INTERANNUAL CHANGES IN THE PELAGIC AND DEMERSAL COMMUNITIES OF THE SHARK BAY WORLD HERITAGE AREA

190012430

9064 Words

Declaration of Authorship

Except where duly acknowledged here and further in the acknowledgments, all work presented is my own.

The initial dataset was provided by Jessica Meeuwig and the Marine Futures Lab. It consisted of 4 years (2017,2018,2019,2021) of seabed and midwater BRUVs data. This data was collected by a range of both past and present lab members, on a number of vessels. Analysis of years 2017-2019 was completed prior to my receipt of the dataset by Adam Jolly and Vyv Summers. Although minor revisions were made to data from years 2017-2019.

Instruction in the analysis or BRUVs data and identification of Western Australian taxa was provided by multiple members of the Marine Futures Lab, although most significantly by Adam Jolly and Vyv Summers.

Instruction in the use of CAL software was given by Thomas Tothill and instruction in producing calibration videos for CAL software was given by Adam Jolly.

Jessica Meeuwig instructed me in both the broader philosophy of statistical analysis and the practical implementation of multivariate analysis using PRIMER 7 with PERMANOVA +.

Hector Clarke 29th June 2023

[redacted]

Acknowledgements

I would firstly like to thank Jessica Meeuwig for welcoming me into her lab and hosting this project. She provided the initial dataset upon which this project is based, including 3 years (2017,2018,2019) or previously analysed BRUVs data and one year of raw footage (2021). Her guidance and willingness to delve into statistical minutia were invaluable to this project. Further, for hosting writing weeks so myself and other students had the chance to develop our ideas and projects alongside her, and her mob of kangaroos.

I am grateful to the entirety of the Marine Futures lab for their advice and assistance throughout this project. In particular Adam Jolly and Vyv Summers for instructing me in the analysis of BRUVs footage and species identification. Difficult species identifications often involved a collaborative effort from Adam Jolly, Vyv Summers, Julien Magne, Thomas Tothill, Dr Chris Thompson, Dr Sean van Elden, Dr Naima Andrea López, Jack McElhinney, Lincoln Hood, Maicey Burkett, Nico Fassbender and myself. For these discussions and opportunities to learn from the experience of other lab members, I am grateful. Those lab members who assisted in the collection of the 2017-2021 Shark Bay dataset have my thanks and admiration. Not only for producing the raw dataset, but for doing so in adverse and testing conditions. Further credit is due to Adam Jolly and Vyv Summers for analysing years 2017-2019 of seabed and midwater BRUVs footage from Shark Bay.

I would like to thank my supervisor, Miguel. Beyond the usual commitments of managing my project from St. Andrews, I appreciate your advice and constant enthusiasm throughout. Thank you also for encouraging me to make the most of my placement and to jump at opportunities when they were presented.

The land and sea on which this data was collected was and continues to be the country of the Malgana peoples. The land upon which this project was undertaken, and data analysed is the country and spiritual home of the Whadjuk people. I would like to pay respects to all elders, past, present, and emerging.

Contents

Abstract

Effective management and conservation of marine biodiversity requires a strong understanding of how marine systems respond to interannual variation and anthropogenic disturbances. Traditional perspectives on marine assemblages neglect to consider the interactions between benthic and pelagic habitats which are a significant component in the function of both systems. This project utilised a multiyear (2017,2018,2019,2021) dataset of both seabed and midwater baited remote underwater video systems (BRUVs) deployments from the Shark Bay World Heritage Area to investigate interannual changes in community composition as well as broader metrics of abundance, richness, biomass, and length for pelagic and demersal assemblages. In total, 297 taxa were recorded, 272 from seabed surveys and 47 from midwater surveys. Interannual trends in benthic and pelagic habitats were not similar but both habitats showed significant shifts in community composition between each year. Pelagic assemblages showed clear signs of excessive fishing pressure favouring large numbers of small fishes. Benthic assemblages were more stable, potentially due to the remoteness of the study area discouraging recreation fishermen. Several vunerable species were recorded including multiple young of the month shortfin mako sharks, *Isurus oxyrinchus*. Overall, the area between the west of Dirk Hartog Island and the Zuytdorp Cliffs presents a strong candidate for legislative protection in accordance with Australia's commitment to protecting 30% of its oceans by 2030.

1. Introduction

Understanding the ecology of both benthic and pelagic marine systems is imperative in a changing world. The Pelagic regions of the world's oceans are the largest habitat on the planet, providing >80% of fishes consumed by humans (Pauly et al., 2002) and hosting 2.7 times the amount of photosynthesis that occurs in tropical rainforests (Field, 1998). Coastal benthic habitats occupy only around 8% of the area in our oceans yet contain among the most diverse systems on Earth (Small, Adey and Spoon, 1998) and produce in excess of 12 billion USD per annum (Constanza et al., 1997). The conservation of these marine habitats and their associated fauna and flora is therefore critical. Global leaders have committed to conserving marine diversity by protecting 30% of the worlds oceans by 2030 (O'Leary et al., 2016; Dinerstein et al., 2019). More recently, this has been supported by the 2023 High Seas Treaty to advance the creation of marine protected areas outside the exclusive economic zones of individual nations (Gjerde, Harden-Davies and Hassanali, 2022). Whether these broad targets will be met remains to be seen, although more specific measures are increasingly necessary. Vunerable groups such as reef sharks have shown a 73% decline (Simpfendorfer et al., 2023), whereas larger shark species have shown up to a 92% decline (Roff et al., 2018) within the last half century. The removal of large predators such as these can trigger trophic cascades, increasing the fragility of the system to disturbance (Ruppert et al., 2013). Many taxa do not solely utilise benthic or pelagic habitats but instead move between the two (Preciado, Velasco and Olaso, 2008; Heithaus et al., 2007). Basing conservation and management decisions on data that considers only one of these habitats excludes a significant portion of the lifespan of these taxa. Creating large marine protected areas, such as those that would be necessary to reach the 30 by 30 target, requires a more holistic view of marine systems and the effects of potential disturbances.

This project primarily aims to identify interannual trends in both pelagic and benthic marine communities. Similarities in trends between the two may indicate overarching causal factors driving shifts marine communities. If there is a clear response, such as an inverse relationship then this would indicate that there may be strong ecological links between habitats which require further research. And if there is no relationship at all between habitats then we must assume that interactions arent significant or interannual trends are driven unilaterally by a more dominant factor. Species specific trends must also be considered to identify which taxa are driving compositional change and if specific groups show consistent decline.

Pelagic and benthic habitats are not ecologically isolated with multiple modes of exerting influence on one another. Traditionally, research on benthic-pelagic coupling and linkages has focused on inanimate processes (Griffiths et al., 2017) and planktonic interactions (Kirby et al., 2007). More recently attention has been drawn to interactions mediated by higher trophic level, macroscopic organisms (Ricci et al., 2022). Taxa that utilise both benthic and pelagic habitats provide a mechanism for nutrient transport between the two. Large Predatory species such as the tiger shark, *Galeocerdo cuiver*, have been recorded moving between both habitats in Shark Bay (Heithaus et al., 2007). Additional shark species as well as large piscivorous fishes have been shown to utilise both benthic and pelagic habitats for foraging (Torres-Rojas et al., 2009; Rajesh et al., 2017). The most direct method of nutrient transfer mediated by these species involves their mortality and consumption, whether that be in benthic or pelagic habitat. However, behavioural factors cannot be omitted. Taxa that feed in both habitats may have significant non-consumptive effects (Mitchell and Harborne, 2020), altering prey behaviour and incurring additional metabolic costs (Anson et al., 2013). Species that feed sparingly in benthic habitats for example, may still alter prey behaviour and energy systems from simply being present in the vicinity. Predator mediated linkages are not limited to motile species. Suspension feeding organisms including sponges (Lesser, 2006; Pile and Young, 2006), bivalves (Porter, Cornwell and Sanford, 2004), and corals (Naumann et al., 2009) may accumulate nutrients from pelagic plankton. Additional nutrients increase growth rates of calcifying organisms (Ferrier-Pages et al., 2003), increasing habitat complexity, reef profile, and refugia density for demersal species. Another mechanism for benthic-pelagic linkages involves ontogenetic differences in habitat utilisation. Many marine species have pelagic larval stages allowing energy transfer through the settlement of larvae, or their consumption by pelagic planktonivores. The inverse is also true for pelagic species with benthic larval stages. Literature on this mechanism has again focused on plankton (Marcus and Marcus, 1998), although higher trophic level examples would also be valid, such as reef fishes with pelagic larvae. The complex and varied nature of benthic-pelagic interactions portray unilateral effects as an oversimplification where the impacts on the alternate habitat are not considered. It is for this reason that to gain a full understanding of anthropogenic effects on marine environments, we must investigate benthic and pelagic systems alongside each other.

The chosen study site was the Shark Bay World Heritage Area. More specifically, the Western side of Dirk Hartog Island south to the Zuytdorp cliffs as shown in figure 1. . This specific area represents a transitional zone between the shallow coastal areas of Shark Bay and the nearshore pelagic habitat found further West. As such, benthic-pelagic interactions, particularly those mediated by movement, will be more apparent due to occuring on smaller spatial scales. Furthermore, close proximity between benthic and pelagic habitat supports a broader sampling effort which is imperative in such a diverse area.

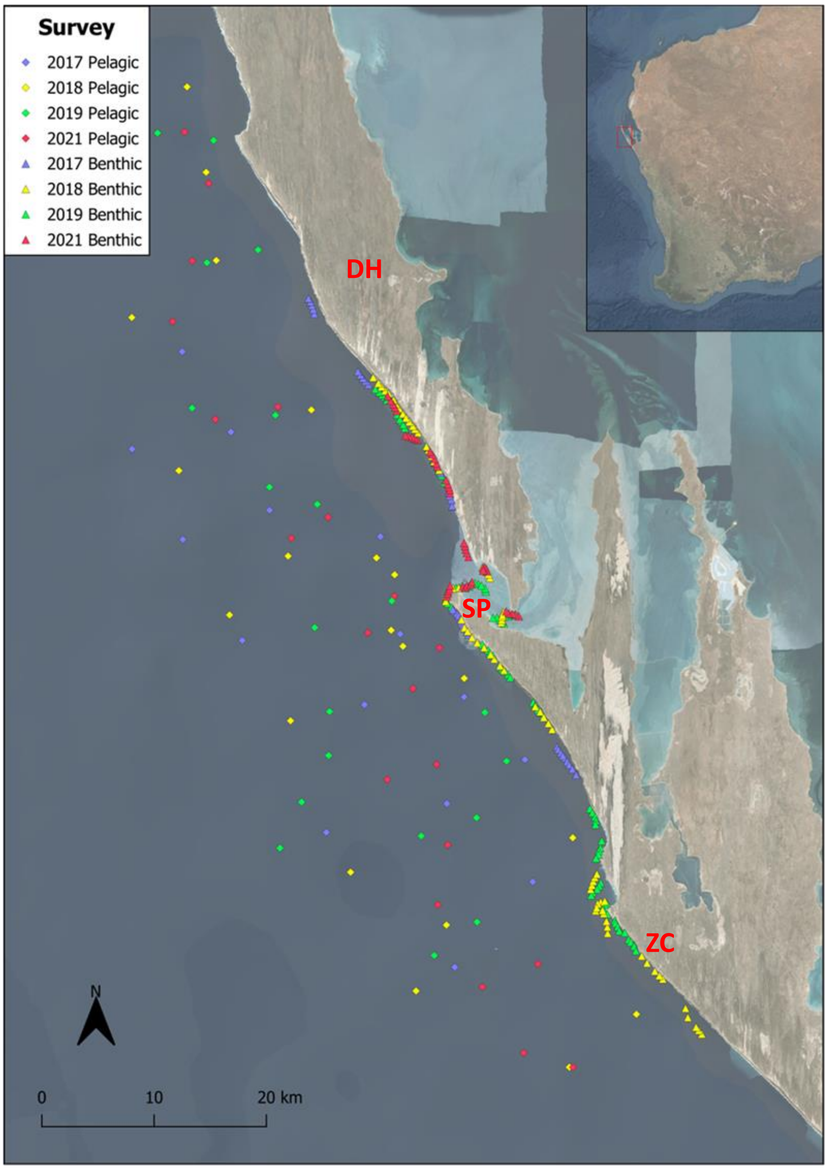


Figure 1. Map showing the study area of West Shark Bay. Inset shows the position of Shark Bay in Western Australia (red box). Midwater BRUVs are marked as the mean geographic position of each string of 5 rigs. Dirk Hartog Island is marked by DH, Steep Point by SP, and the Zuytdorp cliffs by ZC.

Shark Bay is a large region of gulfs and peninsulas situated on the Westernmost point of the Australian mainland. The Francois-Peron peninsula divides the interior into two major gulf systems which are bounded on the north side by the islands of Dorre and Bernier and Dirk Hartog to the west. Hydrological isolation and high evaporation rates in the internal gulfs produce hypersaline water which migrates northward and forms an inverse wedge halocline feature in calm conditions (Hetzel et al., 2015). This saline water extrudes through three channels, the Geographe channel, Naturaliste channel and Southern Passage to interact with oceanic current systems. The Leeuwin current is the most dominant of these and flows southward along the coastline of Western Australia, bringing warm, hyposaline water to greater latitudes (Waite et al., 2007). Although the Leeuwin occasionally intrudes into the interior of Shark Bay (Hetzel et al., 2013) its influence is most prevalent along the Western side of Dirk Hartog Island, southward to the Zuytdorp cliffs.

The temperature anomaly created by the Leeuwin current supports the range extension of many tropical species further south, particularly in offshore and more westerly areas (Phillips and Huisman, 2009; Watson and Harvey, 2009). Marine assemblages in Shark Bay are therefore comprised of a mixture of tropical species near the southern extent of their range, and subtropical species at their northernmost extent. The subsequent community is comprised of a highly competitive assortment of species for whom Shark Bay is their only overlap in distribution. The Leeuwin current also drives productivity in Western Australia by de-stratifying the water column and introducing relatively nutrient-rich water to coastal areas (Koslow et al., 2008). In the context of Shark Bay, this would imply greater productivity in more Westerly areas that are influenced more directly by the Leeuwin current, such as our study area. Pelagic communities also benefit from the Leeuwin current. Large filter feeding species such as the whale shark, *Rhincodon typus*, are more abundant in years where the Leeuwin current is stronger (Hanson and McKinnon, 2009). The effects of the Leeuwin current are not uniform, however, and can be highly species specific (Caputi et al., 1996). The relative strength of the Leeuwin current may be a driving factor in interannual variability of marine assemblages in Western Australia, favouring different species depending on water temperature and current strength.

Due to its remoteness and lack of monitoring, archival fisheries data from Dirk Hartog and Steep point is sparse or non-existent. The history of recreational fishing in the interior gulfs of Shark Bay is better documented. The Australasian snapper, *Pagurus auratus*, (henceforth referred to as snapper), is a demersal (benthopelagic species), sparid which has been historically overexploited in Shark Bay. The Shark Bay snapper are uniquely split into reproductively isolated sub-populations by internal eddy currents in the gulfs (Nahas et al., 2003) making them highly vunerable to fishing pressure. The 1980s and 90s saw the effective collapse of the Shark Bay snapper population to 5 percent of its historic levels due to increased accessibility inviting excessive extraction by recreational fishermen (Christensen & Jackson, 2014). By the end of this period, 70% of snapper in Shark Bay were below minimum size limits and very few mature individuals were recorded. Slot size restrictions and bag limits were introduced to support the recovery of Shark Bay snapper, but management has not been temporally consistent with only 2014-2020 having a catch effort below the maximum sustainable yield for this species (Fairclough, 2021). More recently, other commonly targeted species such as grass emperor, *Lethrinus laticaudis*, have been identified as vunerable to overexploitation due to poor population connectivity in Shark Bay (Fairclough, Ayvazian and Newman, 2022). West Dirk Hartog, Steep point and the Zuytdorp cliffs are comparatively more remote than the inner gulfs with only 4 wheel drive access and no nearby boat ramps. We would therefore expect exploitation of demersal communities to occur to a lesser extent than is observed in the inner gulfs. The closest settlement and boat ramp to steep point is situated in the town of Denham. Denham is the most major settlement in Shark Bay, found on the Western side of the Francois-Peron peninsula and having a population of 964 (Christensen and Jones, 2020). Although the local population is relatively small, Shark Bay receives in excess of 120,000 visitors per year (Tourism WA, 2022) placing large amounts of pressure on the local ecosystem and undoubtedly contributing to local fishing pressure. Nonetheless, increasing access could imperil the areas around West Dirk Hartog and Steep Point to a similar degree of overexploitation as has been historically observed in the inner gulfs.

2. Methods

2.1 BRUVs

Pelagic and demersal marine assemblages were sampled with the use of baited remote underwater video systems, henceforth referred to as BRUVs. BRUVs are defined by the presence of one or more underwater camera, to which bait is attached and then deployed for a given duration. Video from these cameras is later processed and analysed for the presence and abundance of marine fauna. These methods have the advantage of being entirely non extractive for use in, or around marine parks and vunerable species. Multiple BRUVs rigs can be deployed simultaneously, allowing for large sampling efforts which require relatively little time in the field. Areas such as Dirk Hartog Island have variable and often challenging weather and swell conditions, only permitting sampling during certain weather windows so requiring high sampling efficiency.

Individual BRUVs varied in exact specification between two types and whether they were used for sampling benthic or pelagic habitats, but all followed the same overall structure. Two GoPro Hero video cameras were mounted on a steel frame 80cm apart, with a 4 degree inward rotation on each camera (Santana-Garcon, Newman and Harvey, 2014). A perforated bait bag or can was affixed to a steel arm equidistant from each camera. The bait bag protruded forward so that it was always in the frame of video, such that any fauna attracted by the bait plume would be recorded. BRUVs remain in deployment for a standardised time of 1 or 2 hours, depending on habitat, to allow the bait plume time to disperse and attract more distant fauna through olfactory cues (Santana-Garcon, Newman and Harvey, 2014). Bait consisted of approximately 1kg of sardines, *Clupeidae spp.*, per rig, which were partially mashed to release oils and aromatic compounds during deployment.

All BRUVs used were Stereo-BRUVs. Stereo-BRUVs include two separate cameras recording a set distance apart so that fork length estimates could be made through photogrammetric methods (Harvey and Shortis, 1995). Rigs were calibrated in a calm, clear body of water prior to each expedition to account for variability in exact camera angle and position. Calibration involved recording a cube of known dimensions moving through a range of angles and positions. This video was then imported into CAL software (SeaGIS Pty LTD, 2006a) to produce a calibration file for each camera which was then used when producing photogrammetric measurements of taxa. Before the deployment of each rig, both cameras were synchronised using a large hand clap along the bait arm. Obvious gestures were used for synchronisation to avoid mismatching frames during analysis and so maximise the accuracy of fork length estimates.

2.1.1 Seabed BRUVs

Demersal assemblages were sampled using seabed BRUVs. These consisted of a rig frame which rests on the seafloor for the duration of its deployment. For lighter rigs, 3 legs were used to maintain the stability of the rig and prevent rolling in strong currents. These legs also elevated the cameras, preventing the video being obscured by kelp or macroalgae cover. Large expanses of soft sand were avoided in high swells due to suspended sediment obscuring the view of the camera. Weights were attached to the base of the rig for stability. When necessitated by large swell, The number of weights could be increased to prevent rolling. BRUVs were deployed independently across a range of seabed habitat types and depths ranging from 1-39 metres (*Appendix.1*). Rigs were deployed for a duration of 1 hour from the moment the rig settles on the seafloor. A surface buoy was attached to the top of the BRUVs rig with at least 30 metres of 8mm polypropylene rope to mark the rig's location for later retrieval. When necessitated by large swell, weights were used to stabilise the rig and prevent rolling in strong currents.

2.1.2 Midwater BRUVs

Pelagic environments are devoid of solid surfaces which BRUVs rigs can be affixed to, so rigs are instead allowed to drift for the duration of their deployment. Tracking and retrieving multiple drifting rigs in quick succession is impractical so rigs are placed in a longline formation of 5. Each rig is attached to adjacent rigs by 200 metres of 8mm polypropylene rope to form an 800 metre long string that drifts as a single unit (Thompson et al., 2021). The combined bait plume of a string is larger than that of an individual rig and is more effective at attracting pelagic taxa with sparse or patchy distributions.

Midwater BRUVs were deployed at 10 metres depth by attaching a surface buoy with 10 metres of 8mm polypropylene line. Weights were attached to the base of each rig to stabilise the video frame from the effects of the swell. Midwater strings were deployed for 2 hours from the moment each rig settles at depth. Strings could drift significant distances during this time so a flag with a radio beacon was attached to the end of each string. The approximate direction and distance of a string could then be found using the relative strength of the VHF radio signal for retrieval.

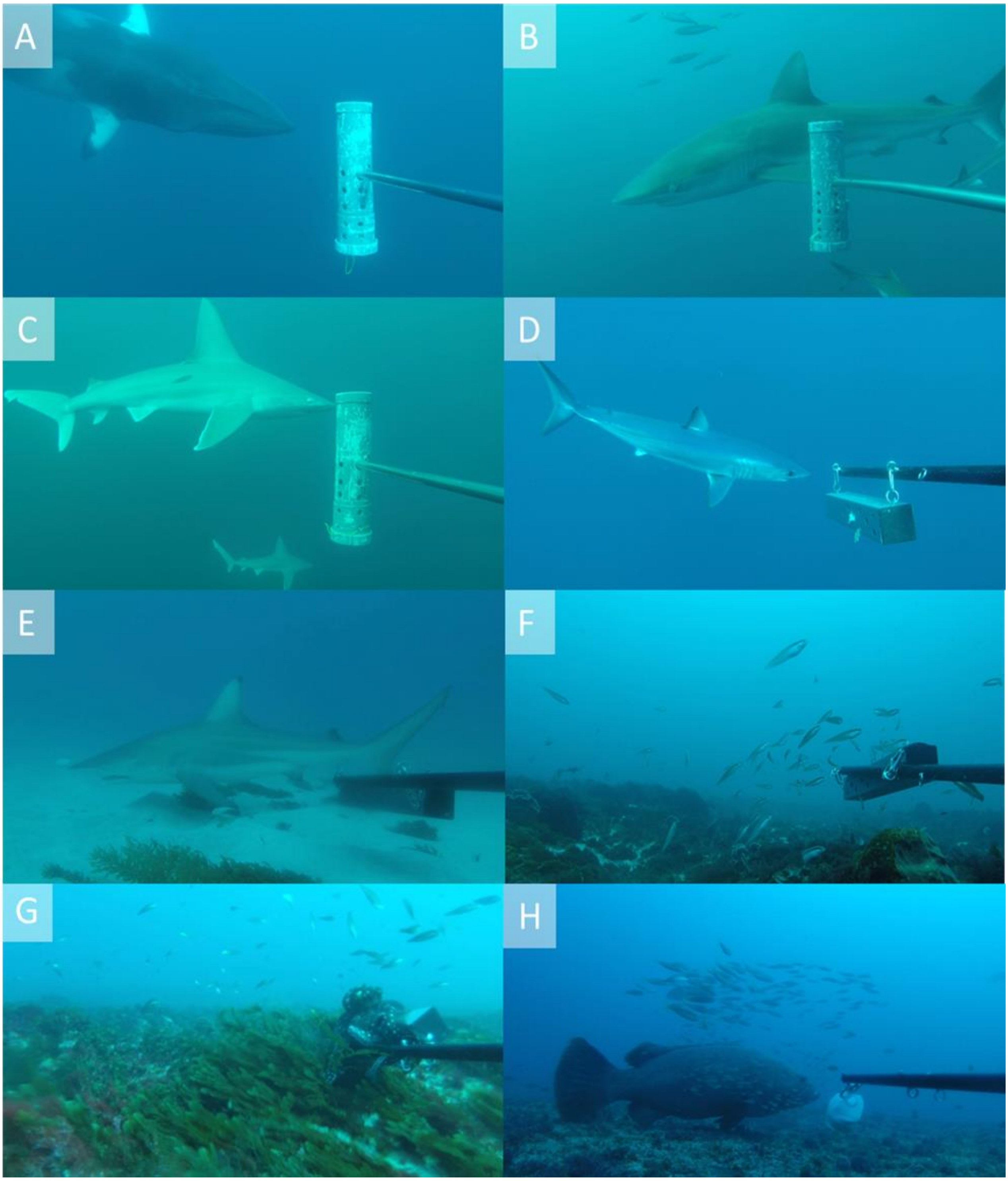


Figure 2. Example images from midwater (**A**-**D**) and seabed (**E**-**H**) BRUVs video showing both rig specifications. Species shown are as follows, **A**. *Balaenoptera acutorostrata*, **B**. *Carcharhinus obscurus*, **C**. *Carcharhinus plumbeus*, **D**. *Isurus oxyrhinchus* juvenile, **E**. *Carcharhinus melanopterus* with fishing hooks in its mouth, **F**. *Coris auricularis*, **G**. *Octopus djinda*, **H**. *Epinephelus lanceolatus*.

2.2 Video Processing

Video was recorded at a resolution of 1080p and frame rate of 60fps before being extracted from cameras in MP4 format post-deployment. MP4 files were later converted to AVI format using Xilisoft Video Converter Ultimate (Xilisoft Corporation,2016). Video files were imported into EventMeasure software from SeaGIS for analysis (SeaGIS Pty LTD, 2006b). The left video of each rig was prioritised for species identification and abundance measurements. In the case that the left video was absent or cloudy due to condensation inside the housing, the right was used.

Each video was watched by an analyst for the duration of its soak time. This was defined as from the point when the rig settles, (either on the seabed or at 10 metres depth), until the full soak time was reached, (1 hour for seabed, 2 hours for midwater). Upon their first appearance, taxa were identified to the lowest possible taxonomic resolution. Abundance was measured by recording the maximum number of a taxa present in a single frame of video, the MaxN. The MaxN provides a conservative estimate of the abundance of each species in each video. All identifications were checked by a second analyst and, if necessary, a third . Once a consensus on each taxa is reached, fork length measurements could be made.

Videos from the left and right side of each rig were loaded into EventMeasure simultaneously and synchronised as closely as the frame rate would allow. 3 dimensional measurements of each taxa were achieved through photogrammetric methods, involving placing two points on both frames corresponding to the desired dimension of the taxon. The majority of fishes were be measured by fork length, from the front of the head to the fork of the caudal fin. Rays, *Batoidea spp.*, were measured by disc width, from one wingtip to the other. Sea turtles, *Cheloniidae spp.* were measured by carapace length. Billfishes, *Istiophoriformes spp.*, were measured to the lower jaw as the length of the upper bill was too variable to be used for biomass calculations. Due to distortion from the camera lens, measurements from the outer edges of the frame were avoided. To ensure the validity and accuracy of fork length estimates, taxa had to be clearly visible in both frames and at an angle no more than 45 degrees to perpendicular from the rig. Certain groups such as sea snakes, *Hydrophidae spp.*, and moray eels, *Muraenidae spp.*, were rarely straight and perpendicular from the camera so, if at all, they were measured at their least sinuous.

2.3 Data Preparation

Species, MaxN and length data were extracted from EventMeasure and subsequently cleaned of unsuitable data points. Firstly, length measurements with a level of precision above 20% of the measured length or an RMS greater than 20mm on either side were deemed too inaccurate. Taxa which could not be identified to any level, either due to poor water clarity or only being present for a few frames of video were excluded. Cetaceans and sea turtles were excluded from length and biomass data due to their size and mass overwhelmingly biasing samples.

Not every individual recorded could be measured due to only appearing on one camera or appearing at too severe an angle from the frame of video to gain an accurate measurement. These practicalities along with necessary exclusions of some length estimates meant that some taxa were left without a length estimate for biomass calculations. Length estimates for these taxa were imported from other sources. Lengths of the taxa from the same string were prioritised, then lengths from the same expedition, from the same location and finally from a larger dataset encompassing locations from across Western Australia. For individuals only identified to a genus or family, the mean of the length estimates from that taxa were used.

Weight was calculated from length estimates using Length-Weight ratios imported from FishBase (Froese and Pauly, 2019) and SeaLifeBase (Palomares and Pauly, 2019). Some species had length-weight ratios which used length measurements other than fork length such as total length. For these species, a length-length ratio from FishBase or SeaLifeBase was first used to obtain an estimate of the desired length type for length-weight calculations. For species with no available length-weight or length-length ratio, the ratio of a closely related species was used. Similarly, for taxa only identified to the genus or family level, ratios for the most commonly observed species were used.

Four univariate metrics were calculated from the BRUVs outputs. Taxonomic richness (TR), Total Abundance (TA), Total Length (TL) and Total Biomass (TB). Richness was calculated as the number of taxa present in each deployment, abundance as the sum of all MaxNs for a deployment. Total length was the sum of the lengths of a taxa multiplied by its MaxN. Length was multiplied by the length weight ratio to give the mass of individual taxa, then multiplied by its MaxN and summed for each deployment to produce total biomass.

As Midwater BRUVs drift in strings of 5 that are 200 metres apart, they cannot be considered statistically independent. Hence, data from midwater deployments was totalled into strings. Abundance per string was calculated as the sum of the mean abundance per deployment.

2.4 Statistical Analysis

Michaelis-Menten species accumulation curves were used to ascertain the proportion of the species pool recorded by our surveys. Smax was used as an estimate of the available species pool and compared to the total species richness for each survey to ensure that there were no significant sampling deficits.

We tested for interannual differences in univariate metrics through Permutational analysis of variance (PERMANOVA) in PRIMER with PERMANOVA+ software (Anderson, 2017). These tests were based on $\log_{10}(x+1)$ transformed Euclidian distance matrices of taxonomic richness, total abundance, total length, and total biomass for both demersal and pelagic communities. Subsequently, pairwise tests between years for each metric and habitats were used to distinguish individual years. Community composition was compared between years using multivariate PERMANOVAs in the same software. These tests were based on Bray-Curtis resemblance matrices of square-root transformed abundance data. Pairwise comparisons of composition were included to ascertain which years were distinctly different. To visualise differences between years, canonical analyses of principal coordinates plots were produced in PRIMER for demersal and pelagic assemblages. These included specific vectors for taxa with a Pearson rank correlation of > 0.3 to identify which species are driving compositional change between years.

3. Results

3.1 Metadata

Surveys took place in Shark Bay across four years, 2017, 2018, 2019 and 2021. A total of 375 midwater BRUVs and 245 seabed BRUVs were deployed during these expeditions. Expeditions took place in either August or September and ranged in length from 6 days in 2017 to 18 days in 2019. Seabed deployments were largely consistent in depth with an overall median of 17 metres. Seabed deployments in 2017 were broadly deeper than in other years, with a median depth of 28 metres. as compared to 19,18 and 17 metres in

2018, 2019 and 2021 respectively. Deployment ranged from 6.35am at the earliest to 16.29pm at the latest. Number of deployments per day was mostly consistent between expeditions with a mean of 16.3 ±1.79 se (standard error) seabed rigs deployed per day and 18.7 ±1.73 se midwater deployments per day across all years. 99.3% of midwater BRUVs and 80.8% of seabed BRUVs deployments produced useable data with the most common reason for exclusion being strong currents tipping rigs.

Table 1a. Metadata summary for midwater BRUVs deployments by expedition. Each string consisted of 5 rigs in a longline formation. Dates are in DD/MM/YYYY format.

Expedition	No. Deployments	No. Strings	Start Date	End Date
Shark Bay 2017	75	15	15/09/2017	21/09/2017
Shark Bay 2018	100	20	06/08/2018	14/08/2018
Shark Bay 2019	100	20	17/09/2019	24/09/2019
Shark Bay 2021	100	20	23/08/2021	26/08/2021

Table 1B. Metadata summary for seabed BRUVs deployments by expedition. Depth is where the rig settles and remains for its soak time. Dates are in DD/MM/YYYY format.

Expedition	No. Deployments	Depth Range (metres)	Start Date	End Date
Shark Bay 2017	40	19 - 37	15/09/2017	20/09/2017
Shark Bay 2018	75	2 - 39	04/08/2018	12/08/2018
Shark Bay 2019	85	4 - 33	09/09/2019	27/09/2019
Shark Bay 2021	45	1 - 35	28/08/2021	30/08/2021

3.2 Sampling effectiveness

Michaelis-Menten species accumulation curves were run for each year and habitat type (table.2). Smax is the estimated available species pool which ranged from 133.92 to 194.6 demersal taxa and 22.69-28.11 pelagic taxa. When compared to the number of species recorded, midwater samples recorded a larger portion of the species pool with a mean of 91.3% ±1.65 se. Seabed BRUVs recorded a mean of 82.2% ±1.33 se of the species pool. Demersal Smax increased from 2017-2019 (133.92-194.6) and subsequently decreased in 2021 to 182.35. Pelagic Smax was more consistent between years, ranging from 22.69 to 28.11, only increasing slighting during 2018. Percentage detection of the species pool was lowest for demersals in 2017 (78.40%) and greatest in 2018 (85.92%). The percentage of the species pool detected in pelagic surveys was more variable, ranging from 88.94% in 2018 to 96.96% in 2019. B is the estimated sampling effort required to detect 50% of the available species pool. Demersal taxa had a slower rate of species acquisition with a mean of

14.3±2.01 se as compared to 3.38±0.59 se for pelagic taxa. The value of B for demersal and pelagic habitats followed similar trends to Smax. Demersal B increased until 2019 (9.8-20.55), then decreased in 2021 (11.91). Pelagic B was mostly consistent (2.08-3.19) apart from 2018 which was noticeably higher (5.06).

Table 2. Table of values from Michaelis-Menten species accumulation curves. Smax is the estimate of the available species pool, B is the sampling effort required to detect 50% of the species pool. No. species is the total taxonomic richness per year, per habitat.

Habitat	Year	Smax	B	No. Species	% Smax Recorded
Demersal	2017	133.92	9.8	105	78.40
	2018	158.28	15.41	136	85.92
	2019	194.6	20.55	160	82.21
	2021	182.35	11.91	150	82.26
Pelagic	2017	25.74	2.08	23	89.36
	2018	28.11	5.06	25	88.94
	2019	22.69	2.75	22	96.96
	2021	24.51	3.19	22	89.76

3.3 Species Recorded

In total, 297 taxa were recorded from 66 families and 147 genre (Appendix 2.). Demersal surveys recorded 272 taxa, 250 of which were exclusively recorded from this habitat. 47 taxa were recorded from pelagic surveys, of which 25 were exclusive. 22,319 individuals were recorded, of which 44.9% were identified to a species level, 33.7% to a genus, 17.9% to a family and 1 individual to an order. 3.4% of individuals were recorded as either unknown or a juvenile fish too young to identify. Individuals identified to a genus level were sometimes indistinguishable between two species. The most common example was *Carcharhinus spp.* Where *Carcharhinus obscurus* and *Carcharhinus brachyurus* were difficult to confidently identify from a distance or in cloudy water so were assigned to a more general taxon. The most abundant families were demersal schooling fishes of the families *Carangidae*, *Labridae*, *Pomacentridae*, and *Caesionidae* with total MaxN's exceeding 1000 individuals. 22 families were represented by 5 or less individuals, with 9 of those being recorded from only a single individual. At least one fork length measurement was obtained for 73.7% of taxa. 24.9% of taxa were only able to be measured only once across all surveys and 26.3% used mean measurements from Western Australia as a whole.

22 taxa were recorded from both demersal and pelagic surveys. Sharks of the family *Carcharhinidae* comprised the greatest number of shared taxa with 6 distinct species and 2

more general classifications, *Carcharhinus spp*., *Carcharhinidae spp*.. Carangid species were also abundant in both habitats, often forming in large schools of *Decapterus spp*. or *Carangidae spp*. Other notable shared taxa included sea snakes, *Elapidae*, Filefishes, *Monocanthidae*, and tuna and mackerel, *Scombridae*. Few of these shared taxa were recorded evenly between both habitats with the 81.8% favouring Pelagic habitats and 13.6% favouring demersal habitats.

Across all four surveys, several notable and rare species were recorded. Multiple juvenile shortfin mako sharks, *Isurus oxyrinchus*, (*Fig.2*,D), were observed from pelagic surveys, with a mean length of 72.39 centimetres between 3 individuals. Minke Whales, *Balaenoptera acutorostrata*, (*Fig.2,*A), were recorded on 8 occasions from pelagic surveys and a single humpback whale was recorded from demersal surveys. 2 species of critically endangered *Rhinidae* were recorded, including *Rhyncobatus australiae*, N=15, and *Rhina ancylostoma*, N=1. Individuals of *Carcharhinus melanopterus* and *Carcharhinus obscurus* were observed from both benthic and pelagic habitats with one or more fishing hooks attached to their mouth (*Fig.2*,E). These individuals typically had deformation of the lower jaw on the side that the hook was fixed.

3.4 Univariate Analyses

The relationship between taxonomic richness and year was significant in both benthic and pelagic habitats (Table 4). Pelagic taxonomic richness decreased overall from 2017 to 2021 and was significantly lower in 2018 (Appendix table 3.). Benthic taxonomic richness showed some variation, being significantly lower in 2019 than other years, but largely stayed consistent. Total abundance varied significantly by year in both benthic and pelagic habitats. Both habitats had a similar pattern of decreasing abundance from 2017 to 2018 which then increased year on year to 2021. This pattern was less severe for benthic assemblages where only 2021 was significantly higher than other years. Pelagic assemblages were significantly different from year to year (Appendix table 3.). Total length and biomass of benthic taxa was very stable between years and did not noticeably vary. Both Total length and biomass of benthic taxa significantly decreased from 2017 to 2021. Total length decreased more gradually than biomass, with a non-significant difference between 2017-2019 and a more dramatic decrease from 2019-2021. Benthic Biomass decreased most dramatically from

2017-2018, then remained largely similar from 2018-2021 with 2021 having the lowest total biomass overall.

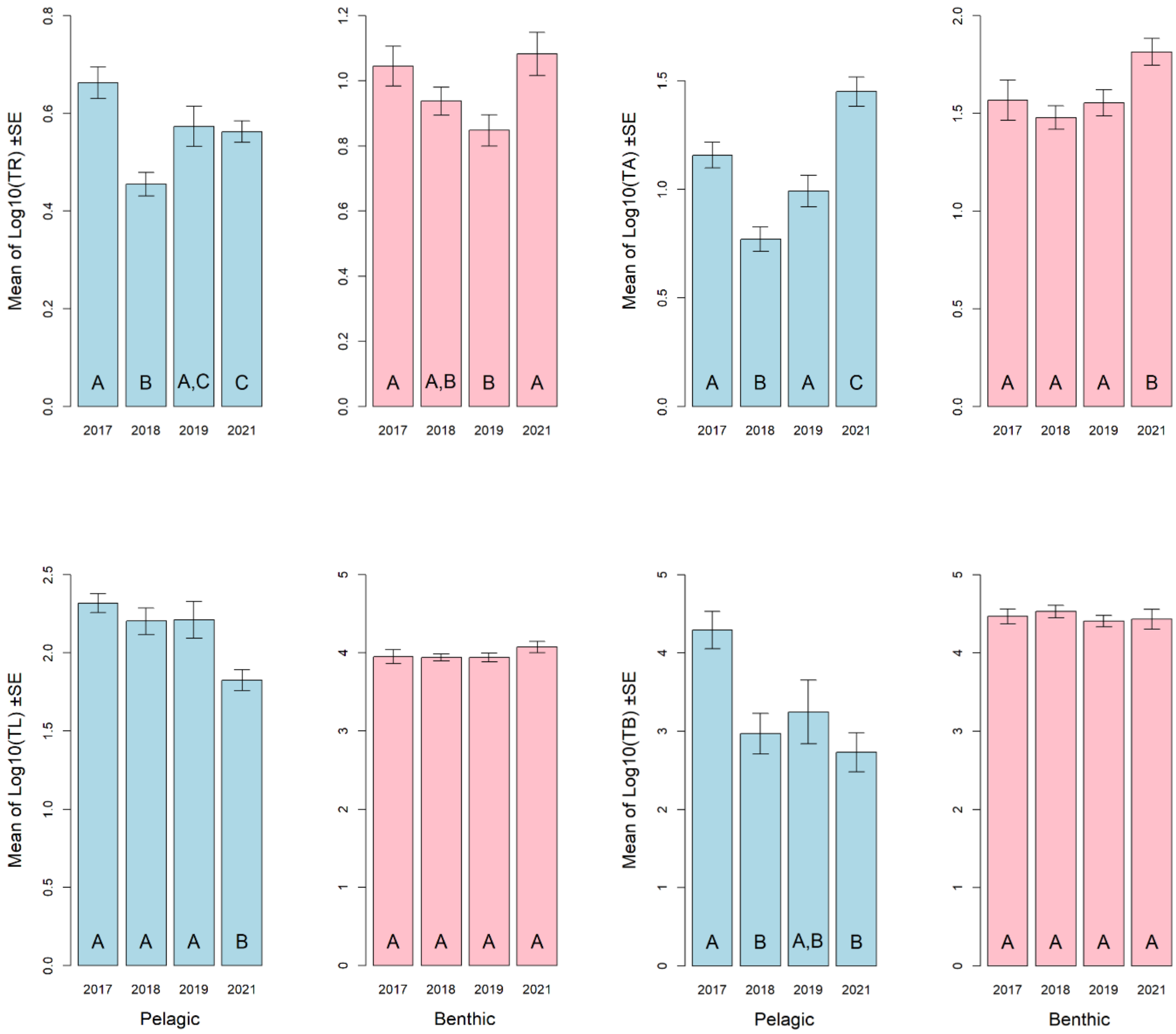


Figure 3. Panel of Mean of log_{10} transformed univariate metrics: Taxonomic richness, total abundance, total fork length and total biomass. Error bars show 1 standard error. Letters signify the results of pairwise PERMANOVAs based on Euclidian distance matrices. Shared letters show lack of significant differences at a p value of <0.05.

Benthic TR

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	1.657	0.55234	3.963	**0.0087**	95507
Residual	194	27.038	0.13937			
Total	197	28.695				

Pelagic TR

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	0.38003	0.12668	7.108	**0.0003**	95507
Residual	71	1.2654	0.017822			
Total	74	1.6454				

Benthic TA

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	2.8605	0.9535	3.7236	**0.0124**	95430
Residual	194	49.677	0.25607			
Total	197	52.538				

Pelagic TA

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	4.8926	1.6309	20.346	**1.00E-05**	95659
Residual	71	5.6912	0.080157			
Total	74	10.584				

Benthic TL

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	0.56039	0.1868	0.99123	0.4007	95583
Residual	194	36.559	0.18845			
Total	197	37.12				

Pelagic TL

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	23.302	7.7674	4.4538	**0.0069**	95642
Residual	71	123.82	1.744			
Total	74	147.13				

Benthic TB

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	0.51999	0.17333	0.4111	0.7466	95474
Residual	194	81.796	0.42163			
Total	197	82.316				

Pelagic TB

Source	df	ss	ms	psuedo-F	P(perm)	Unique perms
Year	3	2.6267	0.87557	6.0104	**0.001**	95703
Residual	71	10.343	0.14568			
Total	74	12.97				

Table 3. Results tables from PERMANOVA analyses to test for significant differences in the four univariate metrics (TR,TA,TL,TB) by year. Significant p values (<0.05) are emboldened.

3.5 Multivariate Analyses

Community composition varied highly significantly between years for both demersal and pelagic assemblages (Table 4a). Pairwise comparisons reveal that each year is compositionally different from one another for both habitat types to below a p value of 0.0001 (Table 4b.). Canonical analysis of principal coordinates (CAP) plots (Figure 4.) for benthic data suggests that 2017 and 2021 were highly distinct from other years, whereas there was a larger overlap between 2018 and 2019. Individual vectors showed strong correlations for smaller schooling fishes such as *Carangidae.spp*, *Caranx.spp*, and *Decapterus spp.* toward 2021. Contrastingly another small schooling fish taxon, *Carangoides*.spp, was found to be far more abundant in 2017 than in other years. Some larger piscivorous fishes such as *Katsuwonus pelamis*, *Istiompax indica* and *Thunnus obesus* were found to be more abundant in 2017 and, to a lesser extent 2018 and 2019. *Carcharhinus obscurus* and *Echeneis naucrates* were often recorded together and had very similar vectors, being more abundant in the first three years, particularly 2018 and 2019. Juvenile fishes were more closely associated with 2018 and 2019. Demersal community composition showed a clear shift, with each year forming a mostly distinct quadrant of the CAP plot. The progression from 2017 to 2021 forms a clockwise circular trend. *Lethrinus miniatus* and, to a lesser extent, *Aspidontus taeniatus* were more abundant in 2017. Some sandflat associated species were more common in 2018, such as *Lagocephalus scleratus*, *Saurida undosquamis* and the critically endangered *Rhyncobatus australiae*. No single taxon was strongly associated with 2019 but *Pagurus auratus* was more abundant in 2019-2021. A large number of taxa were more abundant in 2021 than other years. These include multiple wrasse species, *Anampses geogrpahicus*, *Suezicthys cyanolaemus*, *Labroides dimidiatus*, *Choerodon rubescens*, *Choerodon cauteroma*, larger piscivores, *Carcharhinus limbatus*, *Grammatorcynus bicarinatus*, and smaller benthic species, *Epinephelus rivulatus*, *Parupeneus chrysopleuron*.

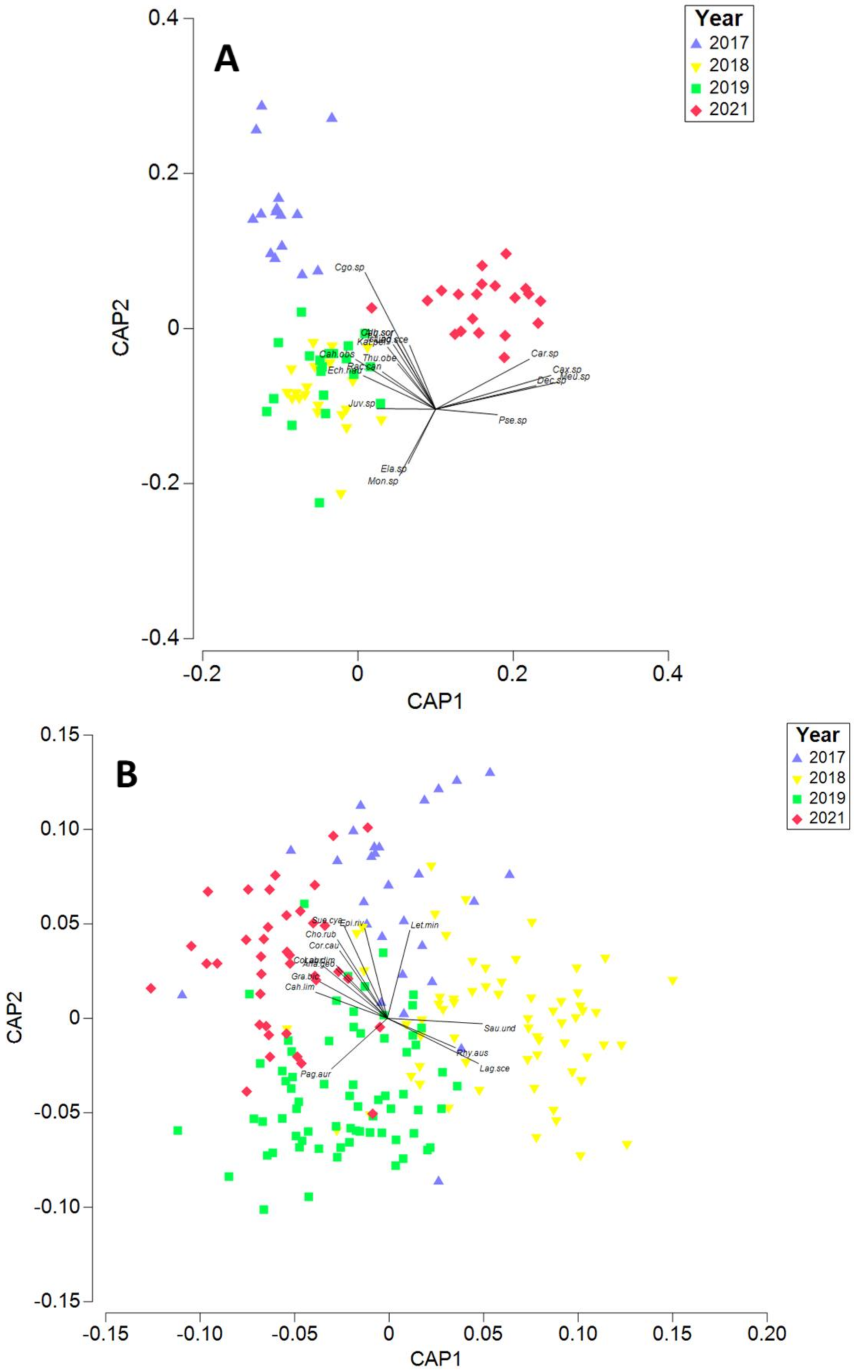


Figure 4. Canonical analysis or principal coordinates (CAP) plots based on Bray-Curtis resemblance matrices of square root transformed data of pelagic (**A**) and demersal (**B**) assemblages. Each data point refers to a single seabed deployment or midwater string. Individual Vectors are shown for taxa with a correlation of greater than 0.3.

Table 4a. Results table from multivariate PERMANOVAs based on Bray-Curtis resemblance matrices of square root transformed data to test for differences in community composition between years. Significant p values (<0.05) are emboldened.

Pelagic

source	df	SS	MS	Psuedo-F	P(perm)	Unique perms
Year	3	60451	20150	16.26	**1.00E-05**	91534
Residual	71	87985	1239.2			
Total	74	1.48E+05				

Benthic

source	df	SS	MS	Psuedo-F	P(perm)	Unique perms
Year	3	57011	19004	5.3339	**1.00E-05**	88027
Residual	194	6.91E+05	3562.9			
Total	197	7.48E+05				

Table 4b. Results table from pairwise multivariate PERMANOVAs based on Bray-Curtis resemblance matrices of square root transformed data to test which years are significantly different in terms community composition. Significant p values (<0.05) are emboldened. The number of unique permutations is included in brackets.

Pairwise Permanova

	2017/18	2017/19	2017/21	2018/19	2018/21	2019/21
Pelagic	**1e-5**(93999)	**1e-5**(94666)	**1e-5**(94832)	**1e-5**(94609)	**1e-5**(94527)	**1e-5**(94675)
Benthic	**1e-4**(92123)	**2e-5**(92105)	**3e-5**(91104)	**1e-5**(92441)	**1e-5**(92082)	**7e-5**(92485)

4. Discussion

Pelagic metrics suggest an increase in human intervention over time through a decrease in biomass and length and increase in abundance. This is consistent with the removal of larger bodied, high trophic level fishes from an ecosystem, driving mean length and biomass down (Pauly et al., 1998). The Concurrent increase in abundance can be explained as a response to the removal of larger individuals. Assuming that trophic level and body mass are correlated in pelagic systems (Ohshimo et al., 2016), reduced predation pressure would allow smaller taxa to become more numerous. Competitive release may also play a minor role, although the lack of fixed territorial boundaries in pelagic habitats makes it unlikely to be a significant mechanism in the shift toward smaller taxa (Dulvy et al., 2004). Multivariate CAP vectors further reinforce this trend as smaller fishes such as *Decapterus spp*., *Caranx spp*. and *Carangidae spp*. are strongly associated with 2021 as compared to other years.

The increase in abundance driven by small fishes was still insufficient to compensate for the loss of biomass from larger taxa. Large recreationally targeted species such as *Istiompax* *indicia* and *Katsuwonus pelamis* were more closely associated with 2017, when biomass was greatest. Some groups such as *Seriola sp*. and *Istiophoridae spp*. were present in 2017-2019 yet absent from 2021. Pelagic species are known to have patchy and uneven distributions (Boyd et al., 2015), but the absence of entire families and genera which were previously present is indicative of a shift in the structure of Shark Bay's pelagic food-webs. Mid-sized fishes such as *Seriola spp.*, *Coryphaena hippurus* and *Katsuwonus pelamis* are prized targets for recreational fishermen. Their absence or lesser abundance in 2021 could be confidently interpreted as their gradual removal from the system. Large pelagic taxa such as *Carcharhinidae spp*. And *Istiophoridae spp.* are occasionally retained by recreational fisherman (Ryan, Lai and Smallwood, 2022), but in insufficient quantities to fully explain their reduced abundances. Scarcity of large pelagic fishes may be primarily due to migration in response to overexploitation of food sources .Pelagic predators are known to aggregate in areas of higher prey density (Benoit-Bird and Au, 2003; Green et al., 2020), so larger pelagics may have migrated elsewhere in response to insufficient prey biomass of medium and small fishes around Shark Bay. The subsequent lack of pelagic predators would offer trophic release of smaller species, allowing for greater abundances but still in reduced biomasses.

Biomass and length of demersal communities was highly stable from 2017 to 2021 despite changes in abundance and richness. One interpretation could be that Shark Bay has sufficient functional redundancy to ensure ecosystem stability despite significant shifts in community composition. This interpretation could be challenged by the relatively low functional redundancy of subtropical (Gilby, Tibbetts and Stevens, 2017) and coral reef (Hoey and Bellwood, 2009) systems in Australia. Many subtropical and tropical species ranges overlap in Shark Bay, as evidenced by our surveys (Appendix Table 2). The resulting community may be more robust than either subtropical or tropical communities due to the presence of multiple functionally similar species at the extremity of their range. Functionally similar species also often occupy similar body sizes (Jacob et al., 2011; Rudolf et al., 2014) allowing total biomass and length metrics to be maintained despite shifts in abundance within functional groups.

Alternatively, stable length and biomass could be a result of sustained fishing efforts in Shark Bay suppressing populations of larger demersals. Demersal fisheries in Shark Bay have been historically overexploited, particularly in the case of snapper, *Pagrus auratus*, (Christensen and Jackson, 2014). Recreational fishing pressure in Shark Bay has been restricted through bag limits and tag lottery systems but these efforts may not be sufficient to allow the recovery of demersal fisheries. In particular, fixed size limits shift pressure on larger individuals and encourage changes in size structure of demersal communities (Moland Olsen et al., 2005; Hsieh et al., 2009) reducing abundances of larger individuals which would disproportionately affect length and biomass. These statistics may, therefore, be artificially stabilised by continued fishing efforts. Sustained fishing efforts may bias composition within functional groups toward less commonly targeted species. Multiple wrasse, *Labridae spp.* were more abundant in 2021 than in other years. Most *Labridae* species are less commonly retained by recreational fisherman (Ryan, Lai and Smallwood, 2022), than other demersal taxa such as *Lethrinus miniatus* and *Pagurus auratus* which were more closely associated with 2017 and 2019 respectively. Increased abundances of wrasses may be due to increased resource availability from the removal of larger demersals. A similar phenomenon has been observed in the Caribbean where moray eels have become more abundant in areas where their competitors are suppressed by fishing pressure (Clementi et al., 2021).

Increased fishing pressure can be inferred from the presence of sharks, *Carcharhinidae spp.,* In 2021 with fishing hooks in their mouths. Individuals of two species were observed with at least one hook present. *Carcharhinus obscurus* in pelagic surveys and *Carcharhinus limbatus* in demersal surveys. Although fishing hooks can lead to mortality (Adams et al., 2014), The presence of 3 separate hooks on one individual of *C.limbatus* suggests that long-term health effects are not significant. Hooks could only be observed in close proximity and good water clarity meaning that not all sharks with hooks will have been recorded as such. A small number of fixed hooks may be due to intentional targeting of sharks by recreational fisherman, but more likely is the retention of hooks from depredation on more desirable species. Depredation from sharks occurs on a large percentage of fishing trips along the Gascoyne coast and is more common in areas of greater fishing pressure (Mitchell et al., 2018). We can infer a greater depredation rate and greater fishing pressure in 2021 than in other years due to the presence of large numbers of fixed fish hooks. Greater depredation rates could also be linked to less prey availability in areas of greater fishing pressure. Suppressed populations of demersal and pelagic fishes may be insufficient to support current shark populations, altering shark behaviour to favour the lesser metabolic demands of depredation rather than active predation.

Fishing pressure in 2021 may have increased due to the COVID-19 pandemic. Early reports from 2020 suggested that recreational fishermen were more active during the pandemic (Ryan et al., 2021), and when movement within Western Australia was once again permitted many fishermen travelled from the Perth Metropolitan Area northward to areas such as Shark Bay. Suggestions of an increase in recreational fishing were further supported by anecdotal evidence (WAIFC, 2020; Birch, 2020; Borrello, 2021) . Our sample area of Steep Point and Dirk Hartog Island is one of the less accessible areas of Shark Bay with 4 wheel drive only access and no sealed boat ramp. Fishermen targeting demersal species may, therefore, find more accessible areas inside the Denham sound or Eastern Gulf. These areas experience smaller swell and weaker currents than those found West of the Southern Passage and Dirk Hartog Island. Historically consistent removal of larger demersal species may also be a factor in discouraging demersal fishing as abundances of target species are insufficient to justify the comparative inaccessibility of the area. Fishermen targeting pelagic species, however, are incentivised to fish around Steep point and Dirk Hartog. Depth in these areas increases rapidly from the shoreline as compared to the sloping gulfs of Shark Bay requiring less fuel expenditure and travel time to access pelagic habitats. The Leeuwin current is also more prevalent on the Western side of Dirk Hartog (Hetzel, Pattiaratchi and Mihanović, 2018), encouraging greater abundance of pelagic species through higher water temperature (Boyce, Tittensor and Worm, 2008) and consistent nutrient input (Lefébure et al., 2013). Progressive degradation of pelagic communities relative to demersal communities around Steep Point and Dirk Hartog may be due to a strong bias in fishermen toward targeting pelagic species in the area.

The presence of certain taxa in both pelagic and benthic habitats imply movement between the two, providing a mechanism for trophic linkages. Of the 22 taxa observed from both midwater and seabed BRUVs, 8 were whaler sharks of the family *Carchirhinidae*. This group is known to utilise both pelagic and demersal habitats (Rogers et al., 2012; Rogers et al., 2013) and feed on taxa that are unique to either habitat (Simpfendorfer, Goodreid and McAuley, 2001). Utilisation of benthic and pelagic habitats may be structured ontogenetically as juveniles are known spend more time in inshore areas (Knip et al., 2011;

Speed et al., 2016), although this may not be true for all species (McAuley et al., 2007). Both regular movement of adults between benthic and pelagic habitats and ontogenetic shifts in habitat preference provide linkages between the two habitats. Benthic-Pelagic linkages arent solely mediated by predatory species. Schools of *Carangidae spp.* were abundant in both habitat types, likely being predated upon and themselves feeding. Benthic Pelagic trophic linkages are known to be an important mechanism for nutrient transfer between systems (Griffiths et al., 2017). In the case of Shark Bay, nutrient flow between benthic and pelagic habitats would increase ecosystem complexity and redundancy. On the contrary, linkages provide an avenue for disturbance in one habitat to have indirect effects in the other, most likely in the behaviour of species that mediate the linkages. Decreasing pelagic biomass and stable benthic biomass could be encouraging shifts in foraging behaviour of predatory species in Shark Bay. Carcharid shark species were more dominant in pelagic systems during 2017 to 2019 and more dominant in benthic systems during 2021. This could be interpreted as the inshore movement of these sharks in response to insufficient prey biomass in pelagic habitats. Through mechanisms such as these, anthropogenic disturbances of pelagic assemblages may produce increased pressure on benthic food webs and vice-versa.

The occurrence of three juvenile shortfin mako sharks, *Isurus oxyrinchus*, suggests the presence of a nearby parturition site. The three individual sharks were measured to be approximately 57.3cm, 100.4cm and 59.5cm in length. This would suggest that the smaller two were young of the month at <70cm and the larger individual born within the last year (Bustamante and Bennett, 2013). Size at birth for this species is often quoted as between 65-70cm (Stevens, 1983; Joung and Hsu, 2005). The occurrence of two individuals of below 60cm emphasises that these sharks were born extremely recently and in close proximity to the study area. This is consistent with previous research suggesting that Western Australia holds a parturition site for this species (Forrest, 2019). Despite being a highly migratory species (Vaudo et al., 2017), whether the smaller two individuals travelled over 500 kilometres from the proposed parturition site of Perth Canyon is currently unclear. Similar submarine canyons such as the Houtman and Zutydorp canyons closer to the study area may be alternate sources for the exceptionally young juveniles. Although further study on the movements of mature females and juveniles would be required to confirm this hypothesis.

Regardless of their source, the occurrence of multiple juvenile shortfin makos West of Steep Point and Dirk Hartog emphasises the significance of this area to vunerable pelagic species.

The presence of large numbers of wedgefishes, *Rhinidae spp.,* demonstrates the importance of Shark Bay as a habitat for vunerable benthic species. 15 individuals of the critically endangered *Rhyncobatus australiae* were recorded in 2017 and 2018. Wedgefishes show a strong preference for shallow coastal waters which overlap with coastal fisheries making them vunerable to bycatch (Kyne et al., 2020). Wedgefishes are further endangered by targeted fishing for the international fin trade where their dorsal fins are highly valued. Their abundance in Shark Bay can be partially explained by the presence of large amounts of their preferred shallow, sandy habitat. The remoteness of the Southern Passage and West Dirk Hartog, particularly for commercial fishing operations, limits pressure from bycatch. Although the targeting of wedgefishes by recreational fishermen is permitted in Western Australia, there are broad bag and size limits which make targeting these species for international trade inviable. Notably, this group was only recorded during 2017 and 2018. This disparity could be influenced by minor biases in seabed sampling locations, but more likely is the migration of *R.australiae* in response to temperature. Shark Bay is near the southernmost extent of wedgefish distribution in Western Australia. Individuals may therefore undertake vertical or horizontal migration to remain in optimal thermal ranges similarly to other large demersal species (Boje et al., 2014; Kessel et al., 2014). Interannual variations in sea surface temperature may be a factor in the absence of *Rhinidae spp.* in 2019 and 2021. Increased recreational fishing pressure may also have affected wedgefish abundance but there is currently insufficient catch data on this species in Western Australia. wedgefish populations are significantly declining (Daly et al., 2020) and the group possesses among the greatest extinction risk of all marine fishes (Kyne et al., 2020). The Status of Shark Bay as a refuge for wedgefishes emphasises the need for specific protection measures to ensure the long-term resilience of the Western Australian population.

The El Niño–Southern Oscillation (ENSO) could have affected marine assemblages through variation in the strength of the Leeuwin current and therefore sea-surface temperatures. The Leeuwin current has been shown to be stronger in La Niña years, increasing sea surface temperatures across Western Australia (Pearce and Phillips, 1988; Feng, 2003; Feng, Waite and Thompson, 2009). Both pelagic and benthic wildlife taxa have been shown to react positively to a stronger Leeuwin current. Large filter feeding species such as whale sharks, *Rhincodon typus*, are more abundant in Western Australia during La Niña years, likely due to increased food availability (Hanson and McKinnon, 2009). The Western Rock Lobster, *Panulirus cygnus*, also shows an affinity for La Niña years as a stronger Leeuwin current results in higher settlement rates in coastal reefs (Pearce and Phillips, 1988). Climate data from 2017 to 2019 is indicative of an extended El Niño period with greatly above average temperatures (Bureau of Meteorology, 2018, 2019, 2020). 2020 and 2021 show a transition to La Niña conditions (Bureau of Meteorology, 2021, 2022). The assumption of a stronger Leeuwin current in 2020-2021 positively impacting marine assemblages is, however, not concordant with the recorded metrics of biomass, length, and pelagic richness. A significant increase in total abundance from 2019 to 2021 may have been related to a stronger Leeuwin current as schooling fishes respond to extreme temperature anomalies in the Eastern Indian Ocean (Puspasari, Rachmawati and Muawanah, 2019). These taxa respond most dramatically though their spawning effort, with different species having different thermal optima (Hamza, Valsala and Varikoden, 2022). Although any effects on the abundance of these species through the mechanism of spawning won't be observed for 1-3 years following a temperature anomaly. Furthermore, increased abundance accompanied by decreasing biomass would appear paradoxical if the strength of the Leeuwin current were indeed a dominant driver in this case. Environmental effects on marine assemblages in Shark Bay may be highly species specific as in the case of schooling fishes and partially explain interannual shifts in composition. However, species specific data on interactions with the Leeuwin current strength are currently insufficient to lend credibility to climatic factors as the major driver of compositional change.

The Shark Bay World Heritage Area shows clear evidence of human disturbance in its unprotected pelagic habitat. The progressive degradation of pelagic assemblages to favour small abundant taxa suggests that recreational fishing pressure is the primary driver of interannual change around Steep point and West Dirk Hartog Island. This is supported by significant shifts in pelagic community composition that suggest a decrease in the abundance of some larger piscivores. Lack of any specific protections and continually increasing accessibility predicts no sign of respite for these areas. The COVID-19 pandemic seemingly exacerbated this trend with an influx of fishermen from elsewhere in Western

Australia supplementing the consistent local fishing effort. Demersal assemblages did not show the same patterns, with more consistent univariate metrics suggesting greater overall stability. The comparative stability of demersal assemblages could be due to the remoteness of West Dirk Hartog and the Zutydorp cliffs discouraging fishing of demersal species which are more easily accessed elsewhere. In the case of more highly desirable species such as snapper, size structure may be artificially truncated by recreational size limits leading to a strong bias toward certain size classes and the appearance of overall stability. Despite consistency in univariate metrics, demersal community composition changed significantly between years. A consistent trend was not entirely clear, although the abundance of less desirable *Labridae* species in more recent years could be due to anthropogenic factors. Either directly by increased fishing pressure on demersal species, or indirectly through a shift in the foraging habits of pelagic piscivores to favour specific demersal prey. Alternatively, The ENSO could be a more major driver of demersal composition, leading to more species-specific trends which would be more difficult to identify.

Michaelis-Menten species accumulation curves showed that BRUVs had a high effectiveness at sampling the available species pool. Despite some disparity in the number of deployments between years, the percentage of the species pool that were recorded at least once remained above 78.4% for demersal surveys and 88.9% for pelagic surveys. Some practical limitations of BRUVs remain, however. Small cryptic species were less likely to be recorded, although these taxa generally contribute less to biomass and length totals, so their omission is unlikely to significantly affect overall trends. A number of seabed BRUVs deployments had to be omitted from analysis due to tipping in rough sea conditions. Although still detrimental, the sampling effectiveness for each survey remained high enough to limit any effect the loss of these deployments would've had on the dataset. The practicalities of using photogrammetric methods for length estimates meant than mean lengths or lengths from alternate individuals had to be used in many cases. The realities of video quality and position of fishes mean that this is a necessity for calculating total length and biomass. The majority of examples where this was necessary, however, were in the cases of large schools of individuals with similar body sizes. For these individuals a mean based on a sample of at least 20% of the school is unlikely to differ greatly from the actual size of the fishes.

Especially in proportion to the inaccuracies inherent in using photogrammetric methods in poor visibility.

This project presents many opportunities for further research. Primarily, the reasons for such stability in the demersal communities of Shark Bay is as yet unclear. Use of a greater number of seabed BRUVs across a range of sites in the interior of Shark Bay could give a broader view of how communities change across wider spatial scales. Further, the acquisition of accurate data on recreational fishing activity, particularly around Steep point and Dirk Hartog Island would provide clarity on the extent to which fishing pressure is a driver of demersal assemblages in the West of Shark Bay. As described, species specific data on interannual responses to the relative strength of the Leeuwin current is currently lacking. Long-term datasets on the abundance and movements of several key groups would be instrumental in understanding compositional change in response to large-scale environmental factors. The presence of juvenile shortfin mako sharks warrants further study. Given the extremely small size of these individuals, a nearby parturition site is likely. Recently developed birth alert tags (BATs) (Sulikowski and Hammerschlag, 2023) could be utilised on large pregnant mako sharks to determine the exact timing and location of the parturition site. Although this presents its own logistical challenges.

the lack of formal protections for all pelagic and most demersal habitats exposes the study area to the risks of increased accessibility. Pelagic habitats show evidence of community wide effects from excessive fishing pressure and would benefit from the management consideration alongside the interior gulfs of Shark Bay. Furthermore, the strong presence of vunerable species such as wedgefishes and a juvenile shortfin mako sharks emphasises the need for species-specific protections to solidify The Shark Bay World Heritage Area as a refuge for these species. In accordance with Australia's commitment to the 30 by 30 biodiversity agreement, West Dirk Hartog Island down to the Zutydorp cliffs stands as a strong and necessary candidate for legislative protections to ensure the long-term stability and recovery of its marine communities.

References

Adams, D.H., Borucinska, J.D., Maillett, K., Whitburn, K. and Sander, T.E. (2014). Mortality due to a retained circle hook in a longfin mako shark Isurus paucus (Guitart-Manday). *Journal of Fish Diseases*, 38(7), pp.621–628. doi:https://doi.org/10.1111/jfd.12277.

Anson, J.R., Dickman, C.R., Boonstra, R. and Jessop, T.S. (2013). Stress Triangle: Do Introduced Predators Exert Indirect Costs on Native Predators and Prey? *PLoS ONE*, 8(4), p.e60916. doi:https://doi.org/10.1371/journal.pone.0060916.

Anderson, M. J. (2017). Permutational Multivariate Analysis of Variance (PERMANOVA), in Wiley StatsRef: Statistics Reference Online (Chichester, UK: John Wiley & Sons, Ltd), 1–15. doi:10.1002/9781118445112.stat07841.

Bureau of Meteorology, Australian Government (2018). *Annual climate statement 2017*. [online] Bom.gov.au. Available at: http://www.bom.gov.au/climate/current/annual/aus/2017/.

Bureau of Meteorology, Australian Government (2019). *Annual Australian Climate Statement 2018*. [online] www.bom.gov.au. Available at: http://www.bom.gov.au/climate/current/annual/aus/2018/.

Bureau of Meteorology, Australian Government (2020). *Annual Australian Climate Statement 2019*. [online] www.bom.gov.au. Available at: http://www.bom.gov.au/climate/current/annual/aus/2019/.

Bureau of Meteorology, Australian Government (2021). *Annual climate statement 2020*. [online] Bom.gov.au. Available at: http://www.bom.gov.au/climate/current/annual/aus/2020/.

Bureau of Meteorology, Australian Government (2022). *Annual Statement 2021*. [online] Bom.gov.au. Available at: http://www.bom.gov.au/climate/current/annual/aus/2021/.

Benoit-Bird, K.J. and Au, W.W.L. (2003). Prey dynamics affect foraging by a pelagic predator (Stenella longirostris) over a range of spatial and temporal scales. *Behavioral Ecology and Sociobiology*, 53(6), pp.364–373. doi:https://doi.org/10.1007/s00265-003-0585-4.

Birch, L. (2020). *'Wheelie bins of waste': Shark Bay tourists 'taking too many fish'*. [online] www.abc.net.au. Available at: https://www.abc.net.au/news/2020-09-02/overfishing-at-shark-bay-western-australia/12611964.

Boje, J., Neuenfeldt, S., Sparrevohn, C., Eigaard, O. and Behrens, J. (2014). Seasonal migration, vertical activity, and winter temperature experience of Greenland halibut Reinhardtius hippoglossoides in West Greenland waters. *Marine Ecology Progress Series*, 508, pp.211–222. doi:https://doi.org/10.3354/meps10874.

Borrello, eliza (2021). For fishers, pink snapper are jewels of the ocean. But there are fears COVID-19 is making them too rare. *ABC News*. [online] 14 Aug. Available at: https://www.abc.net.au/news/rural/2021-08-14/fears-covid-19-is-making-pink-snapper-too-rare/100369750 [Accessed 26 Jun. 2023].

Boyce, D., Tittensor, D. and Worm, B. (2008). Effects of temperature on global patterns of tuna and billfish richness. *Marine Ecology Progress Series*, 355, pp.267–276. doi:https://doi.org/10.3354/meps07237.

Boyd, C., Mathieu Woillez, Bertrand, S., Castillo, R., Bertrand A and Punt, A.E. (2015). Bayesian posterior prediction of the patchy spatial distributions of small pelagic fish in regions of suitable habitat. *Canadian Journal of Fisheries and Aquatic Sciences*, 72(2), pp.290–303. doi:https://doi.org/10.1139/cjfas-2014-0234.

Bustamante, C. and Bennett, M.B. (2013). Insights into the reproductive biology and fisheries of two commercially exploited species, shortfin mako (Isurus oxyrinchus) and blue shark (Prionace glauca), in the south-east Pacific Ocean. *Fisheries Research*, 143, pp.174–183. doi:https://doi.org/10.1016/j.fishres.2013.02.007.

Cappo, M., Harvey, E.S. and Shortis, M.R. (2007). Counting and measuring fish with baited video techniques - an overview. *Australian Society for Fish Biology*.

Caputi, N., Fletcher, W., Pearce, A. and Chubb, C. (1996). Effect of the Leeuwin Current on the Recruitment of Fish and Invertebrates along the Western Australian Coast. *Marine and Freshwater Research*, 47(2), p.147. doi:https://doi.org/10.1071/mf9960147.

Christensen, J. and Jackson, G.L. (2014). Shark Bay Snapper: Science, Policy, and the Decline and Recovery of a Marine Recreational Fishery. *Historical Perspectives of Fisheries Exploitation in the Indo-Pacific*, 12, pp.251–268. doi:https://doi.org/10.1007/978-94-017-8727-7_13.

Christensen, J. and Jones, R. (2020). World Heritage and local change: Conflict, transformation and scale at Shark Bay, Western Australia. *Journal of Rural Studies*, 74, pp.235–243. doi:https://doi.org/10.1016/j.jrurstud.2019.11.017.

Clementi, G.M., Bakker, J., Flowers, K.I., Postaire, B.D., Babcock, E.A., Bond, M.E., Buddo, D., Cardeñosa, D., Currey-Randall, L.M., Goetze, J.S., Harvey, E.S., Heupel, M., Kiszka, J.J., Kyne, F., MacNeil, M.A., Meekan, M.G., Rees, M.J., Simpfendorfer, C.A., Speed, C.W. and Heithaus, M.R. (2021). Moray eels are more common on coral reefs subject to higher human pressure in the greater Caribbean. *iScience*, [online] 24(3), p.102097. doi:https://doi.org/10.1016/j.isci.2021.102097.

Constanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Sutton, P. and van den Belt, M. (1997). The value of the world's ecosystem services and natural capital . *Nature*, 387, pp.253–260. doi:https://doi.org/10.1038/387253a0.

Daly, R.C., Parker, D., Cliff, G., Jordaan, G.L., Nkabi Nomfundo, Bennett, R.H. and Mann, B.L. (2020). Long-term catch trends and risk assessment of the Critically Endangered white-spotted wedgefish (*Rhynchobatus djiddensis*) from South Africa. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31(4), pp.777–788. doi:https://doi.org/10.1002/aqc.3483.

Dinerstein, E., Vynne, C., Sala, E., Joshi, A.R., Fernando, S., Lovejoy, T.E., Mayorga, J., Olson, D., Asner, G.P., Baillie, J.E.M., Burgess, N.D., Burkart, K., Noss, R.F., Zhang, Y.P., Baccini, A., Birch, T., Hahn, N., Joppa, L.N. and

Wikramanayake, E. (2019). A Global Deal For Nature: Guiding principles, milestones, and targets. *Science Advances*, [online] 5(4), p.eaaw2869. doi:https://doi.org/10.1126/sciadv.aaw2869.

Dulvy, N.K., Polunin, N.V., Mill, A.C. and Graham, N.A. (2004). Size structural change in lightly exploited coral reef fish communities: evidence for weak indirect effects. *Canadian Journal of Fisheries and Aquatic Sciences*, 61(3), pp.466–475. doi:https://doi.org/10.1139/f03-169.

Fairclough, D., Ayvazian, S. and Newman, S. (2022). Complementary evidence for small-scale spatial assemblages of the exploited grass emperor (Lethrinus laticaudis) in the Shark Bay World Heritage Area, Western Australia. *Marine Environmental Research*, 173. doi:https://doi.org/10.1016/j.marenvres.2021.105543.

Fairclough, D.V. (2021). *2021 assessment of the status of the West Coast Demersal Scalefish resource*. Perth, WA, WA: Department of Primary Industries and Regional Development.

Feng, M. (2003). Annual and interannual variations of the Leeuwin Current at 32°S. *Journal of Geophysical Research*, 108(C11). doi:https://doi.org/10.1029/2002jc001763.

Feng, M., Waite, A. and Thompson, P. (2009). Climate variability and ocean production in the Leeuwin Current system off the west coast of Western Australia. *Journal of the Royal Society of Western Australia*, 92, pp.67–81.

Ferrier-Pages, C., Witting, J., Tambutte, E. and Sebens, K.P. (2003). Effect of natural zooplankton feeding on the tissue and skeletal growth of the scleractinian coral Stylophora pistillata. *Coral Reefs*, 22(3), pp.229–240. doi:https://doi.org/10.1007/s00338-003-0312-7.

Field, C.B. (1998). Primary Production of the Biosphere: Integrating Terrestrial and Oceanic Components. *Science*, 281(5374), pp.237–240. doi:https://doi.org/10.1126/science.281.5374.237.

Forrest, A. (2019). Pelagic Ecology and Solutions For a Troubled Ocean, PhD Thesis [Unpublished]. University of Western Australia. Available at: https://doi.org/10.26182/5df9bd625f2a1

Froese, R., and Pauly, D. (2019). FishBase. FishBase. Available at: www.fishbase.org.

Gilby, B.L., Tibbetts, I.R. and Stevens, T. (2017). Low functional redundancy and high variability in Sargassum browsing fish populations in a subtropical reef system. *Marine and Freshwater Research*, 68(2), p.331. doi:https://doi.org/10.1071/mf15386.

Gjerde, K.M., Harden-Davies, H. and Hassanali, K. (2022). High seas treaty within reach. *Science*, 377(6612), pp.1241–1241. doi:https://doi.org/10.1126/science.ade8437.

Green, D.B., Bestley, S., Rowan Trebilco, Corney, S., Lehodey, P., McMahon, C., Christophe Guinet and Hindell, M.A. (2020). Modelled mid-trophic pelagic prey fields improve understanding of marine predator foraging behaviour. *Ecograpahy*, 43(7), pp.1014–1026. doi:https://doi.org/10.1111/ecog.04939.

Griffiths, J.R., Kadin, M., Nascimento, F.J.A., Tamelander, T., Törnroos, A., Bonaglia, S., Bonsdorff, E., Brüchert, V., Gårdmark, A., Järnström, M., Kotta, J., Lindegren, M., Nordström, M.C., Norkko, A., Olsson, J., Weigel, B., Žydelis, R., Blenckner, T., Niiranen, S. and Winder, M. (2017). The importance of benthic-pelagic coupling for marine ecosystem functioning in a changing world. *Global Change Biology*, 23(6), pp.2179–2196. doi:https://doi.org/10.1111/gcb.13642.

Hamza, F., Valsala, V. and Varikoden, H. (2022). The puzzle of the anchovy–sardine inverse fishery at the south-eastern coast of the Arabian Sea and climate variability. *Fish and Fisheries*, 23(5), pp.1025–1038. doi:https://doi.org/10.1111/faf.12667.

Hanson, C. and McKinnon, A. (2009). Pelagic ecology of the Ningaloo region, Western Australia: influence of the Leeuwin Current. *Journal of the Royal Society of Western Australia*, 92, pp.129–137.

Harvey, E. and Shortis, M. (1995). A System for Stereo-Video Measurement of Sub-Tidal Organisms. *Marine Technology Society Journal*, 29.

Heithaus, M.R., Wirsing, A.J., Dill, L.M. and Heithaus, L.I. (2007). Long-term movements of tiger sharks satellite-tagged in Shark Bay, Western Australia. *Marine Biology*, 151(4), pp.1455–1461. doi:https://doi.org/10.1007/s00227-006-0583-y.

Hetzel, Y., Pattiaratchi, C. and Mihanović, H. (2018). Exchange Flow Variability between Hypersaline Shark Bay and the Ocean. *Journal of Marine Science and Engineering*, 6(2), p.65. doi:https://doi.org/10.3390/jmse6020065.

Hetzel, Y., Pattiaratchi, C. and Lowe, R. (2013). Intermittent dense water outflows under variable tidal forcing in Shark Bay, Western Australia. *Continental Shelf Research*, 66, pp. 36–48. Available at: https://doi.org/10.1016/j.csr.2013.06.015.

Hetzel, Y., Pattiarachti, C. and Lowe, R. (2015). Wind and tidal mixing controls on stratification and dense water outflows in a large Hypersaline Bay. *Journal of Geophysical Research: Oceans*, 120(9), pp. 6034–6056. Available at: https://doi.org/10.1002/2015jc010733.

Hoey, A.S. and Bellwood, D.R. (2009). Limited Functional Redundancy in a High Diversity System: Single Species Dominates Key Ecological Process on Coral Reefs. *Ecosystems*, 12(8), pp.1316–1328. doi:https://doi.org/10.1007/s10021-009-9291-z.

Hsieh, C., Yamauchi, A., Nakazawa, T. and Wang, W.-F. (2009). Fishing effects on age and spatial structures undermine population stability of fishes. *Aquatic Sciences*, 72(2), pp.165–178. doi:https://doi.org/10.1007/s00027-009-0122-2.

Jacob, U., Thierry, A., Brose, U., Arntz, W., Berg, S., Brey, T., Fetzer, I., Jonsson, T., Mintenbeck, K., Möllmann, C., Petchy, O., Riede, J. and Dunne, J. (2011). The Role of Body Size in Complex Food Webs: A Cold Case. *Advances in Ecological Research*, 45, pp.181–223. doi:https://doi.org/10.1016/B978-0-12-386475-8.00005-8.

Joung, S.-J. and Hsu, H.-H. (2005). Reproduction and Embryonic Development of the Shortfin Mako, Isurus oxyrinchus in the Northwestern Pacific. *Zoological Studies Taipei*, 44(4), pp.487–496.

Kessel, S., Chapman, D., Franks, B., Gedamke, T., Gruber, S., Newman, J., White, E. and Perkins, R. (2014). Predictable temperature-regulated residency, movement and migration in a large, highly mobile marine predator (Negaprion brevirostris). *Marine Ecology Progress Series*, 514, pp.175–190. doi:https://doi.org/10.3354/meps10966.

Kirby, R., Beaugrand, G., Lindley, J., Richardson, A., Edwards, M. and Reid, P. (2007). Climate effects and benthic?pelagic coupling in the North Sea. *Marine Ecology Progress Series*, 330, pp.31–38. doi:https://doi.org/10.3354/meps330031.

Knip, D., Heupel, M., Simpfendorfer, C., Tobin, A. and Moloney, J. (2011). Ontogenetic shifts in movement and habitat use of juvenile pigeye sharks Carcharhinus amboinensis in a tropical nearshore region. *Marine Ecology Progress Series*, 425, pp.233–246. doi:https://doi.org/10.3354/meps09006.

Koslow, J.A., Pesant, S., Feng, M., Pearce, A., Fearns, P., Moore, T., Matear, R. and Waite, A. (2008). The effect of the Leeuwin Current on phytoplankton biomass and production off Southwestern Australia. *Journal of Geophysical Research*, 113(C7). doi:https://doi.org/10.1029/2007jc004102.

Kyne, P.M., Jabado, R.W., Rigby, C.L., Dharmadi, Gore, M.A., Pollock, C.M., Herman, K.B., Cheok, J., Ebert, D.A., Simpfendorfer, C.A. and Dulvy, N.K. (2020). The thin edge of the wedge: Extremely high extinction risk in wedgefishes and giant guitarfishes. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 30(7). doi:https://doi.org/10.1002/aqc.3331.

Lefébure, R., Degerman, R., Andersson, A., Larsson, S., Eriksson, L-O., Båmstedt, U. and Byström, P. (2013). Impacts of elevated terrestrial nutrient loads and temperature on pelagic food-web efficiency and fish production. *Global Change Biology*, 19(5), pp.1358–1372. doi:https://doi.org/10.1111/gcb.12134.

Lesser, M.P. (2006). Benthic–pelagic coupling on coral reefs: Feeding and growth of Caribbean sponges. *Journal of Experimental Marine Biology and Ecology*, 328(2), pp.277–288. doi:https://doi.org/10.1016/j.jembe.2005.07.010.

Marcus, N.H. and Marcus, N.H. (1998). Minireview: The importance of benthic-pelagic coupling and the forgotten role of life cycles in coastal aquatic systems. *Limnology and Oceanography*, 43(5), pp.763–768. doi:https://doi.org/10.4319/lo.1998.43.5.0763.

McAuley, R.B., Simpfendorfer, C.A., Hyndes, G.A. and Lenanton, R.C.J. (2007). Distribution and reproductive biology of the sandbar shark, Carcharhinus plumbeus (Nardo), in Western Australian waters. *Marine and Freshwater Research*, 58(1), p.116. doi:https://doi.org/10.1071/mf05234.

Mitchell, J., McLean, D., Collin, S., Taylor, S., Jackson, G., Fisher, R. and Langlois, T. (2018). Quantifying shark depredation in a recreational fishery in the Ningaloo Marine Park and Exmouth Gulf, Western Australia. *Marine Ecology Progress Series*, [online] 587, pp.141–157. doi:https://doi.org/10.3354/meps12412.

Mitchell, M.D. and Harborne, A.R. (2020). Non-consumptive effects in fish predator–prey interactions on coral reefs. *Coral Reefs*, 39. doi:https://doi.org/10.1007/s00338-020-01920-y.

Moland Olsen, E., Lilly, G.R., Heino, M., Joanne Morgan, M., Brattey, J. and Dieckmann, U. (2005). Assessing changes in age and size at maturation in collapsing populations of Atlantic cod (Gadus morhua). *Canadian Journal of Fisheries and Aquatic Sciences*, 62(4). doi:https://doi.org/10.1139/f05-065.

Moore, A. (2017). Are guitarfishes the next sawfishes? Extinction risk and an urgent call for conservation action. *Endangered Species Research*, 34, pp.75–88. doi:https://doi.org/10.3354/esr00830.

Nahas, E.L., Jackson, G., Pattiaratchi, C. and Ivey, G. (2003). Hydrodynamic modelling of Snapper Pagrus auratus egg and larval dispersal in Shark Bay, Western Australia: Reproductive isolation at a fine spatial scale. *Marine Ecology Progress Series*, 265, pp. 213–226. Available at: https://doi.org/10.3354/meps265213.

Naumann, M., Richter, C., el-Zibdah, M. and Wild, C. (2009). Coral mucus as an efficient trap for picoplanktonic cyanobacteria: implications for pelagic–benthic coupling in the reef ecosystem. *Marine Ecology Progress Series*, 385, pp.65–76. doi:https://doi.org/10.3354/meps08073.

O'Leary, B.C., Winther-Janson, M., Bainbridge, J.M., Aitken, J., Hawkins, J.P. and Roberts, C.M. (2016). Effective Coverage Targets for Ocean Protection. *Conservation Letters*, 9(6), pp.398–404. doi:https://doi.org/10.1111/conl.12247.

Ohshimo, S., Tanaka, H., Nishiuchi, K. and Yasuda, T. (2016). Trophic positions and predator–prey mass ratio of the pelagic food web in the East China Sea and Sea of Japan. *Marine and Freshwater Research*, 67(11), p.1692. doi:https://doi.org/10.1071/mf15115.

Palomares, M. L. D., and Pauly, D. (2019). SeaLifeBase. SeaLifeBase. Available at: www.sealifebase.org

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. and Torres , F. (1998). Fishing Down Marine Food Webs. *Science*, 279(5352), pp.860–863. doi:https://doi.org/10.1126/science.279.5352.860.

Pauly, D., Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R. and Zeller, D. (2002). Towards sustainability in world fisheries. *Nature*, [online] 418(6898), pp.689–695. doi:https://doi.org/10.1038/nature01017.

Pearce, A.F. and Phillips, B.F. (1988). ENSO events, the Leeuwin Current, and larval recruitment of the western rock lobster. *ICES Journal of Marine Science*, 45(1), pp.13–21. doi:https://doi.org/10.1093/icesjms/45.1.13.

Phillips, J. and Huisman, J. (2009). Influence of the Leeuwin Current on the marine flora of the Houtman Abrolhos. *Journal of the Royal Society of Western Australia*, 92(2), pp.139–146.

Pile, A.J. and Young, C.M. (2006). The natural diet of a hexactinellid sponge: Benthic–pelagic coupling in a deep-sea microbial food web. *Deep Sea Research Part I: Oceanographic Research Papers*, 53(7), pp.1148–1156. doi:https://doi.org/10.1016/j.dsr.2006.03.008.

Porter, E., Cornwell, J. and Sanford, L. (2004). Effect of oysters Crassostrea virginica and bottom shear velocity on benthic-pelagic coupling and estuarine water quality. *Marine Ecology Progress Series*, 271, pp.61–75. doi:https://doi.org/10.3354/meps271061.

Preciado, I., Velasco, F. and Olaso, I. (2008). The role of pelagic fish as forage for the demersal fish community in the southern Bay of Biscay. *Journal of Marine Systems*, 72(1-4), pp.407–417. doi:https://doi.org/10.1016/j.jmarsys.2007.04.007.

Puspasari, R., Rachmawati, P.F. and Muawanah, U. (2019). Climate variability impact on Bali sardine fishery: Ecology and fisheries perspective. *Fisheries Management and Ecology*, 26(6), pp.540–547. doi:https://doi.org/10.1111/fme.12374.

Rajesh, K.M., Rohit, P., Thomas, S., Suprabha, V., Nataraja, G.D. and Sampathkumar, G. (2017). Food and feeding habits of the narrow barred Spanish mackerel, Scomberomorus commerson (Lacepede, 1800) off Karnataka, south-west coast of India. *Indian Journal of Fisheries*, 64. doi:https://doi.org/10.21077/ijf.2017.64.special-issue.76262-26.

Ricci, P., Carlucci, R., Capezzuto, F., Carluccio, A., Cipriano, G., Gianfranco D'Onghia, Maiorano, P., Sion, L., Tursi, A. and Libralato, S. (2022). Contribution of Intermediate and High Trophic Level Species to Benthic-Pelagic Coupling: Insights From Modelling Analysis. *Frontiers in Marine Science*, 9. doi:https://doi.org/10.3389/fmars.2022.887464.

Roff, G., Brown, C.J., Priest, M.A. and Mumby, P.J. (2018). Decline of coastal apex shark populations over the past half century. *Communications Biology*, [online] 1(1). doi:https://doi.org/10.1038/s42003-018-0233-1.

Rogers, P.J., Huveneers, C., Goldsworthy, S.D., Cheung, W.W.L., Jones, G.K., Mitchell, J.G. and Seuront, L. (2013). Population metrics and movement of two sympatric carcharhinids: a comparison of the vulnerability of pelagic sharks of the southern Australian gulfs and shelves. *Marine and Freshwater Research*, 64(1), p.20. doi:https://doi.org/10.1071/mf11234.

Rogers, P.J., Huveneers, C., Goldsworthy, S.D., Mitchell, J.G. and Seuront, L. (2012). Broad-scale movements and pelagic habitat of the dusky shark Carcharhinus obscurus off Southern Australia determined using pop-up satellite archival tags. *Fisheries Oceanography*, 22(2), pp.102–112. doi:https://doi.org/10.1111/fog.12009.

Rudolf, V.H.W., Rasmussen, N.L., Dibble, C.J. and Van Allen, B.G. (2014). Resolving the roles of body size and species identity in driving functional diversity. *Proceedings of the Royal Society B: Biological Sciences*, 281(1781), p.20133203. doi:https://doi.org/10.1098/rspb.2013.3203.

Ruppert, J.L.W., Travers, M.J., Smith, L.L., Fortin, M.-J. and Meekan, M.G. (2013). Caught in the Middle: Combined Impacts of Shark Removal and Coral Loss on the Fish Communities of Coral Reefs. *PLoS ONE*, 8(9), p.e74648. doi:https://doi.org/10.1371/journal.pone.0074648.

Ryan, K.L., Desfosses, C.J., Denham, A.M., Taylor, S.M. and Jackson, G. (2021). Initial insights on the impact of COVID-19 on boat-based recreational fishing in Western Australia. *Marine Policy*, 132, p.104646. doi:https://doi.org/10.1016/j.marpol.2021.104646.

Ryan, K.L., Lai, E.K.M. and Smallwood, C.B. (2022). *Boat-based recreational fishing in Western Australia 2020/21*. [online] Available at: https://www.fish.wa.gov.au/Documents/research_reports/frr327.pdf [Accessed 29 May 2023].

Santana-Garcon, J., Newman, S.J. and Harvey, E.S. (2014). Development and validation of a mid-water baited stereo-video technique for investigating pelagic fish assemblages. *Journal of Experimental Marine Biology and Ecology*, 452, pp.82–90. doi:https://doi.org/10.1016/j.jembe.2013.12.009.

SeaGIS Pty Ltd (2006a). CAL. Available at: www.seagis.com.au

SeaGIS Pty Ltd (2006b). EventMeasure. Available at: www.seagis.com.au

Simpfendorfer, C.A., Goodreid, A. and McAuley, R.B. (2001). Diet of three commercially important shark species from Western Australian waters. *Marine and Freshwater Research*, 52(7), p.975. doi:https://doi.org/10.1071/mf01017.

Simpfendorfer, C.A., Heithaus, M.R., Heupel, M.R., M. Aaron MacNeil, Meekan, M.G., Harvey, E.S., C. Samantha Sherman, Currey-Randall, L.M., Goetze, J., Kiszka, J.J., Rees, M.J., Speed, C.W., Vinay Udyawer, Bond, M.E., Flowers, K.I., Clementi, G.M., Valentin-Albanese, J., Adam, M., Ali, K. and Asher, J. (2023). Widespread diversity deficits of coral reef sharks and rays. *Science*, 380(6650), pp.1155–1160. doi:https://doi.org/10.1126/science.ade4884.

Small, A., Adey, W.H. and Spoon, D. (1998). Are current estimates of coral reef biodiversity too low? The view through the window of a microcosm. *Atoll Research Bulletin*, 458, pp.1–20. doi:https://doi.org/10.5479/si.00775630.458.1.

Speed, C.W., Meekan, M.G., Field, I.C., McMahon, C.R., Harcourt, R.G., Stevens, J.D., Babcock, R.C., Pillans, R.D. and Bradshaw, C.J.A. (2016). Reef shark movements relative to a coastal marine protected area. *Regional Studies in Marine Science*, 3, pp.58–66. doi:https://doi.org/10.1016/j.rsma.2015.05.002.

Stevens, J.D. (1983). Observations on Reproduction in the Shortfin Mako Isurus oxyrinchus. *Copeia*, 1983(1), p.126. doi:https://doi.org/10.2307/1444706.

Sulikowski, J.A. and Hammerschlag, N. (2023). A novel intrauterine satellite transmitter to identify parturition in large sharks. *Science Advances*, 9(9). doi:https://doi.org/10.1126/sciadv.add6340.

Thompson, C.D.H., Meeuwig, J.J., Brown, J., Richardson, A.J., Friedlander, A.M., Miller, P.I. and Weber, S.B. (2021). Spatial Variation in Pelagic Wildlife Assemblages in the Ascension Island Marine Protected Area: Implications for Monitoring and Management. *Frontiers in Marine Science*, 8. doi:https://doi.org/10.3389/fmars.2021.634599.

Torres-Rojas, Y.E., Hernández-Herrera, A., Galván-Magaña, F. and Alatorre-Ramírez, V.G. (2009). Stomach content analysis of juvenile, scalloped hammerhead shark Sphyrna lewini captured off the coast of Mazatlán, Mexico. *Aquatic Ecology*, 44(1), pp.301–308. doi:https://doi.org/10.1007/s10452-009-9245-8.

Tourism WA (2022). *Power BI Desktop Overnight Visitor Factsheet 2021 Prepared by Tourism WA Insights and Planning Shire of Shark Bay*. [online] Available at: https://www.tourism.wa.gov.au/Publications%20Library/Markets%20and%20research/2021/LGA%20Factsheets/LGA%20Visitor%20Factsheet%202021%20-%20Shark%20Bay.pdf [Accessed 29 Jun. 2023].

Vaudo, J.J., Byrne, M.E., Wetherbee, B.M., Harvey, G.M. and Shivji, M.S. (2017). Long-term satellite tracking reveals region-specific movements of a large pelagic predator, the shortfin mako shark, in the western North Atlantic Ocean. *Journal of Applied Ecology*, 54(6), pp.1765–1775. doi:https://doi.org/10.1111/1365-2664.12852.

WAIFC (2020). *Greater monitoring of recreational fishing needed to protect the environment - WAFIC*. [online] WAFIC - WA Fishing Industry Council. Available at: https://www.wafic.org.au/news/greater-monitoring-recreational-fishing-needed-protect-environment/ [Accessed 26 Jun. 2023].

Waite, A.M., Thompson, P.D., Pesant, S., Feng, M., Beckley, L.E., Domingues, C.M., Gaughan, D.J., Hanson, C.E., Holl, C.M., Koslow, T., Meuleners, M., Montoya, J., Moore, T.B., Muhling, B.A., Paterson, H., Rennie, S., Strzelecki, J. and Twomey, L. (2007). The Leeuwin Current and its eddies: An introductory overview. *Deep-sea Research Part Ii-topical Studies in Oceanography*, 54(8-10), pp.789–796. doi:https://doi.org/10.1016/j.dsr2.2006.12.008.

Xilisoft Corporation (2016). Xilisoft Video Converter Ultimate. Available at: www.xilisoft.com

Watson, D. and Harvey, E. (2009). Influence of the Leeuwin Current on the distribution of fishes and the composition of fish assemblages. *Journal of the Royal Society of Western Australia*, 92, pp.147–154.

Appendices

Appendix Table 1a. Complete metadata for seabed BRUVs surveys in Shark Bay from 2017,2018,2019 and 2021. Date is in DD/MM/YYYY format. Latitude and longitude are in degrees. Time is in 24 hour format.

ID	Expedition	Date	Lat	Long	Time In	Time Out	Depth (m)
SBB17_001	Shark Bay 2017	15/09/2017	-26.2697	113.2541	08:26	09:30	32
SBB17_002	Shark Bay 2017	15/09/2017	-26.2718	113.2551	08:32	09:35	32
SBB17_003	Shark Bay 2017	15/09/2017	-26.2746	113.2574	08:40	09:40	33
SBB17_004	Shark Bay 2017	15/09/2017	-26.2767	113.2592	08:45	09:40	29
SBB17_005	Shark Bay 2017	15/09/2017	-26.2786	113.2612	08:59	10:00	28
SBB17_006	Shark Bay 2017	15/09/2017	-26.2815	113.2631	10:39	11:45	28
SBB17_007	Shark Bay 2017	15/09/2017	-26.284	113.265	10:42	11:50	28
SBB17_008	Shark Bay 2017	15/09/2017	-26.2874	113.2677	10:45	11:55	26
SBB17_009	Shark Bay 2017	15/09/2017	-26.292	113.2711	10:49	11:57	26
SBB17_010	Shark Bay 2017	15/09/2017	-26.2921	113.2711	11:03	12:10	25
SBB17_012	Shark Bay 2017	16/09/2017	-26.1606	113.1623	07:20	08:23	33
SBB17_013	Shark Bay 2017	16/09/2017	-26.1627	113.1646	07:22	08:26	33
SBB17_014	Shark Bay 2017	16/09/2017	-26.1644	113.1662	07:24	08:29	32
SBB17_015	Shark Bay 2017	16/09/2017	-26.1676	113.1674	07:27	08:31	35
SBB17_016	Shark Bay 2017	16/09/2017	-26.1703	113.1688	08:40	09:00	34
SBB17_017	Shark Bay 2017	16/09/2017	-26.1723	113.17	08:43	09:04	33
SBB17_020	Shark Bay 2017	16/09/2017	-26.1797	113.1748	08:53	09:14	29
SBB17_021	Shark Bay 2017	16/09/2017	-26.0765	113.1601	11:38	12:48	21
SBB17_022	Shark Bay 2017	16/09/2017	-26.0763	113.1601	11:41	12:51	19
SBB17_025	Shark Bay 2017	16/09/2017	-26.0649	113.1569	11:49	13:04	21
SBB17_026	Shark Bay 2017	16/09/2017	-26.0499	113.1498	13:06	14:20	18
SBB17_027	Shark Bay 2017	16/09/2017	-26.0472	113.1483	13:09	14:24	19
SBB17_011	Shark Bay 2017	16/09/2017	-26.1593	113.1607	07:17	08:20	37
SBB17_018	Shark Bay 2017	16/09/2017	-26.175	113.1719	08:47	09:07	27
SBB17_019	Shark Bay 2017	16/09/2017	-26.1773	113.1734	08:50	09:10	28
SBB17_023	Shark Bay 2017	16/09/2017	-26.0711	113.1592	11:44	12:56	22
SBB17_024	Shark Bay 2017	16/09/2017	-26.0679	113.1578	11:46	13:00	22
SBB17_028	Shark Bay 2017	16/09/2017	-26.0447	113.1468	13:12	14:27	20
SBB17_029	Shark Bay 2017	16/09/2017	-26.0419	113.1452	13:14	14:30	20
SBB17_030	Shark Bay 2017	16/09/2017	-26.0391	113.1432	13:17	14:33	21
SBB17_031	Shark Bay 2017	20/09/2017	-25.9217	113.037	07:40	08:43	29
SBB17_032	Shark Bay 2017	20/09/2017	-25.9182	113.036	07:44	08:46	28
SBB17_033	Shark Bay 2017	20/09/2017	-25.9149	113.0348	07:47	08:50	26
SBB17_034	Shark Bay 2017	20/09/2017	-25.9121	113.0335	07:50	08:52	27
SBB17_035	Shark Bay 2017	20/09/2017	-25.9094	113.0317	07:53	08:56	27
SBB17_036	Shark Bay 2017	20/09/2017	-25.9786	113.0853	10:27	10:35	29
SBB17_037	Shark Bay 2017	20/09/2017	-25.9759	113.0826	10:31	10:38	28
SBB17_038	Shark Bay 2017	20/09/2017	-25.9736	113.0804	10:35	10:41	28
SBB17_039	Shark Bay 2017	20/09/2017	-25.9709	113.0782	10:38	10:43	27
SBB17_040	Shark Bay 2017	20/09/2017	-25.9681	113.0758	10:40	10:46	26
SBB18_001	Shark Bay 2018	04/08/2018	-26.17	113.2041	11:41	11:43	8
SBB18_002	Shark Bay 2018	04/08/2018	-26.1677	113.2047	11:44	11:46	8
SBB18_003	Shark Bay 2018	04/08/2018	-26.1654	113.2048	11:47	11:50	7
SBB18_004	Shark Bay 2018	04/08/2018	-26.164	113.2053	11:49	11:52	8
SBB18_005	Shark Bay 2018	04/08/2018	-26.1618	113.2058	11:51	11:55	9
SBB18_006	Shark Bay 2018	04/08/2018	-26.1252	113.1875	13:20	13:22	2
SBB18_007	Shark Bay 2018	04/08/2018	-26.1274	113.1891	13:24	13:26	3
SBB18_008	Shark Bay 2018	04/08/2018	-26.129	113.1906	13:27	13:29	3
SBB18_009	Shark Bay 2018	04/08/2018	-26.1311	113.1927	13:29	13:31	4
SBB18_010	Shark Bay 2018	04/08/2018	-26.1341	113.194	13:32	13:34	4
SBB18_011	Shark Bay 2018	08/08/2018	-26.4998	113.3835	10:35	11:35	30
SBB18_012	Shark Bay 2018	08/08/2018	-26.4968	113.3808	10:39	11:39	31
SBB18_013	Shark Bay 2018	08/08/2018	-26.4943	113.3784	10:44	11:44	30
SBB18_014	Shark Bay 2018	08/08/2018	-26.4866	113.371	10:53	11:54	29
SBB18_015	Shark Bay 2018	08/08/2018	-26.4792	113.369	10:58	11:59	21
SBB18_016	Shark Bay 2018	08/08/2018	-26.4558	113.3486	12:01	13:01	15
SBB18_017	Shark Bay 2018	08/08/2018	-26.4531	113.3455	12:04	13:04	16
SBB18_018	Shark Bay 2018	08/08/2018	-26.4495	113.3415	12:07	13:07	16
SBB18_019	Shark Bay 2018	08/08/2018	-26.443	113.3346	12:10	13:10	19
SBB18_020	Shark Bay 2018	08/08/2018	-26.4374	113.3298	12:13	13:13	15
SBB18_021	Shark Bay 2018	08/08/2018	-26.4191	113.2993	13:28	14:28	36
SBB18_022	Shark Bay 2018	08/08/2018	-26.4141	113.299	13:33	14:33	30
SBB18_023	Shark Bay 2018	08/08/2018	-26.4096	113.2982	13:37	14:37	26
SBB18_024	Shark Bay 2018	08/08/2018	-26.4033	113.2958	13:41	14:41	21
SBB18_025	Shark Bay 2018	08/08/2018	-26.4009	113.2947	13:44	14:44	21
SBB18_026	Shark Bay 2018	08/08/2018	-26.4011	113.2886	14:55	15:55	29
SBB18_027	Shark Bay 2018	08/08/2018	-26.3987	113.2895	14:57	15:57	25
SBB18_028	Shark Bay 2018	08/08/2018	-26.3955	113.2904	14:59	15:59	25
SBB18_029	Shark Bay 2018	08/08/2018	-26.3942	113.2931	15:01	16:01	24
SBB18_030	Shark Bay 2018	08/08/2018	-26.3934	113.2967	15:03	16:03	20
SBB18_031	Shark Bay 2018	08/08/2018	-26.3839	113.2841	16:18	17:20	35
SBB18_032	Shark Bay 2018	08/08/2018	-26.3806	113.2852	16:21	17:23	34
SBB18_033	Shark Bay 2018	08/08/2018	-26.3774	113.2864	16:23	17:26	30
SBB18_034	Shark Bay 2018	08/08/2018	-26.3744	113.2878	16:26	17:29	29
SBB18_035	Shark Bay 2018	08/08/2018	-26.3717	113.2897	16:29	17:32	25
SBB18_036	Shark Bay 2018	11/08/2018	-26.2374	113.2346	08:04	09:12	22
SBB18_037	Shark Bay 2018	11/08/2018	-26.2415	113.2389	08:09	09:15	19
SBB18_038	Shark Bay 2018	11/08/2018	-26.246	113.2422	08:13	09:18	19
SBB18_039	Shark Bay 2018	11/08/2018	-26.2509	113.2463	08:17	09:21	23
SBB18_040	Shark Bay 2018	11/08/2018	-26.2557	113.2496	08:21	09:24	22
SBB18_041	Shark Bay 2018	11/08/2018	-26.2082	113.2066	09:50	10:50	23
SBB18_042	Shark Bay 2018	11/08/2018	-26.2046	113.203	09:53	10:54	27
SBB18_043	Shark Bay 2018	11/08/2018	-26.1993	113.1978	09:56	10:58	24
SBB18_044	Shark Bay 2018	11/08/2018	-26.1957	113.1946	09:59	11:02	21
SBB18_045	Shark Bay 2018	11/08/2018	-26.1902	113.1888	10:02	11:06	19
SBB18_046	Shark Bay 2018	11/08/2018	-26.1861	113.1827	11:27	12:28	26
SBB18_047	Shark Bay 2018	11/08/2018	-26.1819	113.178	11:32	12:32	28
SBB18_048	Shark Bay 2018	11/08/2018	-26.1771	113.174	11:37	12:38	28
SBB18_049	Shark Bay 2018	11/08/2018	-26.174	113.1712	11:42	12:42	29
SBB18_050	Shark Bay 2018	11/08/2018	-26.1675	113.1686	11:47	12:47	35
SBB18_051	Shark Bay 2018	11/08/2018	-26.1528	113.1545	11:52	12:52	39
SBB18_052	Shark Bay 2018	11/08/2018	-26.1486	113.1551	13:08	14:08	28
SBB18_053	Shark Bay 2018	11/08/2018	-26.1465	113.1558	13:12	14:12	26
SBB18_054	Shark Bay 2018	11/08/2018	-26.1423	113.1608	13:16	14:16	17
SBB18_055	Shark Bay 2018	11/08/2018	-26.1419	113.1661	13:20	14:20	17
SBB18_056	Shark Bay 2018	12/08/2018	-26.0474	113.1486	08:35	09:35	19
SBB18_057	Shark Bay 2018	12/08/2018	-26.0405	113.1438	08:40	09:40	21
SBB18_058	Shark Bay 2018	12/08/2018	-26.0363	113.1418	08:45	09:45	20
SBB18_059	Shark Bay 2018	12/08/2018	-26.0314	113.1392	08:50	09:50	12
SBB18_060	Shark Bay 2018	12/08/2018	-26.0289	113.1375	08:55	09:55	17
SBB18_061	Shark Bay 2018	12/08/2018	-26.0285	113.1372	10:04	11:05	10
SBB18_062	Shark Bay 2018	12/08/2018	-26.0175	113.1296	10:08	11:09	11
SBB18_063	Shark Bay 2018	12/08/2018	-26.0144	113.1269	10:12	11:13	10
SBB18_064	Shark Bay 2018	12/08/2018	-26.012	113.1249	10:16	11:17	8
SBB18_065	Shark Bay 2018	12/08/2018	-26.0086	113.1219	10:20	11:21	9
SBB18_066	Shark Bay 2018	12/08/2018	-26.0056	113.1189	11:33	12:33	12
SBB18_067	Shark Bay 2018	12/08/2018	-26.0022	113.1161	11:37	12:37	11
SBB18_068	Shark Bay 2018	12/08/2018	-25.9979	113.1127	11:41	12:41	10
SBB18_069	Shark Bay 2018	12/08/2018	-25.9945	113.1101	11:45	12:45	10
SBB18_070	Shark Bay 2018	12/08/2018	-25.9911	113.1079	11:49	12:49	10
SBB18_071	Shark Bay 2018	12/08/2018	-25.9859	113.1034	13:03	14:03	7
SBB18_072	Shark Bay 2018	12/08/2018	-25.9837	113.1001	13:07	14:07	18
SBB18_073	Shark Bay 2018	12/08/2018	-25.9805	113.097	13:11	14:11	13
SBB18_074	Shark Bay 2018	12/08/2018	-25.9776	113.0941	13:15	14:15	13
SBB18_075	Shark Bay 2018	12/08/2018	-25.9729	113.0895	13:19	14:19	14
SBB19_001	Shark Bay 2019	09/09/2019	-26.1708	113.2066	11:05	NA	6
SBB19_002	Shark Bay 2019	09/09/2019	-26.169	113.2052	11:09	NA	7
SBB19_003	Shark Bay 2019	09/09/2019	-26.1679	113.2028	11:12	NA	7
SBB19_004	Shark Bay 2019	09/09/2019	-26.166	113.2003	11:15	NA	7
SBB19_005	Shark Bay 2019	09/09/2019	-26.1661	113.1966	11:19	NA	7
SBB19_006	Shark Bay 2019	09/09/2019	-26.1449	113.1904	12:37	NA	6
SBB19_007	Shark Bay 2019	09/09/2019	-26.1425	113.1897	12:41	NA	6
SBB19_008	Shark Bay 2019	09/09/2019	-26.1402	113.1864	12:45	NA	4
SBB19_009	Shark Bay 2019	09/09/2019	-26.139	113.1835	12:50	NA	6
SBB19_010	Shark Bay 2019	09/09/2019	-26.1381	113.1806	12:56	NA	4
SBB19_011	Shark Bay 2019	20/09/2019	-26.0572	113.1531	07:39	NA	20
SBB19_012	Shark Bay 2019	20/09/2019	-26.0518	113.151	07:44	NA	16
SBB19_013	Shark Bay 2019	20/09/2019	-26.0483	113.148	07:48	NA	21
SBB19_014	Shark Bay 2019	20/09/2019	-26.0447	113.147	07:53	NA	18
SBB19_015	Shark Bay 2019	20/09/2019	-26.0415	113.145	07:56	NA	18
SBB19_016	Shark Bay 2019	20/09/2019	-26.142	113.1636	10:06	NA	16
SBB19_017	Shark Bay 2019	20/09/2019	-26.1419	113.1665	10:10	NA	14
SBB19_018	Shark Bay 2019	20/09/2019	-26.1407	113.169	10:14	NA	18
SBB19_019	Shark Bay 2019	20/09/2019	-26.1421	113.1719	10:19	NA	17
SBB19_020	Shark Bay 2019	20/09/2019	-26.1409	113.1753	10:25	NA	12
SBB19_021	Shark Bay 2019	22/09/2019	-26.1456	113.156	08:46	NA	24
SBB19_022	Shark Bay 2019	22/09/2019	-26.1488	113.1552	08:50	NA	25
SBB19_023	Shark Bay 2019	22/09/2019	-26.1517	113.1545	08:54	NA	33
SBB19_024	Shark Bay 2019	22/09/2019	-26.1545	113.1564	08:57	NA	29
SBB19_025	Shark Bay 2019	22/09/2019	-26.1574	113.1599	09:03	NA	26
SBB19_026	Shark Bay 2019	22/09/2019	-26.1874	113.1871	10:38	NA	19
SBB19_027	Shark Bay 2019	22/09/2019	-26.1903	113.1892	10:43	NA	20
SBB19_028	Shark Bay 2019	22/09/2019	-26.1919	113.1924	10:46	NA	15
SBB19_029	Shark Bay 2019	22/09/2019	-26.1946	113.194	10:49	NA	18
SBB19_030	Shark Bay 2019	22/09/2019	-26.1961	113.1967	10:52	NA	12
SBB19_031	Shark Bay 2019	22/09/2019	-26.2054	113.2025	12:10	NA	23
SBB19_032	Shark Bay 2019	22/09/2019	-26.207	113.2048	12:14	NA	22
SBB19_033	Shark Bay 2019	22/09/2019	-26.209	113.2072	12:17	NA	21
SBB19_034	Shark Bay 2019	22/09/2019	-26.2115	113.2104	12:20	NA	18
SBB19_035	Shark Bay 2019	22/09/2019	-26.2141	113.2121	12:23	NA	20
SBB19_036	Shark Bay 2019	22/09/2019	-26.2339	113.2328	14:07	NA	16
SBB19_037	Shark Bay 2019	22/09/2019	-26.2364	113.2345	14:11	NA	17
SBB19_038	Shark Bay 2019	22/09/2019	-26.2397	113.2371	14:15	NA	18
SBB19_039	Shark Bay 2019	22/09/2019	-26.242	113.2395	14:18	NA	17
SBB19_040	Shark Bay 2019	22/09/2019	-26.2451	113.2418	14:27	NA	16
SBB19_041	Shark Bay 2019	25/09/2019	-26.3193	113.2834	06:55	NA	19
SBB19_042	Shark Bay 2019	25/09/2019	-26.3226	113.2857	06:58	NA	21
SBB19_043	Shark Bay 2019	25/09/2019	-26.3259	113.2881	07:05	NA	16
SBB19_044	Shark Bay 2019	25/09/2019	-26.329	113.2888	07:09	NA	14
SBB19_045	Shark Bay 2019	25/09/2019	-26.332	113.2885	07:11	NA	19
SBB19_046	Shark Bay 2019	25/09/2019	-26.345	113.294	08:17	NA	16
SBB19_047	Shark Bay 2019	25/09/2019	-26.3507	113.2927	08:19	NA	15
SBB19_048	Shark Bay 2019	25/09/2019	-26.3532	113.2914	08:21	NA	19
SBB19_049	Shark Bay 2019	25/09/2019	-26.356	113.2911	08:23	NA	19
SBB19_050	Shark Bay 2019	25/09/2019	-26.3591	113.2889	08:25	NA	27
SBB19_051	Shark Bay 2019	25/09/2019	-26.3787	113.2931	10:29	NA	23
SBB19_052	Shark Bay 2019	25/09/2019	-26.3813	113.2916	10:31	NA	25
SBB19_053	Shark Bay 2019	25/09/2019	-26.3837	113.2899	10:33	NA	27
SBB19_054	Shark Bay 2019	25/09/2019	-26.3864	113.2858	10:35	NA	30
SBB19_055	Shark Bay 2019	25/09/2019	-26.3888	113.2845	10:37	NA	32
SBB19_056	Shark Bay 2019	25/09/2019	-26.3951	113.2985	12:03	NA	14
SBB19_057	Shark Bay 2019	25/09/2019	-26.3964	113.2966	12:05	NA	16
SBB19_058	Shark Bay 2019	25/09/2019	-26.3989	113.2949	12:07	NA	16
SBB19_059	Shark Bay 2019	25/09/2019	-26.4015	113.2963	12:09	NA	16
SBB19_060	Shark Bay 2019	25/09/2019	-26.4038	113.299	12:11	NA	15
SBB19_061	Shark Bay 2019	25/09/2019	-26.4089	113.3058	13:36	NA	13
SBB19_062	Shark Bay 2019	25/09/2019	-26.4111	113.3064	13:38	NA	15
SBB19_063	Shark Bay 2019	25/09/2019	-26.4138	113.3084	13:40	NA	16
SBB19_064	Shark Bay 2019	25/09/2019	-26.4171	113.3097	13:42	NA	18
SBB19_065	Shark Bay 2019	25/09/2019	-26.4186	113.3147	13:44	NA	11
SBB19_066	Shark Bay 2019	25/09/2019	-26.4243	113.318	15:22	NA	15
SBB19_067	Shark Bay 2019	25/09/2019	-26.4261	113.3199	15:24	NA	15
SBB19_068	Shark Bay 2019	25/09/2019	-26.4287	113.3228	15:26	NA	14
SBB19_069	Shark Bay 2019	25/09/2019	-26.4296	113.3231	15:28	NA	20
SBB19_070	Shark Bay 2019	25/09/2019	-26.4333	113.3246	15:30	NA	19
SBB19_071	Shark Bay 2019	27/09/2019	-26.0136	113.1179	06:35	NA	24
SBB19_072	Shark Bay 2019	27/09/2019	-26.0109	113.1165	06:39	NA	28
SBB19_073	Shark Bay 2019	27/09/2019	-26.008	113.1149	06:42	NA	26
SBB19_074	Shark Bay 2019	27/09/2019	-26.0065	113.1134	06:46	NA	27
SBB19_075	Shark Bay 2019	27/09/2019	-26.0027	113.1112	06:50	NA	24
SBB19_076	Shark Bay 2019	27/09/2019	-25.991	113.1018	08:12	NA	26
SBB19_077	Shark Bay 2019	27/09/2019	-25.9884	113.1	08:16	NA	21
SBB19_078	Shark Bay 2019	27/09/2019	-25.9868	113.0975	08:19	NA	24
SBB19_079	Shark Bay 2019	27/09/2019	-25.9848	113.0951	08:21	NA	23
SBB19_080	Shark Bay 2019	27/09/2019	-25.9823	113.0915	08:24	NA	24
SBB19_081	Shark Bay 2019	27/09/2019	-26.1628	113.2091	11:38	NA	7
SBB19_082	Shark Bay 2019	27/09/2019	-26.1648	113.2108	11:40	NA	8
SBB19_083	Shark Bay 2019	27/09/2019	-26.1637	113.2134	11:43	NA	10
SBB19_084	Shark Bay 2019	27/09/2019	-26.1633	113.2165	11:48	NA	4
SBB19_085	Shark Bay 2019	27/09/2019	-26.1645	113.2191	11:51	NA	8
SBB21_001	Shark Bay 2021	28/08/2021	-26.149	113.1557	07:56	09:04	19
SBB21_002	Shark Bay 2021	28/08/2021	-26.1466	113.1564	08:03	09:19	22
SBB21_003	Shark Bay 2021	28/08/2021	-26.1446	113.1567	08:07	09:25	23
SBB21_004	Shark Bay 2021	28/08/2021	-26.1428	113.1578	08:12	09:30	22
SBB21_005	Shark Bay 2021	28/08/2021	-26.1403	113.1585	08:16	09:36	23
SBB21_006	Shark Bay 2021	29/08/2021	-26.165	113.22	07:04	08:05	8
SBB21_007	Shark Bay 2021	29/08/2021	-26.1635	113.2168	07:09	08:07	8
SBB21_008	Shark Bay 2021	29/08/2021	-26.1628	113.2141	07:12	08:11	7
SBB21_009	Shark Bay 2021	29/08/2021	-26.1626	113.2109	07:16	08:15	4
SBB21_010	Shark Bay 2021	29/08/2021	-26.1608	113.2085	07:21	08:21	6
SBB21_011	Shark Bay 2021	29/08/2021	-26.1288	113.1915	08:34	09:35	2
SBB21_012	Shark Bay 2021	29/08/2021	-26.1267	113.1907	08:37	09:38	2
SBB21_013	Shark Bay 2021	29/08/2021	-26.1251	113.1892	08:40	09:40	1
SBB21_014	Shark Bay 2021	29/08/2021	-26.1261	113.1876	08:45	09:45	1
SBB21_015	Shark Bay 2021	29/08/2021	-26.1282	113.1879	08:49	09:48	3
SBB21_016	Shark Bay 2021	29/08/2021	-26.141	113.1698	10:15	11:17	16
SBB21_017	Shark Bay 2021	29/08/2021	-26.1418	113.172	10:20	11:22	14
SBB21_018	Shark Bay 2021	29/08/2021	-26.1402	113.1737	10:25	11:26	17
SBB21_019	Shark Bay 2021	29/08/2021	-26.1392	113.1766	10:29	11:29	17
SBB21_020	Shark Bay 2021	29/08/2021	-26.1373	113.178	10:33	11:34	9
SBB21_021	Shark Bay 2021	29/08/2021	-26.1172	113.1748	11:42	12:45	18
SBB21_022	Shark Bay 2021	29/08/2021	-26.114	113.1732	11:49	12:50	20
SBB21_023	Shark Bay 2021	29/08/2021	-26.1113	113.1721	11:53	12:54	21
SBB21_024	Shark Bay 2021	29/08/2021	-26.1084	113.1716	11:58	12:56	20
SBB21_025	Shark Bay 2021	29/08/2021	-26.1059	113.1709	12:04	13:02	23
SBB21_026	Shark Bay 2021	30/08/2021	-26.0662	113.1583	07:14	08:16	17
SBB21_027	Shark Bay 2021	30/08/2021	-26.0635	113.1582	07:17	08:20	13
SBB21_028	Shark Bay 2021	30/08/2021	-26.0611	113.1573	07:20	08:23	14
SBB21_029	Shark Bay 2021	30/08/2021	-26.0587	113.1564	10:43	08:28	12
SBB21_030	Shark Bay 2021	30/08/2021	-26.0556	113.1547	07:25	08:32	13
SBB21_031	Shark Bay 2021	30/08/2021	-26.0446	113.1469	08:45	09:50	18
SBB21_032	Shark Bay 2021	30/08/2021	-26.042	113.146	08:49	09:57	16
SBB21_033	Shark Bay 2021	30/08/2021	-26.0384	113.1444	08:52	10:02	15
SBB21_034	Shark Bay 2021	30/08/2021	-26.035	113.1425	08:56	10:09	12
SBB21_035	Shark Bay 2021	30/08/2021	-26.0327	113.1403	08:59	10:14	13
SBB21_036	Shark Bay 2021	30/08/2021	-26.023	113.129	10:25	11:26	22
SBB21_037	Shark Bay 2021	30/08/2021	-26.022	113.1265	10:28	11:31	26
SBB21_038	Shark Bay 2021	30/08/2021	-26.021	113.1241	10:31	11:35	26
SBB21_039	Shark Bay 2021	30/08/2021	-26.0201	113.1212	10:34	11:39	27
SBB21_040	Shark Bay 2021	30/08/2021	-26.0196	113.1184	10:36	11:45	35
SBB21_041	Shark Bay 2021	30/08/2021	-25.9999	113.1106	11:53	12:53	21
SBB21_042	Shark Bay 2021	30/08/2021	-25.997	113.1092	11:56	12:59	18
SBB21_043	Shark Bay 2021	30/08/2021	-25.9944	113.1075	11:58	13:02	17
SBB21_044	Shark Bay 2021	30/08/2021	-25.9916	113.105	12:01	13:07	18
SBB21_045	Shark Bay 2021	30/08/2021	-25.9878	113.1025	12:05	13:12	14

Appendix Table 1b. Complete metadata for Midwater BRUVs surveys in Shark Bay from 2017,2018,2019 and 2021. Date is in DD/MM/YYYY format. Latitude and longitude are in degrees. Time is in 24 hour format.

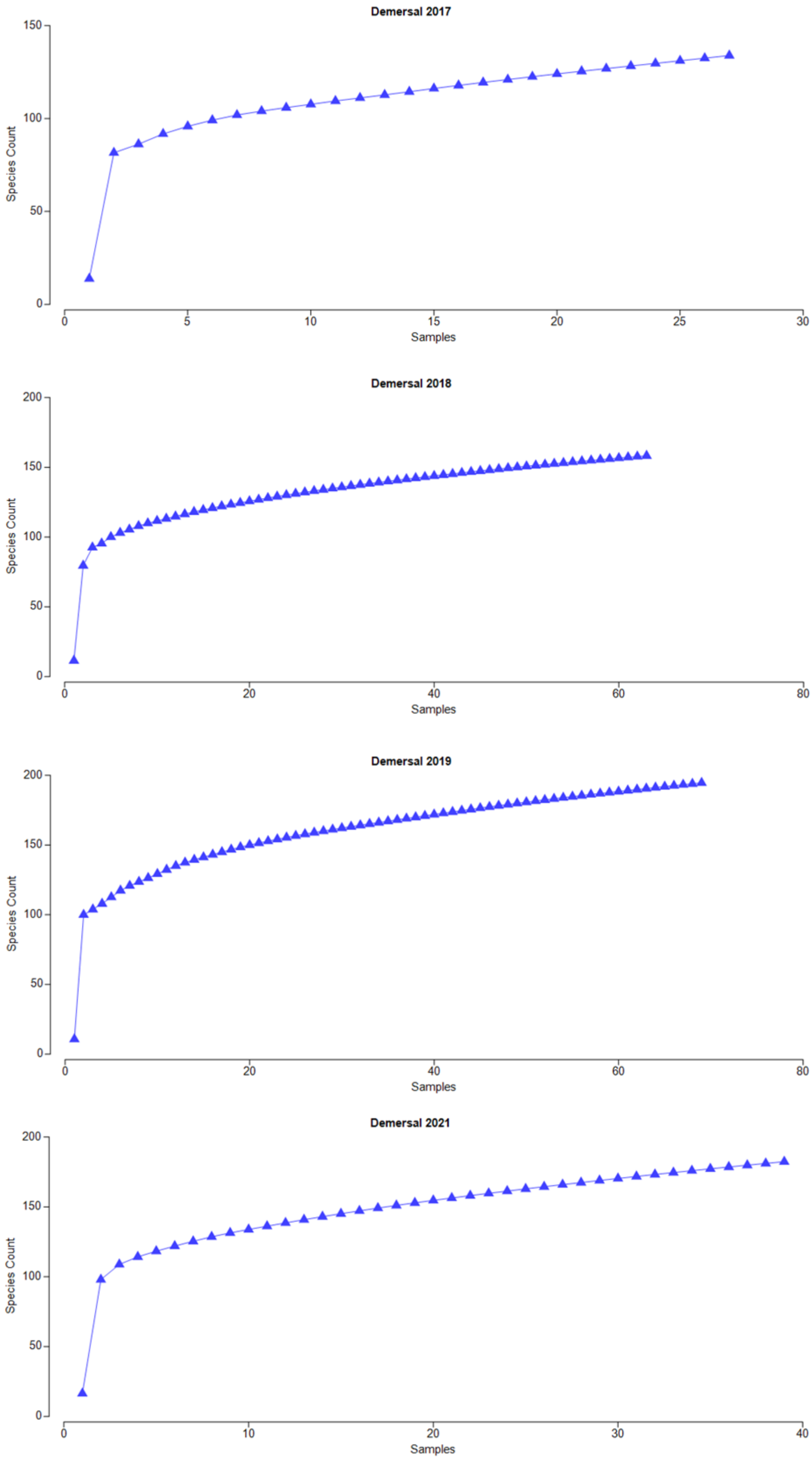
ID	String ID	Expedition	Date	Long in	Lat in	Long out	Lat out	Time In	Time Out
SBP17_001	SBP17_01	Shark Bay 2017	15/09/2017	113.2253	-26.2798	N/A	N/A	07:45	09:05
SBP17_002	SBP17_01	Shark Bay 2017	15/09/2017	113.2268	-26.2803	N/A	N/A	07:48	09:13
SBP17_003	SBP17_01	Shark Bay 2017	15/09/2017	113.2282	-26.282	N/A	N/A	07:51	09:16
SBP17_004	SBP17_01	Shark Bay 2017	15/09/2017	113.2296	-26.2836	N/A	N/A	07:54	09:21
SBP17_005	SBP17_01	Shark Bay 2017	15/09/2017	113.2309	-26.2854	113.2318	-26.2869	07:59	09:25
SBP17_006	SBP17_02	Shark Bay 2017	15/09/2017	113.1489	-26.3158	113.1621	-26.3144	09:43	12:27
SBP17_007	SBP17_02	Shark Bay 2017	15/09/2017	113.1495	-26.3172	113.1645	-26.3152	09:47	12:30
SBP17_008	SBP17_02	Shark Bay 2017	15/09/2017	113.1511	-26.3189	113.1665	-26.3162	09:49	12:35
SBP17_009	SBP17_02	Shark Bay 2017	15/09/2017	113.1528	-26.3205	113.1685	-26.3174	09:51	12:40
SBP17_010	SBP17_02	Shark Bay 2017	15/09/2017	113.1557	-26.3235	113.1701	-26.3186	09:53	12:44
SBP17_011	SBP17_03	Shark Bay 2017	16/09/2017	113.1127	-26.1726	113.1147	-26.1854	07:50	10:32
SBP17_012	SBP17_03	Shark Bay 2017	16/09/2017	113.1139	-26.1745	113.1155	-26.1868	07:52	10:35
SBP17_013	SBP17_03	Shark Bay 2017	16/09/2017	113.115	-26.1766	113.116	-26.1888	07:55	10:39
SBP17_014	SBP17_03	Shark Bay 2017	16/09/2017	113.1155	-26.1788	113.1165	-26.1901	07:57	10:43
SBP17_015	SBP17_03	Shark Bay 2017	16/09/2017	113.1163	-26.181	113.1171	-26.1916	07:59	10:47
SBP17_016	SBP17_04	Shark Bay 2017	16/09/2017	113.0971	-26.095	113.0951	-26.1065	11:11	13:41
SBP17_017	SBP17_04	Shark Bay 2017	16/09/2017	113.0959	-26.0929	113.0943	-26.1048	11:14	13:45
SBP17_018	SBP17_04	Shark Bay 2017	16/09/2017	113.0952	-26.0913	113.0934	-26.1036	11:16	13:49
SBP17_019	SBP17_04	Shark Bay 2017	16/09/2017	113.0947	-26.0898	113.0926	-26.1023	11:20	13:52
SBP17_020	SBP17_04	Shark Bay 2017	16/09/2017	113.0942	-26.0881	113.0925	-26.1009	11:23	13:55
SBP17_021	SBP17_05	Shark Bay 2017	18/09/2017	112.9818	-26.1858	112.9631	-26.1828	06:50	08:50
SBP17_022	SBP17_05	Shark Bay 2017	18/09/2017	112.98	-26.1839	112.9616	-26.1814	06:53	08:54
SBP17_023	SBP17_05	Shark Bay 2017	18/09/2017	112.979	-26.1816	112.9606	-26.1808	06:56	08:57
SBP17_024	SBP17_05	Shark Bay 2017	18/09/2017	112.9778	-26.1795	112.9611	-26.1805	06:59	09:00
SBP17_025	SBP17_05	Shark Bay 2017	18/09/2017	112.9766	-26.1776	112.96	-26.1794	07:02	09:04
SBP17_026	SBP17_06	Shark Bay 2017	18/09/2017	112.9204	-26.1003	112.9181	-26.1061	09:20	11:25
SBP17_027	SBP17_06	Shark Bay 2017	18/09/2017	112.9192	-26.0982	112.9178	-26.1046	09:23	11:28
SBP17_028	SBP17_06	Shark Bay 2017	18/09/2017	112.9185	-26.0966	112.918	-26.1032	09:25	11:30
SBP17_029	SBP17_06	Shark Bay 2017	18/09/2017	112.9178	-26.0947	112.9186	-26.1018	09:27	11:33
SBP17_030	SBP17_06	Shark Bay 2017	18/09/2017	112.9172	-26.0932	112.9181	-26.0995	09:29	11:36
SBP17_031	SBP17_07	Shark Bay 2017	18/09/2017	112.8641	-26.0266	112.8836	-26.0343	11:52	14:02
SBP17_032	SBP17_07	Shark Bay 2017	18/09/2017	112.8632	-26.0249	112.8829	-26.0328	11:54	14:04
SBP17_033	SBP17_07	Shark Bay 2017	18/09/2017	112.8628	-26.0231	112.8819	-26.0315	11:57	14:09
SBP17_034	SBP17_07	Shark Bay 2017	18/09/2017	112.8625	-26.0208	112.8816	-26.0298	11:59	14:11
SBP17_035	SBP17_07	Shark Bay 2017	18/09/2017	112.8623	-26.0195	112.8812	-26.0289	12:01	14:13
SBP17_036	SBP17_08	Shark Bay 2017	19/09/2017	113.2327	-26.3752	113.2319	-26.3805	07:02	09:03
SBP17_037	SBP17_08	Shark Bay 2017	19/09/2017	113.2315	-26.3734	113.2308	-26.3791	07:05	09:07
SBP17_038	SBP17_08	Shark Bay 2017	19/09/2017	113.2299	-26.3719	113.2293	-26.3781	07:08	09:11
SBP17_039	SBP17_08	Shark Bay 2017	19/09/2017	113.2286	-26.3703	113.2284	-26.3769	07:10	09:15
SBP17_040	SBP17_08	Shark Bay 2017	19/09/2017	113.2275	-26.369	113.2278	-26.3763	07:12	09:18
SBP17_041	SBP17_09	Shark Bay 2017	19/09/2017	113.1601	-26.4399	113.165	-26.4526	09:35	11:36
SBP17_042	SBP17_09	Shark Bay 2017	19/09/2017	113.1608	-26.4381	113.1657	-26.4512	09:37	11:39
SBP17_043	SBP17_09	Shark Bay 2017	19/09/2017	113.1613	-26.4363	113.166	-26.4494	09:40	11:42
SBP17_044	SBP17_09	Shark Bay 2017	19/09/2017	113.1616	-26.4346	113.1661	-26.4477	09:43	11:45
SBP17_045	SBP17_09	Shark Bay 2017	19/09/2017	113.1621	-26.4329	113.1658	-26.4463	09:45	11:48
SBP17_046	SBP17_10	Shark Bay 2017	19/09/2017	113.0454	-26.3399	113.05	-26.3365	12:11	14:13
SBP17_047	SBP17_10	Shark Bay 2017	19/09/2017	113.0453	-26.3378	113.05	-26.3349	12:13	14:17
SBP17_048	SBP17_10	Shark Bay 2017	19/09/2017	113.0454	-26.3357	113.05	-26.3332	12:15	14:21
SBP17_049	SBP17_10	Shark Bay 2017	19/09/2017	113.0458	-26.3336	113.0501	-26.3316	12:18	14:24
SBP17_050	SBP17_10	Shark Bay 2017	19/09/2017	113.046	-26.3317	113.0503	-26.3303	12:20	14:26
SBP17_051	SBP17_11	Shark Bay 2017	20/09/2017	112.9223	-25.9501	112.9151	-25.9542	07:04	09:18
SBP17_052	SBP17_11	Shark Bay 2017	20/09/2017	112.9217	-25.9482	112.9156	-25.9524	07:06	09:22
SBP17_053	SBP17_11	Shark Bay 2017	20/09/2017	112.9213	-25.9461	112.9163	-25.9507	07:10	09:26
SBP17_054	SBP17_11	Shark Bay 2017	20/09/2017	112.9207	-25.9442	112.9165	-25.9494	07:15	09:30
SBP17_055	SBP17_11	Shark Bay 2017	20/09/2017	112.9206	-25.9422	112.9166	-25.9487	07:19	09:32
SBP17_056	SBP17_12	Shark Bay 2017	20/09/2017	112.9648	-26.0174	112.9598	-26.016	09:59	12:15
SBP17_057	SBP17_12	Shark Bay 2017	20/09/2017	112.965	-26.0152	112.9602	-26.013	10:02	12:18
SBP17_058	SBP17_12	Shark Bay 2017	20/09/2017	112.9656	-26.0133	112.9605	-26.0105	10:04	12:21
SBP17_059	SBP17_12	Shark Bay 2017	20/09/2017	112.9662	-26.0113	112.9609	-26.0097	10:06	12:25
SBP17_060	SBP17_12	Shark Bay 2017	20/09/2017	112.9669	-26.0098	112.9612	-26.0086	10:09	12:28
SBP17_061	SBP17_13	Shark Bay 2017	20/09/2017	112.9998	-26.0776	112.9939	-26.0815	12:54	15:25
SBP17_062	SBP17_13	Shark Bay 2017	20/09/2017	113.0015	-26.0763	112.9944	-26.0802	12:58	15:28
SBP17_063	SBP17_13	Shark Bay 2017	20/09/2017	113.0027	-26.0745	112.9951	-26.0781	13:02	15:32
SBP17_064	SBP17_13	Shark Bay 2017	20/09/2017	113.0037	-26.0727	112.9953	-26.0768	13:04	15:36
SBP17_065	SBP17_13	Shark Bay 2017	20/09/2017	113.0047	-26.071	112.9957	-26.0755	13:06	15:39
SBP17_066	SBP17_14	Shark Bay 2017	21/09/2017	113.1662	-26.2319	113.1756	-26.2275	06:42	08:42
SBP17_067	SBP17_14	Shark Bay 2017	21/09/2017	113.1685	-26.2307	113.1804	-26.2282	06:44	08:45
SBP17_068	SBP17_14	Shark Bay 2017	21/09/2017	113.1708	-26.2296	113.1821	-26.2277	06:48	08:48
SBP17_069	SBP17_14	Shark Bay 2017	21/09/2017	113.1731	-26.2286	113.1841	-26.227	06:50	08:50
SBP17_070	SBP17_14	Shark Bay 2017	21/09/2017	113.1752	-26.2276	113.188	-26.2265	06:52	08:54
SBP17_071	SBP17_15	Shark Bay 2017	21/09/2017	113.0684	-26.2386	113.0852	-26.233	09:45	11:45
SBP17_072	SBP17_15	Shark Bay 2017	21/09/2017	113.0708	-26.2387	113.0874	-26.2331	09:47	11:48
SBP17_073	SBP17_15	Shark Bay 2017	21/09/2017	113.0738	-26.2384	113.0898	-26.2331	09:50	11:52
SBP17_074	SBP17_15	Shark Bay 2017	21/09/2017	113.0763	-26.2384	113.0921	-26.2328	09:52	11:55
SBP17_075	SBP17_15	Shark Bay 2017	21/09/2017	113.0787	-26.2389	113.0944	-26.2329	09:55	11:57
SBP18_001	SBP18_01	Shark Bay 2018	06/08/2018	113.1096	-26.2479	113.1228	-26.1299	07:54	09:55
SBP18_002	SBP18_01	Shark Bay 2018	06/08/2018	113.1069	-26.2479	113.1208	-26.1284	07:56	09:58
SBP18_003	SBP18_01	Shark Bay 2018	06/08/2018	113.1047	-26.2473	113.1191	-26.1276	07:58	10:00
SBP18_004	SBP18_01	Shark Bay 2018	06/08/2018	113.1025	-26.2464	113.117	-26.1262	08:00	10:02
SBP18_005	SBP18_01	Shark Bay 2018	06/08/2018	113.1003	-26.2455	113.115	-26.1248	08:02	10:04
SBP18_006	SBP18_02	Shark Bay 2018	06/08/2018	113.109	-26.1553	113.1085	-26.1076	08:23	10:23
SBP18_007	SBP18_02	Shark Bay 2018	06/08/2018	113.1068	-26.1541	113.1064	-26.1062	08:25	10:26
SBP18_008	SBP18_02	Shark Bay 2018	06/08/2018	113.1045	-26.153	113.104	-26.1049	08:27	10:29
SBP18_009	SBP18_02	Shark Bay 2018	06/08/2018	113.1027	-26.1526	113.102	-26.1038	08:29	10:31
SBP18_010	SBP18_02	Shark Bay 2018	06/08/2018	113.1003	-26.152	113.0996	-26.1026	08:31	10:33
SBP18_011	SBP18_03	Shark Bay 2018	06/08/2018	113.1032	-26.2388	113.1081	-26.1133	11:00	13:04
SBP18_012	SBP18_03	Shark Bay 2018	06/08/2018	113.1015	-26.2388	113.1061	-26.1123	11:03	13:06
SBP18_013	SBP18_03	Shark Bay 2018	06/08/2018	113.0995	-26.239	113.1049	-26.1116	11:05	13:08
SBP18_014	SBP18_03	Shark Bay 2018	06/08/2018	113.0975	-26.2385	113.1029	-26.1107	11:07	13:10
SBP18_015	SBP18_03	Shark Bay 2018	06/08/2018	113.0962	-26.2383	113.1012	-26.1096	11:09	13:15
SBP18_016	SBP18_04	Shark Bay 2018	06/08/2018	113.0914	-26.1424	113.0937	-26.0934	11:13	13:20
SBP18_017	SBP18_04	Shark Bay 2018	06/08/2018	113.0897	-26.1412	113.0913	-26.0925	11:15	13:22
SBP18_018	SBP18_04	Shark Bay 2018	06/08/2018	113.0885	-26.1399	113.0896	-26.0916	11:17	13:24
SBP18_019	SBP18_04	Shark Bay 2018	06/08/2018	113.0869	-26.1393	113.088	-26.0907	11:19	13:26
SBP18_020	SBP18_04	Shark Bay 2018	06/08/2018	113.0854	-26.1384	113.0866	-26.09	11:21	13:28
SBP18_021	SBP18_05	Shark Bay 2018	07/08/2018	113.1289	-26.4593	113.127	-26.4711	08:00	10:00
SBP18_022	SBP18_05	Shark Bay 2018	07/08/2018	113.1268	-26.4588	113.1254	-26.4711	08:02	10:02
SBP18_023	SBP18_05	Shark Bay 2018	07/08/2018	113.1251	-26.458	113.124	-26.4705	08:04	10:04
SBP18_024	SBP18_05	Shark Bay 2018	07/08/2018	113.1232	-26.4569	113.1224	-26.4703	08:06	10:06
SBP18_025	SBP18_05	Shark Bay 2018	07/08/2018	113.1209	-26.4566	113.121	-26.47	08:08	10:08
SBP18_026	SBP18_06	Shark Bay 2018	07/08/2018	113.1579	-26.4112	113.1523	-26.4138	08:24	10:26
SBP18_027	SBP18_06	Shark Bay 2018	07/08/2018	113.1557	-26.4098	113.1507	-26.4136	08:26	10:28
SBP18_028	SBP18_06	Shark Bay 2018	07/08/2018	113.1537	-26.4087	113.149	-26.4135	08:28	10:30
SBP18_029	SBP18_06	Shark Bay 2018	07/08/2018	113.1519	-26.408	113.1477	-26.4135	08:30	10:32
SBP18_030	SBP18_06	Shark Bay 2018	07/08/2018	113.1499	-26.4072	113.1465	-26.4127	08:34	10:34
SBP18_031	SBP18_07	Shark Bay 2018	07/08/2018	113.0697	-26.367	113.0689	-26.3732	11:01	13:02
SBP18_032	SBP18_07	Shark Bay 2018	07/08/2018	113.0678	-26.3663	113.0674	-26.3733	11:03	13:04
SBP18_033	SBP18_07	Shark Bay 2018	07/08/2018	113.0662	-26.3655	113.0661	-26.3733	11:05	13:06
SBP18_034	SBP18_07	Shark Bay 2018	07/08/2018	113.0641	-26.365	113.0645	-26.3733	11:07	13:08
SBP18_035	SBP18_07	Shark Bay 2018	07/08/2018	113.062	-26.3643	113.0629	-26.3731	11:09	13:10
SBP18_036	SBP18_08	Shark Bay 2018	07/08/2018	113.0196	-26.2489	113.0117	-26.2485	11:33	13:33
SBP18_037	SBP18_08	Shark Bay 2018	07/08/2018	113.017	-26.2491	113.0099	-26.249	11:35	13:35
SBP18_038	SBP18_08	Shark Bay 2018	07/08/2018	113.0142	-26.2489	113.0081	-26.2493	11:37	13:37
SBP18_039	SBP18_08	Shark Bay 2018	07/08/2018	113.0118	-26.2488	113.0067	-26.2493	11:39	13:39
SBP18_040	SBP18_08	Shark Bay 2018	07/08/2018	113.0094	-26.2484	113.0047	-26.2493	11:41	13:41
SBP18_041	SBP18_09	Shark Bay 2018	08/08/2018	113.2662	-26.5271	113.2638	-26.5255	07:38	07:40
SBP18_042	SBP18_09	Shark Bay 2018	08/08/2018	113.2641	-26.5257	113.2626	-26.5247	07:41	07:42
SBP18_043	SBP18_09	Shark Bay 2018	08/08/2018	113.2627	-26.5243	113.2614	-26.5235	07:43	07:44
SBP18_044	SBP18_09	Shark Bay 2018	08/08/2018	113.2614	-26.5223	113.2609	-26.522	07:45	07:46
SBP18_045	SBP18_09	Shark Bay 2018	08/08/2018	113.2605	-26.5203	113.2641	-26.5182	07:47	07:48
SBP18_046	SBP18_10	Shark Bay 2018	08/08/2018	113.3249	-26.4794	113.3252	-26.4885	08:01	10:01
SBP18_047	SBP18_10	Shark Bay 2018	08/08/2018	113.3226	-26.4798	113.3238	-26.49	08:03	10:03
SBP18_048	SBP18_10	Shark Bay 2018	08/08/2018	113.3204	-26.4807	113.3224	-26.4913	08:05	10:05
SBP18_049	SBP18_10	Shark Bay 2018	08/08/2018	113.3188	-26.4814	113.3212	-26.4924	08:07	10:07
SBP18_050	SBP18_10	Shark Bay 2018	08/08/2018	113.3168	-26.4822	113.3197	-26.4933	08:10	10:10
SBP18_051	SBP18_11	Shark Bay 2018	08/08/2018	113.264	-26.3423	113.2722	-26.3428	15:19	17:20
SBP18_052	SBP18_11	Shark Bay 2018	08/08/2018	113.2637	-26.3406	113.2724	-26.3414	15:21	17:22
SBP18_053	SBP18_11	Shark Bay 2018	08/08/2018	113.2637	-26.3392	113.2721	-26.3401	15:23	17:24
SBP18_054	SBP18_11	Shark Bay 2018	08/08/2018	113.2629	-26.3373	113.2716	-26.3387	15:25	17:26
SBP18_055	SBP18_11	Shark Bay 2018	08/08/2018	113.2622	-26.3354	113.2705	-26.3376	15:27	17:28
SBP18_056	SBP18_12	Shark Bay 2018	11/08/2018	113.1851	-26.223	113.1569	-26.2063	07:24	09:30
SBP18_057	SBP18_12	Shark Bay 2018	11/08/2018	113.182	-26.2228	113.1546	-26.2066	07:26	09:32
SBP18_058	SBP18_12	Shark Bay 2018	11/08/2018	113.1796	-26.2227	113.1525	-26.2072	07:28	09:34
SBP18_059	SBP18_12	Shark Bay 2018	11/08/2018	113.1775	-26.2223	113.1507	-26.2072	07:30	09:36
SBP18_060	SBP18_12	Shark Bay 2018	11/08/2018	113.175	-26.2217	113.1486	-26.2072	07:32	09:38
SBP18_061	SBP18_13	Shark Bay 2018	13/08/2018	113.0305	-25.9908	113.038	-26.0072	07:18	09:18
SBP18_062	SBP18_13	Shark Bay 2018	13/08/2018	113.0283	-25.9916	113.0385	-26.0061	07:20	09:20
SBP18_063	SBP18_13	Shark Bay 2018	13/08/2018	113.0268	-25.9922	113.0387	-26.0048	07:22	09:22
SBP18_064	SBP18_13	Shark Bay 2018	13/08/2018	113.0249	-25.9925	113.0395	-26.0039	07:24	09:24
SBP18_065	SBP18_13	Shark Bay 2018	13/08/2018	113.0229	-25.9928	113.0402	-26.003	07:26	09:26
SBP18_066	SBP18_14	Shark Bay 2018	13/08/2018	112.9142	-26.0384	112.9172	-26.0572	07:44	09:44
SBP18_067	SBP18_14	Shark Bay 2018	13/08/2018	112.9119	-26.0397	112.9156	-26.0584	07:46	09:46
SBP18_068	SBP18_14	Shark Bay 2018	13/08/2018	112.9097	-26.0407	112.914	-26.0596	07:48	09:48
SBP18_069	SBP18_14	Shark Bay 2018	13/08/2018	112.9078	-26.0418	112.9124	-26.0606	07:50	09:50
SBP18_070	SBP18_14	Shark Bay 2018	13/08/2018	112.9057	-26.0432	112.9107	-26.0617	07:52	09:52
SBP18_071	SBP18_15	Shark Bay 2018	13/08/2018	112.9565	-26.1528	112.9657	-26.1747	10:31	12:32
SBP18_072	SBP18_15	Shark Bay 2018	13/08/2018	112.9585	-26.1554	112.967	-26.1765	10:33	12:34
SBP18_073	SBP18_15	Shark Bay 2018	13/08/2018	112.9602	-26.157	112.9683	-26.1784	10:35	12:36
SBP18_074	SBP18_15	Shark Bay 2018	13/08/2018	112.9619	-26.1588	112.9692	-26.1808	10:37	12:38
SBP18_075	SBP18_15	Shark Bay 2018	13/08/2018	112.9637	-26.161	112.9712	-26.1821	10:39	12:40
SBP18_076	SBP18_16	Shark Bay 2018	13/08/2018	113.0168	-26.1068	113.0101	-26.1261	10:54	12:54
SBP18_077	SBP18_16	Shark Bay 2018	13/08/2018	113.0182	-26.1092	113.0094	-26.1275	10:57	12:57
SBP18_078	SBP18_16	Shark Bay 2018	13/08/2018	113.0192	-26.1112	113.0092	-26.1295	10:59	12:59
SBP18_079	SBP18_16	Shark Bay 2018	13/08/2018	113.0197	-26.113	113.0094	-26.1311	11:02	13:02
SBP18_080	SBP18_16	Shark Bay 2018	13/08/2018	113.0204	-26.115	113.0098	-26.1326	11:05	13:05
SBP18_081	SBP18_17	Shark Bay 2018	14/08/2018	112.8666	-25.9228	112.8807	-25.9265	08:22	10:22
SBP18_082	SBP18_17	Shark Bay 2018	14/08/2018	112.8681	-25.9211	112.8816	-25.9257	08:24	10:24
SBP18_083	SBP18_17	Shark Bay 2018	14/08/2018	112.8696	-25.9202	112.8826	-25.9246	08:26	10:26
SBP18_084	SBP18_17	Shark Bay 2018	14/08/2018	112.8719	-25.9191	112.8839	-25.9238	08:28	10:28
SBP18_085	SBP18_17	Shark Bay 2018	14/08/2018	112.8739	-25.9178	112.8859	-25.9236	08:30	10:30
SBP18_086	SBP18_18	Shark Bay 2018	14/08/2018	112.9441	-25.8781	112.9543	-25.8794	08:47	10:47
SBP18_087	SBP18_18	Shark Bay 2018	14/08/2018	112.9462	-25.8767	112.9556	-25.8786	08:49	10:49
SBP18_088	SBP18_18	Shark Bay 2018	14/08/2018	112.9487	-25.8757	112.9571	-25.8777	08:51	10:51
SBP18_089	SBP18_18	Shark Bay 2018	14/08/2018	112.9506	-25.8747	112.9584	-25.8768	08:53	10:53
SBP18_090	SBP18_18	Shark Bay 2018	14/08/2018	112.9526	-25.8736	112.9598	-25.876	08:55	10:55
SBP18_091	SBP18_19	Shark Bay 2018	14/08/2018	112.9376	-25.8046	112.9427	-25.8108	11:38	13:38
SBP18_092	SBP18_19	Shark Bay 2018	14/08/2018	112.9376	-25.8026	112.942	-25.8095	11:40	13:40
SBP18_093	SBP18_19	Shark Bay 2018	14/08/2018	112.9372	-25.8007	112.9424	-25.8078	11:42	13:42
SBP18_094	SBP18_19	Shark Bay 2018	14/08/2018	112.9365	-25.7989	112.9419	-25.8063	11:44	13:44
SBP18_095	SBP18_19	Shark Bay 2018	14/08/2018	112.9354	-25.7971	112.941	-25.8019	11:46	13:46
SBP18_096	SBP18_20	Shark Bay 2018	14/08/2018	112.9225	-25.7372	112.9245	-25.7464	12:01	14:01
SBP18_097	SBP18_20	Shark Bay 2018	14/08/2018	112.9222	-25.7351	112.9243	-25.7458	12:03	14:03
SBP18_098	SBP18_20	Shark Bay 2018	14/08/2018	112.9217	-25.7335	112.9244	-25.7443	12:05	14:05
SBP18_099	SBP18_20	Shark Bay 2018	14/08/2018	112.9217	-25.7321	112.9242	-25.7432	12:07	14:07
SBP18_100	SBP18_20	Shark Bay 2018	14/08/2018	112.9222	-25.7304	112.925	-25.7417	12:09	14:09
SBP19_001	SBP19_01	Shark Bay 2019	17/09/2019	113.1048	-26.155	113.1077	-26.15	07:02	09:03
SBP19_002	SBP19_01	Shark Bay 2019	17/09/2019	113.1041	-26.1532	113.1073	-26.148	07:04	09:06
SBP19_003	SBP19_01	Shark Bay 2019	17/09/2019	113.1033	-26.1514	113.1071	-26.1461	07:07	09:10
SBP19_004	SBP19_01	Shark Bay 2019	17/09/2019	113.1024	-26.1495	113.1066	-26.144	07:11	09:14
SBP19_005	SBP19_01	Shark Bay 2019	17/09/2019	113.1015	-26.1479	113.1065	-26.1423	07:15	09:19
SBP19_006	SBP19_02	Shark Bay 2019	17/09/2019	113.0389	-26.1732	113.0357	-26.1746	07:42	09:42
SBP19_007	SBP19_02	Shark Bay 2019	17/09/2019	113.038	-26.1716	113.0343	-26.1735	07:44	09:43
SBP19_008	SBP19_02	Shark Bay 2019	17/09/2019	113.0373	-26.1701	113.0332	-26.1723	07:48	09:50
SBP19_009	SBP19_02	Shark Bay 2019	17/09/2019	113.0362	-26.1685	113.0324	-26.1711	07:49	09:54
SBP19_010	SBP19_02	Shark Bay 2019	17/09/2019	113.0353	-26.1671	113.0318	-26.1698	07:52	09:57
SBP19_011	SBP19_03	Shark Bay 2019	17/09/2019	113.0496	-26.2407	113.0514	-26.242	10:30	12:31
SBP19_012	SBP19_03	Shark Bay 2019	17/09/2019	113.0489	-26.2393	113.0512	-26.2406	10:33	12:33
SBP19_013	SBP19_03	Shark Bay 2019	17/09/2019	113.0481	-26.2376	113.0508	-26.2397	10:36	12:35
SBP19_014	SBP19_03	Shark Bay 2019	17/09/2019	113.0471	-26.2348	113.0505	-26.2346	10:39	12:37
SBP19_015	SBP19_03	Shark Bay 2019	17/09/2019	113.0465	-26.233	113.0507	-26.2344	10:41	12:40
SBP19_016	SBP19_04	Shark Bay 2019	17/09/2019	113.0594	-26.2761	113.04	-26.277	11:02	13:26
SBP19_017	SBP19_04	Shark Bay 2019	17/09/2019	113.0584	-26.2736	113.0389	-26.2754	11:05	13:28
SBP19_018	SBP19_04	Shark Bay 2019	17/09/2019	113.0579	-26.2716	113.0379	-26.2737	11:07	13:30
SBP19_019	SBP19_04	Shark Bay 2019	17/09/2019	113.0573	-26.2698	113.0369	-26.2724	11:09	13:33
SBP19_020	SBP19_04	Shark Bay 2019	17/09/2019	113.0569	-26.2682	113.0369	-26.2723	11:11	13:35
SBP19_021	SBP19_05	Shark Bay 2019	17/09/2019	113.0275	-26.3161	113.0235	-26.3117	14:06	16:05
SBP19_022	SBP19_05	Shark Bay 2019	17/09/2019	113.0269	-26.3143	113.0232	-26.3102	14:11	16:11
SBP19_023	SBP19_05	Shark Bay 2019	17/09/2019	113.0269	-26.3123	113.0228	-26.3082	14:16	16:16
SBP19_024	SBP19_05	Shark Bay 2019	17/09/2019	113.0266	-26.3102	113.0223	-26.3062	14:21	16:22
SBP19_025	SBP19_05	Shark Bay 2019	17/09/2019	113.0261	-26.3083	113.0219	-26.3048	14:25	16:26
SBP19_026	SBP19_06	Shark Bay 2019	17/09/2019	113.0129	-26.3557	112.9995	-26.3459	14:40	16:37
SBP19_027	SBP19_06	Shark Bay 2019	17/09/2019	113.0113	-26.3531	112.9992	-26.3425	14:42	16:39
SBP19_028	SBP19_06	Shark Bay 2019	17/09/2019	113.0105	-26.3513	112.9995	-26.3419	14:45	16:41
SBP19_029	SBP19_06	Shark Bay 2019	17/09/2019	113.0096	-26.3495	112.9991	-26.3411	14:48	16:43
SBP19_030	SBP19_06	Shark Bay 2019	17/09/2019	113.0091	-26.3477	112.9983	-26.3395	14:51	16:47
SBP19_031	SBP19_07	Shark Bay 2019	18/09/2019	113.1549	-26.4471	113.1335	-26.4266	07:26	09:27
SBP19_032	SBP19_07	Shark Bay 2019	18/09/2019	113.1548	-26.4448	113.133	-26.4244	07:29	09:30
SBP19_033	SBP19_07	Shark Bay 2019	18/09/2019	113.1544	-26.4424	113.1325	-26.4222	07:31	09:34
SBP19_034	SBP19_07	Shark Bay 2019	18/09/2019	113.154	-26.4404	113.1318	-26.4201	07:33	09:37
SBP19_035	SBP19_07	Shark Bay 2019	18/09/2019	113.1538	-26.4384	113.1306	-26.4184	07:35	09:40
SBP19_036	SBP19_08	Shark Bay 2019	18/09/2019	113.1935	-26.4188	113.1714	-26.4013	07:49	09:53
SBP19_037	SBP19_08	Shark Bay 2019	18/09/2019	113.1933	-26.4167	113.1711	-26.3993	07:51	09:56
SBP19_038	SBP19_08	Shark Bay 2019	18/09/2019	113.1929	-26.4145	113.1702	-26.3971	07:53	09:59
SBP19_039	SBP19_08	Shark Bay 2019	18/09/2019	113.1924	-26.4126	113.1691	-26.3953	07:55	10:03
SBP19_040	SBP19_08	Shark Bay 2019	18/09/2019	113.1918	-26.4105	113.1681	-26.3931	07:58	10:05
SBP19_041	SBP19_09	Shark Bay 2019	18/09/2019	113.1318	-26.3431	113.1333	-26.3391	10:26	12:30
SBP19_042	SBP19_09	Shark Bay 2019	18/09/2019	113.1325	-26.3415	113.1349	-26.3381	10:29	12:33
SBP19_043	SBP19_09	Shark Bay 2019	18/09/2019	113.1338	-26.34	113.137	-26.3369	10:32	12:36
SBP19_044	SBP19_09	Shark Bay 2019	18/09/2019	113.1353	-26.3385	113.1389	-26.3361	10:35	12:39
SBP19_045	SBP19_09	Shark Bay 2019	18/09/2019	113.1367	-26.3373	113.1406	-26.3355	10:38	12:41
SBP19_046	SBP19_10	Shark Bay 2019	18/09/2019	113.1776	-26.3255	113.1865	-26.3275	10:50	12:57
SBP19_047	SBP19_10	Shark Bay 2019	18/09/2019	113.1793	-26.3248	113.1877	-26.3267	10:53	13:00
SBP19_048	SBP19_10	Shark Bay 2019	18/09/2019	113.1812	-26.3241	113.1894	-26.3258	10:54	13:03
SBP19_049	SBP19_10	Shark Bay 2019	18/09/2019	113.1832	-26.3234	113.1911	-26.325	10:56	13:06
SBP19_050	SBP19_10	Shark Bay 2019	18/09/2019	113.1853	-26.3233	113.1927	-26.3249	10:58	13:09
SBP19_051	SBP19_11	Shark Bay 2019	18/09/2019	113.2102	-26.2819	113.2075	-26.2802	13:30	15:36
SBP19_052	SBP19_11	Shark Bay 2019	18/09/2019	113.2128	-26.2801	113.2091	-26.279	13:33	15:39
SBP19_053	SBP19_11	Shark Bay 2019	18/09/2019	113.2137	-26.2796	113.2107	-26.2779	13:36	15:42
SBP19_054	SBP19_11	Shark Bay 2019	18/09/2019	113.2154	-26.2789	113.212	-26.2769	13:39	15:45
SBP19_055	SBP19_11	Shark Bay 2019	18/09/2019	113.217	-26.2782	113.2135	-26.2765	13:41	15:49
SBP19_056	SBP19_12	Shark Bay 2019	18/09/2019	113.1804	-26.2424	113.1986	-26.2416	13:55	16:14
SBP19_057	SBP19_12	Shark Bay 2019	18/09/2019	113.1822	-26.2417	113.2003	-26.2407	13:58	16:17
SBP19_058	SBP19_12	Shark Bay 2019	18/09/2019	113.1841	-26.2406	113.2026	-26.24	14:01	16:20
SBP19_059	SBP19_12	Shark Bay 2019	18/09/2019	113.1857	-26.2397	113.2048	-26.2392	14:03	16:23
SBP19_060	SBP19_12	Shark Bay 2019	18/09/2019	113.188	-26.2383	113.2068	-26.2389	14:06	16:26
SBP19_061	SBP19_13	Shark Bay 2019	23/09/2019	113.005	-26.0019	112.9993	-26.0046	06:42	08:50
SBP19_062	SBP19_13	Shark Bay 2019	23/09/2019	113.0031	-26.001	112.9979	-26.0041	06:44	08:54
SBP19_063	SBP19_13	Shark Bay 2019	23/09/2019	113.0011	-26.0001	112.9964	-26.0033	06:47	08:58
SBP19_064	SBP19_13	Shark Bay 2019	23/09/2019	112.9991	-25.9993	112.9947	-26.0027	06:50	09:00

SBP19_065	SBP19_13	Shark Bay 2019	23/09/2019	112.9975	-25.9982	112.9929	-26.0023	06:52	09:04
SBP19_066	SBP19_14	Shark Bay 2019	23/09/2019	112.9503	-26.0097	112.9048	-25.9854	07:05	09:47
SBP19_067	SBP19_14	Shark Bay 2019	23/09/2019	112.9478	-26.0092	112.9028	-25.9856	07:07	09:50
SBP19_068	SBP19_14	Shark Bay 2019	23/09/2019	112.9455	-26.0082	112.8985	-25.9843	07:09	09:53
SBP19_069	SBP19_14	Shark Bay 2019	23/09/2019	112.943	-26.0069	112.8964	-25.9839	07:11	09:56
SBP19_070	SBP19_14	Shark Bay 2019	23/09/2019	112.9409	-26.0057	112.8951	-25.9838	07:13	09:59
SBP19_071	SBP19_15	Shark Bay 2019	23/09/2019	112.9892	-25.8666	112.9841	-25.8739	10:39	12:41
SBP19_072	SBP19_15	Shark Bay 2019	23/09/2019	112.9872	-25.8668	112.9825	-25.8747	10:41	12:44
SBP19_073	SBP19_15	Shark Bay 2019	23/09/2019	112.985	-25.8668	112.9811	-25.8748	10:44	12:47
SBP19_074	SBP19_15	Shark Bay 2019	23/09/2019	112.9833	-25.8668	112.9795	-25.8749	10:47	12:49
SBP19_075	SBP19_15	Shark Bay 2019	23/09/2019	112.9813	-25.8668	112.9778	-25.8754	10:50	13:00
SBP19_076	SBP19_16	Shark Bay 2019	23/09/2019	112.9437	-25.8756	112.938	-25.8855	10:58	13:04
SBP19_077	SBP19_16	Shark Bay 2019	23/09/2019	112.9417	-25.8765	112.9365	-25.8866	11:00	13:07
SBP19_078	SBP19_16	Shark Bay 2019	23/09/2019	112.9399	-25.8772	112.9346	-25.8877	11:03	13:11
SBP19_079	SBP19_16	Shark Bay 2019	23/09/2019	112.9377	-25.8779	112.9328	-25.8883	11:06	13:14
SBP19_080	SBP19_16	Shark Bay 2019	23/09/2019	112.9358	-25.8783	112.931	-25.8887	11:09	13:17
SBP19_081	SBP19_17	Shark Bay 2019	23/09/2019	112.9465	-25.7749	112.947	-25.7892	13:50	15:52
SBP19_082	SBP19_17	Shark Bay 2019	23/09/2019	112.9446	-25.7759	112.9455	-25.791	13:53	15:54
SBP19_083	SBP19_17	Shark Bay 2019	23/09/2019	112.9429	-25.7767	112.9442	-25.7926	13:55	15:56
SBP19_084	SBP19_17	Shark Bay 2019	23/09/2019	112.9407	-25.7775	112.9428	-25.7939	13:57	15:58
SBP19_085	SBP19_17	Shark Bay 2019	23/09/2019	112.9388	-25.7781	112.9414	-25.7953	13:59	16:00
SBP19_086	SBP19_18	Shark Bay 2019	23/09/2019	112.8965	-25.7711	112.8968	-25.7811	14:08	16:15
SBP19_087	SBP19_18	Shark Bay 2019	23/09/2019	112.8945	-25.7716	112.8956	-25.7819	14:12	16:18
SBP19_088	SBP19_18	Shark Bay 2019	23/09/2019	112.894	-25.7719	112.8938	-25.7823	14:14	16:20
SBP19_089	SBP19_18	Shark Bay 2019	23/09/2019	112.8922	-25.7722	112.8922	-25.7827	14:16	16:22
SBP19_090	SBP19_18	Shark Bay 2019	23/09/2019	112.8891	-25.7727	112.8907	-25.7833	14:18	16:24
SBP19_091	SBP19_19	Shark Bay 2019	24/09/2019	113.0476	-26.0873	113.0315	-26.0625	07:05	09:26
SBP19_092	SBP19_19	Shark Bay 2019	24/09/2019	113.0468	-26.0851	113.0302	-26.0605	07:08	09:30
SBP19_093	SBP19_19	Shark Bay 2019	24/09/2019	113.0459	-26.0829	113.0293	-26.058	07:18	09:34
SBP19_094	SBP19_19	Shark Bay 2019	24/09/2019	113.0445	-26.0791	113.0283	-26.0557	07:21	09:38
SBP19_095	SBP19_19	Shark Bay 2019	24/09/2019	113.044	-26.0782	113.027	-26.0535	07:25	09:42
SBP19_096	SBP19_20	Shark Bay 2019	24/09/2019	113.0051	-26.0693	112.9884	-26.0527	07:36	09:53
SBP19_097	SBP19_20	Shark Bay 2019	24/09/2019	113.0045	-26.068	112.9873	-26.0509	07:39	09:56
SBP19_098	SBP19_20	Shark Bay 2019	24/09/2019	113.0035	-26.0661	112.9854	-26.0492	07:42	09:59
SBP19_099	SBP19_20	Shark Bay 2019	24/09/2019	113.0027	-26.0641	112.984	-26.0472	07:45	10:02
SBP19_100	SBP19_20	Shark Bay 2019	24/09/2019	113.0017	-26.0619	112.9826	-26.0452	07:48	10:05
SBP21_001	SBP21_01	Shark Bay 2021	23/08/2021	113.1109	-26.1512	113.1061	-26.1461	07:51	09:51
SBP21_002	SBP21_01	Shark Bay 2021	23/08/2021	113.1099	-26.1498	113.106	-26.1448	07:56	09:54
SBP21_003	SBP21_01	Shark Bay 2021	23/08/2021	113.1091	-26.1484	113.1054	-26.1433	07:59	10:04
SBP21_004	SBP21_01	Shark Bay 2021	23/08/2021	113.1081	-26.1467	113.1045	-26.1417	08:03	10:08
SBP21_005	SBP21_01	Shark Bay 2021	23/08/2021	113.107	-26.1449	113.1038	-26.1399	08:06	10:12
SBP21_006	SBP21_02	Shark Bay 2021	23/08/2021	113.0866	-26.1758	113.0831	-26.1802	08:23	10:38
SBP21_007	SBP21_02	Shark Bay 2021	23/08/2021	113.0853	-26.1741	113.0829	-26.1786	08:28	10:43
SBP21_008	SBP21_02	Shark Bay 2021	23/08/2021	113.0846	-26.1732	113.0832	-26.1773	08:30	10:46
SBP21_009	SBP21_02	Shark Bay 2021	23/08/2021	113.0832	-26.1713	113.0828	-26.1762	08:35	10:49
SBP21_010	SBP21_02	Shark Bay 2021	23/08/2021	113.0822	-26.1695	113.0831	-26.1755	08:39	10:52
SBP21_011	SBP21_03	Shark Bay 2021	23/08/2021	113.0481	-26.0904	113.0503	-26.0801	11:38	13:39
SBP21_012	SBP21_03	Shark Bay 2021	23/08/2021	113.0469	-26.0889	113.0492	-26.0776	11:42	13:42
SBP21_013	SBP21_03	Shark Bay 2021	23/08/2021	113.046	-26.0872	113.0484	-26.076	11:45	13:46
SBP21_014	SBP21_03	Shark Bay 2021	23/08/2021	113.0454	-26.0852	113.0474	-26.0734	11:48	13:51
SBP21_015	SBP21_03	Shark Bay 2021	23/08/2021	113.0446	-26.0831	113.0467	-26.0714	11:52	13:55
SBP21_016	SBP21_04	Shark Bay 2021	23/08/2021	NA	NA	NA	NA	NA	NA
SBP21_017	SBP21_04	Shark Bay 2021	23/08/2021	113.0117	-26.1058	113.021	-26.0984	12:06	14:16
SBP21_018	SBP21_04	Shark Bay 2021	23/08/2021	113.0116	-26.1038	113.021	-26.0968	12:09	14:24
SBP21_019	SBP21_04	Shark Bay 2021	23/08/2021	113.0115	-26.102	113.0217	-26.0953	12:12	14:30
SBP21_020	SBP21_04	Shark Bay 2021	23/08/2021	113.0116	-26.1	113.0223	-26.0937	12:15	14:34
SBP21_021	SBP21_05	Shark Bay 2021	24/08/2021	113.0082	-26.0033	113.0005	-25.9898	07:09	09:09
SBP21_022	SBP21_05	Shark Bay 2021	24/08/2021	113.0064	-26.0017	112.9984	-25.9884	07:12	09:12
SBP21_023	SBP21_05	Shark Bay 2021	24/08/2021	113.0049	-26.0004	112.996	-25.9873	07:14	09:17
SBP21_024	SBP21_05	Shark Bay 2021	24/08/2021	113.0031	-25.999	112.9941	-25.9859	07:17	09:22
SBP21_025	SBP21_05	Shark Bay 2021	24/08/2021	113.0016	-25.9977	112.9924	-25.985	07:24	09:26
SBP21_026	SBP21_06	Shark Bay 2021	24/08/2021	112.9506	-26.0101	112.9462	-26.0032	07:45	09:40
SBP21_027	SBP21_06	Shark Bay 2021	24/08/2021	112.9486	-26.0088	112.9438	-26.0023	07:48	09:45
SBP21_028	SBP21_06	Shark Bay 2021	24/08/2021	112.9465	-26.0071	112.942	-26.0015	07:54	09:48
SBP21_029	SBP21_06	Shark Bay 2021	24/08/2021	112.944	-26.005	112.9403	-26.0003	07:58	09:53
SBP21_030	SBP21_06	Shark Bay 2021	24/08/2021	112.943	-26.0044	112.9391	-25.9989	08:01	09:57
SBP21_031	SBP21_07	Shark Bay 2021	24/08/2021	112.9143	-25.9304	112.9059	-25.9253	10:19	12:19
SBP21_032	SBP21_07	Shark Bay 2021	24/08/2021	112.9122	-25.9288	112.9042	-25.9243	10:23	12:22
SBP21_033	SBP21_07	Shark Bay 2021	24/08/2021	112.9108	-25.927	112.9033	-25.9224	10:25	12:27
SBP21_034	SBP21_07	Shark Bay 2021	24/08/2021	112.909	-25.9252	112.9017	-25.9211	10:28	12:31
SBP21_035	SBP21_07	Shark Bay 2021	24/08/2021	112.908	-25.9238	112.9001	-25.92	10:32	12:36
SBP21_036	SBP21_08	Shark Bay 2021	24/08/2021	112.9316	-25.8833	112.9237	-25.8749	10:45	12:50
SBP21_037	SBP21_08	Shark Bay 2021	24/08/2021	112.9297	-25.8819	112.9223	-25.874	10:48	12:54
SBP21_038	SBP21_08	Shark Bay 2021	24/08/2021	112.9286	-25.8808	112.9214	-25.8727	10:49	12:57
SBP21_039	SBP21_08	Shark Bay 2021	24/08/2021	112.9266	-25.8796	112.9199	-25.8714	10:52	13:02
SBP21_040	SBP21_08	Shark Bay 2021	24/08/2021	112.9251	-25.8782	112.9188	-25.8696	10:54	13:07
SBP21_041	SBP21_09	Shark Bay 2021	24/08/2021	112.9177	-25.7773	112.9238	-25.7729	13:30	15:32
SBP21_042	SBP21_09	Shark Bay 2021	24/08/2021	112.9196	-25.776	112.9251	-25.7728	13:35	15:35
SBP21_043	SBP21_09	Shark Bay 2021	24/08/2021	112.9212	-25.7748	112.9263	-25.7722	13:37	15:40
SBP21_044	SBP21_09	Shark Bay 2021	24/08/2021	112.9223	-25.7737	112.9272	-25.7712	13:39	15:45
SBP21_045	SBP21_09	Shark Bay 2021	24/08/2021	112.9241	-25.7728	112.9282	-25.7701	13:43	15:50
SBP21_046	SBP21_10	Shark Bay 2021	24/08/2021	112.9411	-25.8191	112.9436	-25.8143	13:56	16:02
SBP21_047	SBP21_10	Shark Bay 2021	24/08/2021	112.9425	-25.8176	112.9458	-25.8142	13:59	16:06
SBP21_048	SBP21_10	Shark Bay 2021	24/08/2021	112.9442	-25.8165	112.948	-25.8137	14:02	16:11
SBP21_049	SBP21_10	Shark Bay 2021	24/08/2021	112.946	-25.8153	112.9497	-25.8133	14:04	16:16
SBP21_050	SBP21_10	Shark Bay 2021	24/08/2021	112.9477	-25.8145	112.9519	-25.8122	14:06	16:21
SBP21_051	SBP21_11	Shark Bay 2021	25/08/2021	113.2639	-26.5247	113.2729	-26.5279	07:38	09:39
SBP21_052	SBP21_11	Shark Bay 2021	25/08/2021	113.2657	-26.5233	113.2742	-26.5265	07:41	09:43
SBP21_053	SBP21_11	Shark Bay 2021	25/08/2021	113.267	-26.5221	113.2753	-26.5254	07:43	09:46
SBP21_054	SBP21_11	Shark Bay 2021	25/08/2021	113.2687	-26.5211	113.2768	-26.5244	07:45	09:50
SBP21_055	SBP21_11	Shark Bay 2021	25/08/2021	113.2701	-26.5197	113.278	-26.523	07:47	09:52
SBP21_056	SBP21_12	Shark Bay 2021	25/08/2021	113.223	-26.5133	113.2256	-26.5163	07:59	10:07
SBP21_057	SBP21_12	Shark Bay 2021	25/08/2021	113.2249	-26.5126	113.2274	-26.5155	08:01	10:11
SBP21_058	SBP21_12	Shark Bay 2021	25/08/2021	113.2267	-26.5116	113.2293	-26.5149	08:03	10:14
SBP21_059	SBP21_12	Shark Bay 2021	25/08/2021	113.2284	-26.5107	113.2312	-26.5145	08:04	10:17
SBP21_060	SBP21_12	Shark Bay 2021	25/08/2021	113.2302	-26.5097	113.2333	-26.5139	08:06	10:19
SBP21_061	SBP21_13	Shark Bay 2021	25/08/2021	113.1828	-26.4603	113.1918	-26.4638	10:38	12:37
SBP21_062	SBP21_13	Shark Bay 2021	25/08/2021	113.1846	-26.4592	113.1933	-26.4622	10:41	12:40
SBP21_063	SBP21_13	Shark Bay 2021	25/08/2021	113.1862	-26.4581	113.1948	-26.4609	10:43	02:44
SBP21_064	SBP21_13	Shark Bay 2021	25/08/2021	113.1877	-26.4568	113.1965	-26.4596	10:45	12:49
SBP21_065	SBP21_13	Shark Bay 2021	25/08/2021	113.1897	-26.4554	113.1982	-26.4587	10:47	12:52
SBP21_066	SBP21_14	Shark Bay 2021	25/08/2021	113.2339	-26.4432	113.2401	-26.444	10:58	13:07
SBP21_067	SBP21_14	Shark Bay 2021	25/08/2021	113.2352	-26.442	113.2412	-26.4423	11:01	13:11
SBP21_068	SBP21_14	Shark Bay 2021	25/08/2021	113.2365	-26.4405	113.2422	-26.4408	11:03	13:14
SBP21_069	SBP21_14	Shark Bay 2021	25/08/2021	113.2378	-26.4395	113.2431	-26.4394	11:05	13:18
SBP21_070	SBP21_14	Shark Bay 2021	25/08/2021	113.2392	-26.4381	113.2443	-26.438	11:07	13:21
SBP21_071	SBP21_15	Shark Bay 2021	25/08/2021	113.1395	-26.3957	113.1554	-26.397	13:46	15:48
SBP21_072	SBP21_15	Shark Bay 2021	25/08/2021	113.1418	-26.3942	113.1565	-26.3953	13:50	15:52
SBP21_073	SBP21_15	Shark Bay 2021	25/08/2021	113.1433	-26.393	113.1574	-26.394	13:52	15:54
SBP21_074	SBP21_15	Shark Bay 2021	25/08/2021	113.1449	-26.3918	113.1586	-26.3924	13:54	15:57
SBP21_075	SBP21_15	Shark Bay 2021	25/08/2021	113.1468	-26.3912	113.1601	-26.3909	13:56	16:01
SBP21_076	SBP21_16	Shark Bay 2021	25/08/2021	113.1529	-26.3507	113.1597	-26.3458	14:08	16:26
SBP21_077	SBP21_16	Shark Bay 2021	25/08/2021	113.1547	-26.3493	113.1604	-26.3442	14:10	16:30
SBP21_078	SBP21_16	Shark Bay 2021	25/08/2021	113.1563	-26.3481	113.1613	-26.3424	14:12	16:32
SBP21_079	SBP21_16	Shark Bay 2021	25/08/2021	113.1582	-26.3472	113.1622	-26.3406	14:14	16:35
SBP21_080	SBP21_16	Shark Bay 2021	25/08/2021	113.1602	-26.3461	113.1637	-26.3399	14:16	16:38
SBP21_081	SBP21_17	Shark Bay 2021	26/08/2021	113.1037	-26.2972	113.1007	-26.2946	07:32	09:26
SBP21_082	SBP21_17	Shark Bay 2021	26/08/2021	113.1047	-26.2956	113.1015	-26.293	07:34	09:31
SBP21_083	SBP21_17	Shark Bay 2021	26/08/2021	113.1058	-26.2942	113.1018	-26.2912	07:36	09:36
SBP21_084	SBP21_17	Shark Bay 2021	26/08/2021	113.1069	-26.2927	113.1022	-26.2894	07:38	09:42
SBP21_085	SBP21_17	Shark Bay 2021	26/08/2021	113.1078	-26.2911	113.1025	-26.2872	07:39	09:47
SBP21_086	SBP21_18	Shark Bay 2021	26/08/2021	113.1495	-26.2867	113.1433	-26.2807	07:53	10:01
SBP21_087	SBP21_18	Shark Bay 2021	26/08/2021	113.1506	-26.2845	113.1444	-26.2795	07:58	10:05
SBP21_088	SBP21_18	Shark Bay 2021	26/08/2021	113.1515	-26.2835	113.1453	-26.2782	08:00	10:05
SBP21_089	SBP21_18	Shark Bay 2021	26/08/2021	113.1523	-26.2818	113.1464	-26.2767	08:03	10:10
SBP21_090	SBP21_18	Shark Bay 2021	26/08/2021	113.1537	-26.2804	113.1476	-26.275	08:06	10:14
SBP21_091	SBP21_19	Shark Bay 2021	26/08/2021	113.1252	-26.2244	113.1252	-26.2212	10:38	12:38
SBP21_092	SBP21_19	Shark Bay 2021	26/08/2021	113.1259	-26.2223	113.1252	-26.2191	10:41	12:40
SBP21_093	SBP21_19	Shark Bay 2021	26/08/2021	113.1268	-26.2208	113.1261	-26.2175	10:42	12:43
SBP21_094	SBP21_19	Shark Bay 2021	26/08/2021	113.1277	-26.2195	113.1262	-26.2168	10:44	12:46
SBP21_095	SBP21_19	Shark Bay 2021	26/08/2021	113.1288	-26.218	113.1264	-26.215	10:46	12:49
SBP21_096	SBP21_20	Shark Bay 2021	26/08/2021	113.1457	-26.1889	113.152	-26.1913	10:58	13:10
SBP21_097	SBP21_20	Shark Bay 2021	26/08/2021	113.1464	-26.1873	113.1527	-26.1898	11:07	13:13
SBP21_098	SBP21_20	Shark Bay 2021	26/08/2021	113.1469	-26.1857	113.1541	-26.1884	11:03	13:18
SBP21_099	SBP21_20	Shark Bay 2021	26/08/2021	113.1474	-26.1839	113.1554	-26.1868	11:05	13:23
SBP21_100	SBP21_20	Shark Bay 2021	26/08/2021	113.1481	-26.1821	113.1567	-26.1853	11:07	13:27

Appendix Table 2. Aggregated list of species recorded across Shark Bay BRUVs surveys from 2017,2018,2019 and 2021. Species are listed alphabetically by family. Those with a dash in No. FL had length estimates taken from a Western Australian BRUVs dataset.

Family	Binomial	Benthic MaxN	Pelagic MaxN	Total MaxN	No. FL	Mean FL (cm)	SE FL (cm)
Acanthuridae	Acanthurus olivaceus	11	0	11	8	26.58	0.9836
Acanthuridae	Acanthurus sp	100	0	100	51	30.75	1.4245
Acanthuridae	Acanthurus triostegus	17	0	17	4	18.5	1.0576
Acanthuridae	Ctenochaetus sp	1	0	1	-	13.7	-
Acanthuridae	Naso brachycentron	2	0	2	2	10	0.8983
Acanthuridae	Naso hexacanthus	5	0	5	4	40.14	2.8345
Acanthuridae	Naso sp	23	0	23	8	43.17	1.965
Acanthuridae	Naso tonganus	7	0	7	4	47.47	0.7247
Acanthuridae	Naso unicornis	9	0	9	6	38.53	2.3184
Albulidae	Albula argentea	36	0	36	16	61.66	1.0756
Apogonidae	Ostorhinchus aureus	5	0	5	4	10.85	0.2406
Apogonidae	Ostorhinchus taeniophorus	1	0	1	1	9.75	-
Balaenopteridae	Megaptera novaeangliae	1	0	1	-	1023.03	-
Balaenopteridae	Balaenoptera acutorostrata	0	8	8	3	413.85	9.9112
Balistidae	Abalistes stellatus	2	0	2	1	40.37	-
Balistidae	Balistidae sp	1	0	1	-	23.75	-
Balistidae	Rhinecanthus aculeatus	3	0	3	1	18.68	-
Balistidae	Sufflamen chrysopterum	26	0	26	5	19.9	0.7661
Balistidae	Sufflamen fraenatum	67	0	67	39	29.53	1.1469
Balistidae	Sufflamen sp	9	0	9	3	20.03	0.0702
Blenniidae	Aspidontus dussumieri	1	0	1	-	7.1	-
Blenniidae	Aspidontus taeniatus	7	0	7	5	6.54	0.3089
Blenniidae	Blenniidae sp	11	0	11	3	7.18	1.1518
Blenniidae	Cirripectes hutchinsi	3	0	3	1	8.06	-
Blenniidae	Ecsenius lineatus	1	0	1	-	5.9	-
Blenniidae	Meiacanthus grammistes	1	0	1	1	9.62	-
Blenniidae	Plagiotremus rhinorhynchos	14	0	14	7	7.25	0.5686
Blenniidae	Plagiotremus tapeinosoma	1	0	1	-	6.6	-
Caesionidae	Caesio sp	14	0	14	10	16.68	0.5459
Caesionidae	Caesionidae sp	97	0	97	4	16.4	1.0456
Caesionidae	Pterocaesio digramma	9	0	9	7	18.13	0.437
Caesionidae	Pterocaesio marri	278	0	278	29	21.24	0.8314
Caesionidae	Pterocaesio sp	661	0	661	63	17.01	1.4602
Carangidae	Carangidae sp	760	2910	3670	463	4.7	2.8833
Carangidae	Carangoides fulvoguttatus	110	0	110	37	49.21	2.1507
Carangidae	Carangoides gymnostethus	1	0	1	-	37	-
Carangidae	Carangoides orthogrammus	1	0	1	1	31.93	-
Carangidae	Carangoides sp	3	189	192	71	4.12	1.1296
Carangidae	Caranx heberi	14	0	14	-	63.1	-
Carangidae	Caranx sp	86	1087	1173	101	4.2	2.0558
Carangidae	Decapterus sp	265	1714	1979	199	14.2	2.5564
Carangidae	Gnathanodon speciosus	15	0	15	7	27.23	4.9857
Carangidae	Pseudocaranx sp	2951	0	2951	63	6.96	1.228
Carangidae	Selar sp	59	0	59	17	5.72	0.5969
Carangidae	Seriola hippos	23	0	23	13	91.02	2.1204
Carangidae	Seriola lalandi	14	0	14	11	77.98	2.7464
Carangidae	Seriola rivoliana	36	0	36	5	19.83	0.8349
Carangidae	Atule mate	0	2	2	1	29.94	-
Carangidae	Naucrates ductor	0	2	2	1	11.44	-
Carangidae	Seriola dumerili	0	1	1	1	15.61	-
Carangidae	Seriola sp	0	4	4	3	16.96	1.5458
Carcharhinidae	Carcharhinidae sp	1	2	3	-	106.5	-
Carcharhinidae	Carcharhinus brachyurus	1	1	2	1	206.96	-
Carcharhinidae	Carcharhinus brevipinna	24	59	83	54	140.54	2.5677
Carcharhinidae	Carcharhinus limbatus	9	6	15	8	173.13	1.9656
Carcharhinidae	Carcharhinus obscurus	2	170	172	102	198.85	2.3946
Carcharhinidae	Carcharhinus plumbeus	5	68	73	45	140.93	1.9538
Carcharhinidae	Carcharhinus sp	12	41	53	15	198.4	3.5402
Carcharhinidae	Galeocerdo cuvier	3	1	4	2	184.62	0.423
Carcharhinidae	Triaenodon obesus	1	0	1	1	132.54	-
Carcharhinidae	Carcharhinus falciformis	0	1	1	1	196.87	-
Carcharhinidae	Carcharhinus sorrah	0	2	2	1	85.04	-
Chaetodontidae	Chaetodon assarius	133	0	133	53	10.66	0.6311
Chaetodontidae	Chaetodon aureofasciatus	1	0	1	-	9.4	-
Chaetodontidae	Chaetodon auriga	1	0	1	-	15.3	-
Chaetodontidae	Chaetodon lineolatus	3	0	3	2	24.29	0.2246
Chaetodontidae	Chaetodon lunula	17	0	17	6	20.11	0.246
Chaetodontidae	Chaetodon plebeius	42	0	42	14	12.09	0.5203
Chaetodontidae	Chaetodon sp	1	0	1	-	10.5	-
Chaetodontidae	Chelmon marginalis	4	0	4	1	11.7	-
Chaetodontidae	Coradion altivelis	1	0	1	-	12.2	-
Chaetodontidae	Coradion chrysozonus	3	0	3	-	11.4	-
Chaetodontidae	Heniochus acuminatus	1	0	1	-	17.8	-
Chaetodontidae	Heniochus diphreutes	3	0	3	1	23.2	-
Chaetodontidae	Heniochus sp	3	0	3	1	20.62	-
Chanidae	Chanos chanos	1	0	1	-	71.5	-
Cheloniidae	Chelonia mydas	7	0	7	2	66.54	3.0423
Cheloniidae	Chelonia sp	1	0	1	-	0	-
Cheloniidae	Cheloniidae sp	5	0	5	-	0	-
Class:Cephalopoda	Teuthida sp	0	1	1	1	12.85	-
Clupeidae	Clupeidae sp	80	0	80	-	7	-
Coryphaenidae	Coryphaena hippurus	0	5	5	-	640.19	-
Dasyatidae	Bathytoshia brevicaudata	1	0	1	-	84.7	-
Dasyatidae	Dasyatidae sp	4	0	4	1	42.59	-
Dasyatidae	Neotrygon australiae	4	0	4	1	31.28	-
Dasyatidae	Neotrygon sp	4	0	4	-	51.4	-
Delphinidae	Tursiops sp	5	0	5	-	0	-
Echeneidae	Echeneis naucrates	79	247	326	191	54.36	2.669
Elapidae	Disteira major	1	0	1	1	110.25	-
Elapidae	Hydrophis sp	6	1	7	-	110.2	-
Elapidae	Elapidae sp	0	5	5	-	1102	-
Elapidae	Hydrophis elegans	0	4	4	1	146.13	-
Ephippidae	Platax batavianus	2	0	2	2	49.01	1.6898
Ephippidae	Platax orbicularis	1	0	1	-	41.5	-
Ephippidae	Platax sp	6	0	6	1	49.8	-
Gobiidae	Gobiidae sp	1	0	1	-	5.9	-
Grammistidae	Grammistes sexlineatus	1	0	1	-	7.6	-
Haemulidae	Diagramma labiosum	14	0	14	6	57.62	1.6737
Haemulidae	Plectorhinchus albovittatus	2	0	2	2	45.39	3.0233
Haemulidae	Plectorhinchus caeruleonothus	15	0	15	13	58.28	0.8001
Haemulidae	Plectorhinchus flavomaculatus	51	0	51	30	39.86	1.734
Haemulidae	Plectorhinchus sp	2	0	2	1	43.1	-
Hemiscylliidae	Chiloscyllium punctatum	2	0	2	1	67.22	-
Holocentridae	Sargocentron rubrum	1	0	1	-	16.5	-
Istiophoridae	Istiompax indica	0	3	3	1	165.62	-
Istiophoridae	Istiophorus platypterus	0	2	2	1	166.38	-
Juvenile	Juvenile sp	6	758	764	73	2.38	0.5819
Kyphosidae	Kyphosus bigibbus	116	0	116	39	49.41	1.1179
Kyphosidae	Kyphosus cornelii	270	0	270	99	28.75	0.9718
Kyphosidae	Kyphosus sp	49	0	49	-	45	-
Kyphosidae	Kyphosus sydneyanus	4	0	4	3	50.2	0.2585
Labridae	Anampses caeruleopunctatus	6	0	6	1	26.78	-
Labridae	Anampses geographicus	160	0	160	50	11.38	1.2915
Labridae	Anampses meleagrides	3	0	3	2	21.95	0.6367
Labridae	Anampses sp	1	0	1	-	11.81	-
Labridae	Bodianus axillaris	4	0	4	3	12.52	1.8579
Labridae	Bodianus bilunulatus	43	0	43	27	30.9	1.3961
Labridae	Cheilinus chlorourus	1	0	1	1	9.9	-
Labridae	Cheilinus sp	1	0	1	-	14.8	-
Labridae	Cheilinus trilobatus	1	0	1	-	22.6	-
Labridae	Cheilio inermis	1	0	1	-	21.3	-
Labridae	Choerodon cauteroma	41	0	41	22	31.86	1.3744
Labridae	Choerodon cephalotes	1	0	1	-	20.9	-
Labridae	Choerodon cyanodus	1	0	1	-	24.4	-
Labridae	Choerodon rubescens	163	0	163	81	40.01	1.977
Labridae	Choerodon sp	1	0	1	1	36.47	-
Labridae	Cirrhilabrus punctatus	2	0	2	2	12.24	0.1285
Labridae	Cirrhilabrus sp	6	0	6	2	10.5	0.436
Labridae	Cirrhilabrus temminckii	3	0	3	2	10.6	0.3961
Labridae	Coris auricularis	1496	0	1496	395	15.79	2.0046
Labridae	Coris aygula	2	0	2	1	46.07	-
Labridae	Coris caudimacula	71	0	71	30	14.52	1.1601
Labridae	Coris sp	1	0	1	-	8.6	-
Labridae	Gomphosus varius	1	0	1	1	23.83	-
Labridae	Halichoeres brownfieldi	3	0	3	-	8.8	-
Labridae	Halichoeres melanurus	1	0	1	-	6.8	-
Labridae	Halichoeres nebulosus	34	0	34	8	7.31	0.5941
Labridae	Halichoeres sp	4	0	4	1	7.25	-
Labridae	Hemigymnus fasciatus	2	0	2	-	19.9	-
Labridae	Hemigymnus melapterus	2	0	2	-	24.3	-
Labridae	Iniistius sp	3	0	3	1	19.82	-
Labridae	Labridae sp	22	0	22	2	6.77	1.5878
Labridae	Labroides dimidiatus	84	0	84	39	7.43	0.607
Labridae	Macropharyngodon ornatus	1	0	1	-	8.5	-
Labridae	Macropharyngodon sp	1	0	1	-	8	-
Labridae	Notolabrus parilus	28	0	28	7	21.98	1.131
Labridae	Ophthalmolepis lineolata	9	0	9	6	14.91	1.2253
Labridae	Pseudojuloides sp	3	0	3	1	9.63	-
Labridae	Stethojulis bandanensis	8	0	8	1	7.79	-
Labridae	Stethojulis sp	5	0	5	4	7.44	0.4815
Labridae	Suezichthys cyanolaemus	64	0	64	24	9.82	0.6005
Labridae	Thalassoma lunare	120	0	120	50	17.05	1.0762
Labridae	Thalassoma lutescens	222	0	222	109	19.22	1.0849
Labridae	Thalassoma purpureum	6	0	6	-	8.2	-
Labridae	Thalassoma septemfasciatum	68	0	68	30	19.43	1.5762
Lamnidae	isurus oxyrinchus	0	3	3	3	72.39	2.8576
Latridae	Goniistius gibbosus	2	0	2	-	23.3	-
Latridae	Goniistius rubrolabiatus	3	0	3	-	48.7	-
Lethrinidae	Lethrinus atkinsoni	31	0	31	14	32.94	0.9168
Lethrinidae	Lethrinus laticaudis	57	0	57	26	32.26	1.3033
Lethrinidae	Lethrinus lentjan	32	0	32	17	30.05	2.0418
Lethrinidae	Lethrinus miniatus	54	0	54	33	37.34	1.9476
Lethrinidae	Lethrinus nebulosus	114	0	114	54	51.58	1.6971
Lethrinidae	Lethrinus punctulatus	11	0	11	4	26.07	1.0902
Lethrinidae	Lethrinus rubrioperculatus	4	0	4	1	41.89	-
Lethrinidae	Lethrinus sp	8	0	8	1	29.31	-
Lethrinidae	Lethrinus variegatus	1	0	1	1	19.71	-
Loliginidae	Sepioteuthis sp	1	0	1	-	25.1	-
Lutjanidae	Lutjanus carponotatus	31	0	31	17	33.46	1.2767
Lutjanidae	Lutjanus fulviflamma	2	0	2	1	27.95	-
Lutjanidae	Lutjanus lemniscatus	12	0	12	6	41.35	1.0253
Lutjanidae	Lutjanus lutjanus	260	0	260	30	16.03	0.7179
Lutjanidae	Lutjanus quinquelineatus	12	0	12	1	28.22	-
Lutjanidae	Lutjanus sp	1	0	1	1	34.76	-
Lutjanidae	Lutjanus vitta	2	0	2	2	29.68	0.5258
Mobulidae	Mobula alfredi	1	0	1	-	173.2	-
Mobulidae	Mobula thurstoni	8	0	8	-	10.24	-
Monacanthidae	Aluterus scriptus	3	7	10	6	26.34	6.4797
Monacanthidae	Cantherhines fronticinctus	1	0	1	1	24.78	-
Monacanthidae	Meuschenia sp	1	28	29	10	4.3	0.598
Monacanthidae	Monacanthidae sp	2	11	13	9	6.3	2.5124
Monacanthidae	Monacanthus chinensis	1	0	1	-	13.6	-
Monacanthidae	Aluterus scriptus	3	7	10	6	26.34	6.4797
Monacanthidae	Aluterus sp	0	1	1	1	4.14	-
Monacanthidae	Eubalichthys caeruleoguttatus	0	6	6	2	4.1	0.4132
Mullidae	Mullidae sp	5	0	5	3	14.53	0.2382
Mullidae	Parupeneus barberinoides	6	0	6	6	11.88	0.8227
Mullidae	Parupeneus chrysopleuron	27	0	27	18	14.34	1.0649
Mullidae	Parupeneus cyclostomus	3	0	3	2	15.19	0.1432
Mullidae	Parupeneus indicus	3	0	3	2	19.91	0.5973
Mullidae	Parupeneus multifasciatus	5	0	5	4	12.21	1.6859
Mullidae	Parupeneus sp	2	0	2	1	12.61	-
Mullidae	Parupeneus spilurus	559	0	559	216	17.13	1.7588
Mullidae	Upeneus tragula	5	0	5	2	13.39	0.3101
Muraenidae	Gymnothorax prasinus	2	0	2	-	47.9	-
Muraenidae	Gymnothorax sp	11	0	11	-	39.2	-
Muraenidae	Gymnothorax thyrsoideus	6	0	6	-	37.2	-
Muraenidae	Gymnothorax undulatus	7	0	7	1	61.84	-
Muraenidae	Muraenidae sp	1	0	1	1	45.01	-
Nemipteridae	Pentapodus nagasakiensis	4	0	4	1	8.58	-
Nemipteridae	Pentapodus porosus	1	0	1	-	13.8	-
Nemipteridae	Pentapodus vitta	683	0	683	132	17.43	0.5581
Nomeidae	Psenes sp	0	2	2	1	2.82	-
Octopodidae	Octopus Djinda	3	0	3	-	16.1	-
Odacidae	Heteroscarus acroptilus	1	0	1	-	13.9	-
Odontaspididae	Carcharias taurus	1	0	1	1	205.87	-
Orectolobidae	Orectolobus hutchinsi	1	0	1	-	83.9	-
Orectolobidae	Orectolobus sp	1	0	1	-	77.5	-
Ostraciidae	Ostracion cubicus	1	0	1	1	26.71	-
Ostraciidae	Ostracion sp	2	0	2	-	22.7	-
Pempheridae	Pempheris sp	13	0	13	4	13.25	0.4201
Pinguipedidae	Parapercis clathrata	1	0	1	-	12	-
Pinguipedidae	Parapercis nebulosa	7	0	7	4	15.36	1.3393
Pinguipedidae	Parapercis sp	7	0	7	2	16.07	0.356
Platycephalidae	Platycephalus endrachtensis	1	0	1	-	28.6	-
Platycephalidae	Platycephalus indicus	1	0	1	-	20.2	-
Platycephalidae	Platycephalus sp	7	0	7	1	18.23	-
Pomacanthidae	Apolemichthys trimaculatus	1	0	1	-	22.46	-
Pomacanthidae	Centropyge tibicen	6	0	6	3	12.08	0.5164
Pomacanthidae	Chaetodontoplus duboulayi	4	0	4	3	30.97	0.5064
Pomacanthidae	Chaetodontoplus personifer	12	0	12	8	25.93	1.2402
Pomacanthidae	Pomacanthidae sp	1	0	1	1	30.38	-
Pomacanthidae	Pomacanthus imperator	5	0	5	1	23.59	-
Pomacanthidae	Pomacanthus semicirculatus	19	0	19	5	31.37	0.5306
Pomacentridae	Abudefduf bengalensis	12	0	12	3	18.04	0.047
Pomacentridae	Abudefduf sexfasciatus	3	0	3	1	14.53	-
Pomacentridae	Abudefduf vaigiensis	12	0	12	8	18.3	0.466
Pomacentridae	Chromis sp	1	0	1	-	5.9	-
Pomacentridae	Chromis westaustralis	1798	0	1798	180	8.02	0.5136
Pomacentridae	Dascyllus trimaculatus	18	0	18	9	12.44	0.2907
Pomacentridae	Parma occidentalis	52	0	52	14	13.14	0.8239
Pomacentridae	Parma sp	18	0	18	3	15.07	0.4674
Pomacentridae	Pomacentridae sp	1	0	1	1	12.55	-
Pomacentridae	Pomacentrus coelestis	36	0	36	9	6.01	0.7304
Pomacentridae	Pomacentrus sp	3	0	3	1	8.63	-
Pseudochromidae	Labracinus lineatus	4	0	4	1	24.68	-
Rachycentridae	Rachycentron canadum	0	94	94	56	96.35	2.4579
Rhinidae	Rhina ancylostoma	1	0	1	-	162.3	-
Rhinidae	Rhynchobatus australiae	15	0	15	9	203.73	14.789
Scaridae	Cetoscarus ocellatus	1	0	1	-	40.3	-
Scaridae	Chlorurus microrhinos	1	0	1	1	48.38	-
Scaridae	Chlorurus sordidus	9	0	9	1	12.63	-
Scaridae	Chlorurus sp	13	0	13	2	12.62	0.0126
Scaridae	Chlorurus spilurus	2	0	2	-	21	-
Scaridae	Leptoscarus vaigiensis	1	0	1	-	11.5	-
Scaridae	Scaridae sp	8	0	8	1	25.65	-
Scaridae	Scarus chameleon	3	0	3	-	23.25	-
Scaridae	Scarus ghobban	67	0	67	27	41.78	2.2535
Scaridae	Scarus schlegeli	3	0	3	4	29.04	1.2265
Scaridae	Scarus sp	20	0	20	7	45.07	2.3363
Scombridae	Grammatorcynus bicarinatus	27	0	27	21	79.38	2.6633
Scombridae	Scombridae sp	72	1	73	-	41.32	-
Scombridae	Thunnus sp	1	28	29	7	58.1	2.3373
Scombridae	Acanthocybium solandri	0	9	9	7	133.65	1.5346
Scombridae	Katsuwonus pelamis	0	23	23	14	61.27	1.2359
Scombridae	Scomberomorus commerson	0	1	1	1	174.76	-
Scombridae	Thunnus albacares	0	12	12	4	78.54	0.7943
Scombridae	Thunnus obesus	0	38	38	11	44.74	1.4759
Scorpaenidae	Scorpaena sumptuosa	1	0	1	-	30.3	-
Sepiidae	Sepia apama	2	0	2	-	8.7	-
Serranidae	Acanthistius pardalotus	20	0	20	9	30.68	0.6955
Serranidae	Acanthistius serratus	1	0	1	1	31.49	-
Serranidae	Cephalopholis boenak	1	0	1	1	27.85	-
Serranidae	Cephalopholis miniata	18	0	18	8	29.12	1.7041
Serranidae	Cephalopholis sp	1	0	1	-	43.3	-
Serranidae	Epinephelus bilobatus	7	0	7	3	31.42	1.12
Serranidae	Epinephelus fasciatus	27	0	27	12	26.59	1.0369
Serranidae	Epinephelus lanceolatus	5	0	5	2	193.09	0.3295
Serranidae	Epinephelus maculatus	1	0	1	1	37.78	-
Serranidae	Epinephelus multinotatus	9	0	9	7	58.63	2.9553
Serranidae	Epinephelus rivulatus	39	0	39	21	25.78	1.5428
Serranidae	Epinephelus sp	1	0	1	1	64.62	-
Serranidae	Epinephelus tukula	1	0	1	1	152.18	-
Serranidae	Pseudanthias cooperi	7	0	7	2	8.85	0.4857
Serranidae	Pseudanthias sp	13	0	13	9	9.7	0.7208
Serranidae	Variola louti	12	0	12	4	61.74	2.2148
Serranidae	Variola sp	1	0	1	1	58.03	-
Siganidae	Siganus fuscescens	121	0	121	30	22.34	1.0254
Siganidae	Siganus punctatus	2	0	2	-	27.8	-
Sillaginidae	Sillago schomburgkii	8	0	8	7	12.84	0.1717
Sillaginidae	Sillago sp	9	0	9	-	15.2	-
Sparidae	Acanthopagrus morrisoni	1	0	1	1	31.88	-
Sparidae	Pagrus auratus	363	0	363	150	47.09	2.189
Sparidae	Rhabdosargus sarba	60	0	60	24	22.46	0.9954
Sphyraenidae	Sphyraena flavicauda	4	0	4	-	25.7	-
Sphyraenidae	Sphyraena jello	2	0	2	2	103.61	1.9156
Sphyrnidae	Sphyrna lewini	0	1	1	1	191.51	-
Sphyrnidae	Sphyrna mokarran	0	1	1	-	2071.6	-
Synodontidae	Saurida undosquamis	42	0	42	23	41.96	0.891
Synodontidae	Synodus sp	1	0	1	1	11.56	-
Terapontidae	Pelates octolineatus	10	0	10	2	17.88	0.4371
Tetraodontidae	Arothron hispidus	1	0	1	1	46.97	-
Tetraodontidae	Lagocephalus sceleratus	192	1	193	100	62.92	0.9278
Tetraodontidae	Polyspina piosae	1	0	1	1	5.9	-
Tetraodontidae	Tetraodontidae sp	2	0	2	-	20.5	-
Tetraodontidae	Torquigener pleurogramma	2	0	2	1	13.06	-
Unknown	Unknown sp	4	0	4	1	25.01	-

Appendix Figure 1a. Michaelis-Menten species accumulation curves for each year of seabed BRUVs deployments.



Appendix Figure 1b. Michaelis-Menten species accumulation curves for each year of midwater BRUVs deployments.