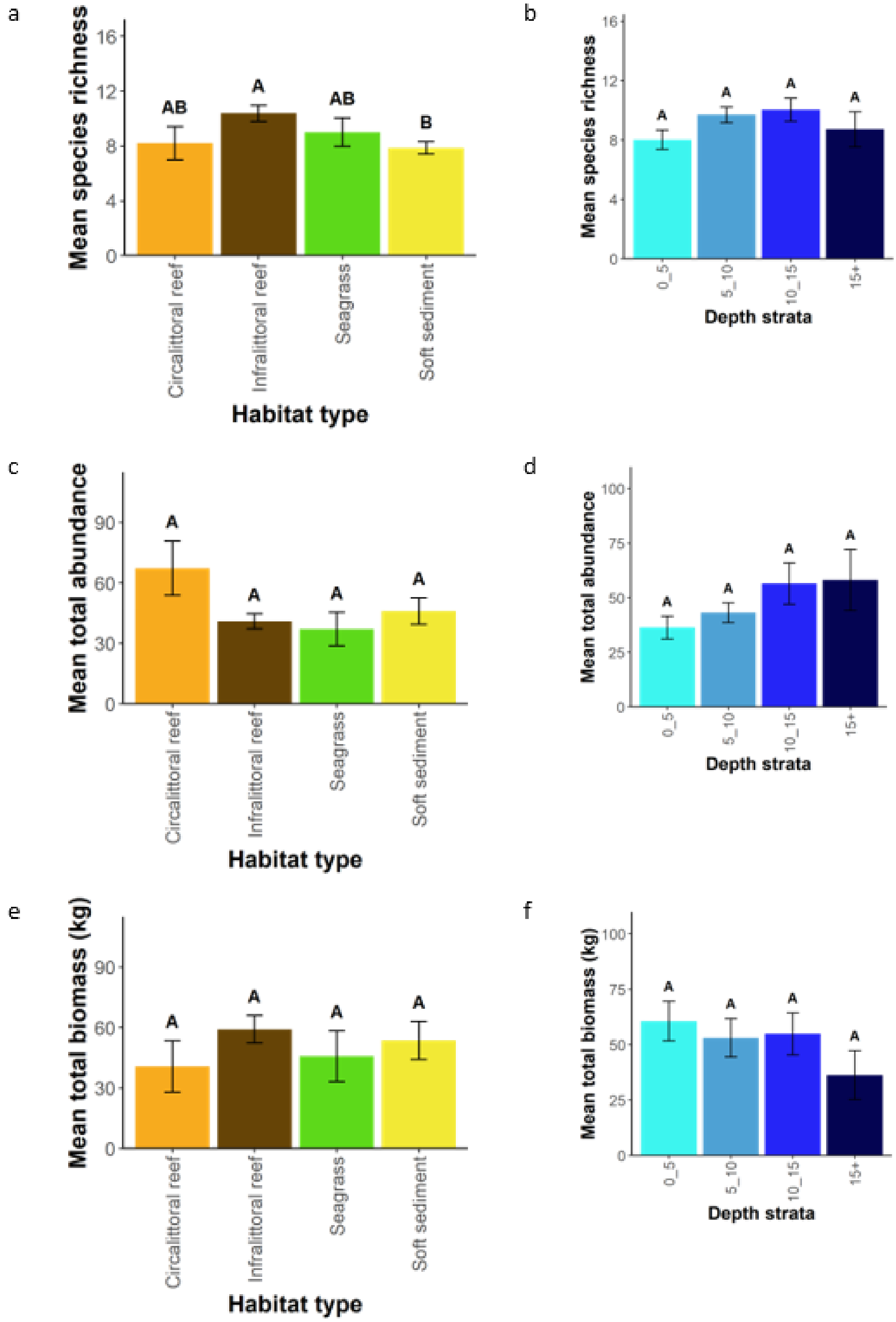


Figure 18: Average (± SE) species richness, total abundance, and total biomass (kg) for habitat type (graphs a, c, e) and depth (graphs b, d, f). Letters denote significant differences among pairs according to PERMANOVA analyses, i.e. bars with the same letter within the same panel are not significantly different.

Table 4: Pairwise tests from PERMANOVA for pairs within habitat type and depth bin.

Pairs	*t*	*P*	Unique perms
Infralittoral reef vs. Soft Sediment	3.30	**0.001**	999
Infralittoral reef vs. Seagrass	1.18	0.151	997
Infralittoral reef vs. Circalittoral reef	2.05	**0.001**	999
Soft Sediment vs. Seagrass	1.86	**0.001**	997
Soft Sediment vs. Circalittoral reef	2.25	**0.001**	998
Seagrass vs. Circalittoral reef	1.96	**0.001**	984
0–5 vs. 5–10	1.37	**0.044**	999
0–5 vs. 10–15	1.74	**0.001**	996
0–5 vs. 15+	1.66	**0.001**	999
5–10 vs. 10–15	1.64	**0.007**	998
5–10 vs. 15+	1.66	**0.004**	998
10–15 vs. 15+	1.02	0.391	997

3.1.7 Influence of depth on fish assemblages

Depth also had a significant effect on the fish assemblages observed within Port Phillip Bay (Pseudo-F = 2.43, P = 0.001; Figure 19), with all depth categories differing except for 10–15 and 15+ m (Table 4). Species influencing the differences included scad *Trachurus* spp. and toadfish *Contusus* spp. in the deeper areas (> 10 m) and senator wrasse *P. laticlavius* and snapper *C. auratus* in shallower areas (< 10 m) (Figure 20, Appendix 5). Depth had no significant effect on species richness, total abundance, or total biomass (Figure 18).

3.1.8 Influence of environmental variables on fish assemblages

DISTLM analysis showed that environmental variables explained 22% of the total variation in the fish assemblages observed. The top model contained six variables including percent cover of rock, membranous macroalgae, erect coarse branching macroalgae, and canopy forming macroalgae, mean relief, and depth (m) (Figure 21).

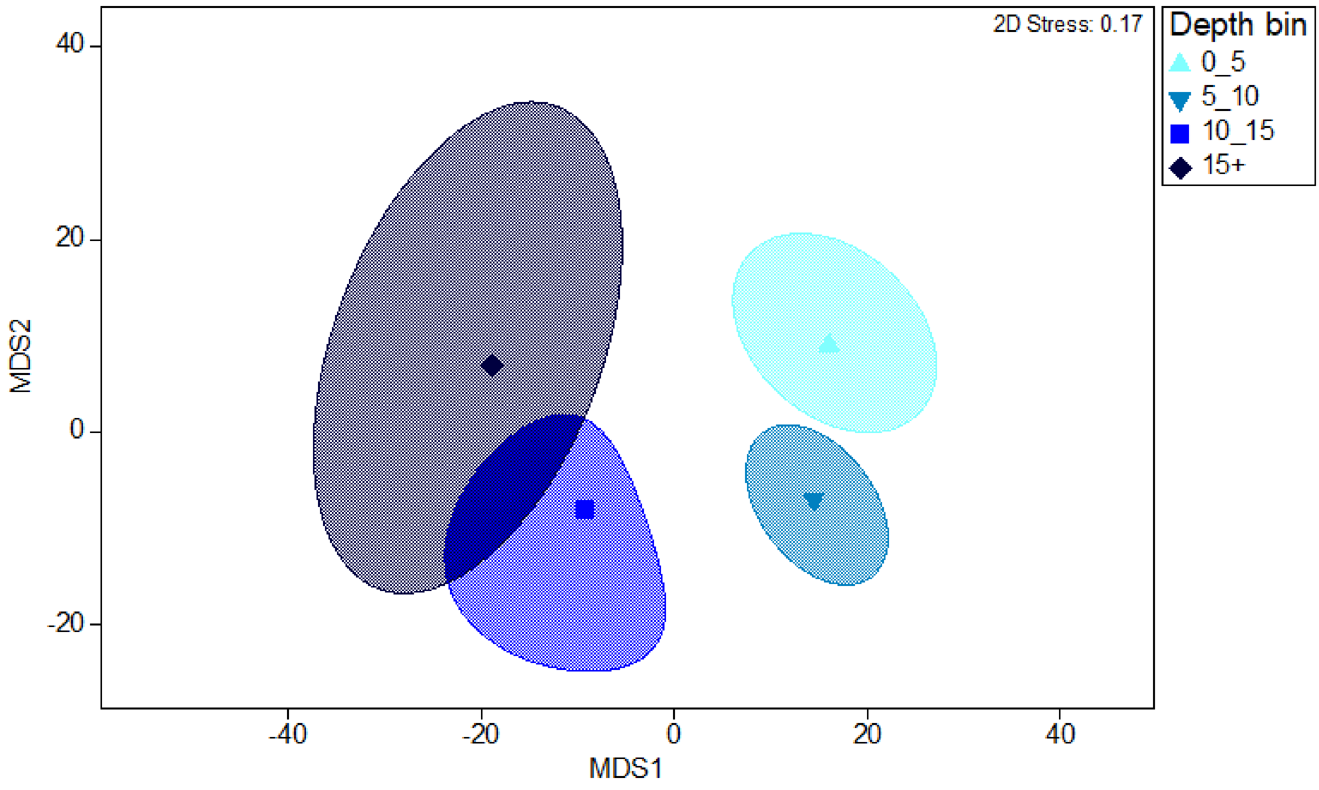


Figure 19: A metric MDS plot showing the bootstrap averages (N = 100) for depth. The symbol indicates the average for that depth bin and the ellipses show 95% of the coverage of the bootstrapped values.

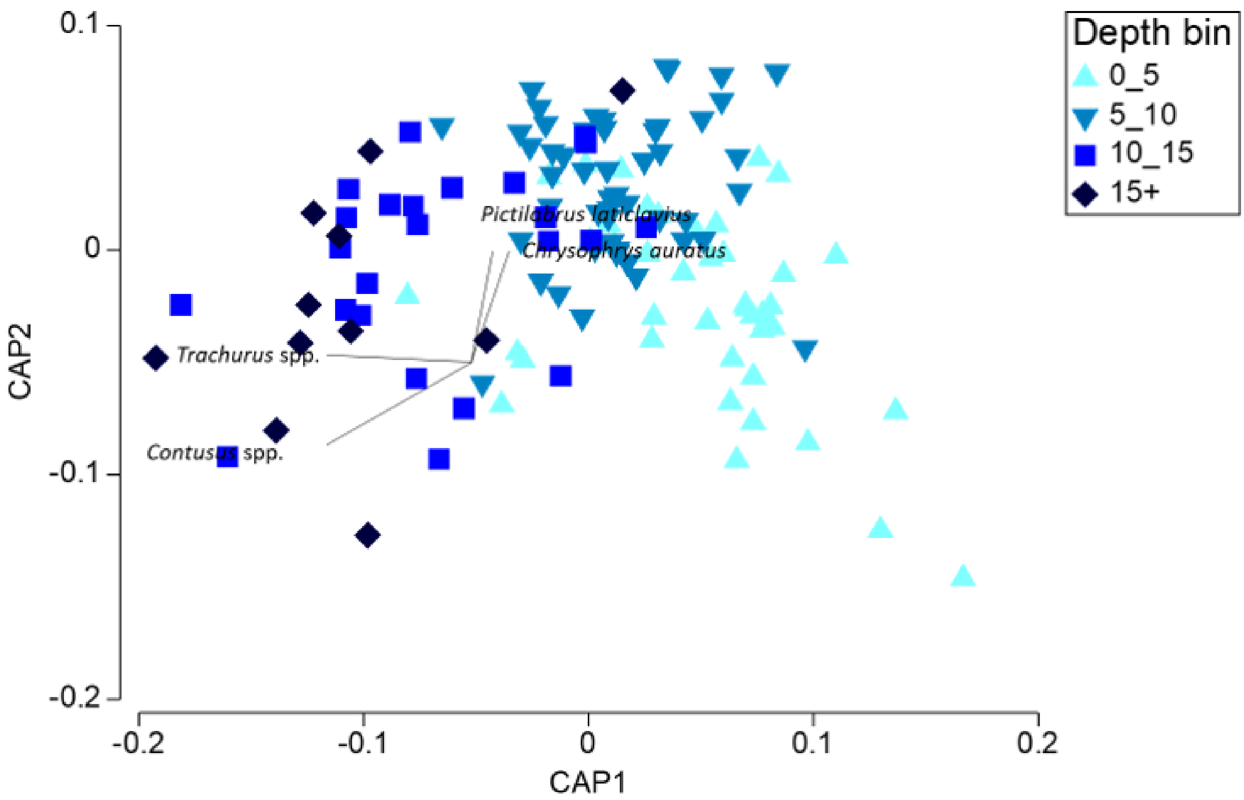


Figure 20: CAP ordination plot for depth showing the similarity of fish assemblages observed via BRUVS in Port Phillip Bay. Fish species correlated (>0.4) with the first two axes that are also contributors to within group similarity from SIMPER (Appendix 5) are shown in black.

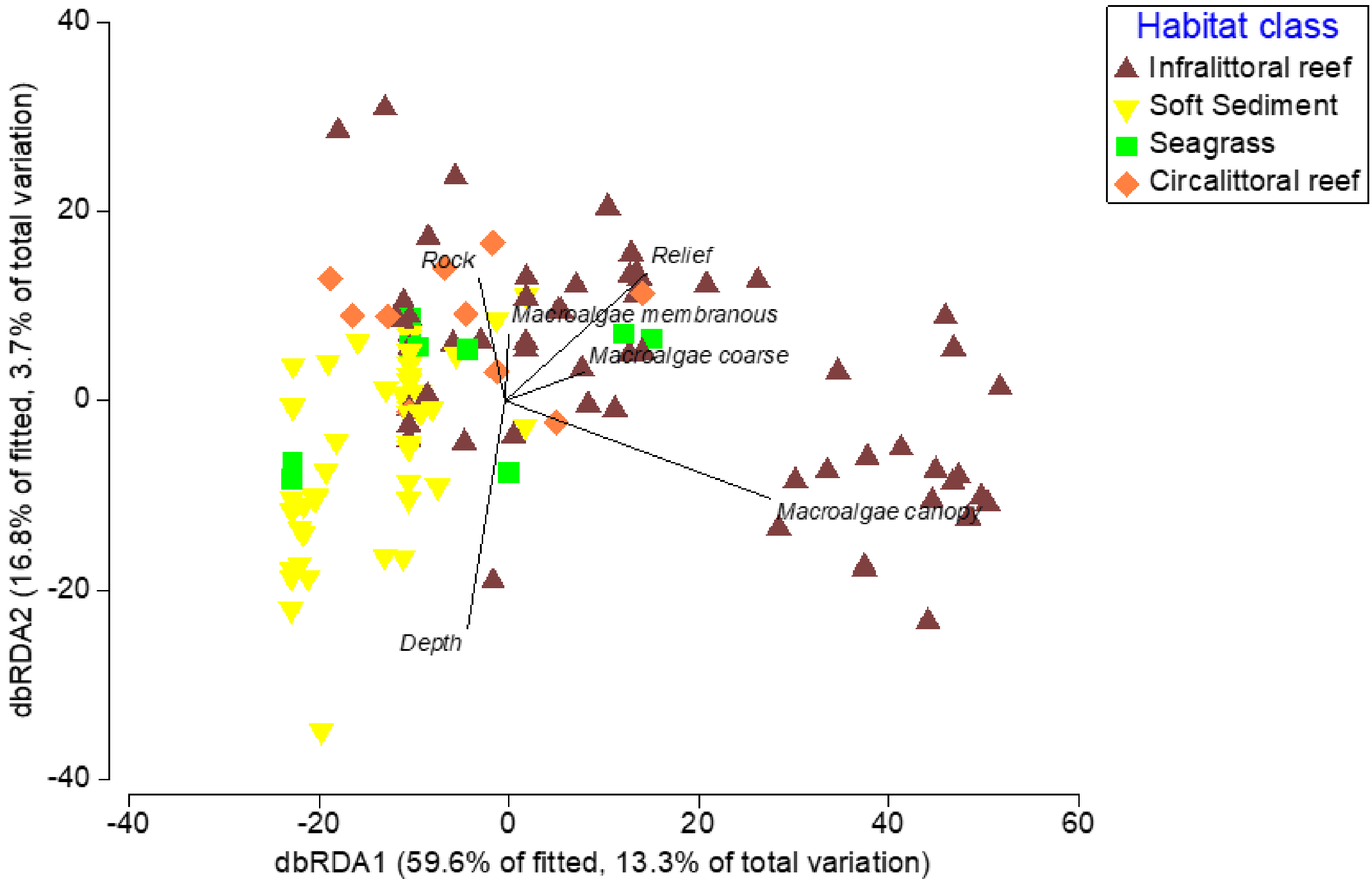


Figure 21: Distance based redundancy analysis plots showing the influence of environmental variables (% cover of rock, membranous macroalgae, erect coarse branching macroalgae, and canopy forming macroalgae, mean relief, and depth (m)) on fish assemblages observed via BRUVS in Port Phillip Bay, based on the top model output from DISTLM.

3.2 Stereo diver operated video (DOVs)

3.2.1 Methods

S-BRUVS were not used at the aggregation site due to presence of the public during survey and potential implications of deploying baits close by. Instead the team adopted stereo diver operated video techniques that provided additional benefits of mapping the aggregation extent, estimates of spider crab densities and predator occurrence. This included the development of a new methodological approach for spider crab assessment documented below to be used in future aggregation assessments. Stereo-DOV was collected from across the aggregations from the 17th – 19th of June 2022 (Figure 22). Divers operated in pairs to swim

100 m transects. Divers operated in transects at a consistent swim speed over the aggregations and surrounds while filming using the stereo-DOV system with start and end points marked with dGPS. In total 25 transects were recorded across the three days with seven recorded on the 17th, seven on the 18th, and 11 on the 19th June.

The video from these transects was analysed using specialized software (EventMeasure and TransectMeasure). For each transect, the start and end time were recorded along with the presence of any large predators (e.g smooth rays). At 5 s intervals across each transect, the density of spider crabs within a 1 m quadrat were counted. This ensured that no crabs were double counted within a transect. The moult stage of each crab was also determined and the presence of any moult discards noted.

The live spider crab densities from the counts at each point were extrapolated across the area of transects using Empirical Bayesian Kriging (EBK) in Arc GIS Pro, resulting in a 1 m resolution density map. A Moran's I cluster analysis was then run on the EBK grids to define the spider crab aggregation for each day. These aggregations were converted to polygons and used to calculated the total number of crabs within each aggregation.

In EventMeasure, bounding boxes were drawn around all crabs present (tight box around the carapace) in 191 different frames (on the left images obtained through DOVs), with a mixture of sparsely and densely populated frames and a mixture of backgrounds. These frames were used in an Automatic Fish IDentification (AFID) AI (Artificial Intelligence) trial to train an algorithm to recognise individual spider crabs.

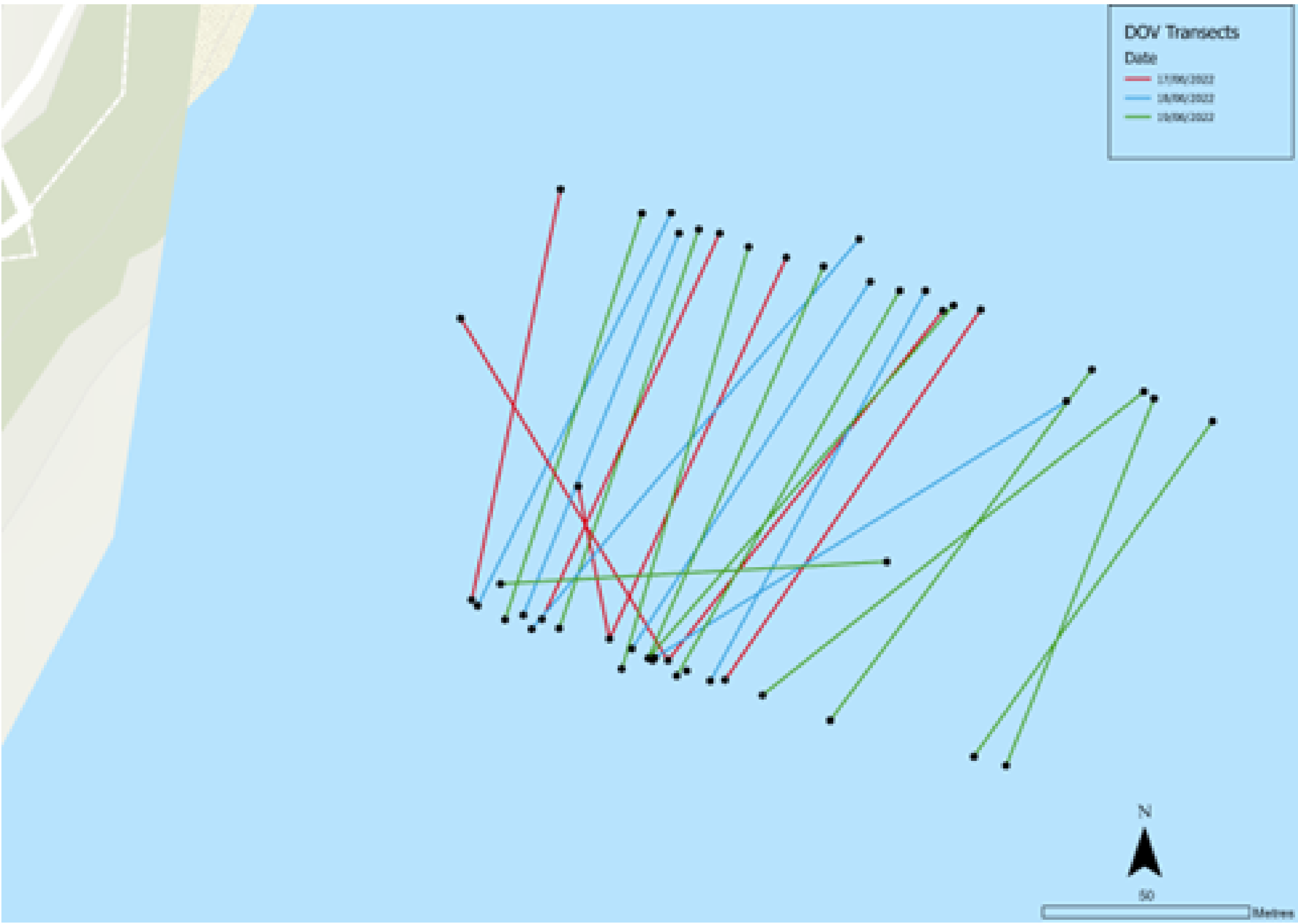


Figure 22: Completed spider crab stereo transects during the spider crab aggregation at St Leonards on the 17th-19th June 2022

A total of 10 smooth stingrays *B. brevicaudata*, were observed across nine of the DOV transects. It is possible that the same smooth ray individual was observed on multiple transects. These were the only predators observed on the DOV footage.

3.2.2 Results

Aggregation size, number and densities of spider crabs were estimated across three days of sampling (Table 5, Figure 23). The transect spacing on the 19th June may have resulted in more over-estimation than other days, which should be taken into consideration when comparing numbers across days or to future estimates.

A machine learning model was trained based on the 191 images provided and found 4386 instances of spider crabs. The model was trained on 141 images and the rest of the images was used for validation and testing. An accuracy of ~85% detection was seeing on these left out images (Figure 24).

Date	Aggregation size (m^2)	Number of spider crabs	Densities of spider crabs (crabs per m^2)
17^{th} June 2022	1,773	42,901	0-79
18^{th} June 2022	1,420	31,012	0-54
19^{th} June 2022	2,104	50,729	0-64

Table 5: Aggregation size, number of spider crabs estimated from stereo diver operated videos taken on the 17th-19th June 2022 at the St Leonards aggregation

3.3 Establishment of acoustic network

The team established a Port Phillip Bay acoustic array of 44 stations including a double curtain across the Heads (Figure 25) for spider crab tracking but also applicable to any other acoustically tagged species maximising leverage of this infrastructure investment.

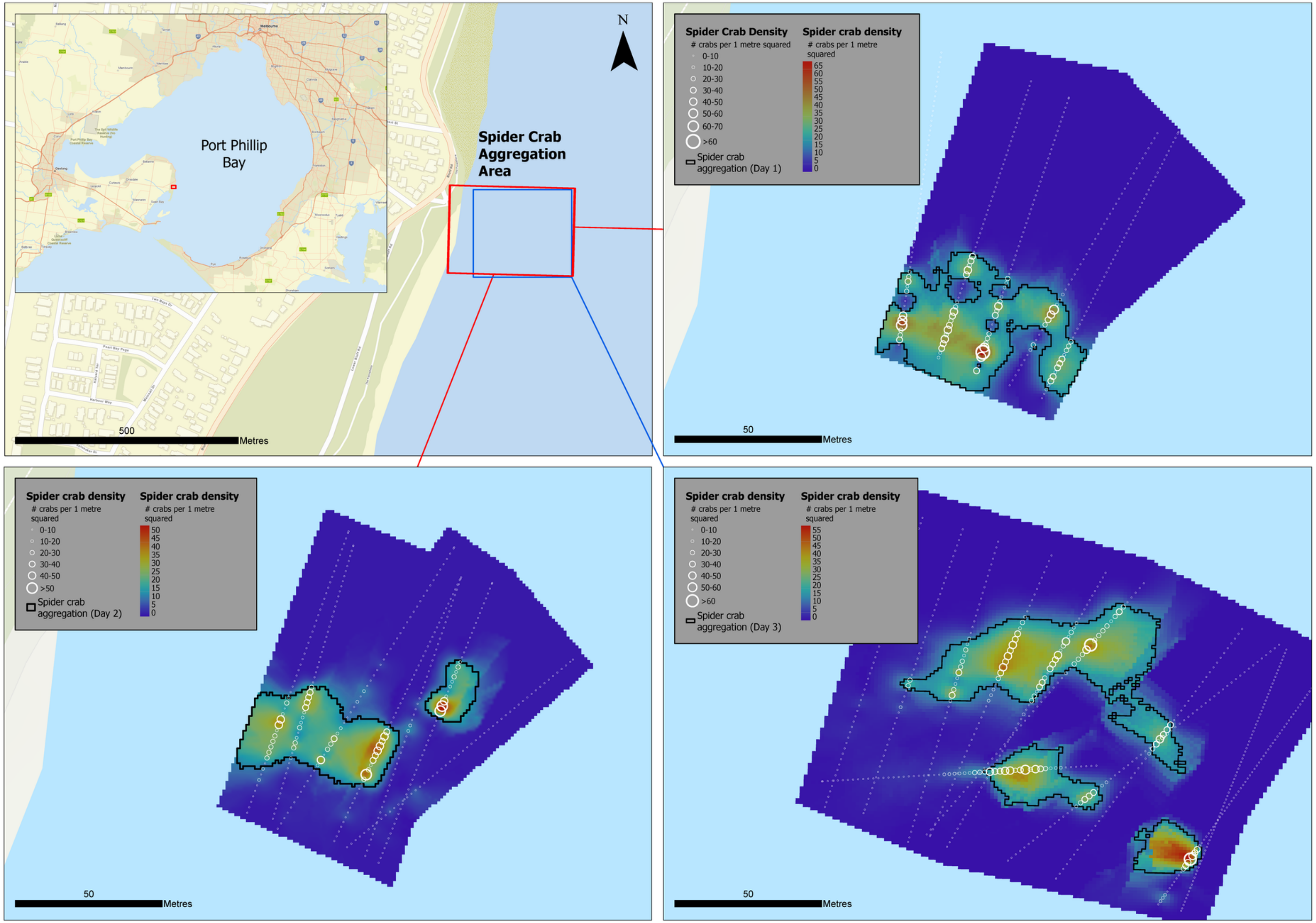


Figure 23: Spider crab density estimates obtained from completed spider crab stereo transects during the spider crab aggregation at St Leonards on the 17th-19th June 2022

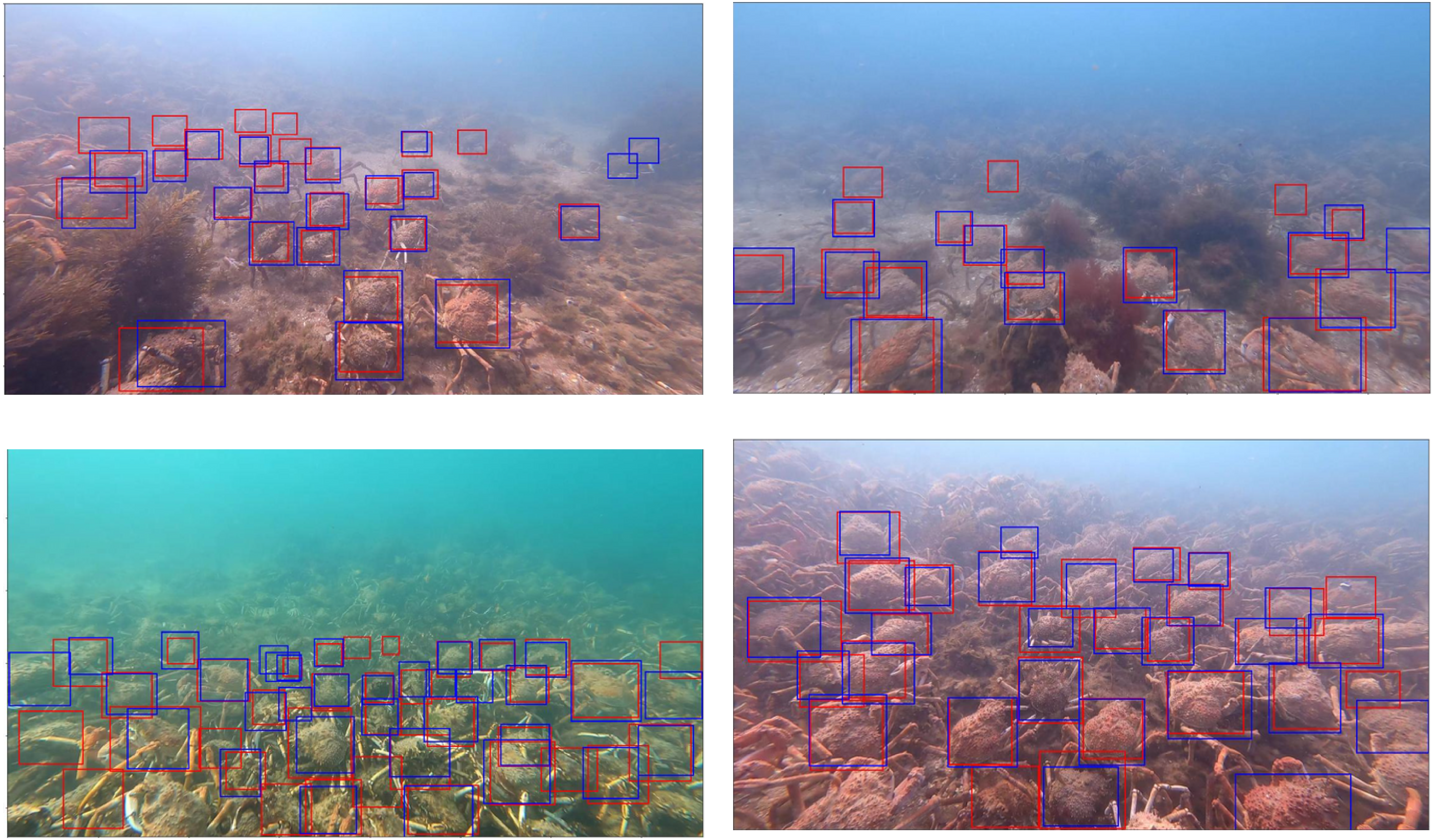
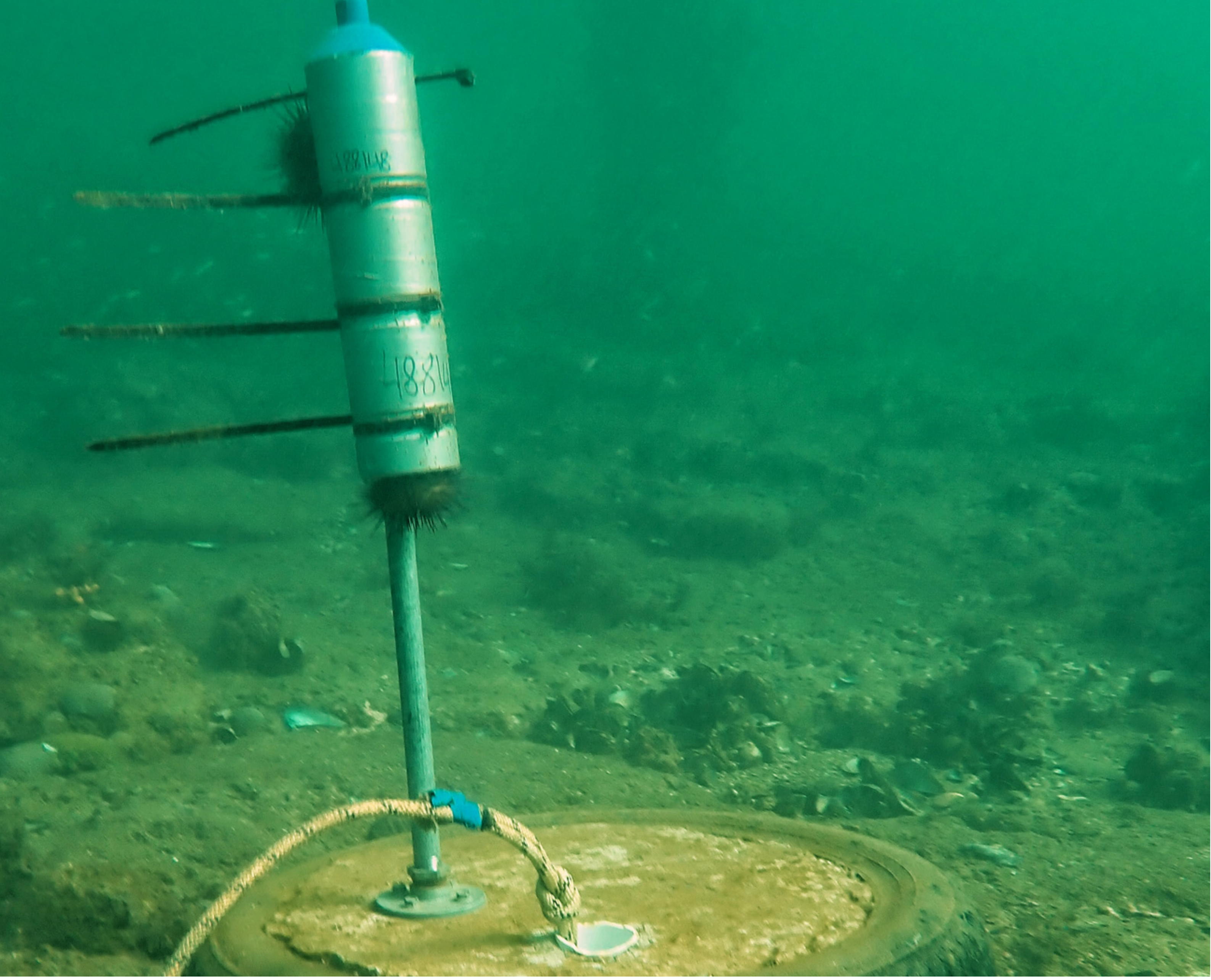


Figure 24: Images obtained during the AFID AI Trials

Figure 25: Map of Port Phillip Bay showing listening stations, with and without detections, and the missing stations (Copyright: Google Earth, used under licence)



3.4 Acoustic tagging

Post-moult spider crabs were captured by hand whilst snorkelling at the St Leonards aggregation on the 16th, 17th and 18th June 2022 and trained personnel performed the tagging procedure. Only crabs with hardened carapaces were selected to avoid hurting the animals. Upon capture each crab was transferred to a shallower wide bucket (similar to a ‘fish bin’ – 80x40cm) filled with sufficient water to cover the carapace. To ensure each tagged crab carried as small a weight as possible, V9 transmitter tags were used. These tags are 9mm in diameter, 27mm in length and weight 4.5g.

The carapace of each crab was air dried to ensure sound attachment of the transmitter using a two-part fast setting epoxy resin applied to both the tag and the dried carapace. These methods have been used on other crustaceans and have proven to be successful (Frusher et al. 2009). Crabs were then released to the

location of capture and monitored to ensure they had recovered from the procedure. Tagged spider crabs were observed at the location. It is anticipated that the tags will remain on the crabs until the next moult which is anecdotally thought to occur on an annual basis. We tagged 35 females (mean 110.6 ± 8.0 mm carapace length and mean 93.5 ± 7.2 mm carapace width), and 15 males (mean 108.1 ± 8.1 mm carapace length and mean 94.3 ± 6.7 mm carapace width).

Because of flooding and heavy rains during November 2022, servicing of the listening stations and retrieval of detection data was postponed with servicing on the 15-16th January and on the 5-6th February 2023.

A total of 56,329 detections occurred, and 27 individual spider crabs were detected across 13 stations in the Southern, South Western parts of the Bay and the Heads (Figures 26, 27 & 28, Appendix 6). The movement of individual crabs could be tracked across stations (Figure 27, Appendix 6). Six stations could not be recovered due to loss of equipment linked to harsh conditions at the Heads, and failed retrievals on multiple occasion due to poor visibility in other parts of the Bay (Figure 25).

Tag A68-1604-7160 dominated the detections with over 50,026 detections from a single station over a 4-month period. This suggests that the tag has stayed within 500m of the receiver station over this time, possibly closer to be able to sustain such a strong signal. A more plausible explanation is that the tag has been discarded post mortality proximal to the station location.

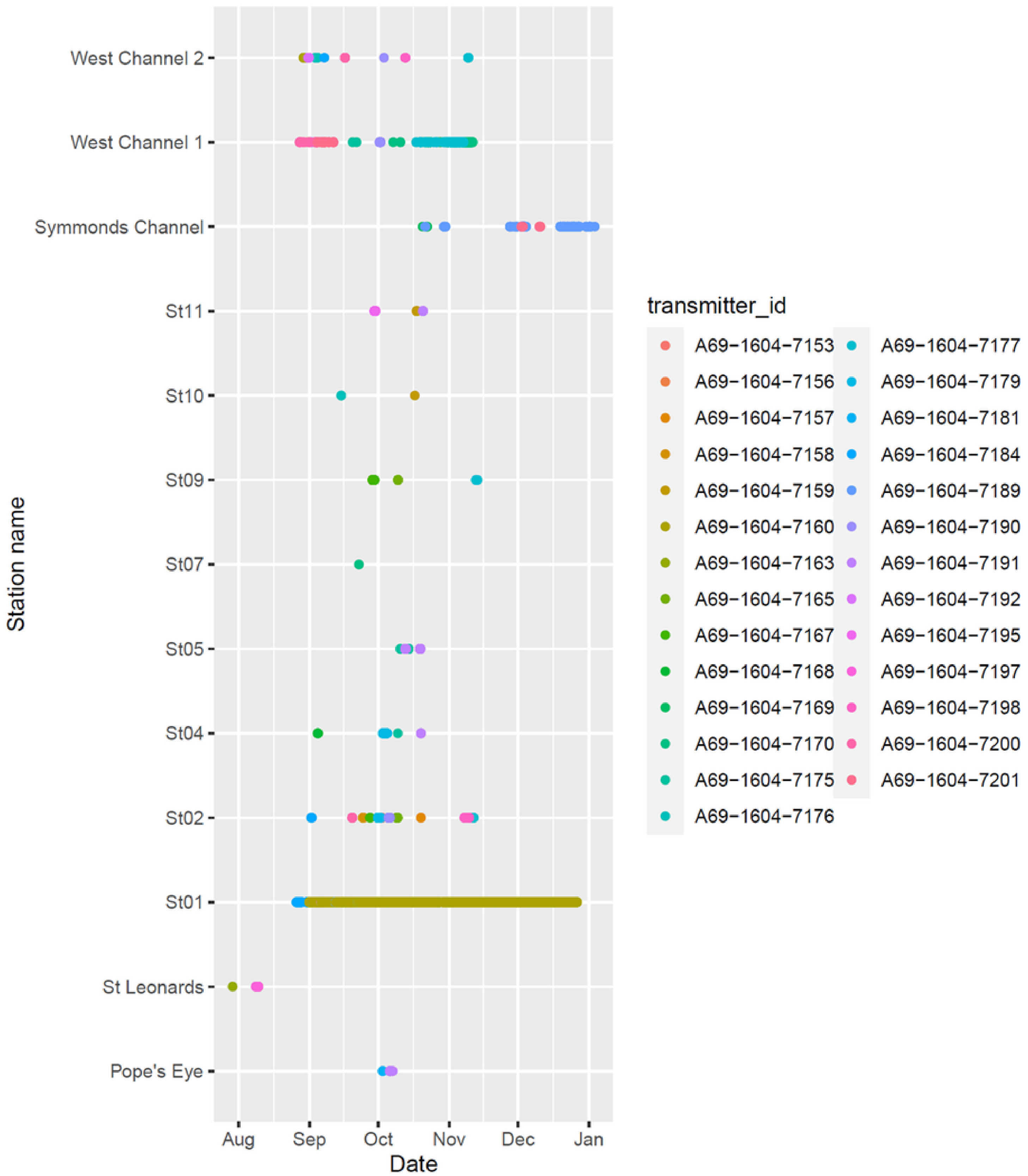


Figure 26: Detections of tagged spider crabs across the 13 listening stations with detections up until January 2023

Figure 27: Detections of tagged spider crabs by tag ID across stations up until January 2023

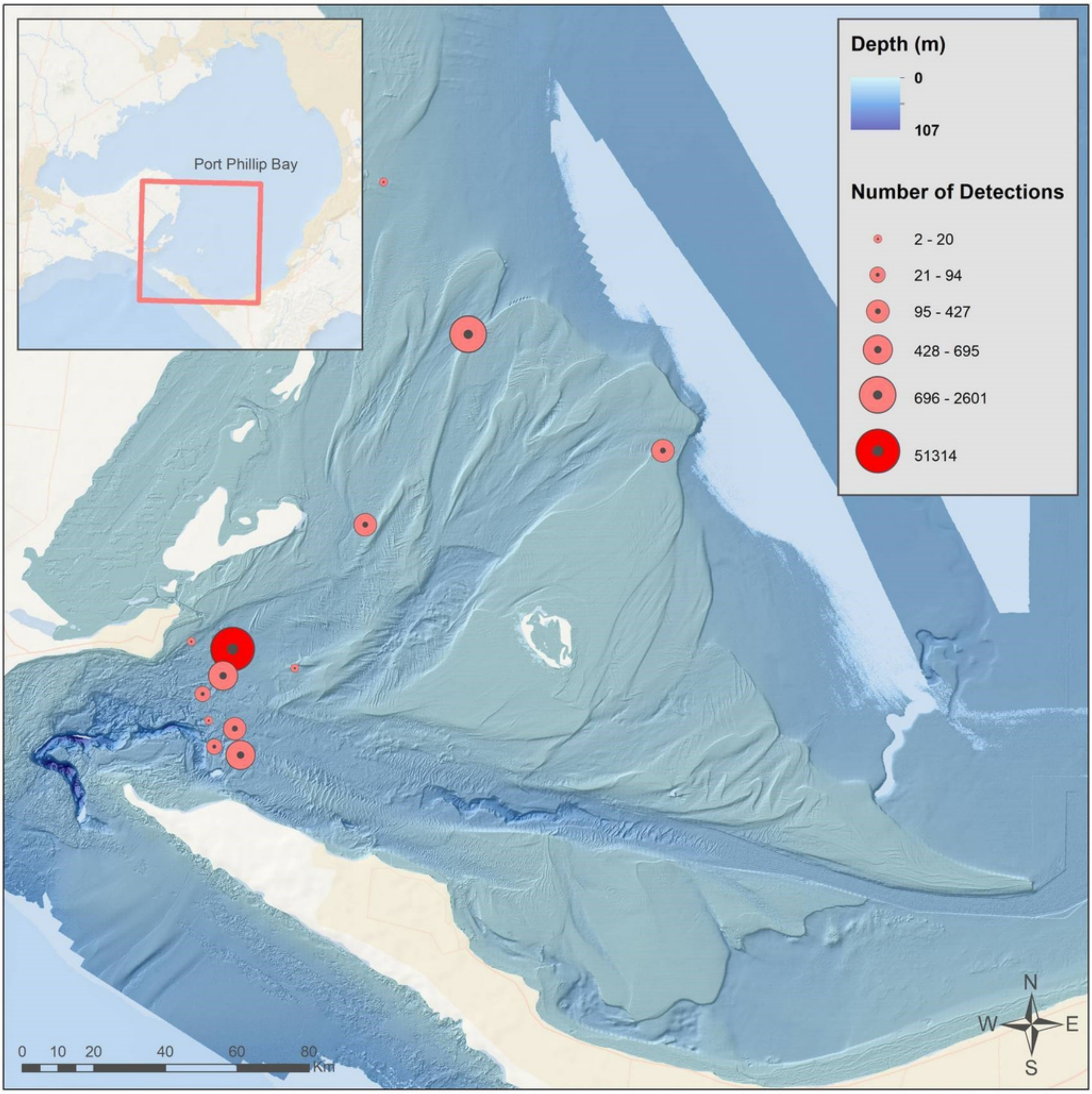


Figure 28: Number of detections of tagged spider crabs across the 13 listening stations with detections up until January 2023

3.5 Morphometrics

No published morphometric data and information about sexual dimorphism was available on giant spider crabs until this study. Our team captured spider crabs by hand in St Leonards between the 16th - 18th June 2022 whilst snorkelling; their carapace width (CW) and length (CL) (mm) were measured and they were sexed based on the shape of their abdominal flap when possible (narrow and angular in males; wide and curve in females) (Figure 29). Most spider crabs were live crabs (n=431), but some were dead (n=28), or moults (empty shells left behind after the moulting process, n=6). Live, dead spider crabs and moults were only measured when the carapace was intact and hard (Figure 30). On 25th June, 35 additional moults were collected and measured. Measurements were taken on tagged spider crabs as mentioned above (Table 6).

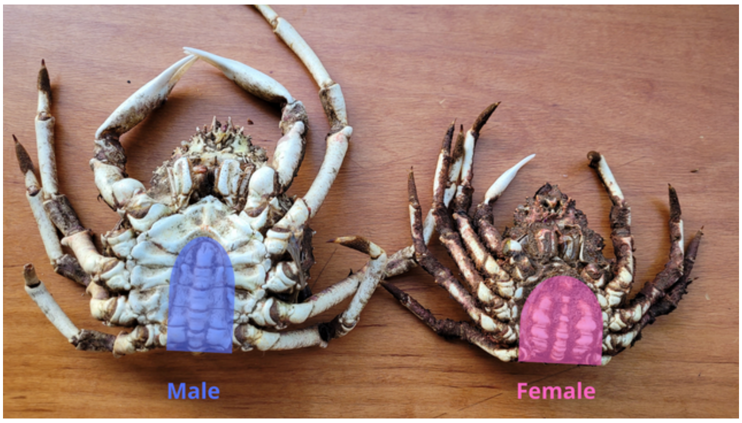
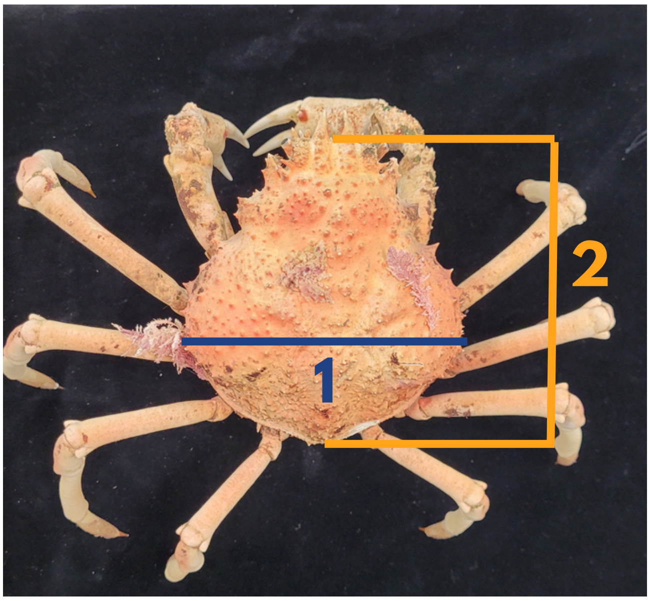


Figure 29: Differences between males and females used for sexing purposes



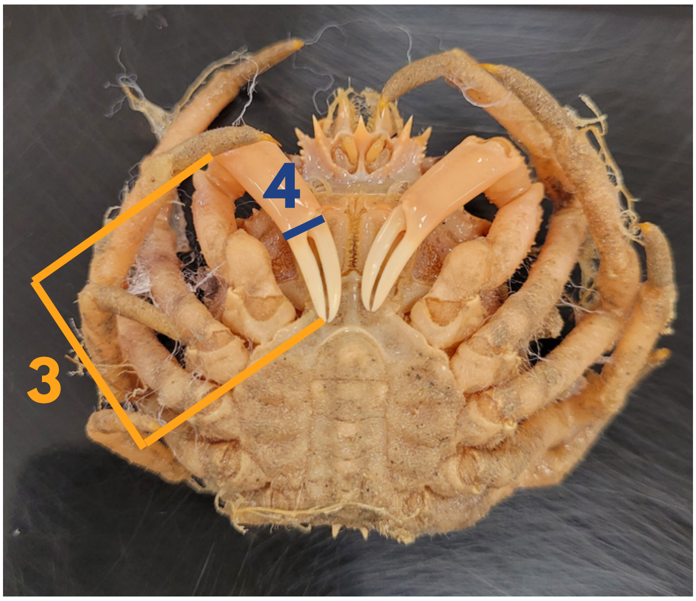


Figure 30: Spider crab morphometric measurements, 1= Carapace Width, 2 = Carapace Length, 3 = Right chela length, 4 = Right cheliped height

Table 6: Spider crab measurements on males and females of different groups of specimens, including minimum and maximum values, means and sample sizes

Specimen types	**Males**		**Females**	
	Carapace width (CW, min-max in mm / mean in mm / n)	Carapace length (CL, min-max in mm / mean in mm / n)	Carapace width (CW, min-max in mm / mean in mm / n)	Carapace length (CL, min-max in mm / mean in mm / n)
Tagged spider crabs	85.0-111.0 / 94.3 / 15	96.0-121.0 / 108.1 / 15	81.0-115.0 / 93.5 / 35	98.0 – 131.0 / 110.6 / 35
Other spider crabs	57.0 – 112.0 / 81.0 / 324	69.0 – 125.0 / 94.3 / 324	55.0 – 113.0/ 73.3 / 176	69.0 - 120.0 / 86.3 / 176
Museum specimens	22.0 – 123.0 / 65.3 / 50	28.0 – 135.0 / 76.3 / 50	16.0 – 118.0 / 57.6 / 38	21.0 – 126.0/ 67.7 / 38

No significant differences were found between the first lot of measurements (16-18th June) and the second (25th June) (CW: t= 0.3, df=501, p-value=0.8; CL: t= 0.6, df=501, p=0.5); as such, these measurements were pooled together and individuals with unidentified sex were removed from further analysis (this group is thereafter referred to as "other spider crabs", Table 6). Males' CW were significantly bigger than females' (t = -8.3, df = 498, p<0.001). Similarly, males' CL were significantly bigger than females' (t = -8.3, df = 498, p<0.001). There were significant differences between the measurements taken on tagged spider crabs and the measurements taken on other spider crabs (CW: F = 203.71, num df =

1.000, denom df = 73.085, p-value < 0.001; CL: F = 223.21, num df = 1.000, denom df = 68.885, p-value < 0.001), with the former bigger than the latter. This was expected because tagged crabs had all finished moulting (the process of getting bigger) and hardening their shells, whilst "other spider crabs" had not necessary moulted yet or were moults (shells left behind, smaller than spider crabs after moults).

The team was granted access to the Museums Victoria's spider crab collection and was able to obtain more morphometric data (Table 6). A total of 88 specimens were measured, which were collected from various states (Victoria, Tasmania, South Australia and Western Australia) between 1896 and 2005. Most specimens were stored in ethanol (n=73), with the rest stored dry (n=15). Whether specimens were collected during aggregations or at other times is mostly unknown. Without time constraints imposed during fieldwork, additional measurements could be taken (right cheliped length, right chela length, Figure 30).

On museum specimens, males' and females' CW and CL did not differ significantly ($t = -1.4$, df = 86, $p=0.2$, and $t = -20.0$, df = 86, $p=0.1$ respectively) (Figure 31). This could be because the range of measurements was a lot wider (most likely including juveniles, in which males and females could be of similar sizes) compared with field measurements (which only included adults at a moulting aggregations). There is no information on juvenile vs adult sizes published in the literature, therefore it is difficult to ascertain how many of the museum specimens measured would have juveniles vs adults.

There was a strong correlation between the right cheliped height and the chela length (claw measurements) and between the claw measurements and the carapace measurements (CW & CL) on the museum specimens (Spearman correlations for each comparison: all $r_S > 0.96$, $p < 0.001$).

3.6 Conclusion and future directions

Our research team used a combination of citizen science and traditional science to gather information on spider crab and their aggregations. Pre-existing spider crab sightings were retrieved from the Spider Crabs Melbourne Facebook page and Atlas of Living Australia. A total of 245 observations of spider crab aggregations were retrieved spanning the years 2008 to 2022 (with observations in nine different years and from 13 locations). However, data quality was lower than expected, complicating the identification of the environmental factors triggering spider crab aggregations.

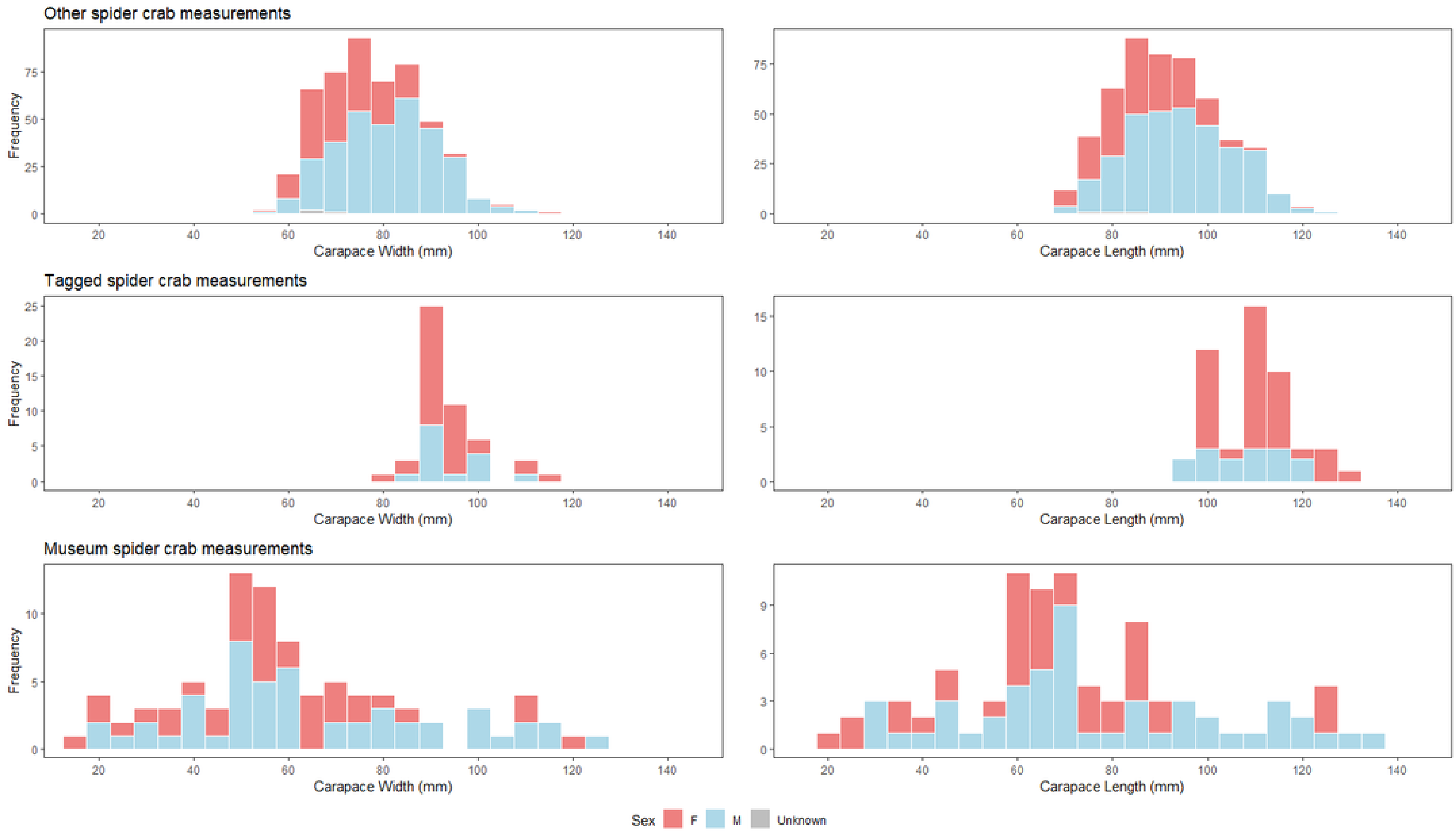


Figure 31: Size frequency for other spider crabs (moults, dead and live crabs measured in the field), tagged spider crabs and museum specimens

An iNaturalist project, Spider Crab Watch, was launched in March 2023 to allow citizen scientists to provide valuable metadata along with any sightings they log (including a rough estimate of numbers of crabs sighted, whether they observed moults or spider crab remains, and the depth of the crabs). As such, the progression of the 2022 aggregation was understood better through citizen science than any previous aggregations for which information was logged. In 2022, 199 observations were logged by 63 citizen scientists.

The iNaturalist project is self-sustaining and citizen scientists can log information on the project from now on. Given the benefit of citizen science to inform traditional science activities, the concern around making spider crab location public and the necessity to provide opportunities for interactions with citizen scientists for best results, it is recommended that community engagement continues to ensure both increased quality and quantity of the data logged. Ongoing data collection will help use identify future aggregations and understand how timing and locations of aggregations vary through time, and allow us to investigate why.

For the first time, timelapse cameras were deployed at Rye and Blairgowrie piers, and then at St Leonards after moulting was confirmed at this aggregation, to monitor spider crab activity. The cameras took photos every 5 minutes during daylight hours, resulting in the collection of 66,000+ images between May and July 2022, with ~7,080 images including spider crabs (between the 16th June and the 10th July, with images showing an active aggregation between the 16th - 22nd June). The images allowed us to determine the stationary time of the aggregation at location combined with citizen science sightings for a period of 33 days (21st May - 22nd June).

A second component of Spider Crab Watch was launched on Zooniverse at the start of September 2022. This project allows citizen scientists to analyse the images obtained with the timelapse cameras. Specifically, three workflows allows them to: identify spider crabs and spider crab remains and label their characteristics (tagged crabs, moulted and unmoulted, remains and moults/dead individuals); identify other marine life (fishes and invertebrates) present in the images; identify human presence or signs of human activity. Classifications are underway; gold standard classifications (outside the scope of DEECA-funded work) will be performed to validate the data. This project's benefit is twofold: increase knowledge of spider aggregation timing and duration, as well as the role spider crabs may play in the broader environment (e.g. for predators and scavengers). The classifications obtained can also be used in future to train a machine learning algorithm to quickly identify spider crabs, other marine life and human presence and activities in images obtained with timelapse cameras in future deployments. As this data currently does not exist, deploying timelapse cameras at several aggregations in future years is recommended.

Baited Remove Underwater Video (BRUVs), Stereo Diver Operated Video (DOVs), acoustic tagging and the collection of morphometric data was used to obtain complementary information on the ecological role of aggregations, spider crab numbers and densities and spider crab biology. In 2022, the only confirmed aggregation occurred at St Leonards on the Bellarine Peninsula and sampling by our scientific diving team took place between the 16th - 19th June 2022.

BRUVs were deployed to assess fish diversity within Port Phillip Bay. From 127 successful BRUVs deployments, 93 fish taxa (5,679 individuals) and 14 invertebrate taxa (282 individuals) were identified. In addition diver operated video (DOV) transects were performed on three consecutive days on the known aggregation site and the results from the DOVs suggested the aggregation size varied between 1,773 and 2,104 square meters and 31,012 and 50,729 spider crabs on those days using a Bayesian interpolation technique. Future data collection at aggregation sites, in different years and different locations would allow us to determine how spider crab numbers and aggregation sizes fluctuate through time, and why. It would also help understand how predator presence and density varies from year to year and across locations. Similar stereo camera devices could be deployed on other platforms such as remotely operated vehicles that would be beneficial at deeper aggregation sites where dive survey time may be limited.

The machine learning algorithm developed to automatically detect spider crabs on DOV footage can be used to speed up analysis of similar footage obtained in future aggregations. The workflows developed could also be applied to other species of interest (e.g Northern Pacific seastars).

Morphometric data was obtained on spider crabs for the first time. In our sample, which included adults present at a moulting aggregations, males had bigger carapaces than females (length and width), which was not the case in the smaller sample obtained from Museums Victoria's collection (which spanned a much wider range of individuals, presumably including juveniles). Obtaining measurements at future aggregations, and collecting standardised data on sex ratios at aggregations in different years and locations would help us determine how the composition of the aggregations vary through time and space.

A network of 44 listening stations was deployed in Port Phillip Bay, allowing tracking of spider crabs (and in future, other species). At St Leonards, 50 spider crabs were tagged (35 females, 15 males). Data from the acoustic stations were retrieved when they were serviced in January and February 2023. A total of 56,329 spider crab detections occurred, and 27 individual spider crabs were detected in the Southern part of Port Phillip Bay across 13 stations. The number of spider crabs detected is encouraging, showing that the attachment method tested was suitable. Individuals were detected as late as mid-January suggesting that individuals are still within the bay after a 5-month period post moult. There is a clear pattern of movement to the south of the bay from the St Leonard aggregation site with all detections moving on the western side of the bay. No detections were observed on receivers north of the tagged location or on the eastern side of the bay. The acoustic curtain deployed at the entrance was clearly effective in spider crab detection (10 of the 12 sites). Three receivers further south were unsuccessful in detecting spider crabs. Only two were recovered (one lost from mooring) with no detections observed, however further analyses of the receiver data is required as the locations are in high noise locations that may swamp out tag signals. Whilst evidence suggests that the spider crab aggregations moved towards the Heads, we would suggest receiver placement outside of the bay in future deployments to confirm whether spider crabs are exiting the system entirely. Spider crabs might also be detected on subsequent service of the listening stations, providing a better understanding of their movements.

Acknowledgements

We wish to thank the many citizen scientists who have helped collect and classify data for this project. Community members also contributed images and videos for advertisement of the program and help raise awareness for the program; in

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Appendix 1

Spider Crab Watch Zooniverse beta test feedback

Timestamp	Are the project goals clear?	Does the question/instruction for the task make sense?	How easy or difficult did you find the task?	If you answered 'Somewhat hard' or 'Very hard' which of the following best describes the problem?	Does the tutorial adequately prepare you to make a classification?	Did you find the task help text useful?	Was the field guide helpful?	Did you read the additional information on other pages?	If 'yes', was the additional informati on useful?	What (if any) additional information would you like added to the project?	Are there suitable Talk boards set up?	If you answered 'no' to the previous question, please tell us what Talk boards you would like to see.	Do you like the name of the project?	If you answered 'no' to the previous question, please feel free to suggest a name here.	In your opinion, is this project suitable for the Zooniverse?	If you answered 'No' to the previous question, please tell us why.	Do you have any other comments on the project?	If we decide to launch this project publicly, do you think you will take part?
8/2/2022 17:30:41	Yes	Yes	Somewhat hard		Yes	Yes	I didn't read it	Yes	Yes		No	I don't know about Talk boards .	Yes		Yes			Not sure
8/2/2022 17:42:09	Yes	Yes	Moderately easy		Yes	Yes	There is no field guide	Yes	Yes		Yes		Yes	It's short, sweet, and to the point. Could be jazzed up a little!	Yes			Yes
8/2/2022 17:44:04	Yes	No	Moderately easy		No	Yes	Yes	Yes	Yes	1) The animal images in the menu are very small - maybe 1 cm by 1 cm and I am on a 27" monitor. So, I have to click on each one over and over to see if it matches the image. A grid of larger images would be more effective. 2) There needs to be more choices; ie, there is other fish, but there needs to be "I don't know". I would like to see the option to check multiple options and/or add a degree of certainty. For example, I saw a puffer fish that wasn't a perfect fit for the globe fish. It was very similar, but not identical. I could have marked Other, or I could have marked Globe fish, but with about a 7 degree of certainty (out of 10). Or, I could mark the few fish that are similar (I think there are two "puffer fish like" fish on the list, and then marked it as similar, or a candidate for being one of those fish.) There was an instance when I could only see part of the fish. I marked that as Other, but it should have been marked as "obscured". 3) the instructions didn't match the actual options. The instructions said that I could circle things, and mark obscured, but when I was actually doing the task, I couldn't make a circle and there wasn't an option for obscured. The instructions also said that I could invert the image colors but I didn't see where to do that.	Yes		Yes		Yes		It needs a little refinement, but was overall the type of project that I think people can do. I would suggest giving us more options for uncertaintly...like I know its a sea star of some kind, but I am not confident enough to mark the specific kind. The reference images generally need to be bigger.	Yes
8/2/2022 17:46:36	Yes	Yes	Somewhat hard	Too many steps, Task too complicated	No	No	No	No				I don't know, I have seen any yet	Yes		Yes		The option about resolution has too many options, what counts as a 2 or 4 is very unclear. Drawing the circles etc is hard on mobile. The difference between a dead/molt crab (cyan) and crab remains (black) is unclear. There was no option to draw the purple "many crabs" circle when I chose no, too many crabs. identifying the other animals is confusing, especially as many aren't showing their colours. Colours of the crabs is hard to figure out in the different water colours, so I don't know if they're premolt or post molt. Is it possible to tell the difference from the front? When you're drawing so many circles it gets confusing quickly. The field guide should have identifying crab types above the other animals identification as they are currently hidden at the bottom of the list. I think it could be a really fun project to help with, but it needs some streamlining and clarification for those of us who do not know much about crabs!	Yes
8/2/2022 18:02:36	Yes	Yes	Moderately easy		Yes	Yes	I didn't read it	No			Yes		Yes		Yes			Yes and I'll bring friends!
8/2/2022 18:18:12	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes			Yes
8/2/2022 18:22:58	Yes	Yes	Moderately easy		Yes	I didn't read it	Yes	No							Yes			Not sure

8/2/2022 18:24:50	Yes	Yes	Moderately easy	Identifying dead spider crab parts (body, legs) can be difficult to layperson	Yes	Yes	Yes	Yes	Yes	Small tutorial with photos on remains of spider crab	Yes		Yes		Yes	engaging project. Different questions per photo is nice	Yes
8/2/2022 18:54:59	Yes	Yes	Moderately easy		Yes	Yes	Yes	No					Yes		Yes		Yes
8/2/2022 19:25:22	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes	More example pictures of other organisms, like different fish species.	Yes		Yes		Yes		Yes and I'll bring friends!
8/2/2022 19:26:50	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes	If possible, an offline platform for further engagement between volunteers to share ideas oftenly.	Yes		Yes		Yes		Yes and I'll bring friends!
8/2/2022 19:49:52	Yes	No	Very hard	Too many steps, Task too complicated, Image resolution too low	No	Yes	There is no field guide	Yes	Yes		Yes		Yes		Yes	This project is trying to get folks to do WAY TOO many tasks. How about "do you see crabs? how many?"	No
8/2/2022 20:29:53	Yes	Yes	Very easy		Yes	Yes	Yes	No			Yes		Yes		Yes	No	Yes
8/2/2022 20:40:54	Yes	Yes	Very hard	Task too complicated	There is no tutorial	There is no help text	There is no field guide	No	No	How to undertake the project, recognising that crabs are on top of each other. How good will the numbers be?	No	How to count most reliably.	Yes			Great project, but needs guidance on counting.	Not sure
8/2/2022 21:37:53	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes	Nagyításkor nagyon elhomályosodik a kép, kissé elmosódnak a körvonalak- bár lehet, hogy a víz alatti felvétel miatt van. Nagyszerű témaválasztás.	Yes		Yes		Yes		Not sure, Nagyon szeretnék ebben is részt venni, de én már "eléggé idős vagyok"
8/2/2022 23:11:50	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes				Yes		Yes	The number of blury images / images with no content is a little taxing	Yes and I'll bring friends!
8/2/2022 23:58:34	Yes	Yes	Moderately easy		Yes	Yes	Yes	No					Yes		Yes		Yes
8/3/2022 1:31:49	Yes	Yes	Moderately easy		Yes	Yes	Yes	No		What to do if there are other species present but not possible to identify, i.e. blurry fish.	Yes		Yes		Yes		Yes
8/3/2022 2:23:13	Yes	Yes	Very easy		Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes		Yes
8/3/2022 2:53:41	Yes	Yes	Very hard	Image resolution too low, not enough categorization example pictures; some don't show all needed features for identification (mostly for the fish identification to identify possible remains))	No	No	Yes	No					Yes		Yes		Not sure
8/3/2022 5:42:55	No	Yes	Somewhat hard	Image resolution too low	Yes	Yes	Yes	No			Yes		Yes		Yes		Yes
8/3/2022 6:51:39	Yes	Yes	Moderately easy		Yes	Yes	Yes	No	Yes	.	No		Yes		Yes		Not sure
8/3/2022 7:04:43	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes		Yes
8/3/2022 8:13:56	Yes	Yes	Somewhat hard	Took too long, Image resolution too low	Yes	Yes	I didn't read it	Yes	Yes		Yes		Yes		Yes		Yes
8/3/2022 9:11:55	Yes	Yes	Very easy		Yes	I didn't read it	Yes	Yes	Yes	majority of the captured images only had fish or spider crab remains in it - this is probably because the spider crabs are rare, but i still didn't get to see them alot :)	Yes		No	super spider crabs go!	Yes	good! very good, just lacks the spider crab bit.	Yes and I'll bring friends!, Yes
8/3/2022 12:39:16	Yes	Yes	Somewhat hard	Task too complicated	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes		No
8/3/2022 13:59:11	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes	Relevant, well documented project within Zooniverse's scope	No
8/3/2022 15:07:28	Yes	Yes	Moderately easy		Yes	I didn't read it	Yes	No			Yes				Yes		Yes
8/3/2022 15:33:44	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes	For identifying the other animal species that may show up in the images, I think it may also be helpful to show some examples from actual project images, so we know what the animals may look like under different conditions! Sometimes the photos that come up are very blue, for instance, so some markings or colors may be unclear. I can see how this may be confusing when trying to identify them. Maybe include these further examples in the Field Guide! Other than that, I found the Field Guide and Tutorial very helpful and clear!	Yes		Yes		Yes	Looks great!!!	Yes and I'll bring friends!, Yes
8/3/2022 15:37:13	Yes	Yes	Moderately easy		No	Yes	No	No		The Pictures of the examples are really bad.	Yes		Yes		Yes		Yes
8/3/2022 15:37:41																	Yes
8/3/2022 16:11:34	Yes	Yes	Somewhat hard	Task too complicated	I didn't read it	Yes	I didn't read it	No					Yes		Yes		Not sure
8/3/2022 17:19:11	Yes	Yes	Very hard	Too difficult to see on my phone.	Yes	I didn't read it	Yes	Yes	Yes		Yes		Yes		Yes	Great project! Just can't see images accurately in murky water on such a small screen.	No

8/3/2022 17:44:56	Yes	Yes	Somewhat hard	it was easy until the id of species. The field guide contains no useful photo (tiny round icon only photo) and after IDing 11 tommys want to add another type fish but when looking for the id of it, "back" erases the tommys and so its frustrating. Need easier to scroll through field slist of species before I will do this one again.	Yes	I didn't read it	No	No		I would like to continue making entries here when its "fixed"				Yes		Yes
8/3/2022 18:22:10	Yes	Yes	Moderately easy		Yes	Yes	Yes	No			No	Yes		Yes	no	Yes and I'll bring friends!
8/3/2022 19:46:18	Yes	Yes	Somewhat hard	Too many steps	No	Yes	Yes	Yes	Yes	For classifying animals, please make their thumbnail pictures larger. This is the most cumbersome step of the whole classification.		Yes		Yes	Is the scope of the project too large/ambitious? Can it be scaled down to just spider crabs and not "extraneous" data.	Not sure
8/4/2022 10:46:48	Yes	Yes	Very easy		Yes	Yes	Yes	No			Yes	Yes		Yes		Yes
8/4/2022 12:32:03	Yes	Yes	Very easy	Image resolution too low	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes		Yes
8/4/2022 14:25:14	Yes	Yes	Moderately easy		Yes	No	I didn't read it	Yes	Yes		Yes	Yes		Yes		Yes
8/4/2022 14:45:19	Yes	Yes	Somewhat hard	Too many steps	No	Yes	Yes	Yes	Yes		Yes	Yes		Yes	the pics in the instructions were very small, so it was hard to see what was being pointed out;	Not sure
8/4/2022 17:32:48	Yes	Yes	Moderately easy		No	Yes	Yes	Yes	Yes	I don't recall seeing specific images of the various states the crab could be in.	Yes	Yes		Yes		Yes
8/4/2022 18:58:29	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes			Yes		Yes		Yes
8/5/2022 4:33:03	Yes	Yes	Very easy		Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes		Yes
8/5/2022 10:53:49	Yes	Yes	Moderately easy	Too many steps	Yes	Yes	Yes	Yes	Yes		No	No	Spider Crab Hunt	Yes		Yes and I'll bring friends!
8/5/2022 10:54:05	Yes	Yes	Somewhat hard	Task too complicated, Image resolution too low	Yes	Yes	Yes	Yes	Yes		No	Yes		Yes		Not sure
8/5/2022 23:22:43	Yes	Yes	Somewhat hard	no way to draw shapes around items	Yes	Yes	Yes	No		There is no way for me to make shapes around the various items. I am using a laptop and mouse.	Yes	Yes		Yes		Yes
8/6/2022 2:25:28	Yes	Yes	Moderately easy		Yes	Yes	Yes	No	Yes		Yes	Yes		Yes	This project is surprisingly addictive. I want to keep going until I find some crabs! It is really clear step by step and easy to follow. The field guide is actually helpful. This is a very well done project.	Yes
8/6/2022 6:37:20	Yes	Yes	Somewhat hard	Task too complicated	Yes	There is no help text	Yes	Yes	Yes		Yes	Yes		Yes	It can be difficult to identify species correctly. Participants may find it frustrating and feel discouraged from taking part in this project (a participant commented on this). Good for participants interested in marine science and don't mind having to spend time looking through the field guide to identify the various species.	Not sure
8/6/2022 8:39:39	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes			Yes		Yes	When clearety nr. 5 you should skip to the next photo	Yes
8/7/2022 10:14:59	Yes	Yes	Somewhat hard	Image resolution too low, There is no option to come back if you're missing something and would like to correct.	Yes	I didn't read it	There is no field guide	No		1. Higher resolution of images. 2. Ability to correct previous step(s).		Yes		Yes		Yes
8/7/2022 15:30:19	Yes	Yes	Very easy		Yes	Yes	Yes	No				Yes		Yes	Fix the spelling mistakes	No
8/10/2022 15:33:39	Yes	Yes	Moderately easy		Yes	Yes	Yes	No			Yes	Yes		Yes		Yes
8/17/2022 0:31:52	Yes	Yes	Moderately easy		Yes	Yes	Yes	Yes	Yes			Yes			I was puzzled why the task didn't ask about the crabs! Instead, only "photo quality" and "other animals" were questioned.	Yes
8/30/2022 16:48:35	Yes	Yes	Moderately easy		Yes	Yes	Yes	No	No		Yes	Yes		Yes		Yes and I'll bring friends!

Appendix 2

Summary of outreach efforts

Table 1 - Timeline of community events and meetings (1/3)

ORGANISATION	DATE	DELIVERY	NUMBER OF ATTENDEES
Spider Crab Alliance	10/03/2022		5
Victorian National Parks Association and the Port Phillip Ecocentre	18/01/2022, 30/03/2022, 02/06/2022		5
Reef Life Survey	17/02/2022		3
Victorian Sub-Aquatic Group	15/03/2022, 19/08/2022		30 15
Rye Coastal Advisory Group	17/02/2022		7
NerdNite	12/04/2022		50
Pint of Science	10/05/2022		70
Coastcare (Volunteer Forum, Port Melbourne)	22/05/2022		30
Diveline Frankston	26/05/2022		30
Snorkel and dive safari Altona Beach	01/06/2022		20

Table 1 - Timeline of community events and meetings (2/3)

ORGANISATION	DATE	DELIVERY	NUMBER OF ATTENDEES
RMIT dive club	02/06/2022		20
Melbourne University dive club	23/06/2022		25
Centre for Integrative Ecology (Wild Webinar series)	02/08/2022		40
Friends of Edwards Point	01/08/2022		28
Mordialloc sailing club, Mordialloc Boating and Angling club and the Mordialloc Motor Yacht Club	02/08/2022		7
National Science Week (virtual spider crab tour launch)	16/08/2022		30
Dolphin Research Institute (Marine ambassadors session)	18/08/2022		15
Laneway Learning	01/06/2022		4

TOTAL NUMBER OF ATTENDEES = 477

Table 1 - Timeline of community events and meetings (3/3)

ORGANISATION	DATE	DELIVERY	NUMBER OF ATTENDEES
Victoria Nature Festival	21/09/2022		10
Quollifed Podcast [upcoming release]	30/09/2022		NA
OzTek Advanced Dive Conference	01/10/2022		25
Black Rock Underwater club	12/10/2022		20

Table 2 - a. Print and online media

DATE	MEDIA	TITLE
04/04/2022	Geelong Advertiser	People power in a pinch
20/04/2022	Surf Coast Times	Local help to track ocean crawlers
19/05/2022	Ecological Society of Australia (e-news)	New citizen science program aims to solve spider crab mysteries
29/05/2022	Mornington Peninsula Magazine	Call for citizen scientists to help aggregation investigation
08/06/2022	Remember The Wild (newsletter & website)	Spider Crabs for National Science Week
08/06/2022	Coastcare (newsletter)	Good news
June 2022	OzFish (newsletter)	Spider crabs are on the move
12/04/2022	Great Southern Reef (newsletter & website)	
05/08/2022	Scuba Diver Australia and New Zealand	Diving with… Dr Elodie Camprasse
May 2022	Port Phillip Ecocentre (website)	Spider Crab Watch – Help Us Solve the Mysteries of the Bay
30/03/2022	Deakin University (media release)	New citizen science program to unlock mystery of giant spider crabs

TOTAL NUMBER OF FEATURES= 11

Table 2 - b. Online articles written by the research team

DATE	MEDIA	TITLE
06/06/2022	Remember The Wild website	Helping solve spider crab mysteries, one citizen scientist at a time
20/04/2022	Ecological Society of Australia Bulletin	New research aims to solve spider crab mysteries
04/07/2022	The Conversation	Thousands of giant crabs amass off Australia's coast. Scientists need your help to understand it
21/07/2022	IFLScience (republished article from the Conversation)	What's Triggering Australia's Annual Crabpocalypse? Scientists Need Your Help To Find Out
04/07/2022	Yahoo! (republished article from the Conversation)	Thousands of giant crabs amass off Australia's coast. Scientists need your help to understand it
21/07/2022	Australian Geographic (republished article from the Conversation)	Thousands of giant crabs amass off Australia's coast. Scientists need your help to understand it

TOTAL NUMBER OF ARTICLES= 3
REACH: >110,100 READS, 18 COMMENTS,
2564 SHARES AND TWEETS

Table 2 - c. Program newsletters

DATE	STATISTICS	TITLE
06/06/2022	61.4% open rate/27 opens	Spider Crab Watch Update #1 - Timelapse Cameras Deployed
20/04/2022	66.1% open rate/109 opens/1 click	Spider Crab Watch Update #2 - Happy World Oceans Day And Spider Crab Cam Images
04/07/2022	61.1% open rate/162 opens/8 clicks	Spider Crab Watch update #3 - One step closer to solving spider crab mysteries
21/07/2022	56.4% open rate/198 opens/24 clicks	Spider Crab Watch update #4 - Spider crab webinar and fieldwork done and dusted
04/07/2022	55.7% open rate/206 opens/33 clicks	Spider Crab Watch update #5 - Help us improve Spider Crab Watch, National Science Week & more
21/07/2022	57.1% open/212 opens/34 clicks	Spider Crab Watch Update #6 - New Spider Crab Virtual Tour And Help Us Improve Spider Crab Watch
21/07/2022	52.8%/201 opens/13 clicks	Spider Crab Watch update #7 - Help us solve spider crab mysteries from anywhere in the world!

TOTAL NUMBER OF NEWSLETTERS= 7

Appendix 3

Abundance and biomass of the fish species observed within Port Phillip Bay in 2022

Family	**Taxon**	**Common name**	**Total MaxN**	**MaxN mean ± SE**	**# of lengths**	**Mean length ± SE (g)**	**Total biomass (g)**	**Mean Biomass ± SE (g)**
Aplodactylidae	*Aplodactylus arctidens*	Marblefish	1	0.01 ± 0.01	1	48.98 ± 0	1383.47	10.89 ± 10.89
Apogonidae	*Vincentia conspersa*	Southern cardinalfish	4	0.03 ± 0.02	2	6.54 ± 2.63	15.08	0.12 ± 0.09
Arripidae	*Arripis georgianus*	Tommy rough	138	1.09 ± 0.63	32	11.99 ± 0.5	2436.17	19.18 ± 10.62
Arripidae	*Arripis trutta*	Australian salmon	246	1.94 ± 0.95	31	30.67 ± 0.77	70608.15	555.97 ± 273.45
Aulopidae	*Latropiscis purpurissatus*	Sergeant baker	3	0.02 ± 0.02	NA	NA	NA	NA
Blenniidae	*Parablennius tasmanianus*	Tasmanian blenny	18	0.14 ± 0.08	2	5.47 ± 0.78	21.94	0.17 ± 0.1
Carangidae	*Pseudocaranx* spp.	Trevally	281	2.21 ± 0.9	94	22.61 ± 0.69	58098.59	457.47 ± 180.41
Carangidae	*Trachurus* spp.	Scad	1383	10.89 ± 2.46	152	21.57 ± 0.19	328474.8	2586.42 ± 580.83
Carcharhinidae	*Carcharhinus* spp.	Whaler shark	2	0.02 ± 0.01	NA	NA	NA	NA
Chironemidae	*Chironemus georgianus*	Western kelpfish	2	0.02 ± 0.01	2	35.08 ± 0.8	1033.28	8.14 ± 5.74
Chironemidae	*Chironemus maculosus*	Silver spot	2	0.02 ± 0.01	NA	NA	NA	NA
Clupeidae	Clupeidae spp.	Bait fish	241	1.9 ± 0.98	NA	NA	NA	NA
Congridae	*Conger verreauxi*	Conger	1	0.01 ± 0.01	NA	NA	NA	NA
Dasyatidae	*Bathytoshia brevicaudata*	Smooth stingray	54	0.43 ± 0.05	24	168.38 ± 7.5	3519333	27711.28 ± 3714.11
Dinolestidae	*Dinolestes lewini*	Long-fin pike	15	0.12 ± 0.08	4	21.3 ± 5.78	982.47	7.74 ± 6.09

Diodontidae	*Diodon nicthemerus*	Globe fish	19	0.15 ± 0.03	8	19.62 ± 1.11	3284.14	25.86 ± 5.84
Enoplosidae	*Enoplosus armatus*	Old wife	21	0.17 ± 0.05	8	22.88 ± 2.24	1537.48	12.11 ± 3.93
Gempylidae	*Thyrsites atun*	Barracouta	2	0.02 ± 0.01	NA	NA	NA	NA
Gerreidae	*Parequula melbournensis*	Silverbelly	36	0.28 ± 0.15	9	11.5 ± 0.68	846.75	6.67 ± 3.46
Gobiidae	*Gobiidae spp.*	Goby	1	0.01 ± 0.01	NA	NA	NA	NA
Gobiidae	*Tridentiger trigonocephalus*	Trident Goby	2	0.02 ± 0.01	1	5.82 ± 0	4.66	0.04 ± 0.03
Hemiramphidae	*Hyporhamphus* spp.	Garfish	51	0.4 ± 0.28	10	27.68 ± 1.07	3725.12	29.33 ± 20.17
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark	52	0.41 ± 0.06	31	68.31 ± 2.69	117165.9	922.57 ± 160.39
Hexanchidae	*Notorynchus cepedianus*	Broadnose sevengill shark	3	0.02 ± 0.01	1	89.67 ± 0	14447.02	113.76 ± 65.15
Kyphosidae	*Girella zebra*	Zebra fish	68	0.54 ± 0.17	20	28.72 ± 1.2	29036.88	228.64 ± 67.23
Labridae	*Achoerodus* spp.	Blue groper	4	0.03 ± 0.02	2	23.73 ± 3.57	1144.83	9.01 ± 4.68
Labridae	*Dotalabrus aurantiacus*	Castelnaus wrasse	4	0.03 ± 0.02	NA	NA	NA	NA
Labridae	*Eupetrichthys angustipes*	Snake-skin wrasse	1	0.01 ± 0.01	NA	NA	NA	NA
Labridae	*Notolabrus fucicola*	Purple wrasse	20	0.16 ± 0.07	9	23.71 ± 1.59	3638.43	28.65 ± 12.36
Labridae	*Notolabrus tetricus*	Blue-throat wrasse	527	4.15 ± 0.66	160	24.12 ± 0.55	29322.31	230.88 ± 35.97
Labridae	*Pictilabrus laticlavius*	Senator wrasse	85	0.67 ± 0.1	36	20.14 ± 0.62	8190.28	64.49 ± 9.78
Labridae	*Pseudolabrus rubicundus*	Rosy wrasse	14	0.11 ± 0.06	5	19.08 ± 1.29	1123.56	8.85 ± 4.66
Latridae	*Pseudogoniistius nigripes*	Magpie perch	24	0.19 ± 0.05	10	30.5 ± 1.82	9118.8	71.8 ± 18.72

Latridae	*Chirodactylus spectabilis*	Banded morwong	1	0.01 ± 0.01	1	37.42 ± 0	2141.87	16.87 ± 16.87
Latridae	*Dactylophora nigricans*	Dusky morwong	14	0.11 ± 0.03	7	52.61 ± 2.64	13084.12	103.02 ± 34.46
Loliginidae	*Sepioteuthis australis*	Southern calamary	13	0.1 ± 0.03	NA	NA	NA	NA
Monacanthidae	*Acanthaluteres spilomelanurus*	Bridled leatherjacket	28	0.22 ± 0.14	6	12.52 ± 2.74	1089.85	8.58 ± 5.14
Monacanthidae	*Acanthaluteres vittiger*	Toothbrush leatherjacket	17	0.13 ± 0.07	5	24.69 ± 0.97	4216.62	33.2 ± 18.14
Monacanthidae	*Eubalichthys gunnii*	Gunn's leatherjacket	1	0.01 ± 0.01	2	23.88 ± 1.35	312.25	2.46 ± 1.76
Monacanthidae	*Eubalichthys mosaicus*	Mosaic leatherjacket	1	0.01 ± 0.01	NA	NA	NA	NA
Monacanthidae	*Meuschenia australis*	Brown-striped leatherjacket	2	0.02 ± 0.01	2	26.49 ± 1.69	612.72	4.82 ± 3.46
Monacanthidae	*Meuschenia flavolineata*	Yellow-stripe leatherjacket	13	0.1 ± 0.04	8	27.16 ± 0.69	4265.49	33.59 ± 11.49
Monacanthidae	*Meuschenia freycineti*	Six-spine leatherjacket	94	0.74 ± 0.12	48	31.05 ± 0.82	47262.74	372.15 ± 60.73
Monacanthidae	*Meuschenia galii*	Blue-lined leatherjacket	11	0.09 ± 0.03	5	27.91 ± 0.89	3899.71	30.71 ± 9.75
Monacanthidae	*Meuschenia hippocrepis*	Horseshoe leatherjacket	53	0.42 ± 0.11	23	23.78 ± 1.7	13489.7	106.22 ± 29.92
Monacanthidae	*Meuschenia venusta*	Stars and stripes leatherjacket	1	0.01 ± 0.01	NA	NA	NA	NA
Monacanthidae	*Nelusetta ayraud*	Ocean leatherjacket	70	0.55 ± 0.23	25	19.99 ± 0.39	10026.53	78.95 ± 32.8
Monacanthidae	*Scobinichthys granulatus*	Rough leatherjacket	21	0.17 ± 0.03	14	24.76 ± 1.13	5491.12	43.24 ± 9.49
Monacanthidae	*Thamnaconus degeni*	Degen's leatherjacket	1	0.01 ± 0.01	1	16.74 ± 0	79.62	0.63 ± 0.63

Moridae	*Pseudophycis* spp.	Codling	5	0.04 ± 0.02	4	35.15 ± 2.37	2006.94	15.8 ± 7.35
Mugilidae	*Aldrichetta forsteri*	Yellow eye mullet	9	0.07 ± 0.06	3	33.57 ± 3.08	3576.32	28.16 ± 25.91
Mullidae	*Upeneichthys vlamingii*	Bluespotted goatfish	191	1.5 ± 0.38	67	18.33 ± 0.45	16400.47	129.14 ± 29
Myliobatidae	*Myliobatis tenuicaudatus*	Southern eagle ray	35	0.28 ± 0.04	14	99.38 ± 6.71	1620074	12756.49 ± 2297.34
Neosebastidae	*Maxillicosta meridianus*	Southern gurnard perch	1	0.01 ± 0.01	1	10.52 ± 0	12.79	0.1 ± 0.1
Neosebastidae	*Neosebastes scorpaenoides*	Common gurnard perch	10	0.08 ± 0.03	7	28.97 ± 3.36	5718.87	45.03 ± 18.21
Odacidae	*Haletta semifasciata*	Blue rock whiting	5	0.04 ± 0.02	2	15.23 ± 9.32	225.23	1.77 ± 1.17
Odacidae	*Heteroscarus acroptilus*	Rainbow cale	3	0.02 ± 0.01	2	25.56 ± 0.67	450.09	3.54 ± 2.03
Odacidae	*Neoodax balteatus*	Little rock whiting	91	0.72 ± 0.29	28	10.33 ± 0.46	544.54	4.29 ± 1.73
Odacidae	*Olisthops cyanomelas*	Herring cale	29	0.23 ± 0.05	13	33.75 ± 1.07	10396.94	81.87 ± 19.11
Odacidae	*Siphonognathus beddomei*	Pencil weed whiting	2	0.02 ± 0.02	NA	NA	NA	NA
Ostraciidae	*Aracana* spp.	Cowfish	5	0.04 ± 0.02	3	16.46 ± 0.89	462.04	3.64 ± 1.63
Parascylliidae	*Parascyllium variolatum*	Varied catshark	1	0.01 ± 0.01	NA	NA	NA	NA
Pentacerotidae	*Pentaceropsis recurvirostris*	Longsnout boarfish	3	0.02 ± 0.02	NA	NA	NA	NA
Pinguipedidae	*Parapercis ramsayi*	Spotted grubfish	1	0.01 ± 0.01	NA	NA	NA	NA
Platycephalidae	*Platycephalus bassensis*	Sand flathead	204	1.61 ± 0.29	77	25.68 ± 0.52	21656.26	170.52 ± 29.87
Platycephalidae	*Platycephalus speculator*	Yank flathead	31	0.24 ± 0.05	19	41.85 ± 1.91	16182.57	127.42 ± 27.81

Plesiopidae	*Paraplesiops meleagris*	Western blue devil	1	0.01 ± 0.01	NA	NA	NA	NA
Plesiopidae	*Trachinops caudimaculatus*	Hulafish	57	0.45 ± 0.45	4	6.83 ± 0.34	120.57	0.95 ± 0.95
Pomacentridae	*Parma microlepis*	White-ear	1	0.01 ± 0.01	NA	NA	NA	NA
Pomacentridae	*Parma victoriae*	Victorian scalyfin	32	0.25 ± 0.05	19	20.96 ± 0.52	6525.58	51.38 ± 9.56
Rajidae	*Spiniraja whitleyi*	Melbourne skate	2	0.02 ± 0.01	2	103.41 ± 31.1	22792	179.46 ± 159.11
Scombridae	*Scomber australasicus*	Blue mackerel	28	0.22 ± 0.16	NA	NA	NA	NA
Scorpididae	*Atypichthys strigatus*	Mado sweep	15	0.12 ± 0.1	8	12.89 ± 0.42	726.02	5.72 ± 4.52
Scorpididae	*Scorpis aequipinnis*	Sea sweep	77	0.61 ± 0.29	25	18.22 ± 1.61	8228.78	64.79 ± 29.8
Scorpididae	*Scorpis lineolata*	Silver sweep	5	0.04 ± 0.03	4	11.87 ± 2.43	123.97	0.98 ± 0.72
Scorpididae	*Tilodon sexfasciatus*	Moonlighter	10	0.08 ± 0.03	5	15.27 ± 2.87	962.75	7.58 ± 3.49
Sepiidae	*Sepia apama*	Giant cuttle	2	0.02 ± 0.01	NA	NA	NA	NA
Serranidae	*Caesioperca* spp.	Butterfly perch	31	0.24 ± 0.16	9	14.26 ± 1.61	861.23	6.78 ± 4.34
Serranidae	*Hypoplectrodes nigroruber*	Banded seaperch	1	0.01 ± 0.01	NA	NA	NA	NA
Sillaginidae	*Sillaginodes punctatus*	King George whiting	78	0.61 ± 0.22	27	33.82 ± 1.57	20486.1	161.31 ± 54.91
Sillaginidae	*Sillago* spp.	Sand whiting	1	0.01 ± 0.01	NA	NA	NA	NA
Sparidae	*Acanthopagrus butcheri*	Black Bream	1	0.01 ± 0.01	NA	NA	NA	NA
Sparidae	*Chrysophrys auratus*	Snapper	655	5.16 ± 0.78	158	22.18 ± 0.33	150195	1182.64 ± 177.21
Sphyraenidae	*Sphyraena novaehollandiae*	Snook	17	0.13 ± 0.04	4	56.45 ± 4.3	10871.09	85.6 ± 27.16

Tetraodontidae	*Contusus* spp.	Toadfish	30	0.24 ± 0.05	18	19.71 ± 0.94	4393.82	34.6 ± 7.76
Tetraodontidae	*Tetractenos glaber*	Smooth toadfish	60	0.47 ± 0.12	39	14.48 ± 0.24	3623.73	28.53 ± 6.68
Triakidae	*Mustelus antarcticus*	Gummy shark	15	0.12 ± 0.04	10	80.39 ± 7.34	58008.64	456.76 ± 156.3
Triglidae	*Chelidonichthys kumu*	Red gurnard	4	0.03 ± 0.02	3	41.08 ± 3.68	2900.14	22.84 ± 12
Trygonorrhinidae	*Trygonorrhina dumerilii*	Southern fiddler ray	250	1.97 ± 0.16	103	69.51 ± 1.43	613243.5	4828.69 ± 408.27
Trygonorrhinidae	*Trygonorrhina fasciata*	Fiddler ray	1	0.01 ± 0.01	NA	NA	NA	NA
Urolophidae	*Urolophus cruciatus*	Banded stingaree	1	0.01 ± 0.01	NA	NA	NA	NA
Urolophidae	*Urolophus gigas*	Spotted stingaree	4	0.03 ± 0.02	2	52.24 ± 10.34	5929.99	46.69 ± 27.38
Urolophidae	*Urolophus* spp.	Stingaree	8	0.06 ± 0.02	4	27.88 ± 4.39	2191.07	17.25 ± 6.55

Appendix 4

SIMPER results for habitat type within group similarity and the top contributing species

Species	Average abundance	Average similarity	Sim/SD	% contribution	Cumulative %
Infralittoral reef					
Average similarity: 21.29					
Trygonorrhina dumerilii	1.14	5.87	0.74	27.58	27.58
Pictilabrus laticlavius	0.63	2.26	0.62	10.60	38.18
Bathytoshia brevicaudata	0.50	2.04	0.47	9.59	47.77
Notolabrus tetricus	0.60	1.65	0.55	7.74	55.51
Parma victoriae	0.50	1.52	0.41	7.15	62.66
Meuschenia freycineti	0.60	1.49	0.48	6.98	69.64
Chrysophrys auratus	0.37	1.25	0.34	5.88	75.53
Soft Sediment					
Average similarity: 27.33					
Trygonorrhina dumerilii	1.46	12.40	1.68	45.36	45.36
Platycephalus bassensis	0.71	4.02	0.72	14.73	60.09
Heterodontus portusjacksoni	0.59	2.16	0.41	7.91	68.00
Platycephalus speculator	0.47	1.55	0.35	5.67	73.67
Seagrass					
Average similarity: 22.31					
Trygonorrhina dumerilii	1.32	6.65	0.79	29.82	29.82
Scobinichthys granulatus	0.60	3.63	0.68	16.25	46.07
Bathytoshia brevicaudata	0.50	2.56	0.51	11.46	57.53
Meuschenia freycineti	0.66	2.10	0.47	9.41	66.95
Pictilabrus laticlavius	0.40	1.83	0.51	8.21	75.16
Circalittoral reef					
Average similarity: 30.32					
Chrysophrys auratus	1.41	16.37	1.06	53.98	53.98
Trygonorrhina dumerilii	0.63	5.56	0.76	18.33	72.31

Appendix 5

SIMPER results for depth within group similarity and the top contributing species

Species	Average abundance	Average similarity	Sim/SD	% contribution	Cumulative %
0_5					
Average similarity: 17.45					
Trygonorrhina dumerilii	1.23	7.61	0.73	43.60	43.60
Bathytoshia brevicaudata	0.52	2.30	0.44	13.18	56.78
Chrysophrys auratus	0.32	1.47	0.30	8.40	65.18
Myliobatis tenuicaudatus	0.29	0.80	0.25	4.61	69.79
Tetractenos glaber	0.28	0.72	0.24	4.15	73.94
5_10					
Average similarity: 21.61					
Trygonorrhina dumerilii	1.16	7.00	0.93	32.39	32.39
Chrysophrys auratus	0.59	2.41	0.43	11.16	43.55
Bathytoshia brevicaudata	0.44	1.48	0.41	6.86	50.41
Pictilabrus laticlavius	0.50	1.42	0.45	6.55	56.96
Notolabrus tetricus	0.45	0.91	0.40	4.20	61.16
Meuschenia freycineti	0.41	0.87	0.34	4.03	65.19
Heterodontus portusjacksoni	0.40	0.86	0.28	3.99	69.18
Parma victoriae	0.38	0.84	0.28	3.87	73.05
10_15					
Average similarity: 27.25					
Trygonorrhina dumerilii	1.44	12.08	1.92	44.33	44.33
Myliobatis tenuicaudatus	0.46	2.40	0.49	8.81	53.14
Platycephalus bassensis	0.48	2.25	0.51	8.25	61.39
Heterodontus portusjacksoni	0.54	1.90	0.42	6.96	68.34
Trachurus spp.	0.56	1.66	0.38	6.09	74.43
15+					
Average similarity: 24.76					
Trygonorrhina dumerilii	1.20	7.92	1.68	31.98	31.98
Platycephalus bassensis	0.73	4.08	0.73	16.46	48.44
Contusus spp.	0.66	3.86	0.71	15.59	64.04
Heterodontus portusjacksoni	0.64	2.65	0.57	10.69	74.72

Appendix 6

Table A6: Individual great spider crab (Leptomithrax gaimardii) detections by transmitter

No.	Transmitter id	Total detections	Total stations	Stations detected at
1	A69-1604-7153	2	1	• St02
2	A69-1604-7156	4	1	• St Leonards
3	A69-1604-7157	30	2	• St01 • St02
4	A69-1604-7158	41	3	• St02 • St09 • West Channel 1
5	A69-1604-7159	5	2	• St10 • St11
6	A69-1604-7160	50,026	2	• St01 • West Channel 2
7	A69-1604-7163	1	1	• St Leonards
8	A69-1604-7165	161	2	• St02 • St09
9	A69-1604-7167	43	2	• St02 • St09
10	A69-1604-7168	7	1	• St04
11	A69-1604-7169	7	1	• Symmonds Channel
12	A69-1604-7170	1811	3	• St01 • St07 • West Channel 1
13	A69-1604-7175	271	4	• St04 • St05 • Pope's Eye • West Channel 1
14	A69-1604-7176	255	2	• St10 • West Channel 2
15	A69-1604-7177	729	4	• St02 • St09 • West Channel 1 • West Channel 2
16	A69-1604-7179	322	2	• St02 • St04
17	A69-1604-7181	3	1	• Pope's Eye
18	A69-1604-7184	1214	3	• St01 • St02 • West Channel 2
19	A69-1604-7189	402	1	• Symmonds Channel
20	A69-1604-7190	441	3	• St02 • West Channel 1 • West Channel 2

21	A69-1604-7191	295	4	• St04 • St05 • St11 • Pope's Eye
22	A69-1604-7192	40	1	• West Channel 2
23	A69-1604-7195	100	2	• St01 • St11
24	A69-1604-7197	4	1	• St Leonards
25	A69-1604-7198	12	2	• St02 • West Channel 2
26	A69-1604-7200	55	4	• St01 • St02 • West Channel 1 • West Channel 2
27	A69-1604-7201	48	2	• Symmonds Channel • West Channel 1

Table B6: Individual great spider crab (Leptomithrax gaimardii) detections

No.	**Station name**	**No. of detections**	**No. of individuals**	**Individuals detected (*n* pings)**
1	Pope's Eye	20	3	• A69-1604-7175 (5) • A69-1604-7181 (3) • A69-1604-7191 (12)
2	St Leonards	9	3	• A69-1604-7156 (4) • A69-1604-7163 (1) • A69-1604-7197 (4)
3	St01	51,314	6	• A69-1604-7157 (28) • A69-1604-7160 (50,008) • A69-1604-7170 (53) • A69-1604-7184 (1209) • A69-1604-7195 (14) • A69-1604-7200 (2)
4	St02	695	11	• A69-1604-7153 (2) • A69-1604-7157 (2) • A69-1604-7158 (13) • A69-1604-7165 (150) • A69-1604-7167 (2) • A69-1604-7177 (43) • A69-1604-7179 (105) • A69-1604-7184 (4) • A69-1604-7190 (354) • A69-1604-7198 (9) • A69-1604-7200 (11)

Table B6: Individual great spider crab (Leptomithrax gaimardii) detections (continued)

5	St04	231	4	• A69-1604-7168 (7) • A69-1604-7175 (1) • A69-1604-7179 (217) • A69-1604-7191 (6)
6	St05	536	2	A69-1604-7175 (263) A69-1604-7191 (273)
7	St07	2	1	• A69-1604-7170 (2)
8	St09	61	4	• A69-1604-7158 (7) • A69-1604-7165 (11) • A69-1604-7167 (41) • A69-1604-7177 (2)
9	St10	5	2	• A69-1604-7159 (1) • A69-1604-7176 (4)
10	St11	94	3	• A69-1604-7159 (4) • A69-1604-7191 (4) • A69-1604-7195 (86)
11	Symmonds Channel	427	3	• A69-1604-7169 (7) • A69-1604-7189 (402) • A69-1604-7201 (18)
12	West Channel 1	2601	7	• A69-1604-7158 (21) • A69-1604-7170 (1756) • A69-1604-7175 (2) • A69-1604-7177 (675) • A69-1604-7190 (86) • A69-1604-7200 (31) • A69-1604-7201 (30)
13	West Channel 2	334	8	• A69-1604-7160 (18) • A69-1604-7176 (251) • A69-1604-7177 (9) • A69-1604-7184 (1) • A69-1604-7190 (1) • A69-1604-7192 (40) • A69-1604-7198 (3) • A69-1604-7200 (11)