FIRST DESCENT: INDIAN OCEAN

SEYCHELLES EXPEDITION CRUISE REPORT

5th March – 18th April 2019, Seychelles, Indian Ocean

Edited by Dr Lucy Woodall and Molly Rivers

First Descent: Seychelles Expedition Cruise Report

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Introduction and aims

Summary

The Seychelles First Descent was a co-produced programme with objectives and outcomes co-defined and co-delivered by the Seychelles Government, Seychelles Partners and Nekton. The expedition began in July 2018 with a series of stakeholder meetings and science planning workshops. And determined a focus on documenting life from the surface to 500 m deep and associate environmental parameters, to improve our understanding of the patterns of biodiversity, their environmental drivers and the impacts of human activities on these ecosystems. These new findings will contribute to the management plans for the new designated protected areas, identified as part of the Marine Spatial Plan.

During the field phase of the Expedition (March-April 2019), the team collected data on the benthos, demersal fish and zooplankton communities providing data that will be invaluable for scientists, policy makers and managers alike. The data from this research program will be shared with participants and stakeholders. In recognition that some data sets may be sensitive, the Ministry of Environment, Energy and Climate Change have been asked if they will determine which data sets can be available for open access. Reports and papers will be disseminated as joint peer-reviewed publications, and additionally information will be curated into actionable data sets.

This Cruise Report is focused on the research activities and provides a brief summary to the two other activities related to the Seychelles First Descent, the public engagement and capacity development.

Rationale

The Indian Ocean is among the most unknown and least protected water masses, with its coastal population highly reliant on sea food harvests (Taylor *et al.*, 2019). Global threats from the consequences of climate change (e.g. increased storm intensity and increased frequency and severity of coral bleaching events), and local effects of human activities (e.g. fishing) are evident and cumulative (Halpern *et al.*, 2015). Therefore, to ensure sustainable use urgent attention is required to document current biological systems, understand how they function and how they change in the presence of stressors.

Seychelles has an Exclusive Economic Zone' (EEZ) of over 1.3 million km^2 across a number of shelf regions and 115 islands. With a national priority for 'planning for and management of the sustainable and long-term use and health of the Seychelles EEZ' (SMSP, 2018) through the Marine Spatial Planning (MSP) Initiative. The MSP aims to ensure representative species and habitats have long-term protection, to improve the resilience of coastal ecosystems with a changing climate, and to ensure economic opportunities for fisheries, tourism and other uses.

Most of the past and present reef surveys and monitoring efforts have been focusing on shallow-waters (≤30 m), leaving adjacent, deeper mesophotic (30-150m) habitats grossly understudied. Mesophotic reefs are considered to have more stable environmental conditions and less human impacts compared to their shallower counterparts. Due to these conditions, mesophotic reefs have been proposed to provide refuge to shallow-water organisms, which could then potentially re-colonise shallow reefs following disturbance events; this is known as the 'Deep-reef refugia hypothesis'. To date, reef surveys to explore this hypothesis have proved contradictory, highlighting that much more work needs to be carried out in this sparsely studied environment before attempting any regional or global-scale extrapolations. Much less is known about faunal connectivity between mesophotic and deeper reef habitats, such as those located in the rariphotic zone (150-300 m) or the upper part of the bathyal zone (300-500 m), despite the fact human activities are generally concentrated in the upper few hundred meters of the water column (e.g. >80% of all exploited fish species globally reside in waters <500 m).

The unique and highly diverse coastal ecosystems of Seychelles means it is ideally placed to be a model for the region. The patterns of biodiversity, biogeography and larger scale patterns of connectivity will help to elucidate the importance of specific environmental drivers and how these change across locations. The focus on photic to deep sea ecosystems and on both fish and benthic communities simultaneously is the first of its kind. This provides an opportunity for a fundamental change in understanding the diversity, connectivity, and function of marine ecosystems.

Note: Samples and data detailed as D'Arros was actually collected from St Joseph, the neighbouring island. This is reflected in the main text but samples details have retained the D'Arros terminology.

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Cruise Narrative – Molly Rivers

5th March

We sailed on the evening of Tuesday 5th March heading initially for Farquhar islands.

6th March

While in transit, due to forecasted weather conditions in Farquhar, we diverted to Alphonse. The site chosen at Alphonse was on the eastern side of the island which was in the lee of the island for the expected wind direction.

7th March

Scientific operations in Alphonse started by deploying a Niskin bottle to collect surface water at approximately 0700. This was followed by a CTD deployment (to provide a water column profile of Conductivity and Temperature by Depth), deployment of the ADCP (Acoustic Doppler Current Profiler to inform on currents at depth) and a surface water towed net (Neuston net) to document the surface fraction of zooplankton.

8th March

Operations started straight after the daily 0645 morning briefing with CTD and a Niskin bottle deployments. We then launched the workboat for multibeam surveys to generate high resolution bathymetry maps of our area of interest. It was a day of firsts, initially the ROV (remotely operated vehicle) deployment revealed a view of the seafloor at 300 m depth. Then a successful test deployment of the yellow submersible (*Kensington Deep*) with Stephanie Marie (SFA) as the onboard scientist. Later we conducted a Neuston net tow. The final operation of the day was a drop camera deployed which was left recording overnight at 300m depth.

9th March

The first deployment of the day was the ADCP and then the drop camera was retrieved, while the workboats deployed to begin multibeam operations. Meanwhile, the CTD and Niskin bottle were deployed. The vessel transited to a site on the north side of the island to a location that was in the lee of the increasing swell. In the afternoon both submersibles were deployed to 250 m. After submersible recovery, two Neuston net tows were made, and deployed the drop camera overnight.

10th March

The recovery of the drop camera was made while simultaneously deploying the CTD and the Niskin bottle. The ROV was deployed on a discovery mission to assess the currents prior to submersible deployment, then a single submersible (*Kensington Deep*) was deployed to develop a protocol for running scientific transects in the strong currents. The final operation of the day was deployment of the drop camera.

11th March

The drop camera was recovered while simultaneously deploying the CTD and the Niskin bottle launching the workboat for multibeam operations. Next there was a Neuston net tow. Both submersibles were deployed in the afternoon, diving to just below 100 m depth as a test dive for the Associated Press live broadcast.

12th March

A SCUBA diving party, including members of Blue Safari and Island Conservation Society, left the ship at 0800 to run video transects and collect specimens at 10 m depth. During these activities, a hydrophone was deployed from the dive boat. Aboard ship, the CTD and Niskin bottle were deployed and then the submersibles launched as part of the very successful Associated Press live broadcast. Chief Scientist provided live commentary using the BlueComm communication system throughout the day from *Omega Seamaster 2*, and Thomas Moore from Sky News was passenger in *Kensington Deep*. Unfortunately, the ROV tether severed during operations.

13th March

The day was spent tracking the ROV using the USBL and attempting recovery of the vehicle using the submersibles. Night-time Neuston nets deployments were made to assess the difference between night and day plankton communities.

14th March

The day was dedicated to the successful recovery of the ROV by *Omega Seamaster 2. Kensington Deep* was then deployed and the two submersibles conducted scientific operations (video transects and sampling). The workboat was deployed in the morning to complete the multibeam survey for N Alphonse. In the evening we began the transit to Aldabra.

15th March

The whole day was spent in transit to Aldabra, however one Neuston net deployment was made, and the ADCP head swapped.

16th March

The vessel arrived at Aldabra at 1230 and briefly welcomed Jude Bryce, Cheryl Sanchez, Dr Lyndsey Turnbull and April Burt on board from SIF. The vessel then moved to the first proposed survey site on the south of Aldabra. Once on site the CTD, Niskin and ADCP were deployed to investigate the water column and associated currents. After dinner, the ROV was deployed to ground truth the current data. Currents were much great that expected, and therefore the decision was made to move to the north of Aldabra.

17th March

The workboat was deployed to collect multibeam data. At midday all science activities were postponed due to a thunderstorm. Later both submersibles were deployed to collect specimens and conduct transects at 120m. The blue comm systems were also deployed during these dives as a test for Sky's live broadcast. In the evening, the CTD, Niskin and Dropcam were successfully deployed.

18th March

The day began with the deployment of the CTD and Niskin bottle, and the recovery of the Dropcam. Shortly after, both submersibles were deployed for the successful first live broadcast by Sky News. Once the submersibles were recovered, a SCUBA diving team conducted a video transect at 10m depth. The ROV was also deployed at 500m and then at 250m but had to be aborted on both dives due to strong currents. The last deployments of the day were two neuston nets tows.

19th March

The Sky News live broadcast from 250m depth was the main event of the day. However, multibeam data were also collected. Due to a fault in one of the submersibles, science operations were cancelled apart from the evening drop camera deployment.

20th March

The Dropcam was recovered, and CTD and Niskin bottle were deployed, as usual at the start of the day. The final live broadcast occupied the rest of the morning, as the broadcast was live from the vessel, *Omega Seamaster 2* and Aldabra. *Kensington Deep* then dived to 60m, collecting three video transects. The Dropcam and the triplicate night neuston nets were deployed successfully.

21st March

The day began with the deployment of the CTD and the Niskin bottle. Both submersibles were then deployed, collecting samples at 250m and 60m and conducting transects at 250m and 120m. The workboat was deployed to finish the bathymetry survey. Unfortunately, the Dropcam was not recovered, as it was released early probably due to a shark biting trough the line. The ROV was deployed to conduct a 500m transect but was unable to navigate through the strong currents so the dive was aborted. Finally, the workboat was used to deploy the Mini ROV to test its efficiency at collecting video transect data and specimens at 10m depth.

22nd March

The CTD and Niskin bottle were deployed first thing in the morning, then the mini ROV was deployed from workboat to collect specimens at 10m. The two submersibles were successfully deployed; *Omega Seamaster 2* to 120 and 90m to conduct video quadrates and then to sample at 30m, and *Kensington Deep* to 30 m to conduct transects. Later recovery of the Dropcam was attempted and the vessel transited to the W site of Aldabra to conduct operations there.

23rd March

The day started with CTD, Niskin bottle and ADCP deployments, and simultaneously the workboat was deployed for multibeam data collection. The ROV was deployed to 100m to explore the currents and topography. The submersibles were deployed to collect transects and specimens at 30m depth. The final deployments were three neuston net deployments. Once the nets deployments were completed, we steamed towards Assumption where the Sky News team were due to depart the vessel.

24th March

The morning was spent ferrying the team to Assumption from the vessel. The science team took the opportunity to calibrate the stereo video systems in the clear, calm waters. This is a very important activities and every time we can get into shallow waters we calibrate the systems to ensure all data are useable. The plane arrived with some stores for the vessel and two new scientists, and the Sky team and one scientist left. The vessel then steamed back to the West side of Aldabra to continue scientific operations. CTD and Niskin bottle deployments were conducted through the afternoon and later the two submersibles were deployed. The subs reached 120m where transects were completed and soft coral, sea urchins and sponge specimens were collected.

25th March

As usual, the day began with CTD and Niskin bottle deployments. The ROV was then deployed to 250m, but due to technical difficulties was retrieved without completing any transects. This was followed by a multibeam survey to explore the deeper topography on the West side of Aldabra. Three

neuston nets were deployed in the afternoon, and a large proportion of gelatinous organisms were seen. The submersible *Omega Seamaster 2* was deployed to collect specimens from 120-60 m and the Mini ROV was simultaneously deployed from the workboat to document 30m and a collect a specimen from 10m.

26th March

A CTD and a Niskin bottle deployment were the first activities. The workboat was deployed shortly after to allow the Mini ROV to conduct video transects at 30m depth. *Kensington Deep* was also deployed to collect video transect data at 250m depth. The ROV was deployed to 450m depth, but after 350m suffered a communication issue and was recovered. Two neuston net tows were conducted after dark to complete the neuston net surveys for this site.

27th March

The first activities were to check the ADCP and the underwater telephone pole in the moonpool. CTD and Niskin bottle deployments then followed. The ROV was then deployed to 450m depth, however there was a technical problem and the dive was aborted. The submersible *Kensington Deep* was deployed to 60m depth to complete video transects for this site (Aldabra W1). The vessel moved back to the north side of the island overnight.

28th March

Working at (Aldabra N1) the multibeam survey was completed. The CTD and Niskin were deployed directly after and then *Kensington Deep* to 60m depth to collect video transect data. In the afternoon *Omega Seamaster 2* was deployed for a live broadcast to Good Morning America, facilitated by Associate Press and also collected a sample from 60m depth. The MiniROV was also deployed in the afternoon, but due to a technical fault, was unable to collect any data. After the MiniROV and *Omega Seamaster 2* were recovered the vessel started towards Astove, the next site.

29th March

We arrived at our new site on the West side of Astove before sunrise. The first activity was to deploy the workboat to collect bathymetry data. Meanwhile the CTD and Niskin bottle and triplicate Neuston nets were deployed. The ROV was then deployed but was unable to go below 70 m depth due to strong currents.

30th March

The day started with deploying the CTD and Niskin bottle. The workboat was then launched to complete the multibeam survey, providing a clear bathymetric map of this side of Astove. Both submersibles were deployed to collect samples and to complete video transects at 60 and 120m depth. While the submersibles were underwater, the hydrophone was deployed at a distance from the vessel, to record cetaceans. Meanwhile, the SCUBA divers, assisted by Blue Safari completed transects at 10m depth, recording incredible coral diversity. Later in the afternoon the ROV was deployed to 250m depth, to collect transect data of the sea wall. These data will be used to compare methodologies between the submersibles and the ROV. The final science activities of the day were three night-time neuston nets, allowing for a day a night comparison of the zooplankton to be made at this site.

31st March

A CTD and Niskin bottle deployment were the first activities of the day. *Omega Seamaster 2* was then deployed to collect specimens at 60m depth, collecting a sponge, a sea urchin and a sea star, the final specimens for this sight. *Kensington Deep* was later deployed to collect video transects at 120m depth.

The ROV was deployed twice during the day, firstly during the morning to collect specimens at 30m depth and secondly in the afternoon to collect transects 250m depth. Late in the afternoon the chase boat was used to drop the hydrophone to record any possible cetacean sounds. Again, the final activity of the day was to collect two neuston net trawls during the night.

1st April

The first activity of the day was a sunrise deployment of the hydrophone next to the reef. A CTD and Niskin deployment followed, and then *Omega Seamaster 2* was deployed to collect quadrat video footage for photogrammetry research. The ROV was deployed to 250m to collect video transects and *Kensington Deep* was deployed to collect video transects at 120m depth. This completed the scientific activities at Astove and the vessel steamed towards Alphonse.

2nd April

The whole day was spent in transit back to Alphonse. The specimens and data were organised and the team prepared for the next two weeks of science operations.

3rd April

The vessel arrived on station, back at the North side of Alphonse at 0830, where CTD and Niskin bottle deployment were conducted, followed by the ADCP. *Kensington Deep* was deployed to complete transects at 30m depth, then *Omega Seamaster 2* was deployed to collect quadrat video data at 120m and 60m depth. *Kensington Deep* was deployed for a second time, to complete transects at 250m, 120m and 30m depth. During *Kensington Deep's* second deployment the hydrophone was deployed using the chase boat to detect for cetaceans.

4th April

Still on site on the North side of Alphonse, the day started with a deployment of the CTD and Niskin bottle. The hydrophone was then deployed from the chase boat, followed by the launch of the workboat to complete the multibeam survey for this area. Three neuston nets were deployed, and the recovered a large amount of seagrass. *Omega Seamaster 2* was the final deployment of the day, collecting the final samples from 120m to 30m depth. After the recovery of *Omega Seamaster 2*, the vessel set off towards Poivre.

5th April

The vessel arrived at Poivre at around 0645, and the first activity of the day was to deploy the ADCP pole. The chase boat was then launched to deploy the hydrophone near the reef. Meanwhile the CTD and Niskin bottle were deployed from the vessel. Shortly after these activities the workboat was deployed to carry out multibeam surveying in order to map the seabed to provide vital information for the submersible operations. Three Neuston nets were deployed, then after the FRC returned with mapping information the ROV was deployed to explore the bathymetry and give an indication of currents. After this deployment the submersible *Kensington Deep* was deployed to 120m depth to collect video transect data and *Omega Seamaster 2* deployed to collect samples at the same depth.

6th April

The day began with CTD and Niskin bottle deployments, followed by the launch of Kensington to 250m depth. While *Kensington Deep* was underwater, the chase boat was launched to deploy the hydrophone. After the recovery of *Kensington Deep*, *Omega Seamaster 2* was launched to collect samples at 250m and 60m depth. *Kensington Deep* was deployed again in the late afternoon, this time to collect

transect videos at 60m. The last activity of the day was a triplicate deployment of the neuston nets after dark.

7th April

Omega Seamaster 2 started the day collecting video data for photogrammetry at 120m and 60m, after its recovery, *Kensington Deep* was deployed to 30m to collect video transects of the shallow water environment. Meanwhile, with the help of Blue Safari, a SCUBA diving team carried out two dives to 10m collecting transects, photogrammetry video data and specimens of hard and soft coral. Shortly after the recovery of *Kensington Deep*, *Omega Seamaster 2* was launched again to collect samples at 30m. During these activities CTD and Niskin bottle deployments were carried out. Four neuston net tows were also completed, two during the day and two at night. Once the last neuston net was collected, the vessel started to toward St Joseph.

8th April

The vessel arrived at St Joseph during the night. The day started with an early morning deployment of the hydrophone near the reef. While the hydrophone was being deployed from the chase boat, the workboat was being launched to start the seabed survey of this area. The CTD and Niskin bottle were deployed and three neuston net samples were also collected. Once the initial bathymetry survey data was collected, the ROV was deployed to test the currents and locate the best site for the submersibles to be deployed. *Kensington Deep* was then deployed to collect transects at 250m and 120m depth. *Omega Seamaster 2* was deployed shortly after the recovery of *Kensington Deep*, to collect samples at 120m depth. While *Omega Seamaster 2* was in the water, the hydrophone was deployed again, to collect data at dusk.

9th April

The first activity of the day was an early morning deployment of the hydrophone in the chase boat. The CTD and Niskin bottle were then deployed. Shortly after this, *Kensington Deep* was deployed to 250m, completing three video transects. On the recovery of *Kensington Deep*, *Omega Seamaster 2* was deployed to collect samples at 120m and 60m depth. *Kensington Deep* was scheduled to dive for a second time, but due to a technical issue the ROV was deployed instead. The ROV was deployed to 250m depth but due to strong currents was aborted. The ROV was instead deployed to collect photogrammetry video data at 60m depth. Meanwhile, the chase boat was deployed to collect photogrammetry video data at 10m depth using snorkelers. Finally, triplicate neuston nets were deployed to collect the night time plankton data for St Joseph.

10th April

An early morning hydrophone deployment was the first deployment of the day, followed by a CTD and Niskin bottle deployment. The ROV was then deployed to 400m depth, where transects were completed and our first specimen from 305m depth was collected. *Omega Seamaster 2* was then deployed to collect samples at 30m. *Kensington Deep* was launched immediately after the recovery of *Omega Seamaster 2*, to collect transects at 30m depth. The chase boat was used by snorkelers to collected photogrammetry video data as the last attempt was unsuccessful due to camera malfunctions.

11th April

The morning started with CTD and Niskin bottle deployments, followed shortly by deploying *Kensington Deep* to 60m depth to collect transects. As soon as *Kensington Deep* was recovered *Omega Seamaster 2* was deployed to 60m depth for specimen collections at this site. Once *Omega Seamaster 2* was recovered the vessel transited to Desroches. Arriving Desroches at 1500 the CTD and Niskin

bottle were deployed immediately. We then deployed two neuston nets tows were conducted before the dusk.

12th April

The workboat was deployed to collected bathymetry data. Then the CTD and Niskin bottle were deployed. Once these activities were complete triple neuston net deployments was carried out. The workboat returned with survey data around 1100. The workboat was launched again to finish the surveying for this site, and the ROV was deployed to exam the seabed and test the currents. Once the ROV was recovered, *Omega Seamaster 2* was deployed to 120m and 60m depth to collect the samples at this site. After *Omega Seamaster 2* was recovery, *Kensington Deep* was deployed to collect video data at 120m depth. While *Kensington Deep* was in the water the chase boat was launched to deploy the hydrophone. Due to battery issues in *Kensington Deep* the hydrophone deployment had to be aborted to facilitate the recovery of *Kensington Deep*. The final activity of the day was to complete triple neuston net deployments at night, completing the neuston net deployments for this site.

13th April

The day began with an early morning hydrophone deployment to record the morning reef noise. This was followed by CTD and Niskin bottle deployments when the sun was higher in the sky, allowing for fluorescence to be accurately recorded. *Kensington Deep* was then deployed to 30m depth to collect video transect data in shallow water. After the recovery of *Kensington Deep*, *Omega Seamaster 2* was deployed to 250m to collect samples. Once *Omega Seamaster 2* was back on the surface *Kensington Deep* was deployed again, this time to 250m depth. Shortly after *Kensington Deep* was deployed the President of Seychelles arrived to visit the vessel. After the President and his delegation left the vessel, the ROV was deployed to 30m depth to collect samples.

14th April

The hydrophone deployment was the first activity of the day, with the President of Seychelles arriving shortly after its recovery. *Kensington Deep* and *Omega Seamaster 2* were deployed together in order for the President to make a live broadcast from the submersible at 120m depth. After the submersibles were recovered and the President left the vessel, *Kensington Deep* and *Omega Seamaster 2* were deployed again to 120m depth to collect video transects and specimens. During the afternoon a dive team, with the help of Blue Safari, collected transects, quadrat video data and specimens at 10m depth.

15th April

The day started with an early morning deployment of the hydrophone, followed by CTD and Niskin bottle deployments. Guests were welcomed onboard, but operations were postponed due to inclement weather. Pleasure dives were conducted in the afternoon, then the ROV was deployed to collect a specimen from 30m depth.

16th April

A hydrophone, CTD and Niskin deployment were the first activities of the day. We then, welcomed our guests back on board, for some more pleasure dives in the submersibles. The ROV was deployed to collect a specimen from 30m depth. The rest of the afternoon was spent starting to pack up all the equipment ready for demobilization.

17th April

The final activities for the expedient were made, these were the CTD and Niskin deployments, followed by a ROV dive. The vessel started the transit back to Port Victoria and the whole team was busy with demobilisation, packing and sample curation.

18th April

The vessel went to anchor at Port Victoria and the whole team were again busy with demobilisation, packing and sample curation. Most of the team left the vessel at 1700.

19th April

The vessel went alongside the berth at 0900 and the final demobilisation was completed with all disembarking at 1100.

Summary of locations and timeline

Table 1: *Summary of expedition operations date, location, sample site and activity.*

Date	Island	Location Code	Activity	Deployment numbers
7-9 March 2019	Alphonse	E1	Equipment trials	1-14
9-14 March 2019	Alphonse	N1	Equipment trials Science data collection	15-49
16 March 2019	Aldabra	S1	Science data collection	50-53
17-22 March 2019	Aldabra	N1	Science data collection Live media broadcasts	54-97
23-27 March 2019	Aldabra	W1	Science data collection	98-137
28 March 2019	Aldabra	N1	Science data collection	138-144
29 March to 1st April 2019	Astove	W1	Science data collection	145-186
2 April 2019	Transit		Science data collection	187-188
3-4 April 2019	Alphonse	N1	Science data collection	189-203
5-7 April 2019	Poivre	E1	Science data collection	204-235
8-11 April 2019	St Joseph (D'Arros)	N1	Science data collection	236-273
11-17 April 2019	Desroche	S1	Science data collection VIP sub dives	274-319

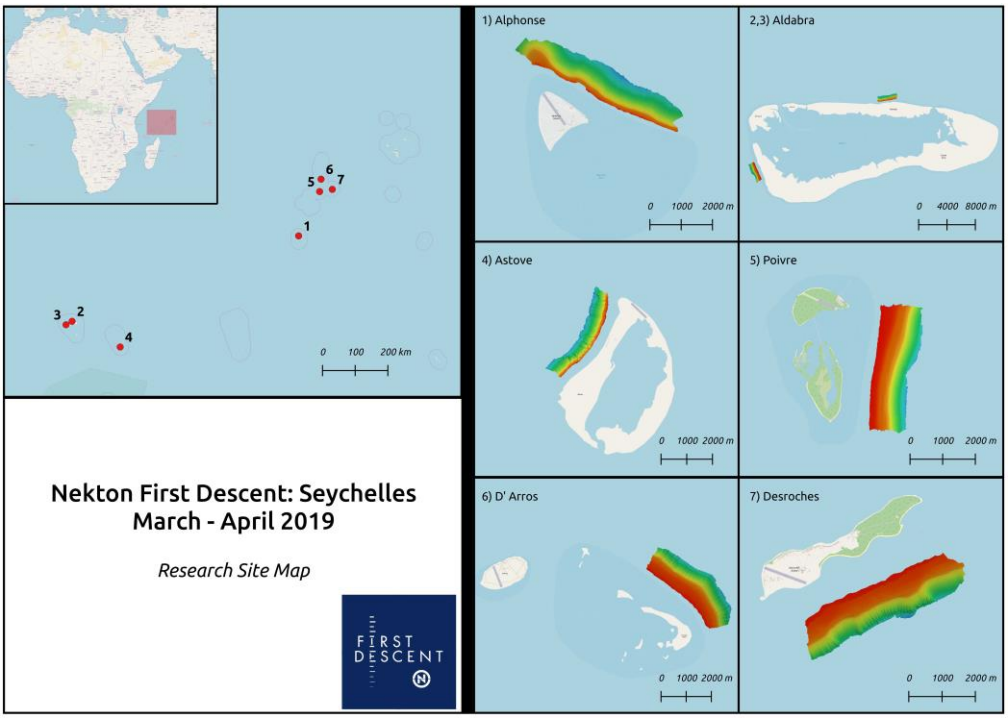


Figure 1: *Map of island locations and sampled locations of each island visited.*

Water chemistry – Jerome Harlay

Protocols

Vertical profiles of temperature, conductivity, depth, fluorescence, oxygen, photosynthetically active radiation (PAR) and pH were undertaken on a daily basis, followed by **water collection** (Niskin or bucket sampling) at surface for chlorophyll-a, salinity, nutrient concentrations and total alkalinity. In addition, the **submersible** *Omega Seamaster 2* measured temperature, depth and conductivity but no water collection was possible due to malfunctioning equipment.

Vertical profiles

A self-recording SBE19 Plus V2 SeaCAT conductivity, temperature and depth (CTD) profiler equipped with fluorescence, oxygen, photosynthetically active radiation (PAR) and pH sensors was deployed from the deck at a profiling speed of about 0.5 m s^{-1} (Table 2). The SBE19 Plus V2 SeaCAT rans continuously during profiles and acquired data at a rate of 4 Hz. The SeatermV2 (SBE19PlusV2) package was used to upload single casts of the SeaCAT profiler in the form of a .hex and a .xml data files. The SBEDataProcessing package (Win-32) was used to convert the .hex file into a .cnv file, exploitable with Windows programs (practically, a .xlsx file tagged with deployment ID, location and site, containing headers and data, showing profiles and ancillary information provided during sub dives on the same day). For data processing, a .con file was provided with the instrument and contained calibration information.

Table 2: *SBE 19 Plus V2 SeaCat sensors details.*

Measured parameter	Sensor	Unit
Depth	SBE19PlusV2 - 7936	dbar
Conductivity	SBE19PlusV2 - 7936	S m^{-1}
Temperature	SBE19PlusV2 - 7936	ITS-90 scale (°C)
Fluorescence (*in situ*)	ECO Chlorophyll Fluorometer FLRT-5478	Counts/sec
Dissolved Oxygen	SBE 43 - 3781	µmol kg^{-1}
PAR	SBE PAR-Log - 1385	µmol photons m^{-2} s^{-1}
pH	SBE 18 - 1440	NBS
Calculated parameter	**Sensor(s)**	**Unit**
Salinity	SBE19PlusV2 - 7936	PSU
Density	SBE19PlusV2 - 7936	Kg m^{-3}
Oxygen saturation	SBE 43 - 3781	%
Sound velocity	SBE19PlusV2 - 7936	m s^{-1}

Water sampling

A 5L Niskin bottle (or a 5-L bucket) was deployed from the deck to collect surface water at each station. Shortly after collection, approximately four litres were filtered through a GF/F filters (the exact volume noted) using a Millipore filtration set and vacuum pump; filters were folded, wrapped in aluminium foils and kept frozen (-20°C) after labelling of the specific deployment ID assigned to the sampling and filtered volume. Nutrients (40 ml) were sampled in sterile centrifugation tubes (labelled with the deployment ID) and preserved at +4°C. A 250 ml sample was kept for measurement of salinity using a PORTASAL 8414 in the ship's chemistry laboratory. Finally, a 200 ml sample was preserved in a GL45 borosilicate bottle with 1 ml saturated $HgCl_2$ for total alkalinity determination (in triplicates of 50 ml) at the University of Seychelles.

Omega Seamaster 2 submersible sampling and CTD

A SBE49 FastCat CTD measures temperature, conductivity and depth and was activated by the pilot and/or passenger during each deployment of *Omega Seamaster 2*, data (temperature, conductivity, depth, salinity and sound velocity – mode 3) were acquired at a rate of 1Hz in a text file (.cap). The submersible was also equipped with a 6-250 ml Niskin rosette for water collection at depth. Collection bottles were activated on demand during the dive.

Narrative about changes in protocols success and failures

The SBE19PlusV2 SeaCat instrument produced reliable data for conductivity, temperature, depth, *in situ* fluorescence, oxygen and PAR. The pH sensor was not calibrated with appropriate buffers and should not be used in the context of Ocean Acidification studies. The probe was however calibrated in factory against NBS buffers prior to its deployment. Hence, pH data in profiles should suitable to describe the variability of this parameter in the different habitats encountered in the expedition.

The SBE49 FastCat instrument mounted on the submersible worked very well. However, the capture procedure on the Nomad Spare Windows Tablet was tedious and many errors are found in the .cap files. Changing the COM port from 24 (emulated port) to the genuine COM 1 improved data acquisition without removing completely the corrupted lines.

The messenger hit the top of the Niskin bottle on the 10th of March (deployment 24). From this day on, Niskin deployment were substituted by bucket sampling for the sake of consistency.

The Niskin system mounted on *Omega Seamaster 2* failed to work and never allowed collection of water samples. In few occasions, the submersible co-pilot reported electrical issues when attempting to fire the bottles at depth; firing the bottles on the deck did not pose any problem, even when the submersible was in sub-surface, at sea.

The Portasal salinometer was not able to regulate temperature towards the lowest values on the 16/04/2019. A new calibration was done with success at ambient temperature (>33˚C) and samples were processed with excellent reproducibility.

Summary data collected-

The NEKTON expedition visited several coralline (outer) islands of the Seychelles archipelago in March-April 2019 (Table 3) and sampled reference oceanic-type waters during transit.

Table 3: *Locations and dates of CTD profiles and water collection.*

Group	Island	Location	Date
Alphonse	Alphonse	East	7 – 9/03/2019
		North	10 - 12/03/2019 3 - 4/04/2019
Aldabra	Aldabra	South	16/03/2019
		North	17 - 22/03/2019 28/03/2019
		West	23 - 27/03/2019
Astove	Astove	West	29/03/2019 – 1/04/2019
Amirantes		*Transit*	*2/04/2019*
	Poivre	East	5 – 7/04/2019
	D'Arros (St Joseph)	North	8 – 11/04/2019
	Desroches	South	11 – 17/04/2019

Example charts for comparison

The **water quality** of the studied area was very good in general, exhibiting very low light attenuation coefficients (K_d) in the range of 0.015 m^{-1} and 0.032 m^{-1}, representative of oligotrophic oceanic sub-basins. A vertical stratification of the water column was observed at most stations, with strong density gradients (>4 $kg.m^{-3}$) driven by temperature, mainly. The upper water column was in equilibrium or slightly over-saturated with respect to atmospheric oxygen partial pressure, as a result of active autotrophic activity by phytoplankton (as indicated by *in situ* fluorescence counts).

The sea surface temperature recorded on a quasi-daily basis at each site from early March to mid-April remains around 30°C and exhibits an overall increasing tendency that coincides with a decrease of sea surface oxygen saturation, as expected from the thermodynamics of oxygen dissolution (Fig. 1). A latitudinal bias on temperature may not be excluded though, but a warming was also recorded at the same period by the NOAA Coral Reef Watch Monitoring centre that issued a level 1 alert in the region during the expedition.

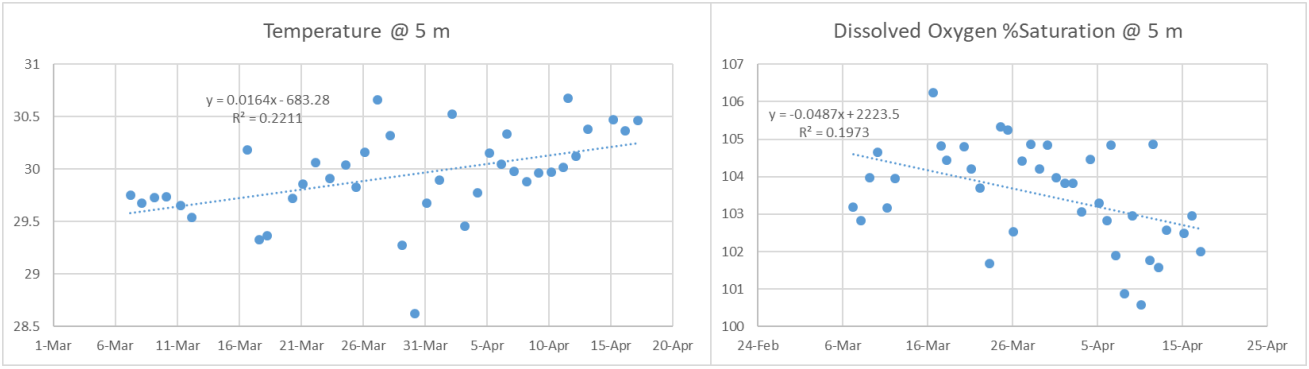


Figure 2: *Sea surface temperatures and dissolved oxygen saturation levels (at 5 m) during the NEKTON expedition.*

ALPHONSE

Alphonse was visited on the and two different occasions during our survey and at two different locations, the northern part and the eastern part of the island (Tab. 2). During the first visit 3rd - 12th March, the skies were cloud cover with negligible rainfall. The second visit 3rd - 4th March was under very good weather condition with respect to precipitations and cloud cover. The only major rainfall (above 25 mm/day) pertinent for our survey occurred 4 days prior to the second visit, late March (Fig. 3).

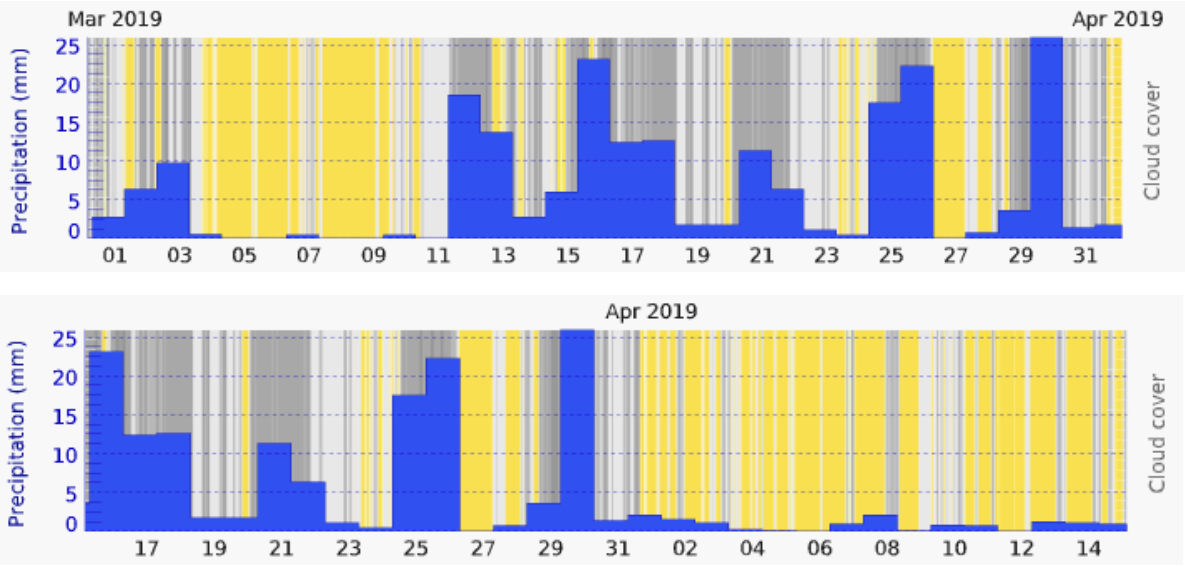


Figure 3: *Precipitation regime and cloud cover in Alphonse, Seychelles, 7°S 52.73°E (source: www.meteoblue.com).*

The vertical profiles of temperature during our first visit in the northern part (10 – 12 March) show a deepening of the surface mixed layer, associated to a decrease of the barrier layer thickness, traducing a build-up of the thermocline in the top 100 meters of the water column (Fig. 4). Deeper, multiple successive warming (staircase effect) is observed, the deepest at 300 m depth. Revisiting Alphonse in early April (3 – 4th), the pattern of temperature remains similar, as well as its dynamics with; on the second day of measurement, an upper mixed layer of about 50 m with a marked thermocline established at about 80 m. By comparing the two periods, it is evident that hydrodynamics play a strong role at this station where destratification is probably of tidal origin.

Salinity profiles appear homogenous down to 300 m in March, with fairly constant surface values of about 35.2 PSU in all stations (Fig. 4). In the eastern part of Alphonse the vertical distribution remains similar from one day to another. The signature of Alphonse waters on a T-S diagram did not suggest any different water masses in the region (Fig. 5). In early April, when the northern station was revisited, salinity profiles showed a dilution pattern in the surface layer, down to 60, as a likely consequence of the rainfall of the 28th March (Fig. 3).

In situ fluorescence peaks at depths ranging between 50 and 90 m, just above or at the depth of the thermocline, and are associated to a well-established oxycline at comparable depths (Fig. 4). Deeper fluorescence peaks appeared in the eastern region (80 to 95 m). Deep phytoplankton blooms were not surprising in a region where water transparency is very high, and the thickness of the photic zone probably in the range of 120 m.

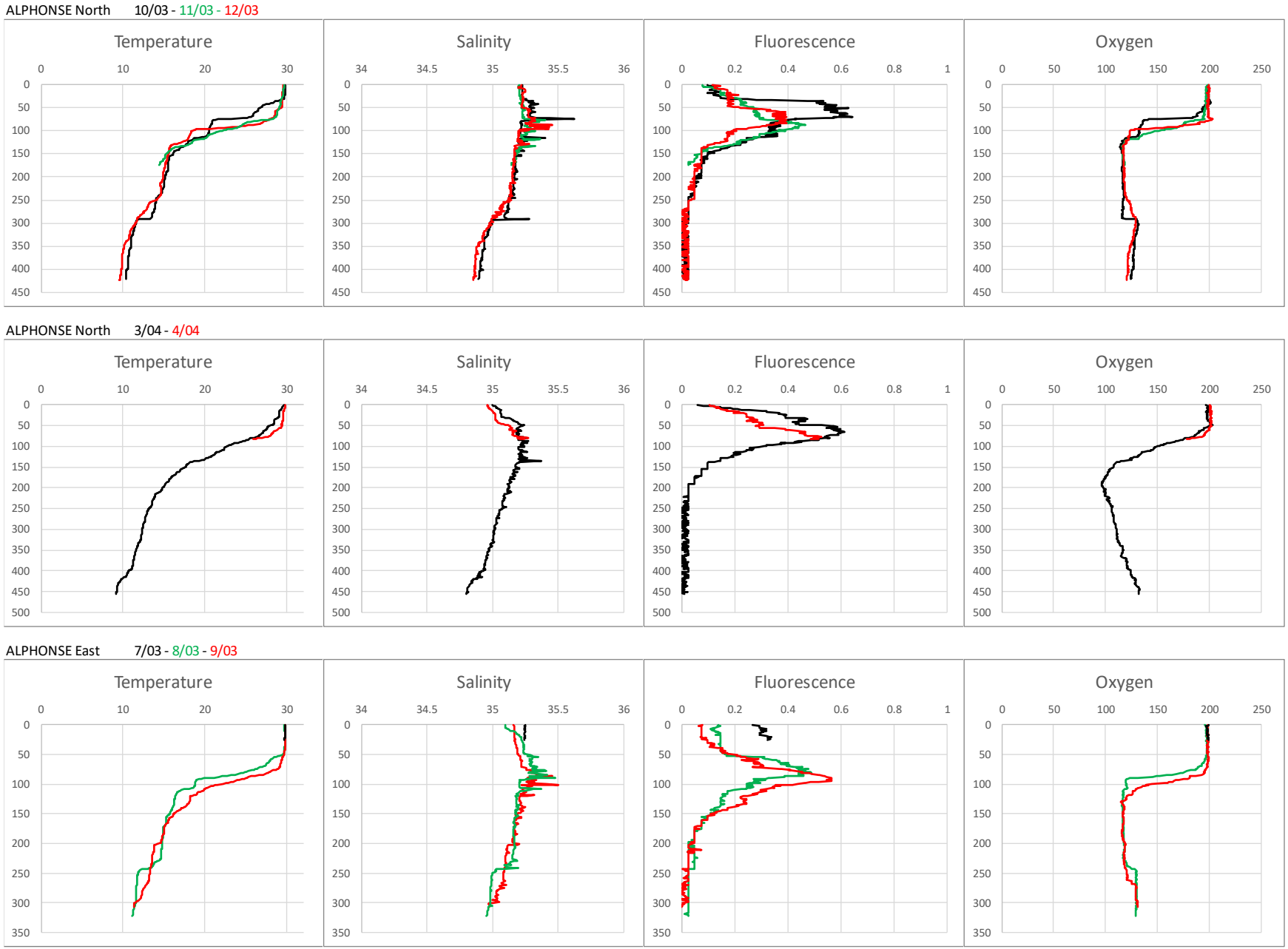


Figure 4: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L) and dissolved oxygen concentration (µmol kg⁻¹) in Alphonse.*

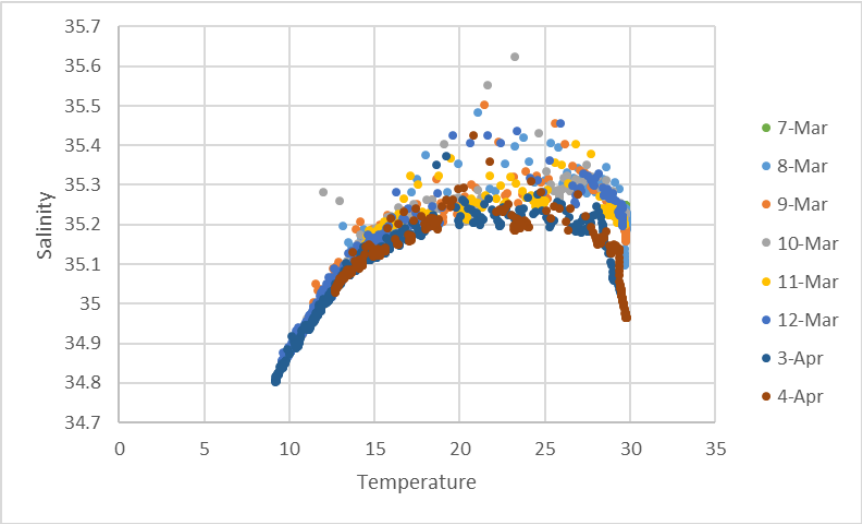


Figure 5: *T-S diagram of water masses in the top 450 m in Alphonse (March 2019).*

Aldabra

The Aldabra region was visited 17th - 27th March and three main locations were investigated, in the south (1 day), the north (6 days) and the west (5 days) (Table 3). At Aldabra, important rainfall (>20 mm/day) occurred on the 16th and 17th March (Fig. 6). Minor showers accompanied by a significant cloud cover lasted until the 25th of March, after which date the weather was sunny with little wind.

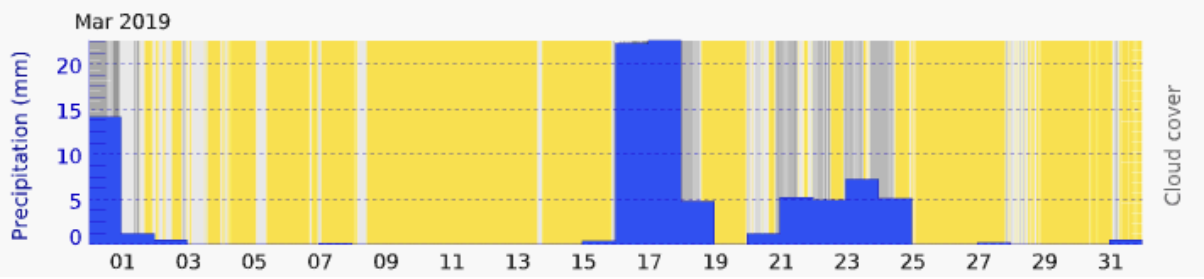


Figure 6: *Precipitation regime and cloud cover in Aldabra, Seychelles, 9.72°S 47.04°E (source: www.meteoblue.com).*

Surface waters at all stations remained warm, within a narrow range around 30°C (Fig. 7). Thermal stratification was observed in the southern region at 68 m and 148 m depth. Northern stations exhibited an alternation between shallow and deeper thermoclines on the first two days, then a deepening of the upper thermocline with the establishment of a stratified upper mixed layer over the following three days (20 – 22). When revisited on the 28th March, a new thermocline had appeared at 12 m. Such changes in the vertical structure suggest a tidal influence and the advection of a warm water plume coming out of the lagoon.

Surface salinity values in Aldabra (Fig. 7) were in the lower range across our entire survey, with values as low as 34.05 PSU observed 17th March at the northern station. Lower sea surface salinity coincided with the intense rainfall event (>20 mm/day) that occurred 17th and 18th March, diluting the upper water column (Fig. 6). All profiles of this station converged to a salinity close to 35.18 PSU at a depth of 120 m, which suggests that such storms are susceptible to affect the structure of the water column over the entire photic zone. A dilution in the upper water column were clearly visible on the T-S diagram for the 17th, 18th and 24th March (Fig. 8). Changes in surface water density can explain the variable depth of the thermocline (see above).

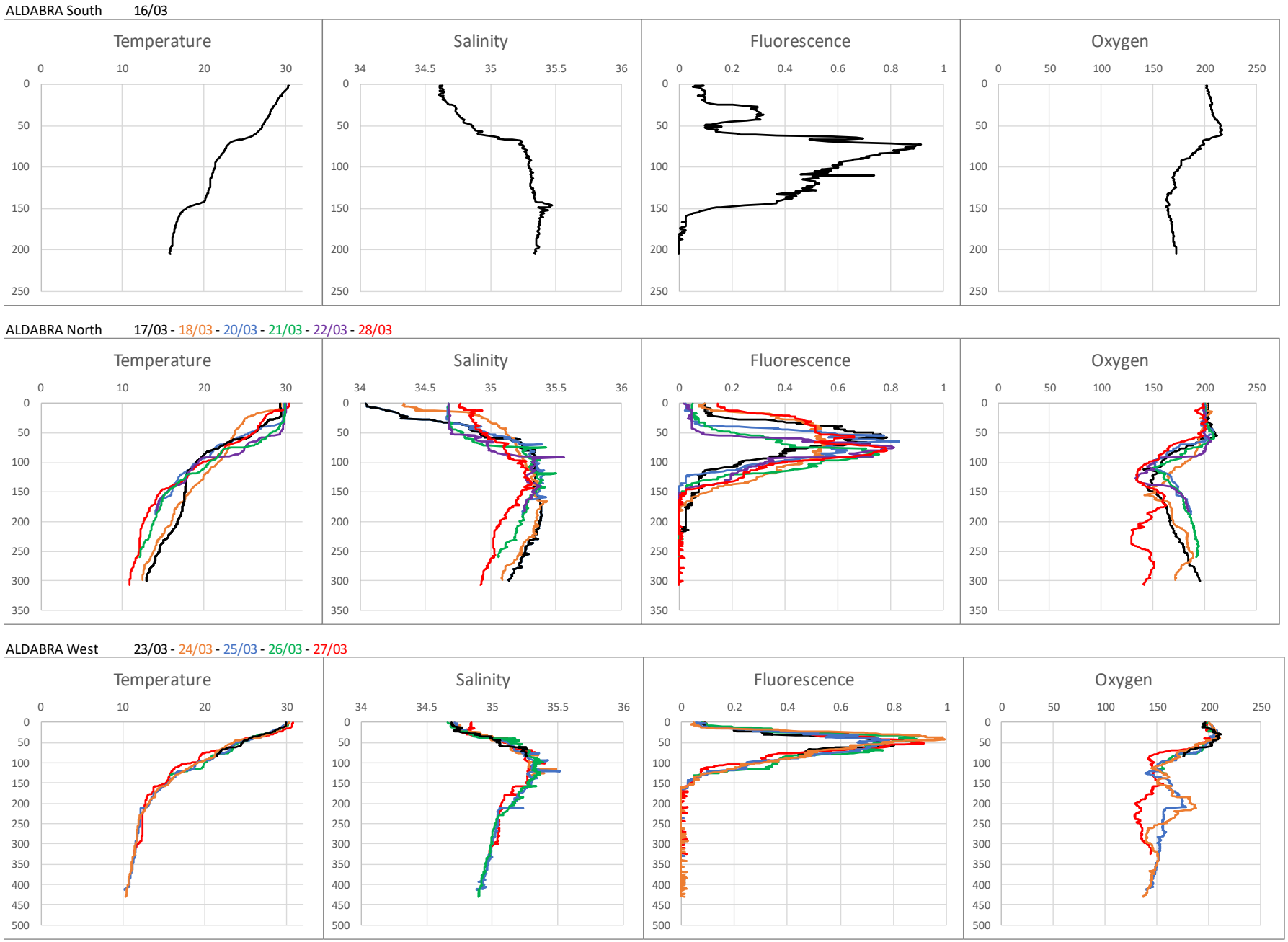


Figure 7: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L) and dissolved oxygen concentration (µmol kg⁻¹) in Aldabra.*

In situ fluorescence profiles showed a deep and intense phytoplankton bloom in the region, with maximum values 0.8 - 1.0 count/L (Fig. 7). The bloom peaks at about 60 - 70 m and expanded down to 150 m. At the southern station (16/03/2019), the bloom shows a second shallower maximum at 37 m.

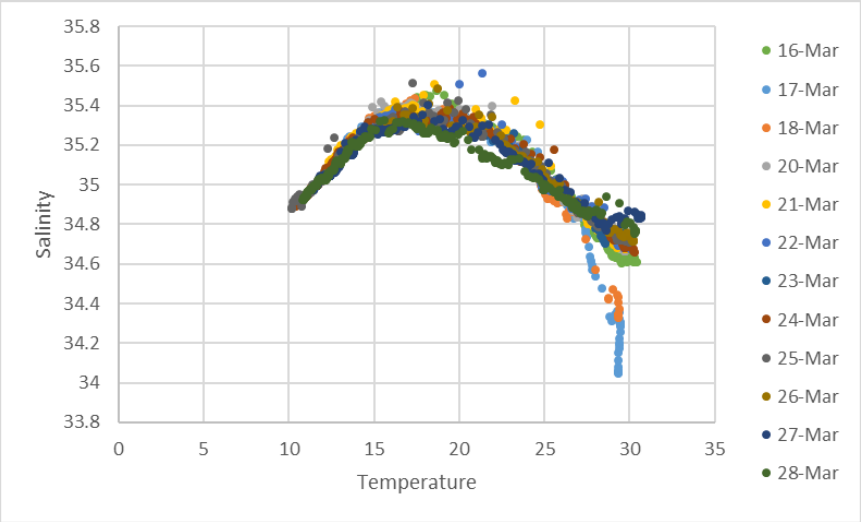


Figure 8: *T-S diagram of water masses in the top 450 m in Aldabra (March 2019).*

Astove

The atoll of Astove was visited between 29th of March - 1st April on its western reaches (Table 2). There was also no significant rainfall either during our stay nor prior to our arrival (Fig. 9).

The temperature profile on the first day showed an upper mixed layer of 26 m and a deep well-marked thermocline at 92 m (Fig. 10). A shallower, not yet established, thermocline above 50 m that strengthened towards the end of our survey was observed, a strong, almost horizontal temperature gradient of about 12˚C at 47 m. Such conditions induce a strong gradient of density that reduces drastically the exchange of dissolved nutrients and gases across the interface.

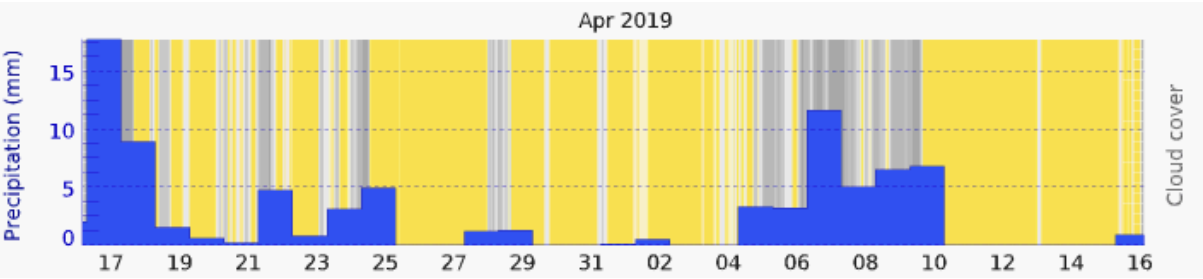


Figure 9: *Precipitation regime and cloud cover in Astove, Seychelles, 10.1°S 47.75°E (source: www.meteoblue.com).*

Vertical profiles of salinity show lower-than-normal (34.8-34.9 PSU) salinity in the surface layer, down to 100 – 120 m, where salinity reaches a maximum of 35.4 PSU (Fig. 10). The lower profile showed a fairly constant decrease in salinity with depth, down to the maximum depth of 445 m. Astove, due to its proximity to Aldabra, may still remain under the influence of the recent atmospheric perturbation on Aldabra, which would explain the slight dilution if the surface layer (Fig. 6).

In situ fluorescence profiles (Fig. 10) showed a phytoplankton bloom at about 70 m that rose from one day the next then shrank to half of its surface on the last day (data not shown). This dynamic was accompanied by a shallowing of the oxycline and was strengthened by the more intense stratification observed towards the end of our survey of this station (Fig. 10). The site had a well-established

oxycline and a relative deficiency in oxygen just below the peak of the bloom that may indicate its decaying stage. Visual observations during the submersible dives at a depth of 250 m tends to confirm a decaying situation with a presence of abundant suspended matter in the form of marine snow.

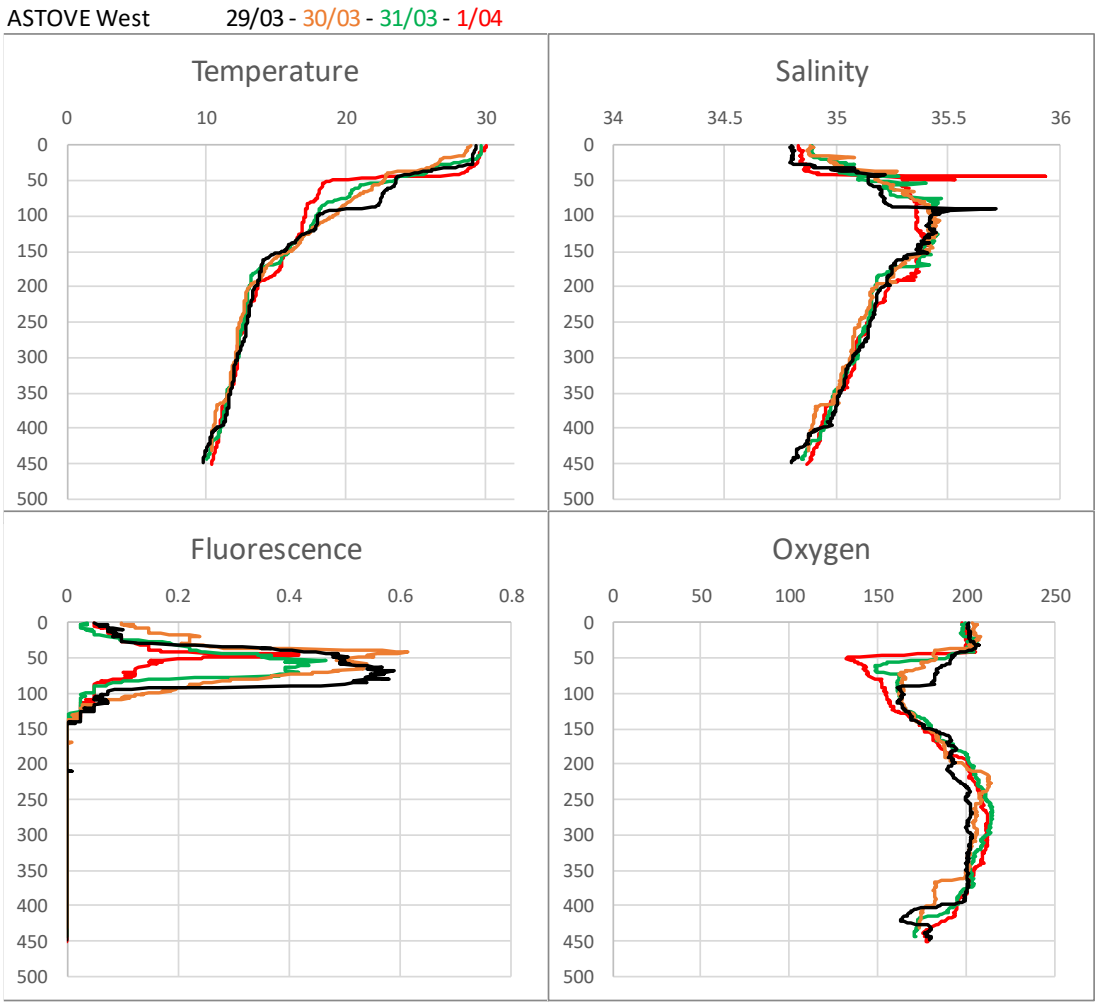


Figure 10: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L) and dissolved oxygen concentration (µmol kg-1) in Astove.*

Poivre

Eastern side of Poivre island was visited 5th - 7th April (Table 3), shortly after moderate rainfall 2nd and 3rd April (Fig. 11). Four CTD SeaCat profiles were conducted, two on 5th April and one per day during the following two days (Fig. 12).

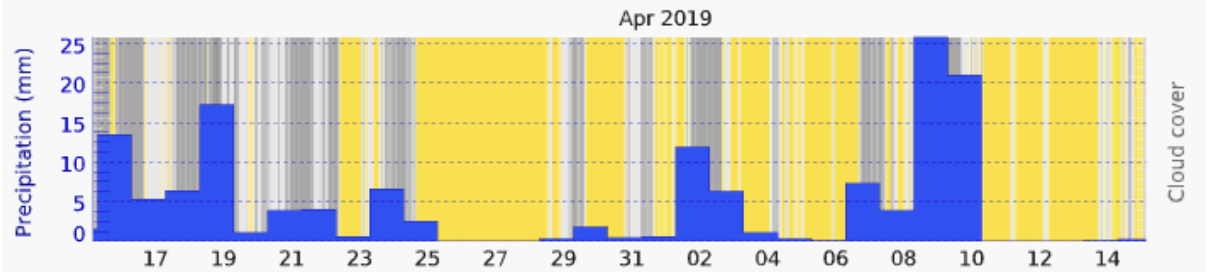


Figure 11: *Precipitation regime and cloud cover in Poivre, S Seychelles, 5.77°S 53.32°E (source: www.meteoblue.com).*

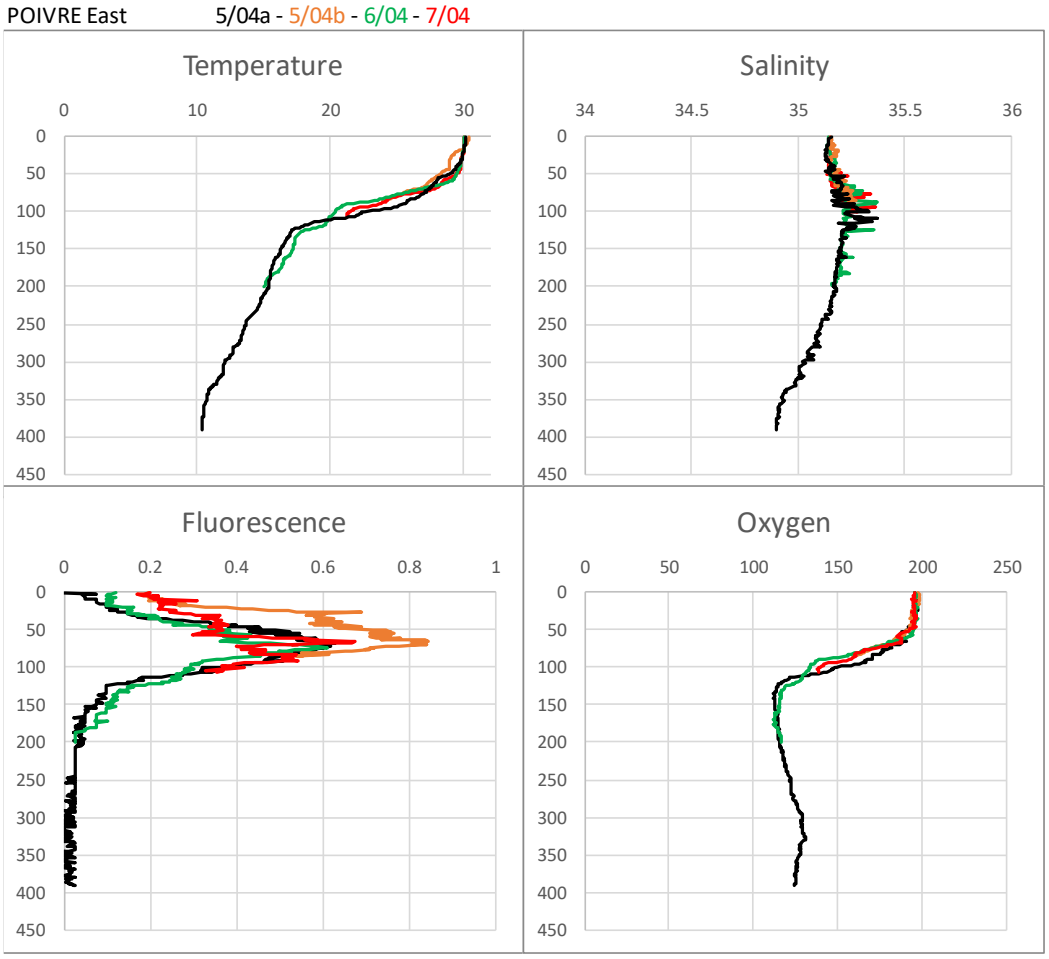


Figure 12: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L) and dissolved oxygen concentration (µmol kg⁻¹) in Poivre.*

Surface water temperature was close to 30°C and decreases steadily with depth (Fig. 12). The major thermocline is observed at 80 m and strengthened with time. Other shallower and deeper thermoclines of weaker amplitude are observed along the profiles and can be interpreted as former (for the deepest) or more recent (for the shallowest) warming events. These could be of tidal origin and linked to the flushing to the area of a warm water pool formed in the lagoon at high tide.

Salinity profiles did not exhibit features characteristic of dilution of surface waters by rainfalls and were fairly homogenous with depth (Fig. 12).

A large phytoplankton bloom was characterized by the *in situ* fluorescence maximum at 70 m (Fig. 12). Comparing the two consecutive vertical profiles acquired in the morning and in the evening of 5th April, illustrated the daily variability of phytoplankton distribution in the water column. The successive profiles tend to indicate shrinking of the bloom. The gradual rise of the oxycline tends to confirm the ageing of the bloom at this site.

St Joseph

The north side of St Joseph island, in the Atoll of D'Arros, was visited 8th - 11th (Table 3). Only the end of the survey was sunny, the first days were rainy with heavy rainfall 9th and 10th April (> 20 mm/day) (Fig. 13).

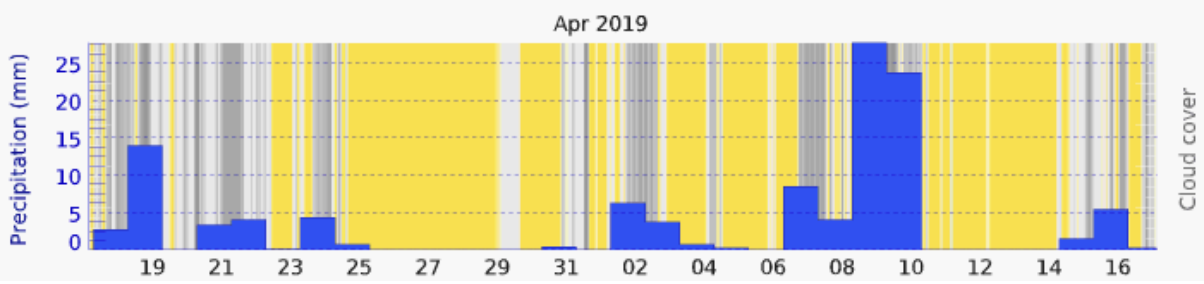


Figure 13: *Precipitation regime and cloud cover in St Joseph, Seychelles, 5.42°S 53.3°E (source: www.meteoblue.com).*

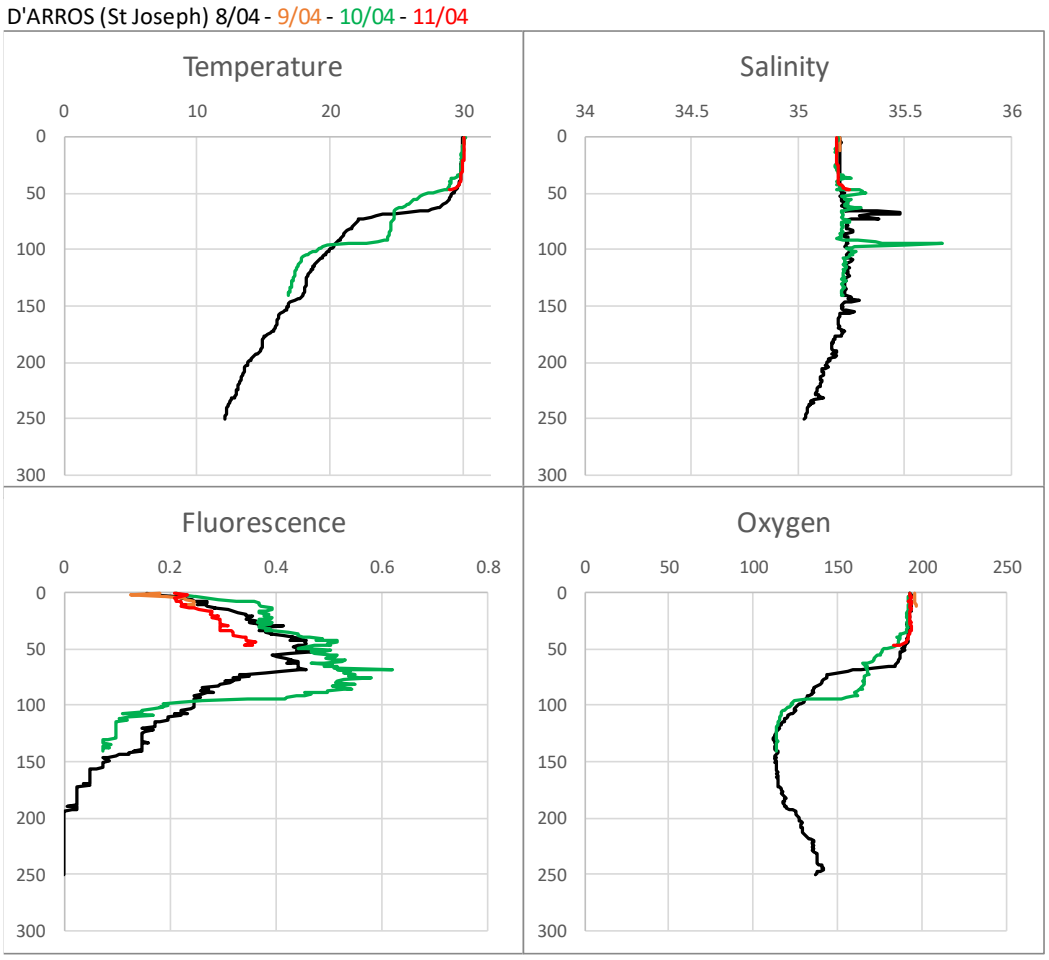


Figure 14: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L)and dissolved oxygen concentration (µmol kg⁻¹) in St Joseph.*

St Joseph sea surface temperature was close to 30°C (Fig. 14). The first profile (8th April) exhibited a well-established thermocline at 60 m depth underlying a well-mixed and quasi-homogenous surface layer of about 50 m. Only two deep profiles covering the water column down to at least 150 m allow us to speculate on the dynamics of the water column, on this site. Between 8th - 10th April, the top 100 m saw a deepening of the original strong thermocline to 95 m and the appearance of two successive ones at 50 m and 40 m, on which one can speculate a tidal influence dominated by the discharge of a warm water pool originating from the lagoon.

Salinity profiles (Fig. 14) were fairly constant from one day to the other, which indicates a strong dynamism. It is noticeable that no dilution was observed in surface waters, in spite of the rainfall. This suggested that the water mass investigated was advected from a region where no such rainfall occurred.

Desroches

The southern side of Desroches island was visited 11th - 17th of April (Table 3). The survey was conducted in good weather conditions (Fig. 15). The recent weather history showed heavy rainy events (> 20mm/day) in the two days prior to our arrival.

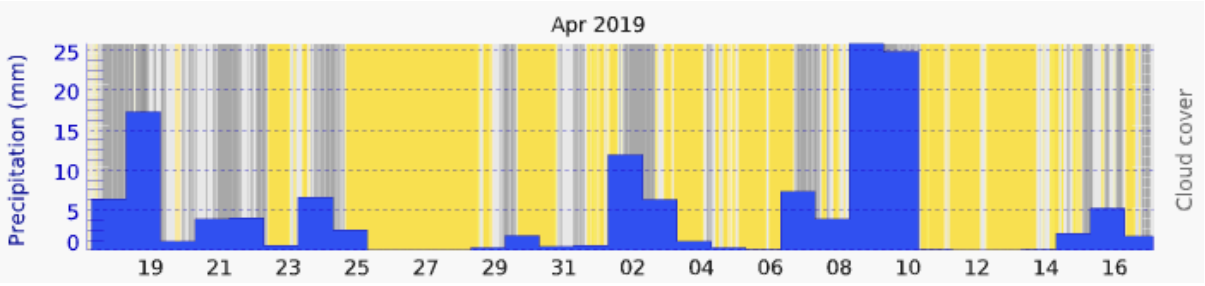


Figure 15: *Precipitation regime and cloud cover in Desroches, Seychelles, 5.7°S 53.66°E (source: www.meteoblue.com).*

Desroches' sea surface temperature was above 30°C (Fig.16). Vertical profiles of temperature showed the formation of a thermocline in the top 85 m that strengthened and deepened toward the end of the survey.

Sea surface salinity remained in a narrow range around 35.18 PSU (Fig. 16). Salinity profiles show computation artefacts at the depth of the thermocline. A salinity maximum was observed at about 100 m depth and was followed by a gradual decrease, as visible on the deepest profile, on 15th April (green plot).

In situ fluorescence was at its maximum on the first day, 0.955 counts/L at 58 m (Fig. 16). The data showed a decrease of the amplitude of the phytoplankton bloom with time. The oxygen concentration was high in the upper layer of the water column and the vertical profiles showed an oxycline at about the same depth as the thermocline.

Desroches 11/04 - 12/04 - 13/04 - 15/04 - 16/04 - 17/04

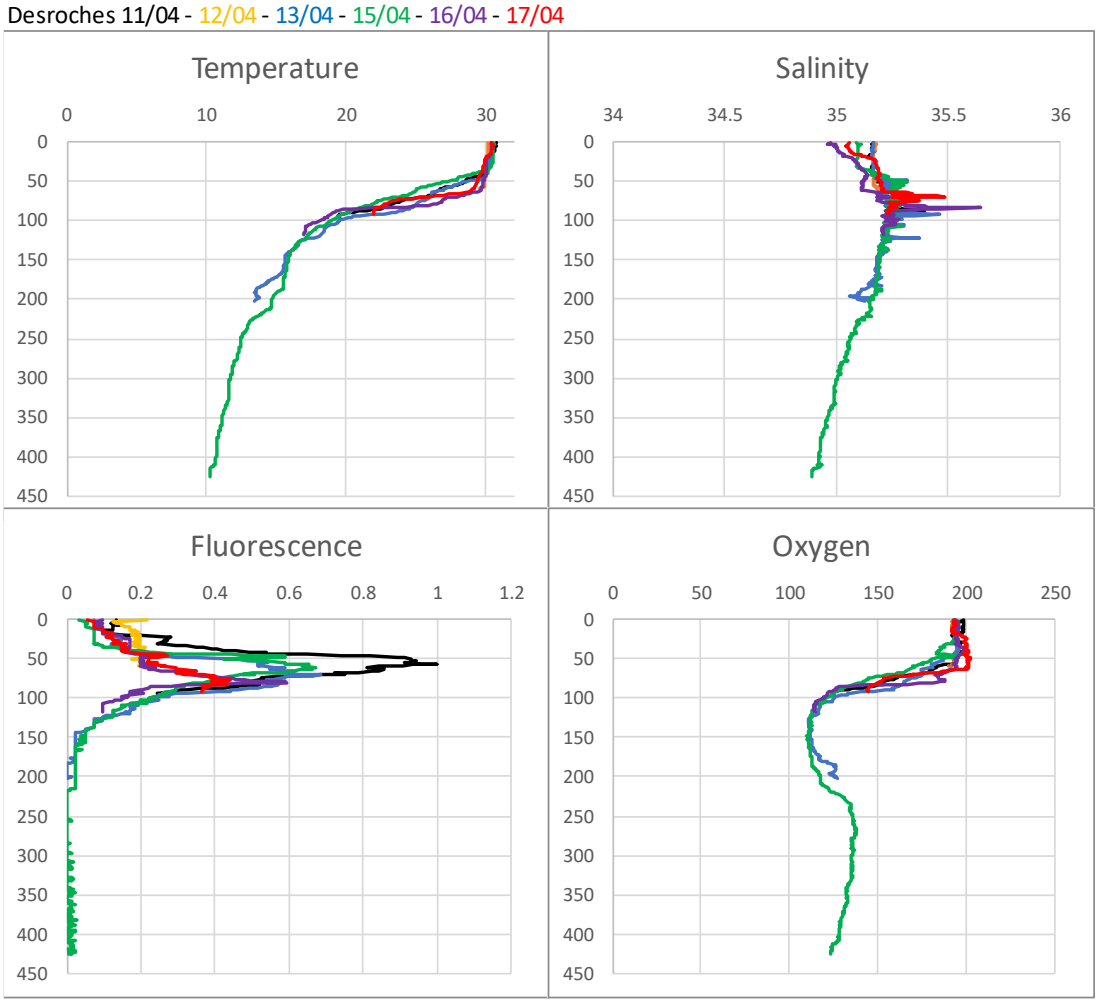


Figure 16: *Vertical profiles of temperature (°C), salinity (PSU), in situ fluorescence (counts/L) and dissolved oxygen concentration (µmol kg⁻¹) in Desroches.*

Current Velocity – Jérôme Harlay

Protocols

Upon arrival at a new site:

- Visually inspect system
- Lower ADCP through moon pool (2 people)
- Connect power cable to deck box and apply power to system
- Start VMDAS program on ADCP computer in dry lab
    - Set up data collection parameters under 'Edit Data Options' and change site name
- Start data collection by clicking blue square in top left corner
    - a box for each port will open showing recording information
- The ADCP will start displaying data and views can be adapted as needed
    - Raw single ping data, short term average, long term average
    - Profile plots of magnitude vs direction, relative signal strength vs correlation magnitude

On departure:

- End data collection, turn off VMDAS
- Save files to computer: VMDAS will generate a folder with different file formats and time stamps, that can be read in in VMDAS later ('Replay Data')
- Back up files from the site onto the server
- Remove ADCP from moon pool when moving to a new site

Narrative

Two different ADCP systems were supplied by from Teledyne, the 'WorkHorse' and their new 'Pinnacle' system. The WorkHorse was mounted during the mobilisation as there were issues fitting the Pinnacle on the mounting plate for moon pool deployment. During the first week it became apparent that the range of the WorkHorse (150m) was not enough to support operations and the decision was made to change to the Pinnacle system after leaving Alphonse.

The Pinnacle system was calibrated at Aldabra N1, with a specific focus on finding correct alignment angles and interference patterns.

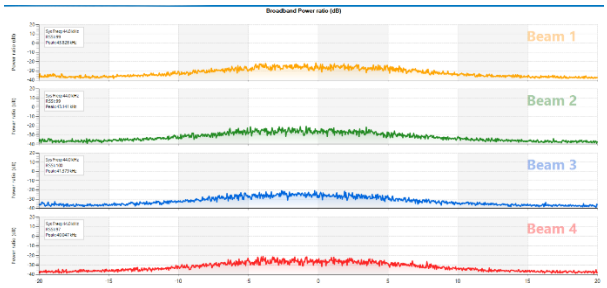


Figure 17: *Acoustic interference pattern logged at ALD N1*

Teledyne offered support during this process and provided new set up files. The calibration process took a few days and the Pinnacle was running since March 21st. However, some other issues were encountered after this date including crashes of the system during multi-day logging.

Summary of data collected

The ADCP logged data continuously at a site starting on arrival and stopping upon departure. The software produces a number of different formats that can be replayed in VMDAS.

Real-time ADCP data has been used to inform deployments of subs and ROVs over the course of the expedition.

Examples of data

VMDAS has three main ways to display data – raw data, short term average (STA) data and long term average (LTA) data. STA and LTA data is displayed in a plot showing depth, magnitude and direction (Fig. 18). Raw velocity data (Fig. 19) shows beam velocity at different depths.

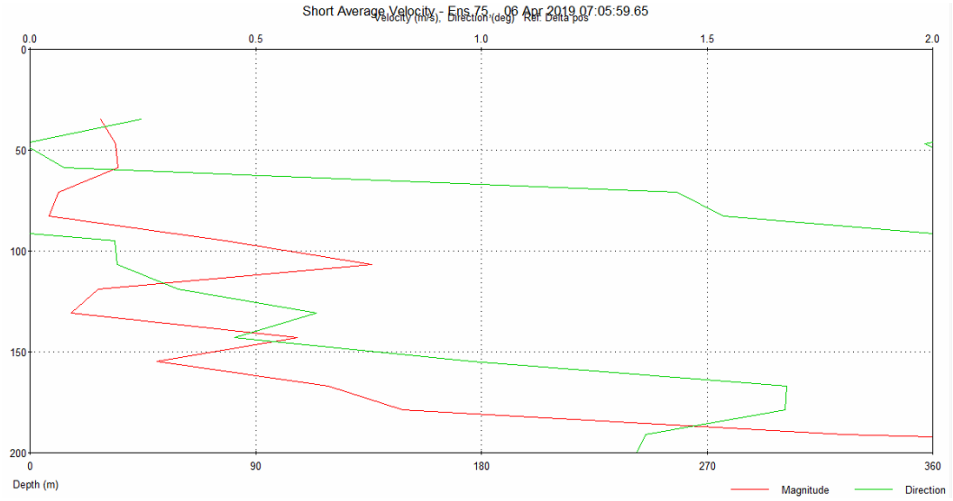


Figure 18: *Example of a short term average velocity profile (Poivre): Showing velocity on the x axis and depth on the y*

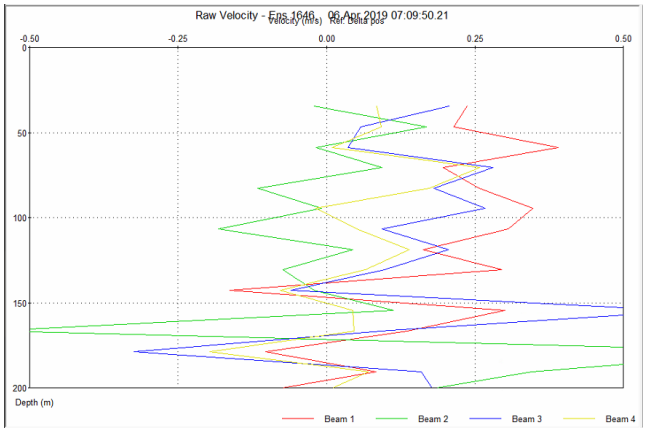


Figure 19: *Example of a raw velocity data plot (Poivre)*

Immediate findings

A formal comparison between different sites has not taken place yet. However, strong surface currents were seen at a few sites including ALD W1 and AST. At some other sites currents were more pronounced at deeper depths (100m) such as ALD N1.

Bathymetry: Seafloor Morphology – Denise Swanborn

Protocols

Upon arrival at a new site, the workboat was deployed to conduct an initial survey to find areas of interest for diving.

Preparation:

- Prepare new project, including Google Earth GeoTIFF, geoid model and grid model (2m)
- Discuss survey plan (area to be surveyed, depth ranges, timings and day plan)

- Prepare survey lines
- Check weather and water conditions

Pre-deployment:

- Pack survey equipment (laptop + charger, mouse, adaptors, hard drive, GPS data logger, SVP + cable)
- Pack satellite phone
- Check generator and fuel level
- Check whether SVP can be used of CTD

Deployment:

- Launch workboat with minimum crew; passengers board at pilot door
- Deploy multibeam pole and mount antennas
- Connect MBES system, GPS system and computer to generator
- Turn on computer and check pilot screen and auxiliary screen are working after connecting and displaying correct data
- Launch POSMV, wait for GPS to converge and turn data logging on
- Launch PDS project, including acquisition and presentation (pilot) screens
- Launch Sonar UI and adjust settings
- Drive to survey lines and start surveying, whilst monitoring Sonar UI and adjusting settings as appropriate.
- Conduct SVP if no data from CTD can be obtained.

Post-deployment:

- Close PDS and wait for data logging to be complete.
- Close POSMV and make sure logged data is saved.
- Turn off multibeam and POSMV systems
- Pack up survey equipment
- Remove antenna from multibeam pole and recover pole
- Wait for permission to be recovered

Data processing

- Create a rough grid with contour lines in PDS to inform locations for sub and ROV operations.

In 2m grid model:

- Import SVP data from the CTD upcast
- Import SBET data file obtained through processing POSMV data in PosPac MMS
- Interpolate data (25m circular)
- Edit individual data points

On final data file:

- Create contour lines showing the depths for science activities (10, 30, 60, 120, 250, 300, 450)
- Export final data file in different formats (.xyz, point cloud, GeoTIFF, .kmz)

Overview

Surveying work was conducted at all seven sites visited during the expedition.

Upon arrival at site, surveying work started at an arbitrary point to find the drop off and box an area to be surveyed. The survey boat travelled in shore as far as possible, followed by off shore travel in

lines parallel to shore until limit of system would be reached. Approximately 500m was found to be the maximum depth for the system (see Table 4).

This initial survey would give a rough outline of the site to inform diving operations. Following this deployment surveyors boxed off a total area to be covered at the respective site and created survey lines.

Table 4: *Summary data*

Site	Area surveyed (km2)	Max depth surveyed	Min depth surveyed	Average depth
Alphonse N1	4.84	-562.22	-6.32	-274.96
Aldabra N1	2.03	-538.39	-39.46	-239.93
Aldabra W1	2.29	-522.44	-6.32	-192.02
Astove W1	2.37	-511.60	-2.28	-277.25
Poivre	4.48	-481.42	-12.03	-150.65
St Joseph	4.61	-527.22	-4.55	-180.08
Desroches S1	5.98	-528.01	-8.64	-167.77
Total:	26.6			

Some lessons were learned from surveying experiences this expedition, mostly relating to equipment used (cover on boat to protect equipment, waterproof computers, screens, keyboards and adaptors, careful use of generators), but also to assessment of surveying conditions (weather, communications with bridge).

Site summaries:

Alphonse

Alphonse was the first site visited during the expedition. Sites visited at this location were E1 and N1, but these sites are merged in the final survey picture. Surveying work here involved coping with some start up issues, including correct GPS settings and calibration of the system.

Upon returning to Alphonse later in the expedition, two extra survey lines were run to finalize the dataset. The bathymetry follows the outline of the island, with a relatively broad shelf and steep drop off.

Aldabra

Parts of the North and West side of Aldabra island were surveyed (Fig. 20).

The survey coverage of these sites is smaller in comparison to other sites, which is partly due to limited possibilities to go out (weather) and technical difficulties (loss of computers and data in weather, two broken generators, boat reparations necessary, issues with adaptors and HDMI connection).

Calibration of the multibeam lines was performed during the stay around Aldabra W1 and applied to Alphonse data.
At Aldabra W1 it was decided to obtain SVPs from CTD upcast data when multibeam data was collected at the same part of the day as the CTD was deployed (AM/PM).

The sites were found to have similar profiles, but with a striking cavity and steep drop off on the west site.

Figure 20: *Map of Aldabra showing surveyed areas.*

Astove

The north-western side of Astove was surveyed and found to be one of the more dramatic sites having a short slope and a steep drop off between 30 m and 250m with prominent ridges. This drop off started about 70m out from the shore. Three survey deployments were performed at Astove over the course of two days. The rest of the time at Astove was spent processing data collected.

Alphonse

After Astove a short return to Alphonse was made to complete surveying deeper parts of Alphonse. Parts of the shallow bathymetry have to be interpolated as there was not enough time to survey both deep and shallow parts.

Poivre

The east side of the island of Poivre was surveyed. It differed from other sites surveyed up to that point in the sense that it has a large shelf and gradual drop off. One survey full day survey deployment was enough to map this site (5th March). CTD data from morning and afternoon were used for SVPs.

St Joseph

As with Poivre, St Joseph has a large terrace-like shelf between 30 and 120m and a more gradual drop off than the sites surveyed earlier on. More pronounced ridges can be seen on the drop off. St Joseph survey data was also collected in one full day, with one morning and afternoon deployment (8th March). The FRC broke down upon recovery and multibeam kit had to be taken off for reparation.

Desroches

Desroches was the last site surveyed and most of the Southern side of the island was covered. The same pattern of an extended shallow flat was seen here, but with a steeper drop off to 500m. Surveying was done in one full day on 12th March and the final part of surveying was done during the presidential visit on 13th March. Final days were spent processing data and creating exports of all sites.

Demobilisation of the multibeam and workboat was completed on 16th March.

Data Exports

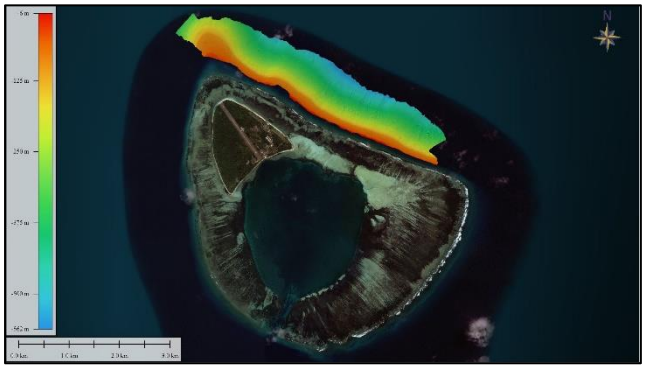
For all datasets the following data files have been generated:

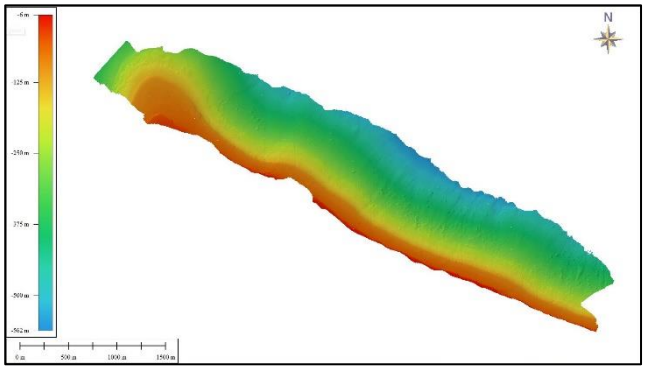
- .xyz of the gridded data (2m)
- .xyz point cloud data of the whole data set
- Contour files indicating depths of interest
- geotiff and .kml for viewing

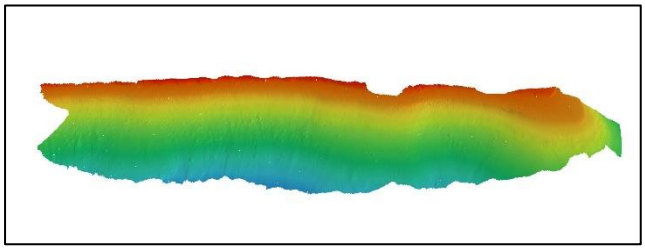
Site Images

Images show (1) an overview of the site and island, (2) top view of the bathymetry data collected and (3) a perspective view of the bathymetry data collected.

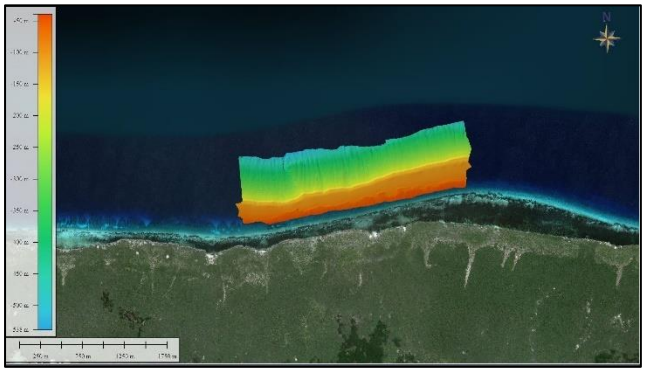
Alphonse N1

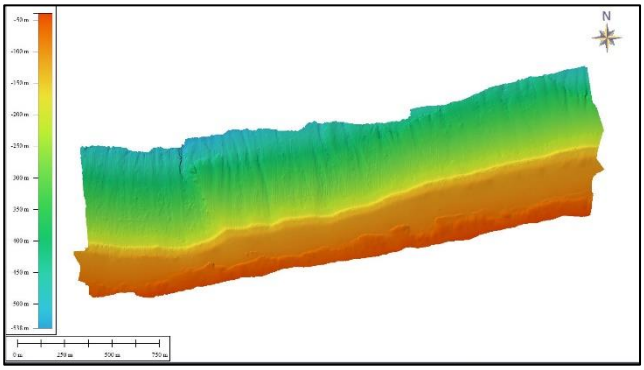


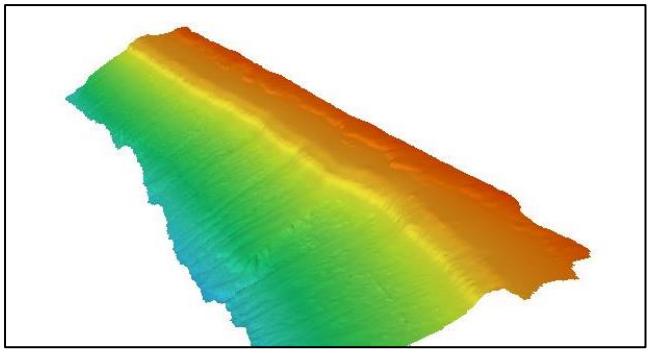




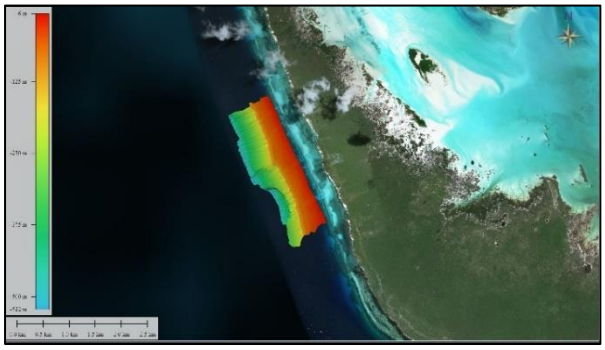
Aldabra N1

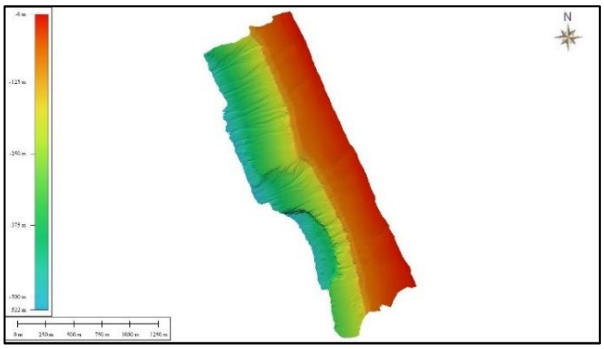


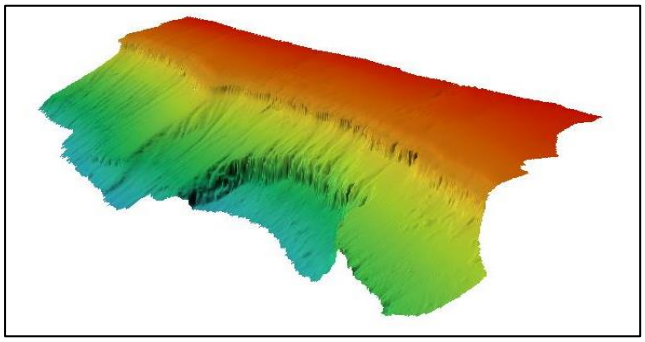




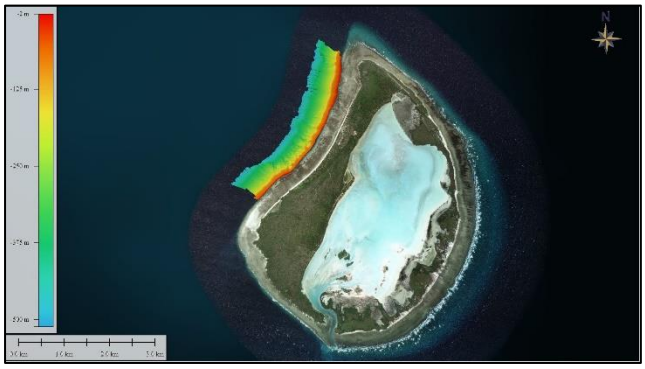
Aldabra W1

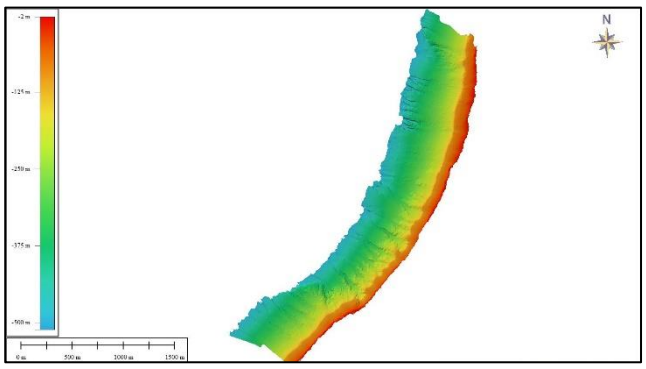


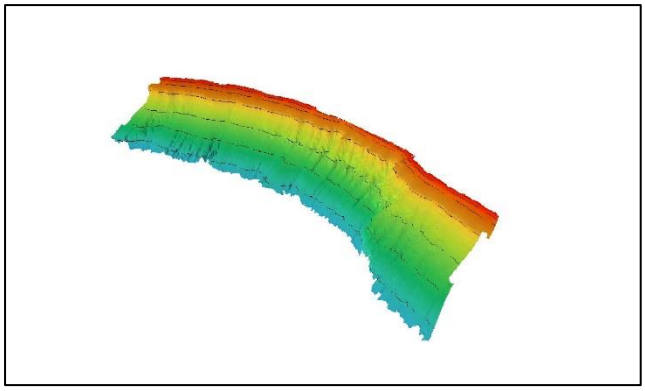




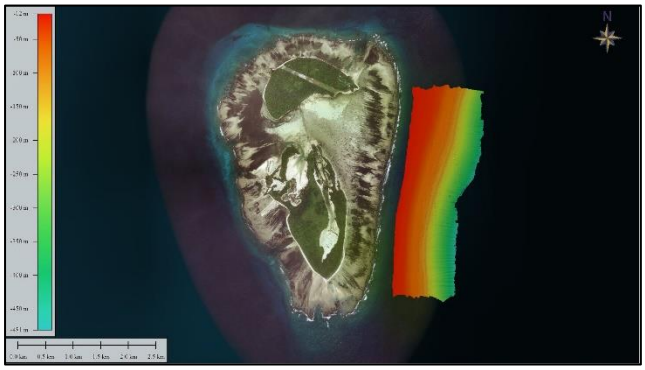
Astove W1

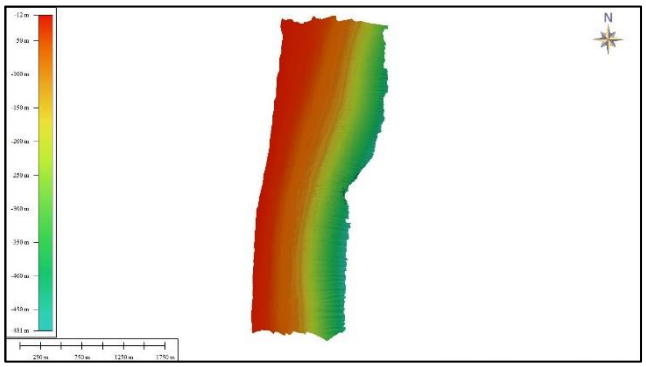


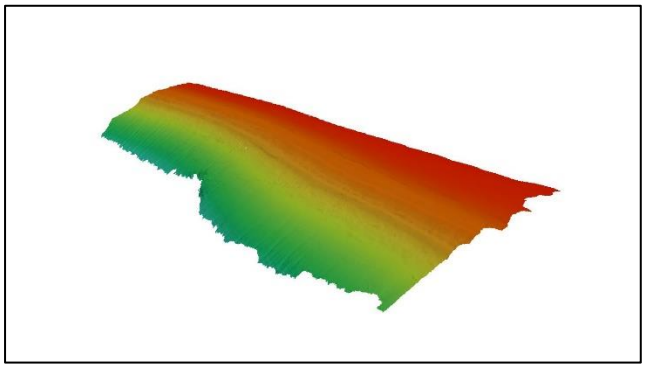




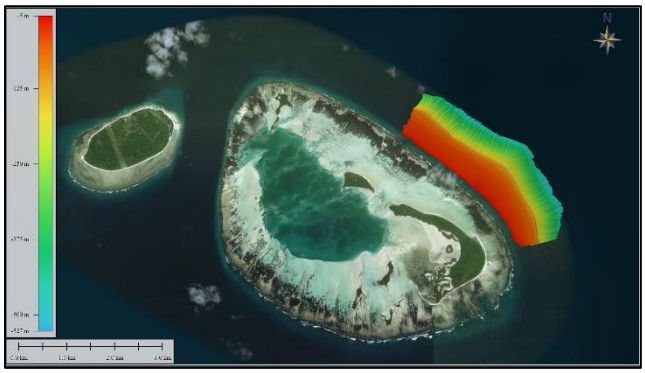
Poivre E1

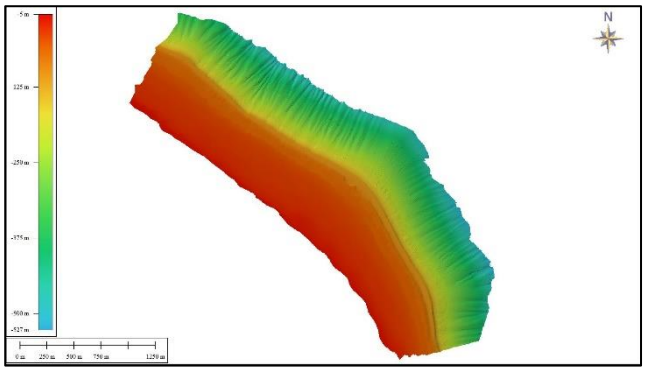


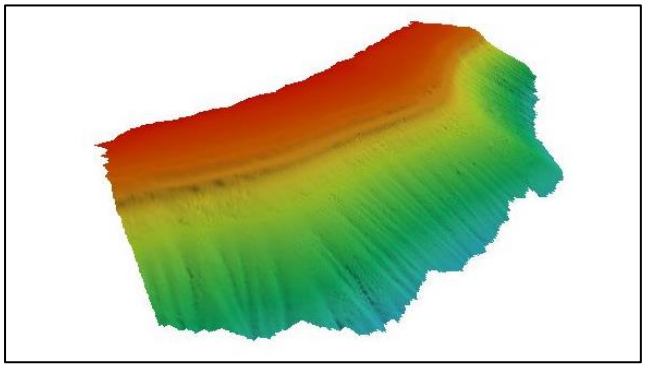




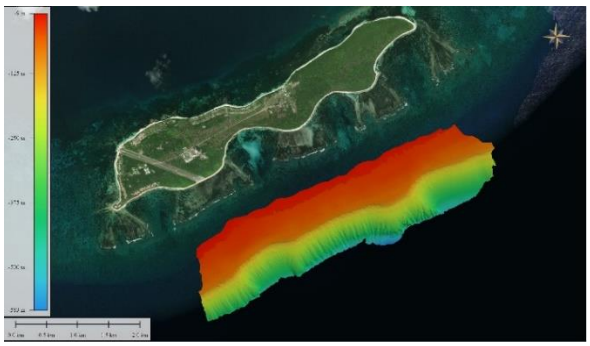
St Joseph N1

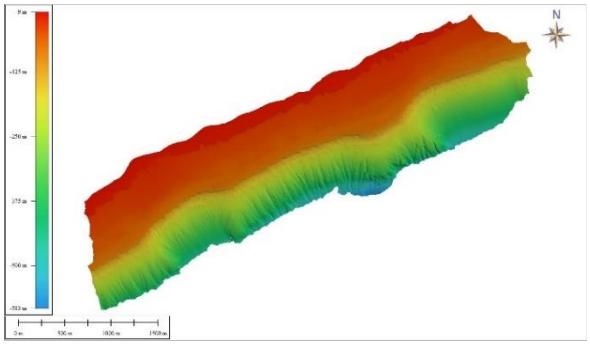


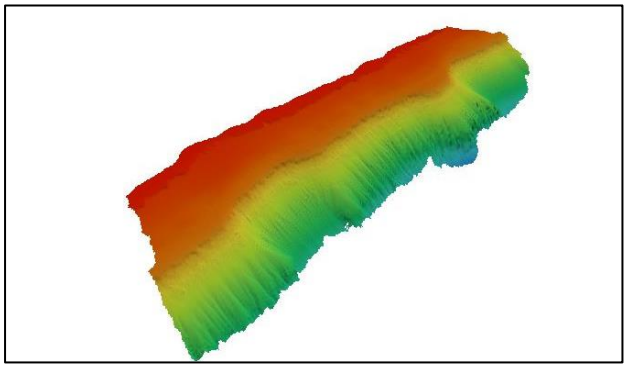




Desroches S1







Zooplankton Biology – Molly Rivers

Protocols

A neuston net samples the neuston layer, the interface between the sea surface and the air. Net samples require at least three replicates at each site to produce robust data sets.

Deployment

1. Attach the cod end to the net
2. Record the flowmeter reading in the Flowmeter recording sheet
3. Attach rope to D-ring on net strop and to the ship
4. Attach safety rope to net frame and ship
5. Lay out both ropes on ship floor to avoid tangling
6. Radio to bridge to inform them of deployment (Channel 1 then channel 3)
7. Contact bridge to move ship in a safe direction at 2 knots
8. Deploy the net into the water
9. Radio to bridge to inform them that the net is in the water
10. Radio to inform recording scientist of transect start
11. Tow the net for 20 minutes

Recovery

1. Recording scientist will radio to inform that the 20 minutes are finished
2. Radio to request the vessel stops
3. Remove the net from the water
4. Inform bridge gear is clear of the water
5. Place the cod end and the net in a large bucket
6. Record the flowmeter reading in the Flowmeter recording sheet
7. Wash the net with seawater from the outside into the cod end
8. Transfer the sample from the cod end into a sieve and then into a white tray, using sea water
9. Hang the net over the rope near the tap to easily clean the net with fresh water for the next deployment
10. Wash the cod end with fresh water for the next deployment

Sample Processing

1. Collect five sample labels (with unique numbers)
    - The first unique number is for the whole sample (parent sample)
    - The other four unique numbers are for the four splits
2. Take a photo of the whole sample in the white tray, with the label in shot
    - Destroy the first label, as there will be no parent sample remaining
3. Record information about parent sample into the yellow book, with its photo number and a note that there is 'no parent sample'
    - If any photos of individual specimens are taken, track which split they end up in and put their photo number in this sub-samples row in the yellow book
    - If the organism is too small to track through the split, put their photo number in the parent sample row in the yellow book
4. Label four 50ml centrifuge tubes with the following information
    - Unique ID number (with the prefix 'UID')
    - Parent ID number (with the prefix 'PID')
    - Deployment number (with the prefix 'D')
    - Location and site (e.g. Aldabra N1)
    - Net type (always Neuston net)

- Split number
- Preservation method, these will be denoted as follows:
  - Sea water = SW
  - 70% Ethanol = E 70%
  - 10% Formalin = F 10%
- Note:
  - Split number 1 will always be in Sea water
  - Split number 2 and 3 will always be in 70% ethanol
  - Split number 4 will always be in 10% Formalin

5. Transfer the sample from the tray into the 200 µm sieve
6. Transfer the sample into the Folsom splitter using a funnel
7. Split the sample into the two collection troughs
8. Transfer the contents of one collection trough into a container and set aside
9. Transfer the contents of the other collection trough back into the Folsom splitter and split the sample again
10. Select the first collection trough and transfer it to the 200 µm sieve
11. Using the funnel, rinse this sample into the correctly labelled 'Split 1' centrifuge tube with sea water
12. Fill out the information on to the corresponding label, place it inside the tube, seal it and place it in the freezer
13. Fill out the information in the yellow book
14. Select the next collection trough and using the sieve, transfer this into the 'Split 2' centrifuge tube using ethanol
15. Fill out the information on to the corresponding label, place it inside the tube and seal it
16. Fill out the information in the yellow book and transfer this sample into the fridge
17. Transfer the remaining split that was set aside, into the Folsom splitter and split the sample
18. Using the sieve, transfer the sample in one collection trough into the 'Split 3' centrifuge tube using ethanol
19. Fill out the information on to the corresponding label, place it inside the tube, seal it and place it in the fridge
20. Using the sieve transfer the contents of the remaining collection trough into the 'Split 4' centrifuge tube
21. Fill out the information on to the corresponding label, place it inside the tube, seal it and transfer it to the fridge
22. Ensure you have correctly entered all information into the yellow book

Summary of net deployments

Table 1 shows the number of neuston net samples collected at each site, excluding those that were not usable for quantitative analysis. We collected a number of neuston samples that were unusable for this purpose, mainly due to high proportions of sea grass being collected. On a few occasions we also collected samples with such high quantities of gelatinous organisms, that they are also not usable.

Table 5: *summary of all the usable neuston net deployments during the expedition, stating their sampling location, site and time of day.*

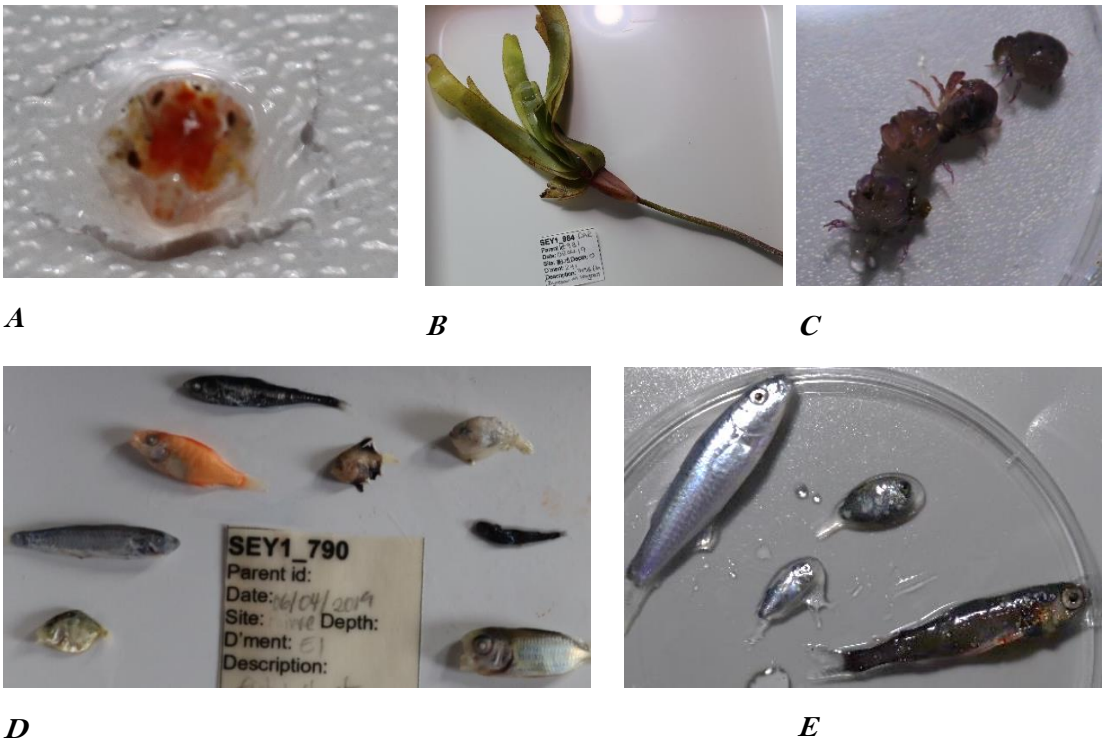
Location	Site	Number of usable deployments	
		Day	Night
Alphonse	E 1	2	0
Alphonse	N1	3	3
Aldabra	N 1	5	3

Aldabra	W 1	3	4
Astove	W 1	3	3
Poivre	E1	4	3
St Joseph (D'Arros)	N1	3	3
Desroches	S1	3	3

For each sampling site we endeavoured to collect at least three replicates during the day and at night. In only one location was this not achieved, Alp E 1.

Common of fauna found

Plate 1 shows the most common fauna and flora capture in the neuston nets from across all sites.



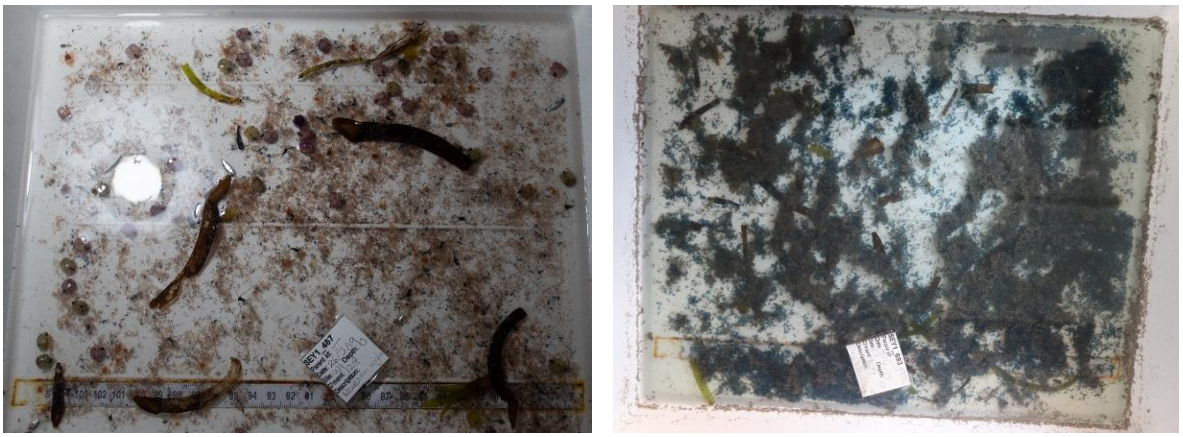
A ***B*** ***C*** ***D*** ***E***

Plate 1*: Shows some of the common fauna and flora found in the neuston net samples. A:Red/orange crab seen only in samples collected at night and generally in large quantities (Alphonse, S1), B: Thalassodendron, a sea grass commonly found in samples (D'Arros, N1), C: A common crab species found in night samples (Aldabra, W1), D: A selection of fish morphotypes found (Poivre, E1) and E: The most common fish morphotypes (Desroches, S1).*

Immediate observations:

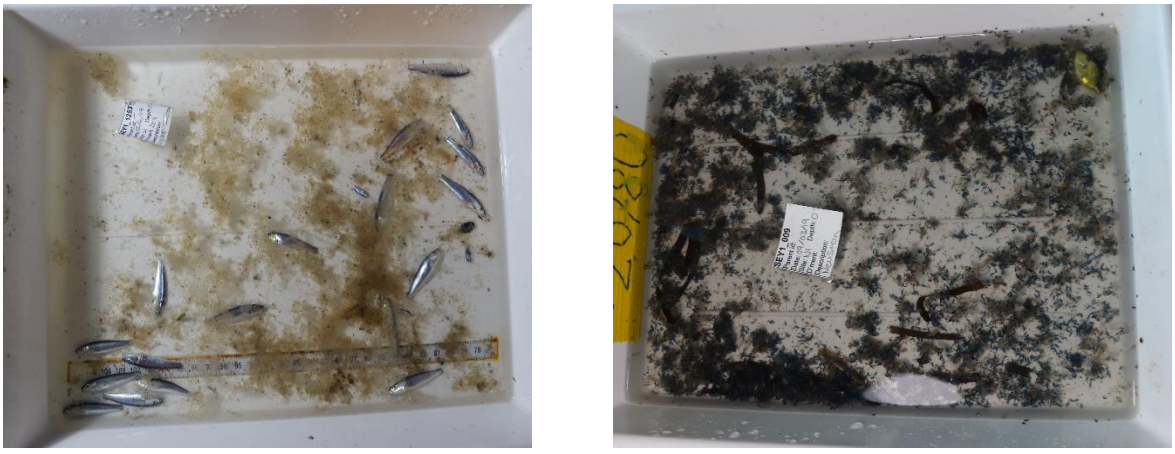
There were some immediately obvious differences between samples collected in the daylight and at night, Plate 2.

Night Samples **Day Samples**



A ***B***

C ***D***



E ***F***

Plate 2*: Photographic representation of the difference between zooplankton samples collected during the day and during the night. A: High quantity of decapods (including a specific group of round crabs that were never seen in day samples) and other crustacea (Aldabra, W1), B: Very high density of biota, with high quantity of copepods, gastropods and eggs (Poivre, E1), C: Very high proportion of decapod crustaceans, specifically a bright orange decapod species not seen in day sample (Aldabra, N1), D: Lower density of biota with much*

larger quantity of sea grass and algae (D'Arros, N1), E: Many more juvenile fish found in this sample than most with a smaller proportion of crustacean than in most night samples (Desroches, S1) and F: High density of biota with a high proportion made up of copepods (Alphonse, N1).

Surface water zooplankton samples taken during the day and at night often differed dramatically. In general, night samples contained a higher proportion of decapod crustaceans and fish larvae. They often also contained a higher total biomass than samples collected during the day. Samples collected during the day were often rich in copepods, gastropods and sea grass.

For daylight collected samples Astove N1, stood out as having fewer biota than at other sampled sites. Both of our sampling sites around Aldabra appeared to contain greater proportions of gelatinous organisms than other sites. On occasion, gelatinous organisms were so numerous that the sample was not quantifiable. At Desroches, due to very high quantities of seagrass, much greater than seen at any other site, samples were also no quantifiable. Our sampling site North of Alphonse contained the highest proportions of copepods. A visualisation of these difference are shown as plate 3.

A

B

C

D

E

F

G

Plate 3: *Photographic representation of the variance in zooplankton assemblage across the sites sampled in Seychelles. A: Extremely high quantity of copepods (Aldabra, W1), B: Low density of biota, many gastropods but very few crustacea (Aldabra, N1), C: Very sparse concentration of biota (Astove, W1), D: Much higher abundance of crustacean and juvenile fish (Alphonse, N1), E: Very dense sample with very high quantity of copepods, gastropods and eggs (Poivre, E1), F: Smaller quantity of biota, with high proportion of copepods and gelatinous organisms (D'Arros, N1)and G: Small denisty of biota with very large quantity of fish larvae compared to other sampling sites (Desroches, S1).*

Notes:

The neuston net was deployed from the stern of the vessel, on the starboard side to avoid dragging the net through too much ship propeller disturbance. It was towed at about 10m distance from the vessel so the frame was roughly half submerged. The flowmeter attached to the net frame was often not fully submerged during deployments, however this was consistent throughout deployments.

Day deployments were conducted any time during the day (not at dusk) and night deployments were conducted as soon as the night became completely dark (roughly 1945) and no later than 2130. Most replicate samples were conducted on the same day, one after the other. Therefore, little geographical or weather differences apply.

When seagrass or macroalgae were present in the samples they were rinsed with seawater to extract any zooplankton from them and removed from the sample. Occasionally, representative specimens from a species/group of interest were sampled. On some occasions the quantity of seagrass was so high that the sample could not be split or quantitatively analysed. These samples were either returned to the sea or bulk fixed in formalin.

When juvenile fish or larvae were sampled, fin clips were collected from each individual and stored in 98% ethanol for DNA analysis.

Video Surveys and Sample Collection – Paris Stefanoudis, Louis Allcock, Rowana Walton and Lucy Woodall

Protocols

SCUBA

Video transects at 10m were undertaken by SCUBA divers. At 10m depth, three 100m stereo video transects for fish (forward facing) and benthic cover (downward facing) were completed parallel to shore with at least 20m between each 100m transect. Two Paralenz cameras were attached to a metal frame and swum along the transects around 0.5m above the reef by a SCUBA diver.

MiniROV

Occasionally, video transects at 10m and 30m were undertaken by the MiniROV. At 10m depth, three 100m stero video transects for fish (forward facing) and benthic cover (downward facing) were completed parallel to shore with at least 20m between each 100m transect. Two Paralenz cameras were attached to a metal frame and flown along transects by the MiniROV.

Submersibles

Predeployment checks & activities

1. Assess bathymetry to formulate dive plan.
2. Check that three pairs of stereo Paralenz cameras are attached to *Kensington Deep* (downward, forward and sideways) and correctly set to run at 2.7K and 30-60 FPS, with time set to GMT, Auto White Balance, DCC off.
3. Check status of wildlife tag and attach to *Kensington Deep*, activate if necessary.
4. Check biobox on *Omega Seamaster 2* is clean and empty.
5. Query readiness of CTD on *Omega Seamaster 2*.
6. Check battery, dock, and SSD for high def camera have been returned and installed in *Omega Seamaster 2*.
7. Check two sets of log sheets (one for each sub) with dive plan are ready on clipboard.
8. Place clipboard, dive plan and data sheets, pencil, clicker counter (*Kensington Deep*), personal water bottle and camera/phone in appropriate sub, well in advance of deployment.

Immediately predive

1. Remove red cap from CTD
2. Start Paralenz cameras – turn blue ring to on/off symbol, pull thumb switch for four secs until camera vibrates, turn blue ring to video camera symbol, pull thumb switch for one sec until camera vibrates. Check display screen to ensure camera is recording.

On descent

1. Record time leaving surface, time bottom sited, time at target depth.

Only *Omega Seamaster 2*

1. Start CTD following instructions on laminated card
2. Turn Lasers on

On bottom

Transects (Kensington Deep)

Run three transects 250 m length, and record start and finish time and start and finish depth on Dive Info Sheet. Indicate start and finish of transect by flashing lights. Communicate start of transect to surface officer so surveyor can track the transect length. Maintain a constant altitude from the seafloor

between 1-2 m. Note that >2m will not allow observation of the smaller benthic organisms, while <1m, might not allow the two stereo-cameras to have any overlap.

To estimate distance along transect, in fast currents, position *Kensington Deep* facing the wall and drift with the current maintaining this direction and close to the wall as is possible. Note distance travelled by fixing eyes on wall fauna near outside forward (with respect to direction of drift) pontoon and watching to outside left pontoon. Click clicker counter and repeat. When counter reaches 80, transect is complete. If a lack of currents necessitates forward travel, remember sub is 4 m long, and judge 3 m accordingly.

Faunal Collection Red Sub (Omega Seamaster 2)

Collect five of the most abundant but not yet collected organisms (focus on corals and sponges). Record the time at which the sample is placed in the biobox in the Event Log. Ensure that no similar looking samples are placed in the biobox. Mixed-up samples are a waste so it is essential samples can be separately identified on recovery. If possible, take a photograph of the specimen before it is sampled. Direct the pilot to manoeuvre sub to take excellent close-up high def video of interesting fauna, particularly before collection. Record collection of high def video as a separate event.

On ascent

Record time off bottom, depth when leaving bottom and time on surface on Dive Info Sheet.

Post Dive

Biological sample processing

1. Prepare buckets of filtered sea water prior to submersible arrival on surface, and keep them in a cool place, e.g., the wet lab. Ensure they are labelled with deployment number.
2. Fill aquarium.
3. Approach the ROV only when deck boss indicates it is safe to do so.
4. Empty the biobox into the labelled bucket, making sure no organisms are left in the bottom of the box. Photograph the bucket and its contents, ensuring deployment label is visible.
5. Carry bucket(s) to the wet lab and refrigerate as soon as possible to ensure that the water and specimens do not overheat.

There is a priority order for processing samples, according to scientific interest. The five main samples must be processed BEFORE their associates. Remove the first large target species from the bucket and pass to the book and label guardian and subsampler (see below). Repeat until all target species are processed from that bucket. When all target species have been removed from the bucket, place the bucket containing the incidental bycatch to one side for processing later.

Wet lab stations

a. Book and label guardian

This person controls the wet lab. The book and label guardian assigns a unique ID number to each sample, writes the labels and writes details of the sample in the yellow lab record book.

b. Subsampler

The subsampler prepares 2 ml vials of ethanol 98% in the freezer and RNA later at room temperature in advance. As soon as a unique ID number has been assigned, the subsampler writes a vial sized label indicating just the unique ID number, places this in the vial such that it is easy to read, and takes a small tissue sample which he/she adds to the vial. These samples MUST be taken as speedily as possible. Once taken, subsamples in ethanol 98% should be stored in the freezer, subsamples in RNA

later at room temperature. Prior to storage vials should have all details written on the outside in ethanol proof marker pen.

c. Tray photographer

The tray photographer takes high res photographs in a tray/neutral background. The unique ID label, a ruler, and a colour correction chart must be in all photographs. Tray photography is essential for every specimen.

d. Preserver(s)

Once the tray photography has been completed, the preserver first picks off any associated fauna and places these in an appropriate sized tray labelled with a handwritten label noting the parent sample ID provided by the book and label guardian. The preserver places the associates to one side, working on them only when the main five specimens have been processed, OR when the preserver is waiting for main specimens. The preserver consults the table below for the correct method of preservation for main specimens, and follows those details exactly, according to taxon (Table 6)

If aquarium photography is required, once all associated fauna have been removed then the target samples is passed to the aquarium photographer (see below for details). However, a photograph with associated fauna may also be deemed important is some situations).

All scientists can assist with preserving associates. Associate unique ID labels must be logged with their parent sample number as well as their own. All associates must be logged in the yellow book, so close liaison between the preserver(s) and the book and label guardian is essential.

Finally, the bycatch (any collected fauna that do not have a clear parent sample association, e.g. found floating in bucket) is processed. All bycatch must be logged in the yellow book. Note the difference between 'associates' and 'bycatch'. Associates are physically removed from the specimen by the scientist such that we know they were associated with it. Bycatch is taken incidentally, and we cannot be sure of its origin.

Table 6: *Details of common taxa sampled*

Taxon	Preservation	Notes
Scleractinia	Ethanol 98%	If samples are larger than 10 x 10cm please subsample a 3 x 3cm piece with a hammer/chisel and preserve this tissue sample in 96% Ethanol. The remaining material can be either cleaned in bleach (Sodium Hypochlorite - by leaving overnight in a bucket with a ratio of 1/3 bleach to freshwater) or Frozen.
Antipatharia	Ethanol 70%	Subsample large colonies from various parts of colony: base, tentacles, stem etc
Alcyonacea	Ethanol 70%	Subsample large colonies from various parts of colony: base, tentacles, stem etc
Pennatulacea	Ethanol 70%	
Zoantharia	Ethanol 70%	
Porifera	Ethanol 70%	If large, specimen may be frozen instead

For the preservation of the main target samples, heat sealed poly bags should be used of the smallest size possible. These bags should be filled with enough Ethanol at the appropriate dilution, in order to cover the sample. Place the unique ID label in a separate compartment. Ensure that all samples are double bagged with multiple seal lines to prevent leakage. After sealing place in large white try to check for leakage. Once checked transfer into site specific blue barrel.

e. Aquarium photographer

The aquarium photographer takes high quality photographs with the aquarium camera (Canon DSLR) of the whole target sample (parent). The unique ID label and a ruler must be in all photographs.

Paralenz camera data export

Remove bars with the dual Paralenz cameras attached. Connect Paralenz to a networked laptop via USB-C in the dry lab and copy files to RAID storage system into the SUB folder, using standard naming convention. Wipe files from microSD card, recharge cameras ready for next dive.

High def camera data export

Remove the dock, SSD, and battery. Connect the SSD to a networked computer via the dock and copy files to RAID storage system into the SUB folder, using standard naming convention. Once files copied, immediately pass dock, SSD, and battery to media Will who will supply same to Sky Media Team. Will will retrieve these from Sky Media Team and return to sub pilots for charging and reinstallation.

CTD data export

Two USB sticks are available for CTD data export.

Wildlife tag data export

Remove wildlife tag. See separate protocol for programming and processing.

Remotely operated vehicle (ROV)

Pre-survey

1. Assess bathymetry to formulate dive plan
2. Check stereo cameras (forward and downward facing) with battery extenders (x4) fully charged
3. Check wildlife tag has been set up to record
4. Check bioboxes are clean and empty

Immediately pre-dive

1. Attach wildlife tag to the ROV cage (tether management system – TMS).

2. Turn cameras on, place in housings (2 housings on each of the two frames; 1 forward and 1 downward-looking frame), and attach to ROV (see separate protocol)

On descent and descent

1. Log time into water
2. Note observations of interest in the Event Log

On bottom

1. Run three transects 250 m length (estimated at ~ 40 mins at a speed of 0.2 knots; leave 5 mins between transects), logging each in the Dive Events Log Sheet, and recording start and finish time on Dive Info Sheet. Keep constant and low altitude (~ 1m above seabed) and constant and slow speed (0.2 knots or less) throughout transect. Communicate with the surveyor who will be able to give more accurate estimates of distance covered using the USBL system.
2. During transects, take screen grabs regularly – that's from the camera of the ROV team, hence you have to ask the ROV team to do it - during transect and of anything particularly interesting. Log each screen grab (or set of screen grabs of a single organisms) as a unique event.
3. Collect five most abundant but not yet collected organisms (focus on corals and sponges). Take extensive photos of each organism prior to collection, logging each set of photos in the Event Log. Record in which biobox the sample is placed, logging sample collection in the Event Log. Ensure that no similar looking samples are placed in the same biobox. Bioboxes are Left, Middle, Right and Left is left as seen by the ROV etc. as it faces on to the cage and bioboxes.

Post Dive

Biological sample processing

See submersible operations.

GoPro Camera data export

1. Remove the two stereo camera frames (one forward and one downward facing) from the ROV cage.
2. Rinse with freshwater, and then use a towel to dry them.
3. Remove the cameras from the housings (see separate protocol for that).
4. Remove the micro-SD cards and import the data into the RAID storage system into the ROV folder, using standard naming convention.
5. Wipe files from microSD card, recharge cameras ready for next dive (charging takes approx. 3.5 hours).
6. Do not forget to charge the GoPro cameras as well as the battery extenders as well.

Wildlife tag data export

Remove wildlife tag. See separate protocol for programming and processing.

Biological patterns with location and depth – Paris Stefanoudis, Jennifer Appoo, Kaveh Samimi-Namin and Rowana Walton.

Alphonse N1

10 m

Gentle sloping reef with a medium coverage of hard corals. Dominated by colonies of *Porites*, *Millepora*, *Tubipora*, *Acropora* and crustose coralline algae (CCA). Reef slopes at around 12-15m into vertical reef wall that is covered in gorgonian soft corals. Rich fish communities comprising of fairy basslets (*Pseudanthias*), damselfish (e.g. *Chromis*), soldierfish (*Myripristis*) and fusiliers (Caesionidae).

30 m

Steep, rocky reef slope, with occasional sandy patches. Highly 3D complex environment with numerous ledges and caves. Dense benthic communities dominated by the encrusting hard coral *Pachyseris*, and numerous gorgonian fans (e.g. *Annella*). Other encrusters include demosponges and CCA. High number of associated fish such as basslets (Anthiinae), snappers (Lutjanidae), and surgeonfish (Acanthuridae).

60 m

Gentle slope seabed located at the base of a steep, near vertical wall. Substratum consists of thin overlying sediment layers on bedrock, with patches of gravel and rubble. Benthic communities consist primarily of yellow-green gorgonian fans (possibly Acanthogorgiidae or Plexauridae family), a variety of encrusting sponges, CCA, and occasional plating hard corals (*Pachyseris* and *Leptoseris*). Small basslets (e.g. *Nemanthias*), snappers (*Lutjanus kasmira*) and groupers (Epinephelinae) dominate fish communities at this depth.

120 m

Rocky habitat with variety of encrusters. Large (1-2m long), white whip corals (*Junceella / Viminella*), are dominant here, along with small white stylasterids and fleshy soft corals (Nephtheidae); not many predatory fish present at this depth. Small wrasse (Labridae) and fairy basslets were the most common types, typically seen near crevices and small caves.

250 m

Gentle slope to flat seabed with sporadic occurrences of boulders. Substratum is primarily bedrock often overlaid by thin sediment layers. Megafaunal diversity is quite low and dominated by a few morphotypes of sea urchins and one type of pink sea fan (*Primnoa*). Very few fish spotted at this depth, but there was a rare encounter with a sunfish (*Mola mola*).

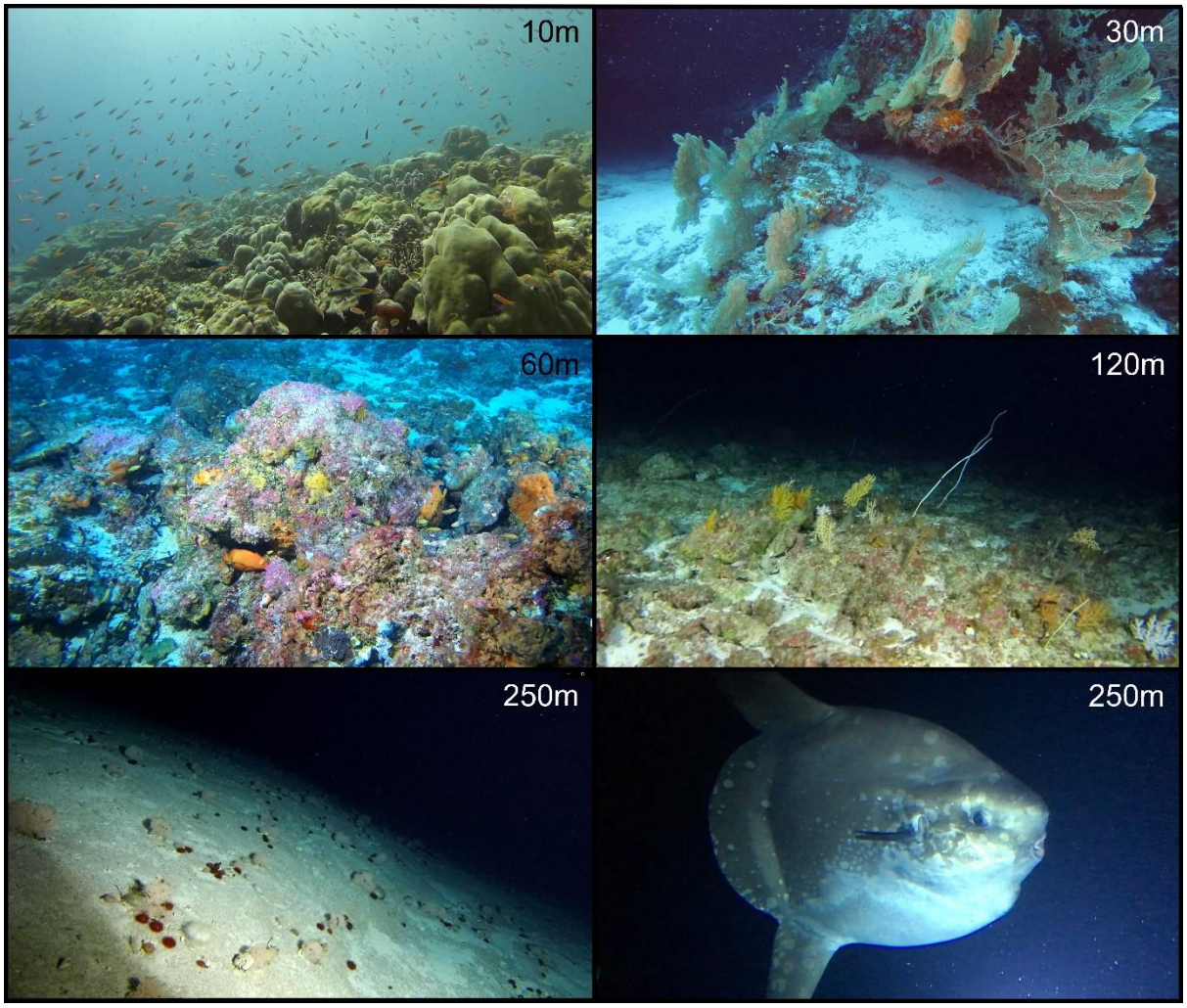


Figure 21: *Representative habitats per surveyed depth at Alphonse N1.*

Aldabra N1

10 m

Gentle sloping reef at 10m characterized by the hard corals *Heliopora* and *Porites*, the green calcareous algae *Halimeda* and CCA. Overall, low coverage of hard corals with patches of rubble and sand in between. Reef slopes into sand at between 15-20m. Small basslets and damselfish (Pomacentridae) were common, but of note was the high abundance of large predatory fish such as snappers, emperors and reef sharks.

30 m

Steep sloping reef with high complexity covered mostly in hard coral and very few sandy patches in between. The reef was supported a diverse suite coral species, dominated by the scleractinian *Pachyseris*, *Leptoseris*, *Favites* and large sea fans (e.g. *Annela*). High abundance of reef fish consisting of fusiliers (e.g. large schools of *Pterocaesio tile*), butterflyfish (Chaetodontidae), angelfish (Pomacanthidae), snappers, groupers and trevallies (Carangidae).

60 m

Steep rock wall which descends to a gentle to medium sloping bottom. Substrate was covered by a thin sediment veneer with some patches of exposed bedrock. The base of the wall was dominated by sea fans (*Annella* and *Astrogorgia*) and whip corals. Several schools of fish were spotted consisting of snappers, trevallies. Other types of fish included surgeonfish and triggerfish (Balistidae).

120 m

Steep slopes with rocky outcrops and occasional patches of sand; with numerous overhangs, caves and small crevices. Communities dominated by white whip corals (*Junceella / Viminella*), several types of sea fans from Ellisellidae and Plexauridae families, and large white sponges (possibly *Pachastrella*). Several small fish present including fairy basslets and soldierfish that commonly associate with corals and seek refuge in crevices when the submersible was in close proximity. Other larger fish such as trevallies (Carangidae) and groupers (Epinephelinae) are also occasionally found roaming at that depth. From those, potato groupers (*Epinephelus tukula*) are by far the most inquisitive of all. One spotted moray eel (*Gymnothorax* sp.) also observed at this depth.

250 m

Medium to steep slopes with rocky outcrops often covered by a thin layer of sand; with occasional few sandy patches in between. Barren landscape, often covered by dead seagrass fragments (*Thalassodendron*), and a few sea urchins and sea stars. Very few fish present.

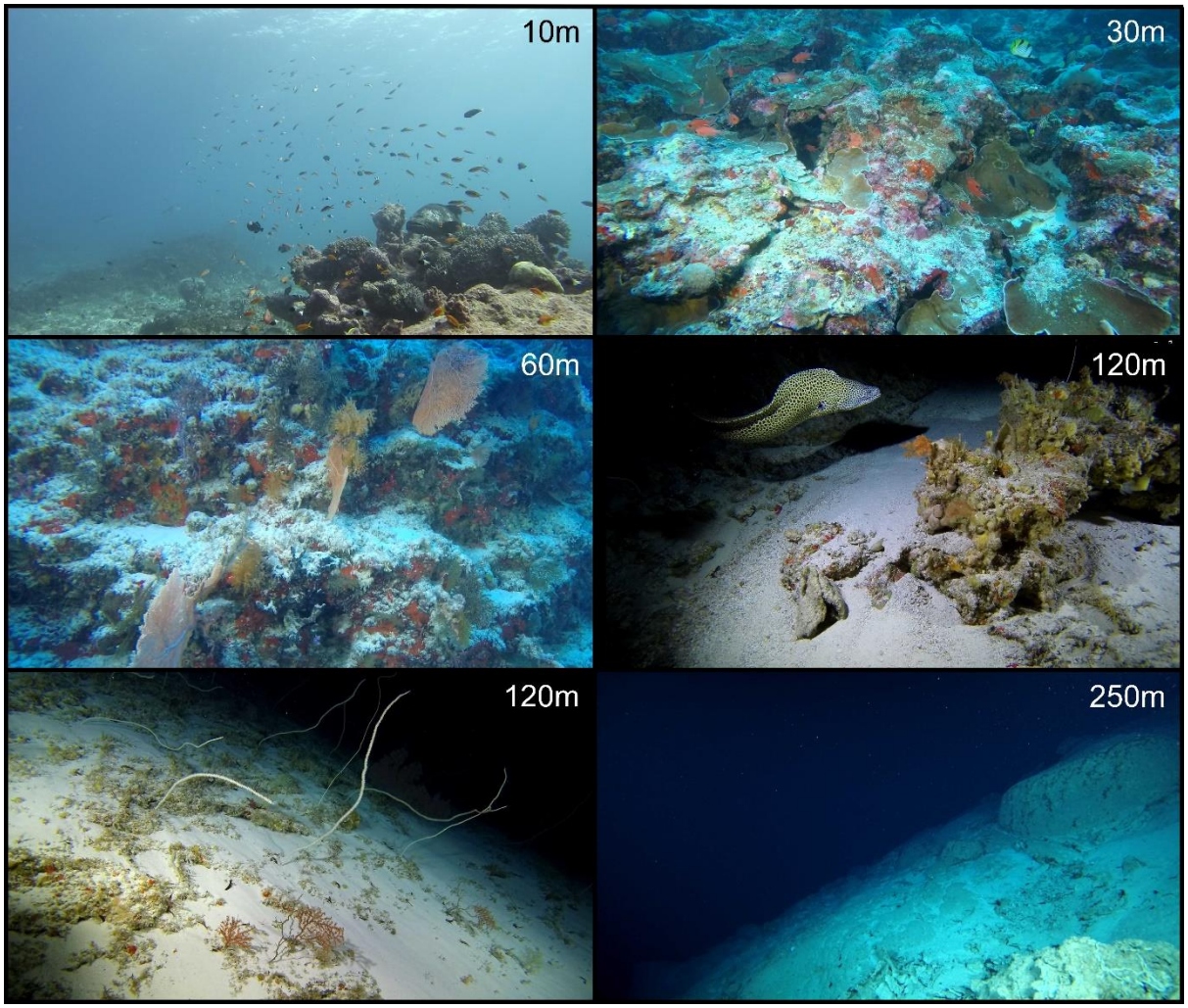


Figure 22: *Representative habitats per surveyed depth at Aldabra N1.*

Aldabra W1

10 m

Shallow flat reef that graduates into seagrass beds (*Thalassodendron*) at the reef crest (around 3-4m). Reef at 10m dominated by *Porites* and *Favites*. Sings of the impact of the 2016 coral bleaching event were still evident. Rich fish communities, with high stocks of large predatory fish such as snappers, groupers, emperors and reef sharks.

30 m

Sandy habitat, in the form of a thin sediment veneer overlaying bedrock, with several patches of exposed bedrock providing suitable habitat for corals and encrusting organisms. Benthic communities comprise a mixture of hard corals (e.g. *Pachyseris*, *Physogyra* and *Turbinaria*), sponges (e.g. mainly *Theonella* and *Spheciospongia* spp.), sea fans and other soft corals (Nephtheidae). Incredible diversity of fish some of which include surgeonfish, blue-fin trevallies (*Caranx melamphygus*), butterflyfish and triggerfish.

60 m

Large sandy expanses with rocky outcrops. Overall, fish and corals are sparse above sandy habitats but much more common when hard substratum is available. Common types of fish include basslets, surgeonfish, triggerfish, and larger pelagic aggregations of blue-fin trevallies and snappers. Benthic communities comprise several types of sea fans, sea whips and other branching corals (Ellisellidae), a

variety of encrusting sponges (yellow, orange, red and green morphotypes), some tube sponges, and crinoids.

120 m

Similar to Aldabra N1, habitat topography at this depth comprised steep slopes with rocky outcrops, often overlaid by thin sediment layers. Abundance of small overhangs and crevices provided habitat for many cryptobenthic fish. Coral communities dominated by red, soft, fleshy corals (*Litophyton*) as well as white whip corals (*Junceella / Viminella*). White cup sponges are also quite common. With occasional encounters of large predatory fish such as sharks, including a silvertip reef shark (*Carcharhinus albimarginatus*), and potato groupers.

250 m

Extensive thin sedimented layers covering bedrock with frequent large boulder-like features. Due to little available exposed substratum very, few encrusting organisms are present at this depth, and benthic fauna is dominated by white Stylasterids, sea urchins and bryozoans. Some black corals were also spotted. Several dead fragments of seagrass populating the seafloor. Very few fish present at this depth.

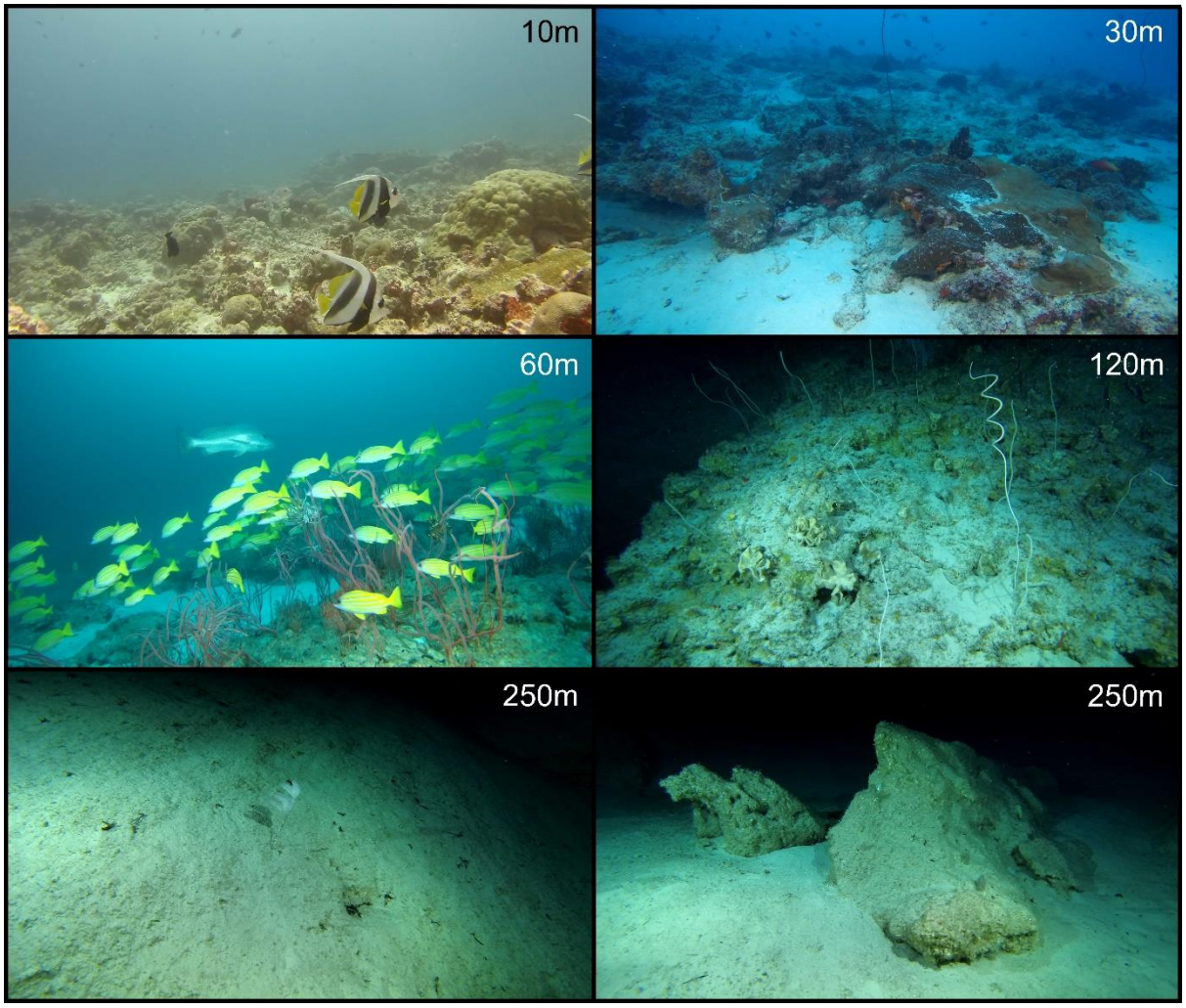


Figure 23: *Representative habitats per surveyed depth at Aldabra W1.*

Astove W1

10 m

Spectacular reef wall with top of reef at 2 m depth sloping quickly into vertical reef wall that descended to around 60 m depth. At 10 m, reef wall undulated with some spur and groove formations and several overhangs and caves. Incredibly high coral cover (est. >70%) with a high diversity of hard coral species (e.g. *Echinopora*, *Montipora*, *Tubastrea*). Hawksbill (juveniles) and green turtles (juveniles and adults) (*Eretmochelys imbricata* subs. *pissa* and *Chelonia mydas*, respectively) are common and a representative diversity of fish species present, although with lower abundance of large predatory fish compared to Aldabra.

30 m

Very steep slope commencing at ~25 m, leading to an almost vertical wall >30 m. Reefs between 25–30 m with very high coral coverage, almost exclusively dominated by *Pachyseris*. Vast abundance of reef-associated fish, with trevallies, fusiliers and butterflyfish being particularly abundant. With populations of hawksbill and green turtles (*Eretmochelys imbricata* subs. *pissa* and *Chelonia mydas*, respectively) present.

60 m

Vertical wall leading to medium slopes at about 60 m. Wall with incredibly dense benthic coverage comprising several types of sea fans of the Plexauridae family and numerous types of encrusting sponges. Benthic coverage is comparatively less on the slope, where thin sediment layers leave fewer patches of exposed bedrock available for encrusting organisms. The plate algae *Lobophora* is quite common on the slope along with tube-shaped sponges. Small reef fish such as fairy basslets, several types of wrasse and surgeonfish are the dominant fish representatives at this this depth, although tuna (*Gymnosarda unicolor*) and great barracudas (*Sphyraena barracuda*) can also be occasionally spotted.

120 m

Steep walls comprising exposed bedrock, at times overlaid by thin sediment layers. Plenty of small caves, crevices and overhangs provide habitat for a variety of small fish, such as fairy basslets and soldierfish. Large predatory fish such as barracudas and reef sharks are occasionally present. Most common benthic organisms are corals, members of the Plexauridae, Anthothelidae and Elliselidae families, as well as zoanthids and encrusting sponges.

250 m

Steep slopes to almost vertical walls making the topography at this depth horizon very dramatic. A sediment layer of varying thickness overlaying the seafloor. Very low densities of benthic and demersal fauna, with the former concentrating on the exposed sides of large boulders. White stylasterids, sea urchins, and numerous dead seagrass fragments are common features of the seafloor. A lone tiger shark (*Galeocerdo cuvier*) is reported from one of the dives.

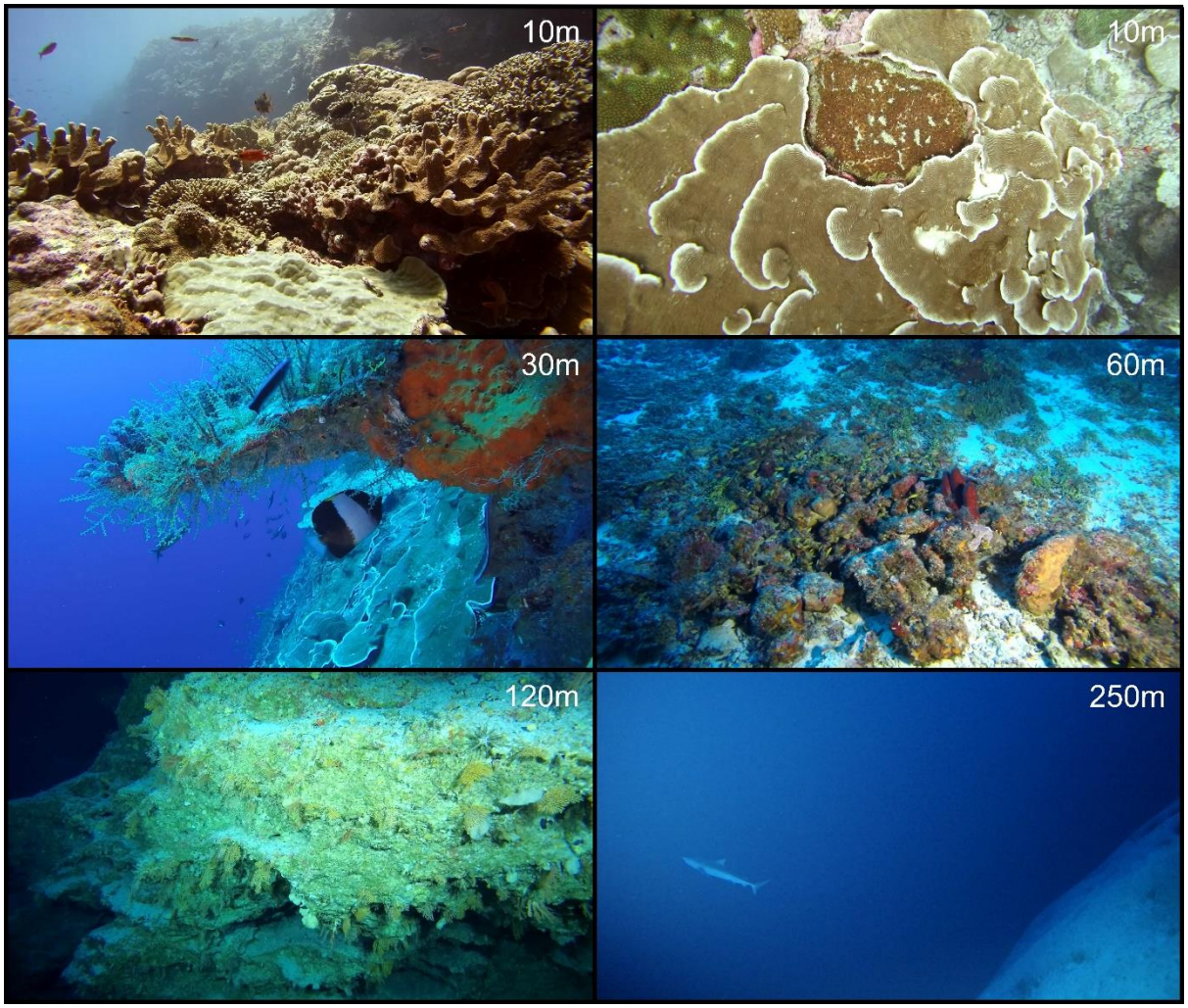


Figure 24: *Representative habitats per surveyed depth at Astove W1.*

Poivre E1

10 m

Flat reefs with moderate coverage of scleractinian corals (e.g. *Porites*, *Acropora*, *Dipsastrea and Favites*) and CCA; with occasional patches of sand. Angelfish, butterflyfish, surgeonfish, triggerfish, wrasse and parrotfish (Scaridae), are some of the common fish types at this depth. Patches of seagrass beds (*Thalassodendron*) are also common.

30 m

Flat, sedimented area with patches of rubble and rock. Very high abundance of mushroom corals (Fungiidae) and branching *Acropora*. Tube-shaped demosponges and the green calcareous algae *Halimeda* are also quite common. Fish abundance was moderate; fairy basslets, wrasse, butterflyfish and triggerfish are typical representatives.

60 m

Flat, sedimented habitats, with few patches of exposed hard substratum. However, the frequent occurrence of large whip corals and black corals indicates that overlaying sediment layer is quite thin. With a variety of encrusting sponges and algae present on exposed bedrock patches; sea cucumbers and dead seagrass fragments (*Thalassodendron*) are also commonly found on the seafloor. Overall, there fish abundance is low, with triggerfish, wrasse and basslets being the most common.

120 m

Flat to medium slope habitats consisting of exposed bedrock with few sandy patches. Seabed heavily covered by red, green and yellow encrusters (probably a mixture of sponges, coralline algae and bryozoans). Other benthic components include sea stars and urchins. Notably, there are very few whip corals and sea fans, in contrast to most other surveyed locations. Overall fish density is very low.

250 m

Flat to gentle sloping sedimented habitats with very low benthic and fish abundance. Main benthic representatives sand dollars (*Clypeaster*) and other sea urchins; seafloor is populated with several dead seagrass fragments (*Thalassodendron*). With some encounters of jacks (Carangidae).

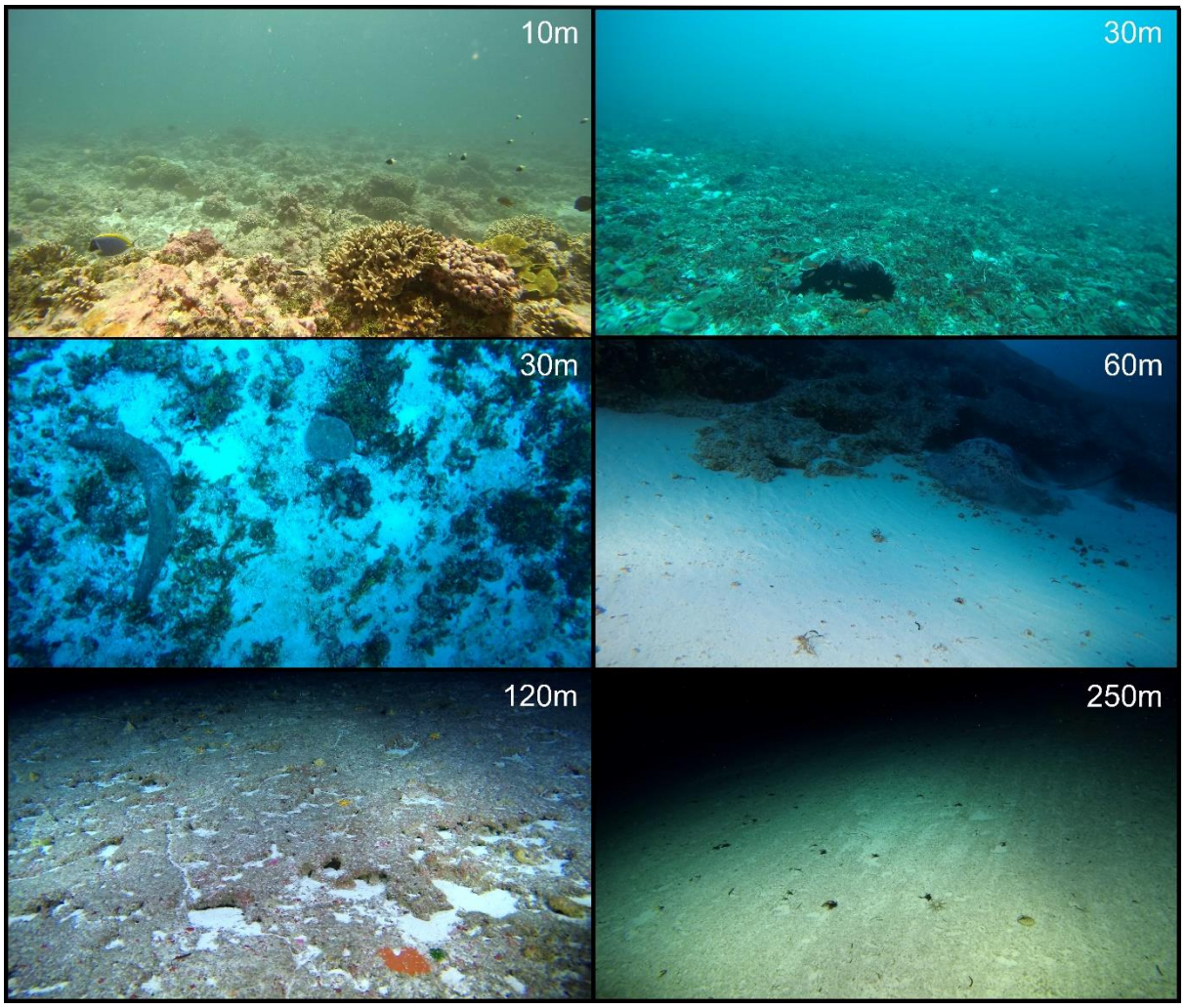


Figure 25: *Representative habitats per surveyed depth at Poivre.*

St Joesph (D'Arros)

30 m

Flat, sedimented habitats with occasional patches of exposed substratum. Whip corals were present, along with calcareous (CCA and *Halimeda*) and other network-like forming algae. The red-toothed triggerfish (*Odonus niger*) is overwhelmingly common at this depth and usually hides beneath corals when submersibles are approaching, leaving only their tails visible. Other smaller-sized fish (e.g. angelfish, wrasse and fairy basslets) are also common.

60 m

Flat sedimented habitats with slightly more exposed bedrock than at 30 m. Members of the Ellisellidae family (e.g. *Ellisella*, *Dichotella*, *Junceella / Viminella*) dominate communities, followed by sea fans (Plexauridae), hydrozoans and crustose coralline algae. Fish communities are comparable to those from 30m. Mounds of pebbles, presumably created by the tilefish *Hoplolatilus* cf. *cuniculus*, are occasionally common.

120 m

Sloping habitats comprising exposed bedrock with patches of overlying sand; with numerous small caves, crevices and overhangs. Plexaurid sea fan corals dominate this depth, along with a variety of encrusters such as zoantharians and sponges. Fish not very abundant; however colorful fairy basslets are frequently sighted along with some reef sharks.

250 m

Vast expanses of flat to gentle sloping sedimented habitats, with local depressions and occasionally exposed boulders. Sand dollars (*Clypeaster*), white stylasterids and dead seagrass fragments (*Thalassodendron*) are the common benthic features at this depth. Low fish abundance.

350 m

Topography similar to 250 m. Several types of sea stars, crinoids (usually on top of corals), and some black corals are the main benthic components at this depth. Very low fish abundance.

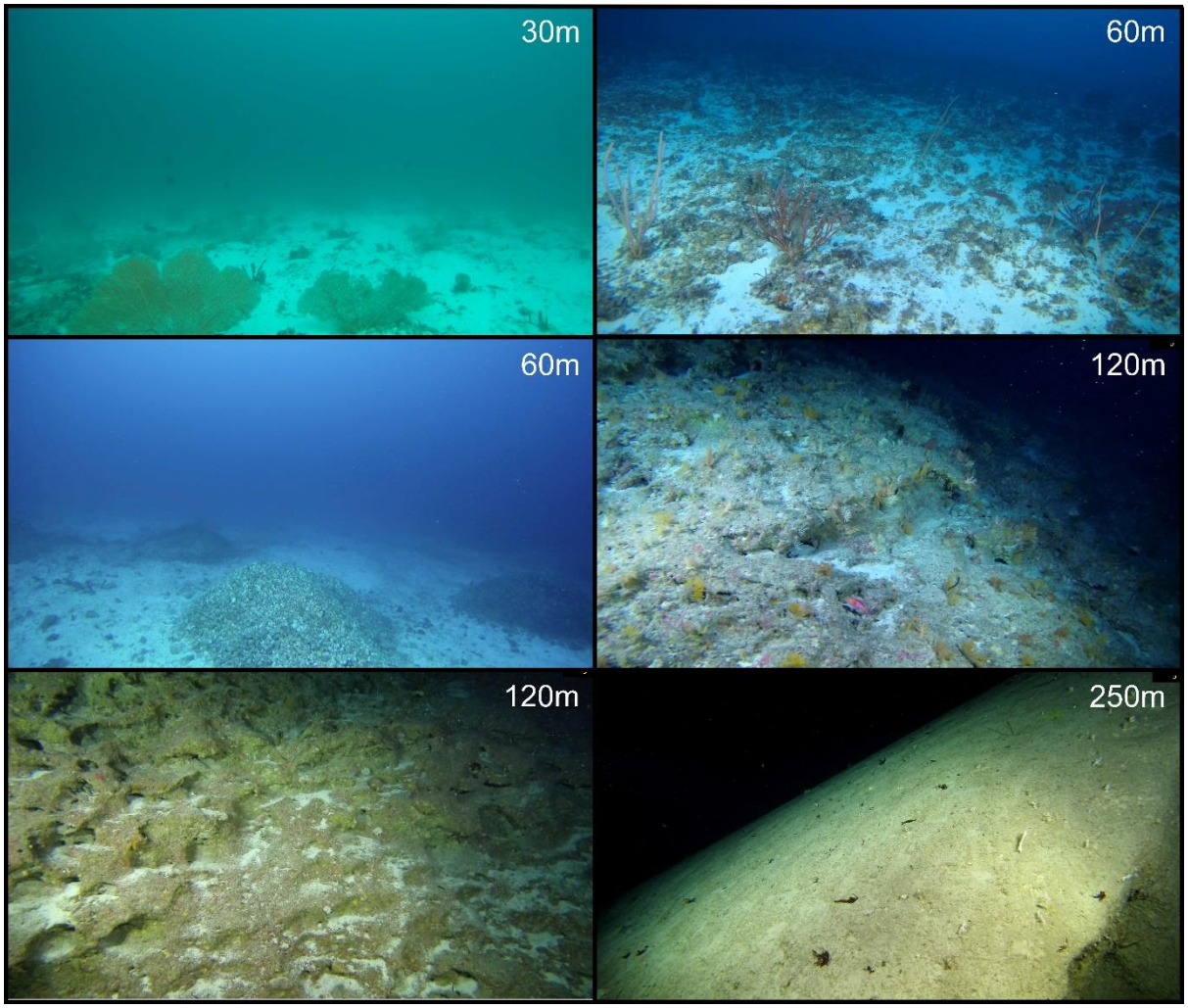


Figure 26: Representative habitats per surveyed depth at St Joesph.

Desroches

10 m

Low relief reefs typified by high coverage of algae, low coverage of hard corals, with patches of rubble and sand in between. Main types of algae included the calcareous green algae *Halimeda* and other red turf algae. Coral communities are dominated by *Favites*, *Fungia*, *Lobophytum* and *Porites*. Signs of bleaching were evident in some of the coral colonies. An isolated patch of seagrass meadows (*Thalassodendron*) was also present. Fish abundance was modest, mainly consisting of triggerfish, angelfish and wrasse species.

30 m

Flat bottom habitat situated next to a 10–15 m-high vertical wall. The wall is covered with mat-like algae and white sponges. Rich fish communities right next to the wall and associated cryptic habitats (e.g. openings and small caves/crevices found at the bottom of the wall). Several schools of tiny, juvenile fish are common, along with larger fish including different types of soldierfish, blue-fin trevallies, sweetlips, fusiliers and groupers. Benthic cover is moderate, dominated by calcareous (e.g. *Halimeda*) and other turf algae, and encrusting sponges. Typical hard coral genera include *Porites* and mushroom corals (Fungiidae).

60 m

Flat, thinly sedimented habitats with patches of exposed bedrock. With moderate abundance of sea fans (Plexauridae) and whip corals (e.g. *Junceella / Viminella*); typical fish include angelfish, coral hinds (*Cephalopolis miniata*) and other groupers.

120 m

Habitats at 100-120 m, located next to a drop-off that starting at 90-100 m. The wall contains rich coral communities, mostly of the Plaxauridae family. Several encrusting forms of sponges are also present. Fish assemblages are dominated by trevallies, groupers, fusiliers and snappers. Barracudas, a thresher shark (*Alopias*), and an orange-brown octopus (*Octopus*) have also been spotted in some of the dives.

250 m

Flat, sedimented habitat. Fish abundance very low. Seafloor covered mostly by dead seagrass fragments (*Thalassodendron*) and sea urchins, including sand dollars (*Clypeaster*).

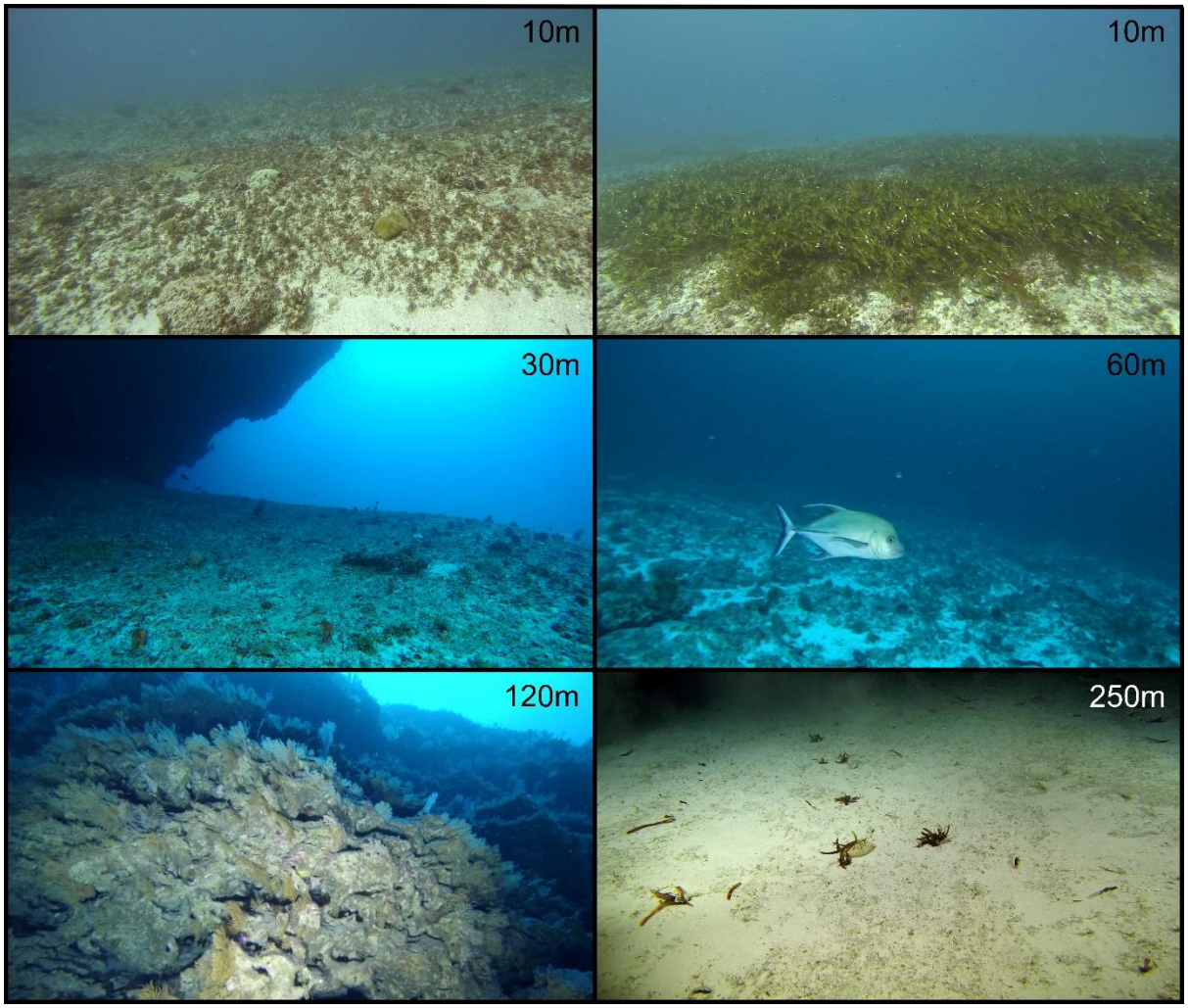


Figure 27: *Representative habitats per surveyed depth at Desroches.*

Dropcam – Jonatha Giddens

Protocol/operations

National Geographic's Exploration Technology Lab developed Deep-Ocean Dropcams to observe deep-sea life *in situ* by capturing high quality imagery of the sea floor. Deep-Ocean Dropcams are an autonomous lander system with high definition cameras encased in a 33-cm diameter borosilicate glass sphere that are rated to 7,000 m depth. Dropcams housed a Sony Handycam FDR-AX33 4K Ultra-High Definition video camera with a 20.6 megapixel still image capability. Viewing area per frame was between 2–6 m^2, depending on the steepness of the slope where the Dropcam landed. Cameras were baited with ~ 1 kg of previously frozen mackerel fish and deployed for 12 hrs, from roughly just after dusk to early day-break. Using these Dropcams, video footage was collected from five locations around Seychelles, from 300 m to 320 m depth. From the video footage, fauna will be classified to the lowest possible taxonomic level. The relative abundance of each identifiable taxon will be calculated as the maximum number of individuals per frame (MaxN). For presence/absence analyses, these observations will be converted to incidence per deployment.

Summary of deployments

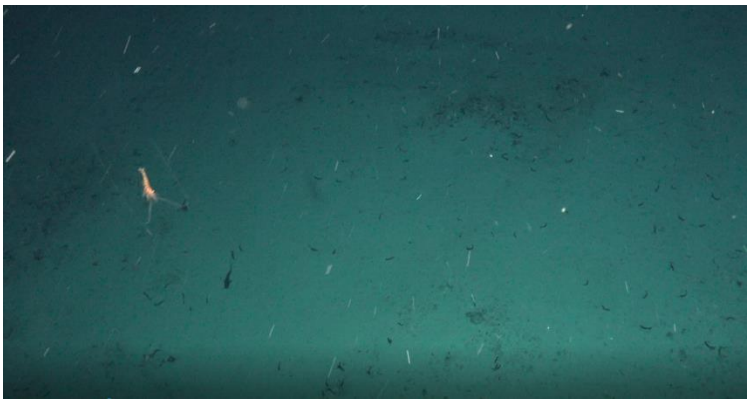
Table 7: *List of Dropcam deployments detailing location, date and duration of deployment.*

Deployment	Date	Site	Deployment Duration	Notes
001	08/03/2019	Alphonse, E1	12h45m	
002	09/03/2019	Alphonse, N1	13h20m	Dropcam spent two hours on the surface before it was retrieved.
003	10/03/2019	Alphonse, N1	14h30m	
004	17/03/2019	Aldabra, N1	12h20m	
005	19/03/2019	Aldabra, N1	12h75m	
006	20/03/2019	Aldabra, N1	NA	Dropcam was lost on deployment and unable to be retrieved.

The intention was to complete three deployments of the Dropcam at each site, however this was not prossible (Table 7). One Dropcam did not function properly and so the back-up could not be used. While deploying for the third time at Aldabra (North) the Dropcam was lost. Currents were very strong at this site; it appears that the Dropcam came to the surface too early and was swept far away from the Ocean Zephyr before we were able to retrieve it. The tracking system was used to look for the Dropcam, however it was not found.

Taxa seen

The Dropcam recorded many groups of organisms including macro-zooplankton, benthic fauna and demersal organisms such as shrimps, polychaetes, and fish (Fig 28). Several shark species were seen on the Dropcam footage, including, on one occasion, a bluntnose 6-gill shark.



A

B

C

Figure 28: *Examples of fauna documented by the Dropcam. A zooplankton community (Alp E1): B Dense zooplankton and fish (Alp N1) and C Fish near benthos (Ald N1).*

Photogrammetry – Denise Swanborn

Protocol

Goal and background

Underwater photogrammetry is the 3D reconstruction of underwater environments using scaled images. Images used for model construction will be extracted from the video material collected by divers, subs and ROVs during First Descent. The 3D reconstruction process relies on combining overlapping images from the site.

Photogrammetry is a low-cost survey technique with the potential to develop high resolution models and provides visual accuracy. The purpose of the models constructed from Seychellois sites is to study the underwater environment from an ecological point of view. The models will primarily be used for habitat characterization and environment inspection (specifically surface complexity).

The success of constructing these models strongly depends on the input images, and therefore the method of footage collection. Underwater photogrammetry can be challenging, especially in deep water environments. Complicating circumstances include uneven lighting of the site, turbidity of water, currents, including a scaling measure and maintaining a constant direction and speed. This means that care is necessary when collecting footage.

General instructions

- **Always:** Maintain a slow, constant speed – it is important to prevent a smeary/blurry video
- **Always:** Maintain an equal distance from the object/seafloor, close to object (between 0.5 and 2 to 3 meters)
- **Always:** Aim for even lighting across the object.
- **Object:** Perpendicular camera orientation to the object
- **Sub/ROV:** Use paired lasers for scaling in an overview of the scene, but turn off during subsequent video collection
- **Sub/ROV**: Lighting may need to be adjusted in situ to avoid overly light or dark spots and deal with detritus in the water.
- **Sub/ROV**: Continuous recording of position to allow georeferencing of site afterwards.

Operations on board

The described filming operations formed part of the overall scientific data collection procedures. Transect footage collection was conducted with biological video data collection, as benthic video imagery collected can also be used to construct photomosaic.

Quadrat footage collection possibilities per site depended on time and resource availability as well as current strength.

Narrative

Data collection

During the mission, photogrammetry input footage has been collected with a submersible and ROV and through SCUBA diving and snorkeling.

Two different video collection scenarios were distinguished:

Transect filming:

Benthic transect data was collected at different depths using different equipment for benthic habitat analysis. Depending on the quality of the collected footage, this transect data can be converted to photomosaics. No scaling measure was included in these transects. No special protocols were applied in addition to the standard transect filming procedures to make footage suitable for photomosaicing.

Quadrat filming

Quadrat video data for photogrammetry was collected at every site (table 8) using subs at 120m and 60m where possible, and at 5-10m scuba diving/snorkeling. One ROV dive has taken place with successful quadrat data collection at 60m. A scale bar was included in quadrat filming. Sub/ROV quadrat sizes were roughly 5mx5m and scuba/snorkeling quadrat sizes were roughly 2mx2m.

Quadrat filming required moving in two intersecting raster patterns of four runs over the site whilst maintaining a constant camera orientation. The overlap between the runs was approximately 50%. The distance to the seafloor needs to be constant and filming needs to happen at a slow and even speed.

Table 8: *Quadrat data collected*

Site	Sub quadrats	ROV quadrats	Scuba quadrats
Alphonse	3x120m 1x60m 1x50m (HD+Paralenz footage)	NA	2x5m (Scuba) 9x10m (Scuba, along transects)
Aldabra N1	3x120m 2x60m (HD+Paralenz footge)	NA	2x10m (Scuba)
Aldabra W1	3x120m 1x100m (HD+Paralenz footage)	NA	NA
Astove	3x120m 1x90m 1x60m (HD + Paralenz footage)	NA	8x5m (snorkeling)
Poivre	3x120m 2x60m	NA	
St Joseph	3x120m (Paralenz footage)	5x60m (Paralenz footage)	6x5m (snorkeling)
Desroches	NA	NA	3x10m (Scuba)
Total	26	5	30

Data processing

Video data collected from submersible quadrats was processed into models to look at the effect of different video collection strategies on the final model. Variables that were considered in this process were:

- Camera type: Bowtech and Paralenz
- Paralenz: white balance settings
- Speed of movement
- Distance from substrate
- Number of passes
- Lighting on sub
- Angle of filming

Data was processed by extracting relevant video segments from overall video roll, converting these segments into individual photo frames and feeding these photo frames into Agisoft Photoscan.

Video preparation was generally time consuming. Bowtech videos needed to be converted from a .mov to .mp4 format (.mov not readable on Windows). For both Paralenz and Bowtech videos the correct segments needed to be found and stitched together. In some videos the arm or another part of the sub was visible for most or the whole segment, which was solved by cutting off that part of the video frame.

Conversion to photogrammetry models was generally run overnight and resulted into initial 3D visualisations of mesophotic habitats (fig. 29 & 30). Some of these have been shared with the different media teams on board as well as with Al Jazeera for outreach purposes.

Upon return in Oxford all quadrat video data sets will be converted into separate film fragments and prepared for processing to photogrammetry models. Optimum settings will have to be explored.

No data from benthic video transects has been processed into photomosaics. Upon return in Oxford the individual video transects will be isolated and then converted into a photomosaic.

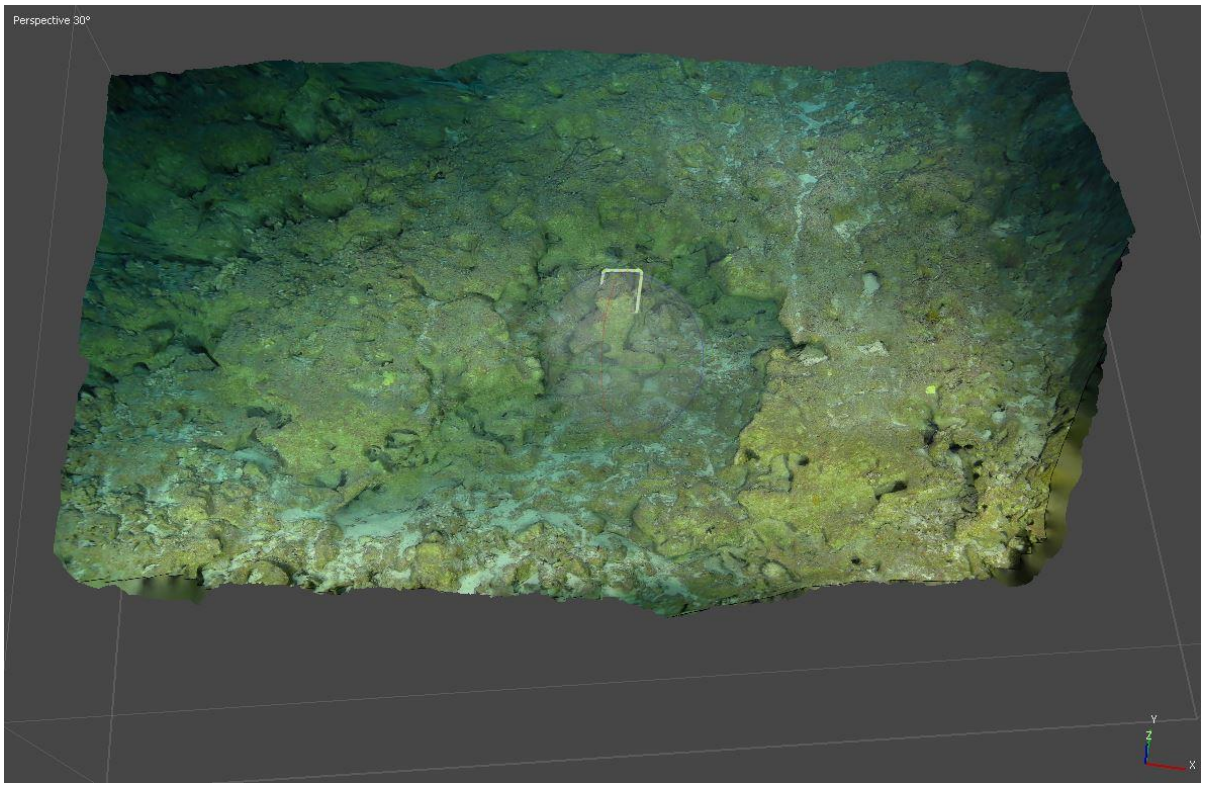


Figure 29: *Photogrammetry model from Astove at 120m (data collected with sub)*

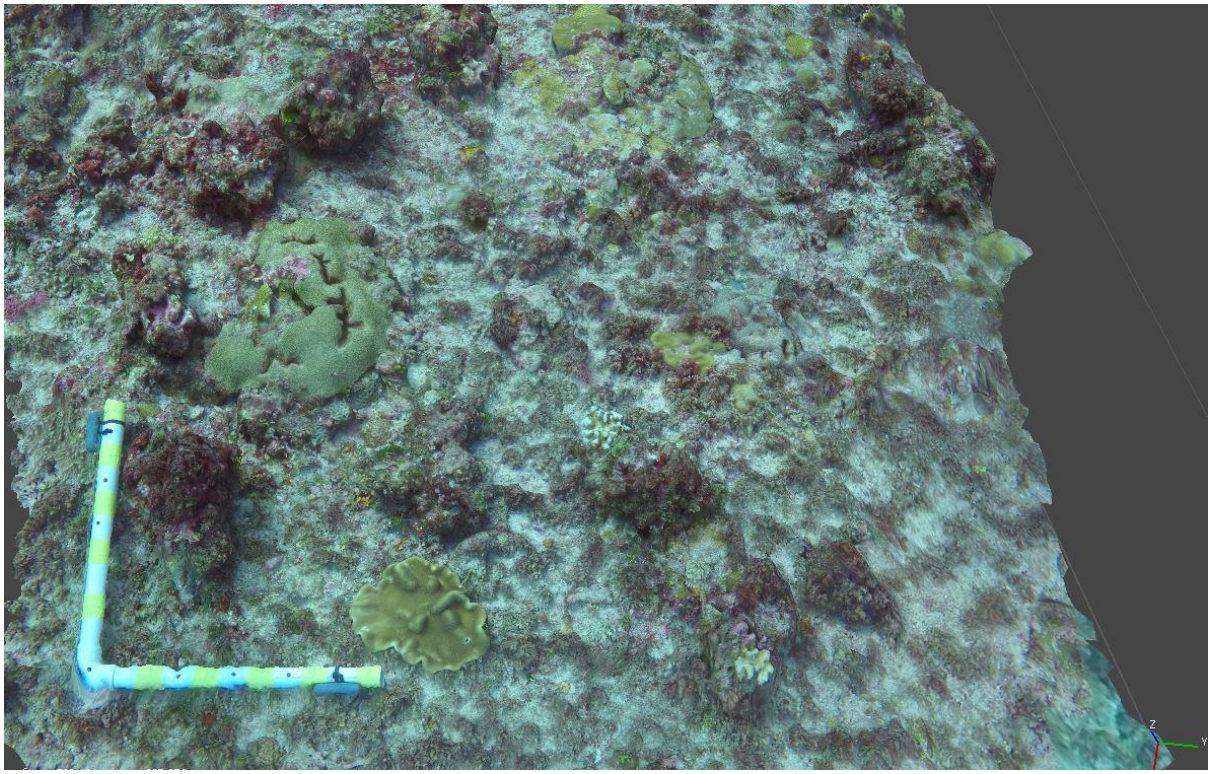


Figure 30: *Photogrammetry model from Astove reef at 5m depth (data collected by snorkelling)*

Synthesis

Because photogrammetry of deeper water habitats is still a very young field, there were no established protocols for data collection using subs and ROVs. A significant part of the cruise was spent on figuring out how to collect suitable sub data, within the context of other vessel and science operations. Especially the first dives were focused on establishing a filming protocol.

The limited battery life of the Paralenz cameras meant that photogrammetry generally could not be included in collection dives and required a separate dive.

As with other ROV operations, currents were a limiting factor. ROV quadrat photogrammetry was therefore restricted to one, but successful, 60m dive.

Shallow water quadrat photogrammetry was limited by restricted SCUBA diving opportunities. Where possible divers included photogrammetry in their dives, but video transects and sampling logically had the higher priority. To overcome diving difficulties, efforts were made to have separate photogrammetry snorkeling trips with the chase boat. Challenges here were the influence of surface currents and waves on keeping the camera steady, as well as inconsistent distances to the substrate.

Recommendations for a future cruise where photogrammetry needs to happen would firstly be to have a camera system on the sub/ROV with a longer battery life, so that photogrammetry can be included in other dives (sampling). Secondly, shallow water photogrammetry does not require carrying a physical quadrat of 2mx2m. Rather, a scale bar as in fig. 30 should be enough to provide a measure of scale for analytical software. Third, the potential for using stereo-video systems for photogrammetry should be explored. If so, photogrammetry could also be included in transect dives.

Acoustic Data – Molly Rivers

Protocol

1. Connect the hydrophone to the PC using the Ethernet cable

2. Ensure hydrophone is fully charged. To do this:
    - Open the Marco software
    - Refresh the page to get a current battery charge level
3. If hydrophone battery level is below 50% make sure to charge before deployment. To charge hydrophone connect power adaptor cable to Ethernet cable and plug into wall socket. At this point the hydrophone does not need to be connected to the PC anymore but should be periodically checked to monitor the battery charging process. The hydrophone will generally take around an hour to charge for every 10% of battery life. Make sure the hydrophone is charged in a safe area where it cannot be knocked or fall onto the floor.
4. To set up the hydrophone for deployment make sure it is connected to the PC and open the Lucy software.
5. When the software opens click on the icListen button in the Setup box in the bottom right hand corner.
6. In the new window that opens, go to the Link Setup tab and select the connection type to Ethernet. Then click Find all Units.

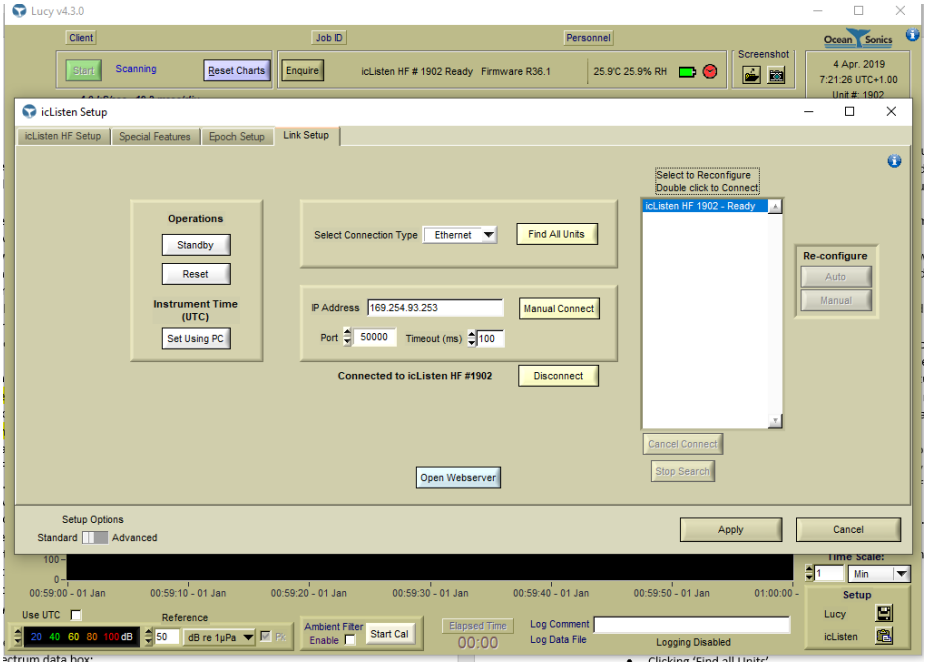


Figure 31: *Shows the link setup page of icListen Lucy v4.3.0 software.*

7. icListen HF 1902 should appear in the white box, select the unit by double clicking on it.
8. 'Connected to icListen HF #1902', should appear in the box, then click apply and it will return to the Lucy home screen.
9. The hydrophone should vibrate once when connected indicating it is booting up.
10. Once the hydrophone is connected check that all files from the previous deployment have been retrieved and erased from the hydrophone (this should have been done immediately after the last deployment). The hydrophone data folder on the server should contain the last deployment files, check they are there and that they play before deleting off hydrophone. If they need to be retrieved/erased see points 27 - 36 below.
11. Continue to set up the hydrophone for deployment by clicking on the icListen button in the set up box in the bottom right hand corner of the Lucy home screen.
12. Click on the icListen HF Setup tab in the box that opens.
13. In the Waveform and Spectrum data box:
    - Ensure 'Log continuous' is selected

- Ensure 102.4 kHz is selected
- Ensure the max log length is set at 20 minutes
- Ensure the wave streaming and spectrum streaming are not enabled
- Once all is set then click Apply and ensure the set up is accepted

14. In the icListen setup box go to the Special Features tab and ensure the Shorting-Plug Wake-up mode is selected and click Apply.

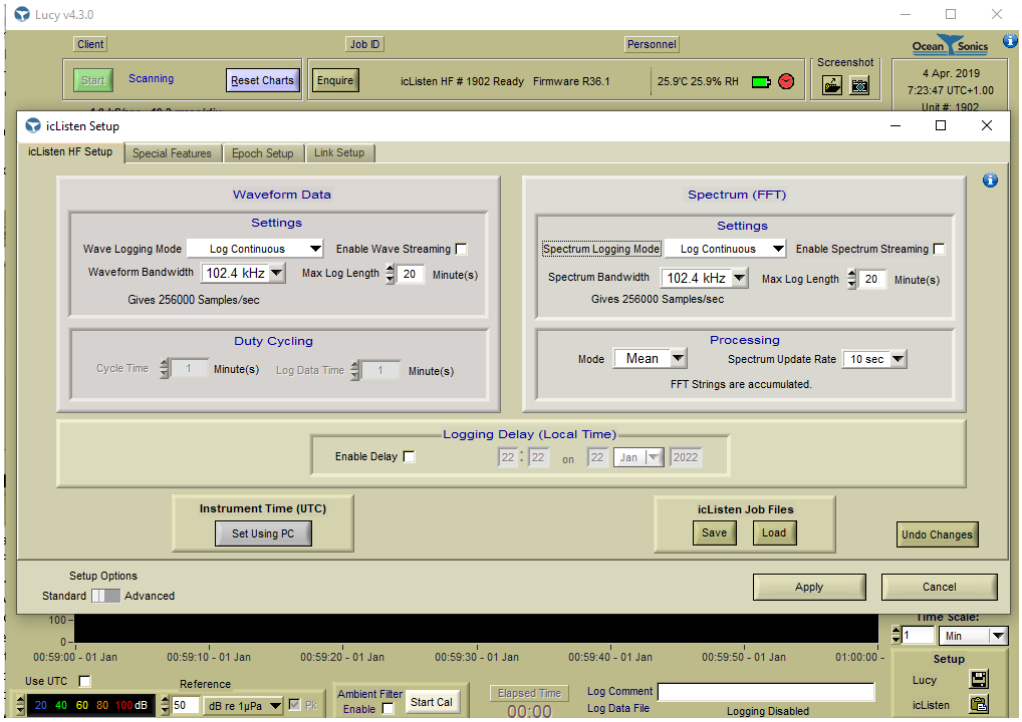


Figure 32: *Shows the hydrophone setup page of icListen Lucy v4.3.0 software.*

15. In the icListen setup box go to Link setup tab and click on the Standby button and click yes, to put the device in standby mode.
    - The device should vibrate three times to indicate it has powered off.
    - Disconnect the hydrophone from the PC and Ethernet cable and store in the yellow box.
    - **Note that the hydrophone will run out of battery in 4 days if left in standby mode.**
16. Before deployment ensure you have:
    - The hydrophone
    - The dummy plug (labelled)
    - The shorting cable (labelled)
17. When deploying the hydrophone from the chase boat, ensure you are as far away from the vessel as possible. Also try to deploy in deep water a little distance from the shallow reef.
18. Once you have arrived at a suitable deployment location turn the engine of the chase boat off.
19. Attach the shorting cable to the hydrophone and the dummy plug to the other end of the shorting cable.
20. The hydrophone should buzz three times to indicate it is awake and ready to start recording.
21. Ensure the rope is firmly attached to the shorting cable and tie it to a handhold on the chase boat.
22. Slowly lower the hydrophone into the water and keep hold of the shorting cable for the duration of deployment.

23. As well as the required information on the deployment info sheet, also record the sea state and deployment depth on the sheet. Also record any cetacean sightings during deployment.
24. Keep the hydrophone in the water for 90 minutes, do not turn the chase boat engine on and do not tow the hydrophone in the water. If the chase boat must be moved before the 90 minute deployment is complete, retrieve the hydrophone and record this break in recordings on the deployment information sheet.
25. When 90 minutes has been reached, bring in the hydrophone and record the end time on the deployment information sheet. Disconnect the dummy plug and the hydrophone from the shorting cable, making sure to connect the two ends of the shorting cable together. Store the hydrophone safely in its box.
26. On return to the ship wash shorting cable with fresh water. Attach dummy plug to hydrophone and then wash with fresh water as well.
27. To retrieve data from hydrophone connect it to the PC using the Ethernet cable and open the Lucy software.
28. Click on the icListen button in the Setup box in the bottom right hand corner of the home screen
29. Select the setup tab and connect the device by:
    - Selecting Ethernet connection type
    - Clicking 'Find all Units'
    - Double click on icListen HF 1902 in the white box
    - The hydrophone should vibrate three times once connected.
30. Click on the icListen button in the Setup box in the bottom right hand corner of the home screen and select the icListen HF setup tab.
31. Set both logging modes to 'logging off' and click 'Apply'
32. To retrieve data files click on the icListen button in the Files box on Lucy home page.

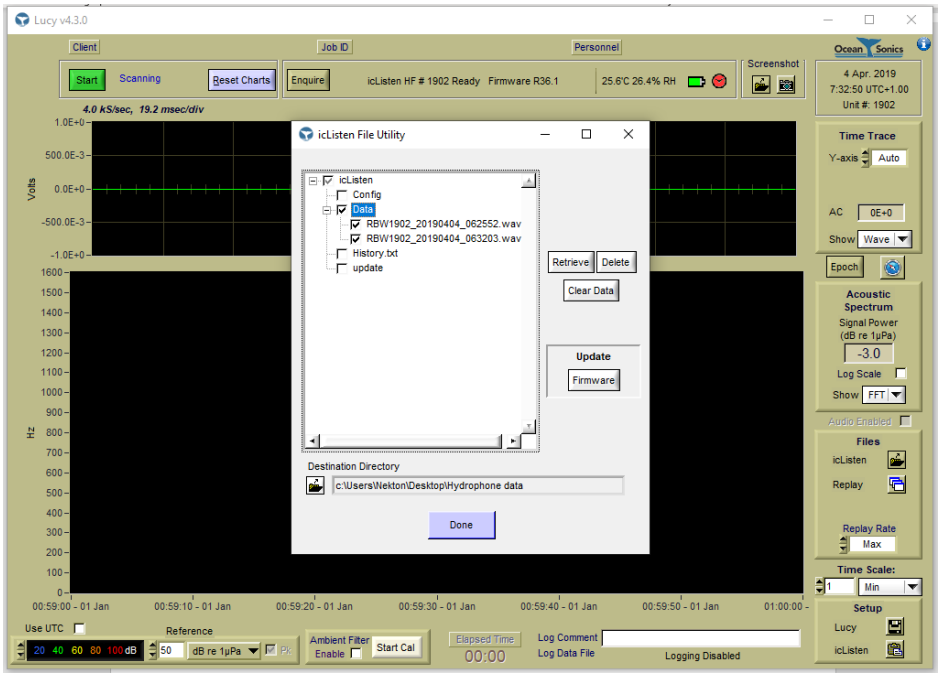


Figure 33: *Shows the file utility box of icListen Lucy v4.3.0 software.*

33. All files will appear in a white box, select all files by checking the box next to Data.
34. Click the retrieve button and a window showing progress of the files will open.

35. When the download is complete check the files have been saved into the Hydrophone Data folder on the desktop and ensure the files play. Copy all these files onto the server into the relevant folder.
36. Once copied, delete the files from the hydrophone by selecting all the files and clicking clear data (insert screenshot). Click Done to close the window.

Narrative

The hydrophone was first deployed during our fourth week at sea, at our sampling site North of Aldabra.

The hydrophone had to be deployed off the chase boat, in order to minimise the amount of disturbance in the recording from ship noise. Due to the importance of the chase boat for the deployment of the hydrophone and the submersibles, the timings in which we could deploy the hydrophone were limited. We found early morning (before submersible launch), midday (during submersible deployment) and early evening (after all other operations) to be the best times for deployment. When on site, we deployed the hydrophone at one of these times each day, unless conditions or other circumstances prevented it.

During our early morning deployments we deployed close to the reef, in order to pick up the early morning sounds of the reef. During the midday day and early evening deployments we moved to deeper waters to increase our chances of recording cetacean sounds. When deploying we aimed to travel as far from the vessel as was safely possible, to decrease the interference of the vessel noise. We also ensured the chase boat engine was turned off for the duration of the deployment.

Initially we set the hydrophone to record at 102.4 kHz, as suggested by the manual, and recorded for as long as possible (usually about an hour). After about a week of deployments, we realised that we needed to record at a higher frequency in order to detect the area's most common cetacean species (spinner dolphins). For the remaining deployments the hydrophone was set to record at around 60 khz, which reduced the recording time to 30 minutes.

There were several issues that arose when deploying the hydrophone. Firstly, other operations often required the chase boat, meaning that the deployments were frequently delayed, interrupted or cancelled. When moving to a new site we often had no data regarding the bathymetry, which lead to occasions when the hydrophone was touching the sea floor without our knowledge. There were also technical difficulties with the charging of the hydrophone that meant it was not charged in time for the scheduled deployment. It also had issues with recording, on several occasions it had not started recording, so there was no data for a whole deployment. This all resulted in a smaller data set than expected.

Example of output

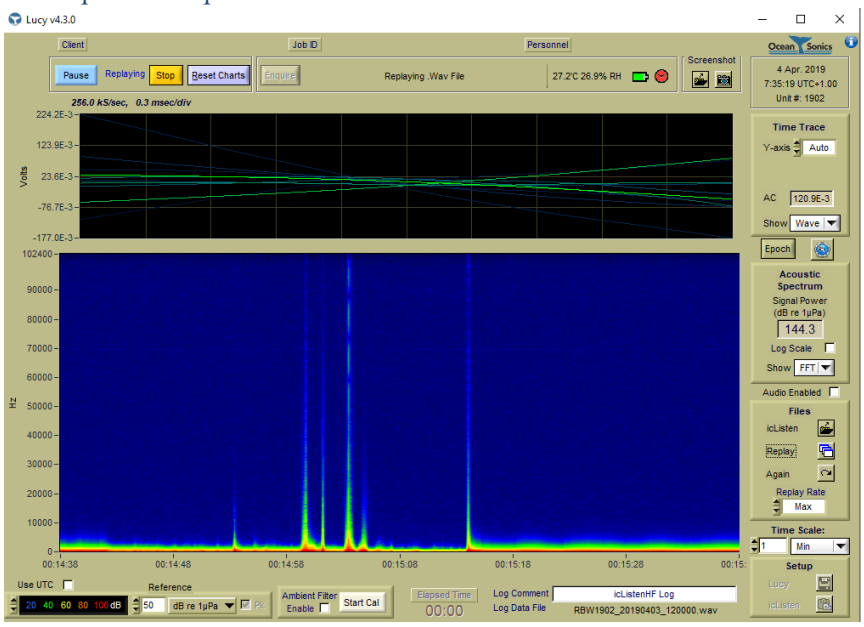


Figure 34: *An example of the visual output produced by the OceanSonics software. It is also possible to listen to the recording using any playback software.*

Initial findings

At this stage it is hard to know if we have found anything of great interest. On only one occasion was there a cetacean sighting during the hydrophone deployment and after initial reviews of the recordings it appears that no cetacean sounds were recorded. The data will need to be analysed by an experienced collaborator before we will be able to say for sure what we have recorded.

Outreach – Oliver Steeds and Lisa Hynes

Communications Aims

The overall communication aim was to inspire and engage Seychelles, Indian Ocean and international audiences with the scientific exploration of Seychelles' unknown deep ocean and promote the Seychelles as a beacon of leadership in ocean management and the sustainable blue economy. The desired outcomes were to:

- *Promote marine tourism as a pillar of the sustainable Blue Economy.*
- *Create a new cadre of Seychelles Ocean Leaders in the local, regional and international spotlight*
- *Strengthen the public mandate for political action*

Teams

Nekton Communications Team on Board

The Nekton Content team on board for the duration of the First Descent Mission consisted of Head of Content, Will West, Digital Media Producer Rhys Dyer and Content Manager, Sarah Hammond. All three were skilled in production, camera work and editing and were therefore able to create content for all social media platforms and for a future documentary.

Lisa Hynes, Nekton's Head of Communications, was on board for the mobilisation and was then based in Begbroke for thuration of the expedition communicating daily with the team on board and with Mission Partners.

Associated Press Team on Board – Official News Agency Partner

AP had a team of three on board at any one time who were responsible for the live broadcast of our first descents, filing news stories and creating packages for AP's Horizon features strand. As well as filing edited packages, they streamed live feeds from the submersible, the ROV and President Faures's descent all over the world.

About AP:

The Associated Press is the essential global news network, delivering fast, unbiased news from every corner of the world to all media platforms and formats. Founded in 1846, AP today is the most trusted source of independent news and information. On any given day, more than half the world's population sees news from AP. On the web: www.ap.org.

SKY News Team on Board – Official Broadcast Partner

Deep Ocean Live on Sky News and Sky Atlantic launched the week commencing 18th March 2019. It was led by Sky News Presenter Anna Botting alongside Mark Austin and Sky News' Science Correspondent, Thomas Moore.

Their production included three one-hour live broadcasts from the ocean depths which were simulcast on Sky Atlantic. Their output included the world's first live subsea news bulletin.

The Sky team were on board for a week, but Thomas Moore was on board from the start of the mission writing a daily blog.

Activities

Social Media

Science was at the forefront of our story telling and we posted almost daily to the three key platforms Instagram, Facebook, and Twitter with some posts to LinkedIn. Posts were linked to international events i.e. for Women in Science day we made a film about Stephanie Marie, the first Seychellois to dive in a submersible. We reached up to half a million people a day across our platforms.

Instagram:
We reached 3.93 million users and had 21.4K engagements (to compare, the Mission I to Bermuda gained 152 followers).

Facebook:
We reached 4.7 million users and had 80.9k engagements during our time in Seychelles. We have 17K followers on our Facebook page. As well as reporting on the Mission we also posted about the wider issues surrounding ocean conservation (to compare Facebook engagement during Mission I was 38K).

Twitter:
We reached 109.5K followers on Twitter and currently have 1,905 followers.

YouTube:
During the Mission we posted 18 videos to YouTube covering an array of topics from the best underwater imagery, to features on scientists, surprising underwater discoveries and technology. Our Live First Descents were streamed to YouTube and there was a marked peak in our figures when we were broadcasting live. Danny Faure, the President of Seychelles' Live broadcast was our most popular time on YouTube.

Website:
1.1 million people visited our website throughout the mission.

Captivating Global Audiences

"Half of the world's population saw coverage of Nekton's Mission". Sandy MacIntyre, VP, Associated Press (Official News Agency Partner)

Emphasising Seychelles in the international spotlight as a champion and beacon for ocean conservation. The First Descents of the Mission's aquanauts into the last great frontier of our planet is an inspirational story of human endeavour that has captivated audiences throughout the world. We pioneered the development of new subsea broadcasting technologies that achieved a series of world firsts.

- **30 hours live subsea** broadcasting distributed by Associated Press (Official News Agency Partner). AP reach two-thirds of the world on a daily basis with their content. More information about broadcasters reach in image below.
- **First Descent Live:** by 49 broadcasters (incl. ABC, CCTV, Al Jazeera, ITN, Euronews) on 760 occasions in 24hours. Shortlisted (one of three) for prestigious IBC Innovation Award (announced in September 2019
- **First live submersible documentary series & newscast** – 'Deep Ocean Live' - 9 hours of live prime-time television broadcast on Sky (Official Programming Partner). Sky reach 110million people in 140 countries.
- **First live submersible 2-ways interviews with broadcasters globally** including ABC's flagship show, Good Morning America (4.5million viewers) and CGTN.
- **First Live Subsea Presidential Address:** President of Seychelles, distributed globally by AP.
- **Submarine Live (STEM Education) –** hundreds of thousands of young people engaged including 10,000 in 16 countries directly participating in 5 days of live links to scientists and technicians on board the Mothership.

Press

The story of the Nekton mission was shared widely in print and online around the world and a summary of coverage please view here:

Figure 35: *A visual to represent the vast amount of media coverage generated by the presidential broadcast from the submersible.*

Figure 36: *A visual to represent the many broadcasters that ran multiple packages.*

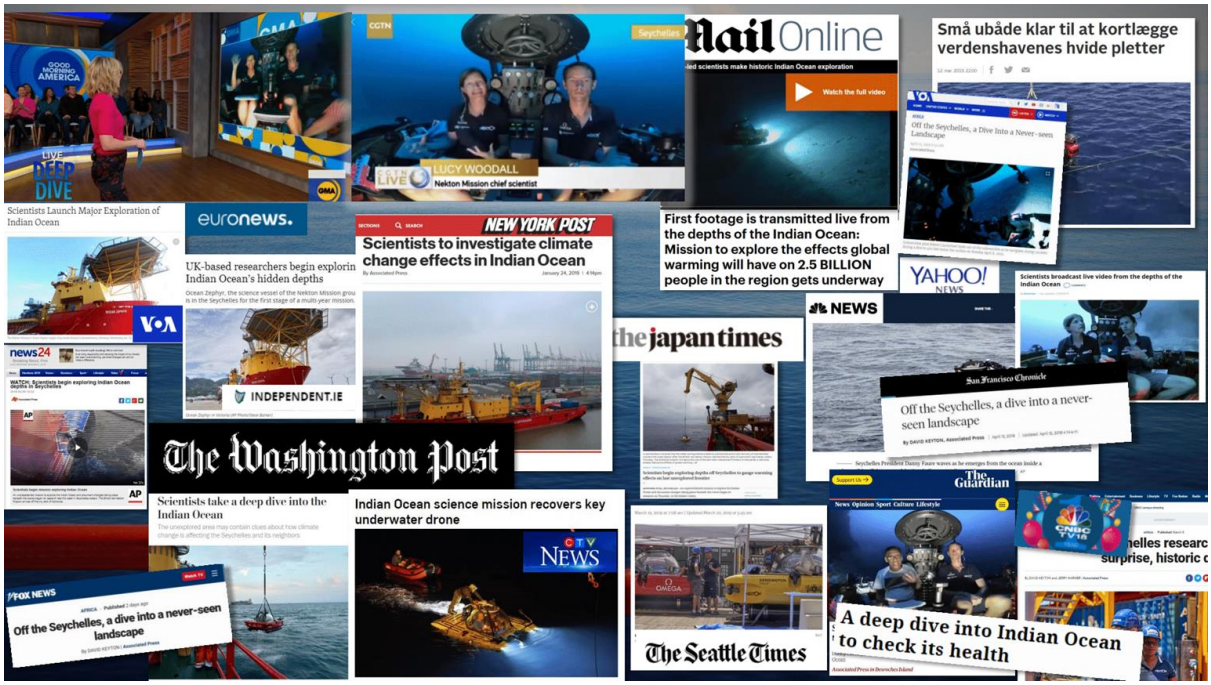


Figure 37: *A visual to show the vast amount of coverage the whole expedition generated.*

Partners

The expedition was only possible thanks to the alliance of partners that contributed in kind or financially. Before, during and after the expedition we provided all partners with content for social media, tagged them in posts, made them short films and promoted them at any opportunity in targeted ways. We were also able to make introductions to potential new clients to some of our partners.

Documentary

The onboard Nekton Content team filmed extensively throughout the mission, not just for immediate social media use, but to gather footage for a potential documentary to be made in the months following the Seychelles. The series will be pitched, along with the rights to future live broadcasts. At the time of writing a short sizzle tape is being made which will be presented to potential broadcasters in the coming weeks. We will be approaching the streaming services as well as other digital broadcasters and offering them a documentary series from this Mission and any in the future.

Training

Trainees and grant recipients

A partnership between Nekton and SeyCCAT facilitated the awarding for six grants to Seychellois scientists to participate in the expedition and to conduct their own research.

Awardees were:

- Damien Labiche of the Ministry of Environment, Energy and Climate Change
- Stephanie Marie of Seychelles Fishing Authority
- Sheena Talma of the Ministry of Environment, Energy and Climate Change
- Jennifer Appoo of the Seychelles Island Foundation
- Clara Belmont of the Seychelles Fishing Authority
- Dr Jeanne Mortimer

Training activities

In addition to the experience and multi learning opportunities for being on board ship, networking with other scientists and technicians, specific training was provided.

Training provided included:

- Deployment and recovery of science tools
- Conducting ROV and Sub video surveys
- Data curation
- Specimen curation
- Seamanship skills (e.g. knot tying)
- Logistics and expedition preperation
- Initial data analysis (e.g. collectors curve and basic ID skills)
- Calibration of stereo video units

In addition, Jennifer Appoo and Sheena Talma were competitively selected for the Africa-Oxford Institute (AfOx) fellowship to join the Nekton team in Oxford.

Learning objectives included:

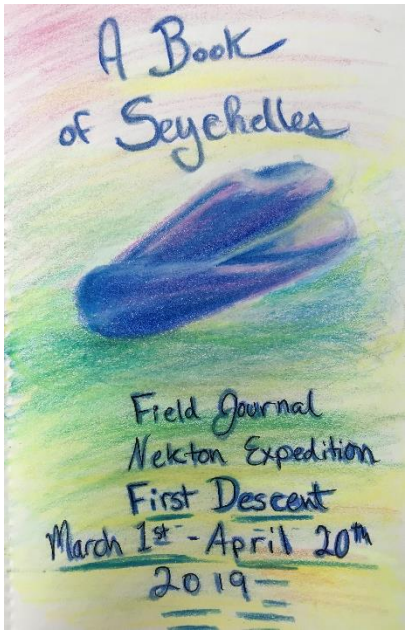
- Learn to calibrate and analyse stereo video data using EventMeasure software
- Learn to identify major zooplankton groups
- Make progress on their SeyCCAT facilitated research projects
- Obtain guidance in data analysis and manuscript writing skills
- Develop their professional networks through connections within Oxford University

Schools

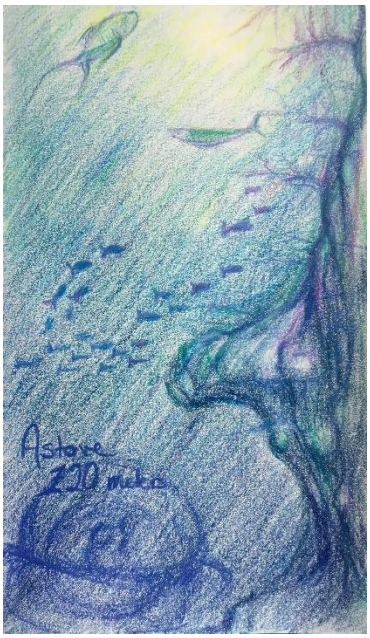
In partnership with Encounter EDU, 11 members of the expedition team spoke during 20 live broadcasts across from the vessel, answering questions about the expedition, their role on board and marine sciences, to 9,300 students across 16 countries.

An artist impression: Jonatha Giddens

Field sketches of taxa, as well as underwater scenes were drawn by scientist/artist Dr. Jonatha Giddens during March 2019, at Alphonse, Aldabra, and Astove. Sketches were primarily drawn of Deep-ocean Dropcam encounters (sharks ect), however, reef scenes and sub transects were also depicted after each underwater experience. In total, four drawings were completed and shared on social media (Instagram, twitter, and Open Explorer), identified with the Nekton Mission and First Descent hashtags. The purpose of sharing field sketches is both to help identify the fauna encountered (drawing helps to focus attention and see defining features better) as well as an engagement tool with the general public. Artwork can be a bridge to spark interest and awareness and raise engagement with the public whom may not otherwise think about our take interest in ocean, and especially deep ocean matters.

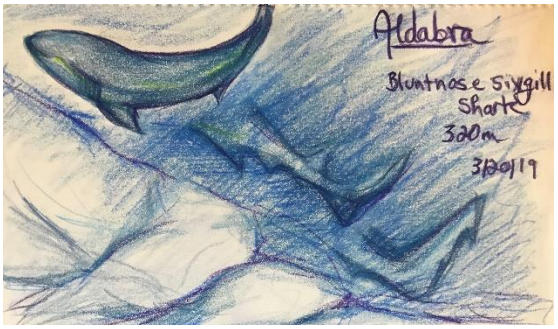


Seychelles Expedition cover art



Astove submersible dive

Approaching Alphonse in the rain



Bluntnose sixgill shark

Golden reflections on the ocean

Shark seen in the deep waters of Alphonse

Figure 38: *Shows the artistic work of Jonatha Giddens, inspired by incredible organisms seen the beautiful landscapes of the expedition in Seychelles.*

Conclusion and future plans

The Seychelles Expedition is a co-produced expedition between Seychelles and Nekton. It successful documented benthic and demersal communities and associated environmental conditions from seven locations across six of the outer islands. This expedition brought together activities that sort to increase scientific data, provide training opportunities and improve ocean literacy.

The scientific data and specimens collected will be used to understand the patterns of biological communities across depth and geography. The biological assumptions made during the marine spatial planning of Seychelles EEZ, will be tested and patterns extrapolated across Seychelles using the environmental data to model ecological conditions. Specific research questions led by SeyCCAT grant recipients will provide clarity to other patterns, trends and mechanisms in the coastal waters of Seychelles. In addition, the VIP submersible dives that allowed the Seychelles President and government officials to experience their ocean was a powerful activity.

Knowledge sharing was at the heart of the expedition and continues with a taxonomic workshop, skills training workshop and long-term engagement with grant recipients. The media coverage of the expedition was fundamental to telling the story of the ocean, and its importance in the lives of every living being on the planet. Using live broadcasts from the submersibles for the first time gave an immersive experience for viewers across the globe, shining a light on the vibrancy of the waters of the Seychelles as well some of the challenges they face.

Full reports on these extended activities will be conveyed in annual reports.

Acknowledgements

This was an ambitious expedition that could not have taken place without a huge number of people with diverse skills and backgrounds. It is their dedication and diversity that resulted in the ultimate success of the expedition. We can never thank all of these unique individuals and organisations, but attempt to do so below.

We would like to thank our mission partners Omega and Kensington Tours for their unwavering faith and support in First Descent: Seychelles Mission.

We would also like to thank our strategic partners Sky Plc, Associated Press, Teledyne Marine, Inmarsat, Global Subdive and ROV Support.

Many thanks goes to our partners in Seychelles, including: Seychelles Fishing Authority, Ministries of Environment, Energy and Climate Change, The Blue Economy Department, The Seychelles Tourism Board, The Ministry of Tourism, Civil aviation, Ports and Marine, Blue Safaris Seychelles, University of Seychelles, Island Conservation Society, Seychelles Island Foundation, Marine Conservation Society Seychelles, The Nature Conservancy, The Seychelles Conservation and Climate Adaptation Trust, Nature Seychelles, The Island Development Company, The National Institute of Science and Technology and The Seychelles National Parks Authority.

In addition we are grateful for our partner's contributions, including from: A1 Offshore, Bibby Hydromap, Priavo Security, Sonardyne, Encounter Edu, Helly Hansen, Triton Submarines, Subsea Consultants, Oxford University, The Commonwealth, CEFAS, Eyos Expeditions, LH Cameras, Great Britain Campaign, Technicolor Animation and Games, Institute of Marine Engineering, Science and Technology, Ocean Sonics, Ocean Elders, IUCN, Global Ocean Trust, Western Australian Museum and Paralenz.

Finally thanks to all those individuals who helped to make this possible, including all the Expedition participants, those involved in the Expedition mobilisation, Nekton office team (Belinda Bramley, Corinne Green, Lisa Hynes, Alex Murphy) and trustees (Juliet Burnet, Paul Crowther, Rupert Grey, Paul Jardine, Rob Mccallum, Emily Penn, Callum Roberts, Nigel Winser) without whose support this would have not been possible, B Frinault for assistance with initial spreadsheet design and file architecture, A Rogers and G Rowlands for early scientific discussions.

Appendices

1- Deployment summary table

Table: *List of all dates, gear type, location and purpose of all deployments and dives completed during the Nekton First Descent Seychelles Expedition.*

Deployment number	Dive type	Date	Location	Site	Data
001	Niskin Bottle	07/03/2019	Alphonse	E1	Sample Collection
002	Neuston Net	07/03/2019	Alphonse	E1	Sample Collection
003	CTD	07/03/2019	Alphonse	E1	Data Collection
004	ADCP	07/03/2019	Alphonse	E1	Data Collection
005	ADCP	07/03/2019	Alphonse	E1	Data Collection
006	CTD	08/03/2019	Alphonse	E1	Data Collection
007	Multibeam	08/03/2019	Alphonse	E1	Data Collection
008	Niskin Bottle	08/03/2019	Alphonse	E1	Sample Collection
009	Neuston Net	08/03/2019	Alphonse	E1	Sample Collection
010	Yellow Sub	08/03/2019	Alphonse	E1	Technical/test
011	ROV	08/03/2019	Alphonse	E1	Transect
012	Dropcam	08/03/2019	Alphonse	E1	Data Collection
013	CTD	09/03/2019	Alphonse	E1	Data Collection
014	Niskin Bottle	09/03/2019	Alphonse	E1	Sample Collection
015	ADCP	09/03/2019	Alphonse	N1	Data Collection
016	Multibeam	09/03/2019	Alphonse	N1	Data Collection
017	Yellow Sub	09/03/2019	Alphonse	N1	Transect
018	Neuston Net	09/03/2019	Alphonse	N1	Sample Collection
019	Neuston Net	09/03/2019	Alphonse	N1	Sample Collection
020	Red Sub	09/03/2019	Alphonse	N1	Sample Collection
021	Dropcam	09/03/2019	Alphonse	N1	Data Collection
022	Multibeam	09/03/2019	Alphonse	N1	Data Collection
023	CTD	10/03/2019	Alphonse	N1	Data Collection
024	Niskin Bottle	10/03/2019	Alphonse	N1	Sample Collection
025	ROV	10/03/2019	Alphonse	N1	Exploratory dive
026	Yellow Sub	10/03/2019	Alphonse	N1	Transect
027	Dropcam	10/03/2019	Alphonse	N1	Data Collection
028	Multibeam	11/03/2019	Alphonse	N1	Data Collection
029	CTD	11/03/2019	Alphonse	N1	Data Collection
030	Neuston Net	11/03/2019	Alphonse	N1	Sample Collection
031	Niskin Bottle	11/03/2019	Alphonse	N1	Sample Collection
032	Red Sub	11/03/2019	Alphonse	N1	Sample Collection
033	Yellow Sub	11/03/2019	Alphonse	N1	Transect
034	CTD	12/03/2019	Alphonse	N1	Data Collection
035	SCUBA	12/03/2019	Alphonse	N1	Transect

036	Niskin Bottle	12/03/2019	Alphonse	N1	Sample Collection
037	Yellow Sub	12/03/2019	Alphonse	N1	Transect
038	Red Sub	12/03/2019	Alphonse	N1	Sample Collection
040	Hydrophone	12/03/2019	Alphonse	N1	Data Collection
041	Neuston Net	13/03/2019	Alphonse	N1	Sample Collection
042	Neuston Net	13/03/2019	Alphonse	N1	Sample Collection
043	Neuston Net	13/03/2019	Transit	NA	Sample Collection
044	Red Sub	14/03/2019	Alphonse	N1	Sample Collection
045	Yellow Sub	14/03/2019	Alphonse	N1	Transect
046	Multibeam	14/03/2019	Alphonse	N1	Data Collection
047	Red Sub	14/03/2019	Alphonse	N1	Sample Collection
048	Yellow Sub	14/03/2019	Alphonse	N1	Transect
049	Neuston Net	15/03/2019	Alphonse	N1	Sample Collection
050	CTD	16/03/2019	Aldabra	S1	Data Collection
051	ADCP	16/03/2019	Aldabra	S1	Data Collection
052	ROV	16/03/2019	Aldabra	S1	Aborted
053	Niskin Bottle	16/03/2019	Aldabra	S1	Sample Collection
054	ADCP	17/03/2019	Aldabra	N1	Data Collection
055	Multibeam	17/03/2019	Aldabra	N1	Data Collection
056	ROV	17/03/2019	Aldabra	N1	Aborted
057	Red Sub	17/03/2019	Aldabra	N1	Sample Collection
058	Yellow Sub	17/03/2019	Aldabra	N1	Transect
059	CTD	17/03/2019	Aldabra	N1	Data Collection
060	Niskin Bottle	17/03/2019	Aldabra	N1	Sample Collection
061	Dropcam	17/03/2019	Aldabra	N1	Data Collection
062	CTD	18/03/2019	Aldabra	N1	Data Collection
063	Niskin Bottle	18/03/2019	Aldabra	N1	Sample Collection
064	Red Sub	18/03/2019	Aldabra	N1	Sample Collection
065	Yellow Sub	18/03/2019	Aldabra	N1	Media dive
066	SCUBA	18/03/2019	Aldabra	N1	Transect
067	ROV	18/03/2019	Aldabra	N1	Aborted
068	Neuston Net	18/03/2019	Aldabra	N1	Sample Collection
069	Neuston Net	18/03/2019	Aldabra	N1	Sample Collection
070	Multibeam	19/03/2019	Aldabra	N1	Data Collection
071	NA	NA	NA	NA	NA
072	Red Sub	19/03/2019	Aldabra	N1	Sample Collection
073	Yellow Sub	19/03/2019	Aldabra	N1	Transect
074	Dropcam	19/03/2019	Aldabra	N1	Data Collection
075	CTD	20/03/2019	Aldabra	N1	Data Collection
076	Niskin Bottle	20/03/2019	Aldabra	N1	Sample Collection
077	Red Sub	20/03/2019	Aldabra	N1	Sample Collection

078	Yellow Sub	20/03/2019	Aldabra	N1	Transect
079	Neuston Net	20/03/2019	Aldabra	N1	Sample Collection
080	Neuston Net	20/03/2019	Aldabra	N1	Sample Collection
081	Neuston Net	20/03/2019	Aldabra	N1	Sample Collection
082	Dropcam	20/03/2019	Aldabra	N1	Data Collection
083	CTD	21/03/2019	Aldabra	N1	Data Collection
084	Niskin Bottle	21/03/2019	Aldabra	N1	Sample Collection
085	Multibeam	21/03/2019	Aldabra	N1	Data Collection
086	Red Sub	21/03/2019	Aldabra	N1	Sample Collection
087	Yellow Sub	21/03/2019	Aldabra	N1	Transect
088	ROV	21/03/2019	Aldabra	N1	Aborted
089	MiniROV	21/03/2019	Aldabra	N1	Technical/test
090	Neuston Net	21/03/2019	Aldabra	N1	Sample Collection
091	Neuston Net	21/03/2019	Aldabra	N1	Sample Collection
092	Neuston Net	21/03/2019	Aldabra	N1	Sample Collection
093	MiniROV	22/03/2019	Aldabra	N1	Sample Collection
094	CTD	22/03/2019	Aldabra	N1	Data Collection
095	Niskin Bottle	22/03/2019	Aldabra	N1	Sample Collection
096	Red Sub	22/03/2019	Aldabra	N1	Sample Collection
097	Yellow Sub	22/03/2019	Aldabra	N1	Transect
098	CTD	23/03/2019	Aldabra	W1	Data Collection
099	Niskin Bottle	23/03/2019	Aldabra	W1	Sample Collection
100	ADCP	23/03/2019	Aldabra	W1	Data Collection
101	Multibeam	23/03/2019	Aldabra	W1	Data Collection
102	ROV	23/03/2019	Aldabra	W1	Exploratory dive
103	Red Sub	23/03/2019	Aldabra	W1	Sample Collection
104	Yellow Sub	23/03/2019	Aldabra	W1	Transect
105	Neuston Net	23/03/2019	Aldabra	W1	Sample Collection
106	Neuston Net	23/03/2019	Aldabra	W1	Sample Collection
107	Neuston Net	23/03/2019	Aldabra	W1	Sample Collection
108	Multibeam	24/03/2019	Aldabra	W1	Data Collection
109	Niskin Bottle	24/03/2019	Assumption	NA	Sample Collection
110	Yellow Sub	24/03/2019	Aldabra	W1	Transect
111	Red Sub	24/03/2019	Aldabra	W1	Sample Collection
112	CTD	24/03/2019	Aldabra	W1	Data Collection
113	Niskin Bottle	24/03/2019	Aldabra	W1	Sample Collection
114	ADCP	24/03/2019	Aldabra	W1	Data Collection
115	CTD	25/03/2019	Aldabra	W1	Data Collection
116	Niskin Bottle	25/03/2019	Aldabra	W1	Sample Collection
117	Multibeam	25/03/2019	Aldabra	W1	Data Collection
118	ROV	25/03/2019	Aldabra	W1	Aborted

119	Red Sub	25/03/2019	Aldabra	W1	Sample Collection
120	MiniROV	25/03/2019	Aldabra	W1	Transect
121	Neuston Net	25/03/2019	Aldabra	W1	Sample Collection
122	Neuston Net	25/03/2019	Aldabra	W1	Sample Collection
123	Neuston Net	25/03/2019	Aldabra	W1	Sample Collection
124	CTD	26/03/2019	Aldabra	W1	Data Collection
125	Niskin Bottle	26/03/2019	Aldabra	W1	Sample Collection
126	MiniROV	26/03/2019	Aldabra	W1	Transect
127	Yellow Sub	26/03/2019	Aldabra	W1	Transect
128	ROV	26/03/2019	Aldabra	W1	Aborted
129	Neuston Net	26/03/2019	Aldabra	W1	Sample Collection
130	Neuston Net	26/03/2019	Aldabra	W1	Sample Collection
131	Red Sub	26/03/2019	Aldabra	W1	Photogrametry
132	Niskin Bottle	27/03/2019	Aldabra	W1	Sample Collection
133	CTD	27/03/2019	Aldabra	W1	Data Collection
134	ROV	27/03/2019	Aldabra	W1	Aborted
135	Yellow Sub	27/03/2019	Aldabra	W1	Transect
136	Multinet	27/03/2019	Aldabra	W1	Technical/test
137	Red Sub	27/03/2019	Aldabra	W1	Media dive
138	Multibeam	28/03/2019	Aldabra	N1	Data Collection
139	CTD	28/03/2019	Aldabra	N1	Data Collection
140	Niskin Bottle	28/03/2019	Aldabra	N1	Sample Collection
141	Yellow Sub	28/3/20019	Aldabra	N1	Transect
142	Hydrophone	28/03/2019	Aldabra	N1	Data Collection
143	MiniROV	28/03/20019	Aldabra	N1	Aborted
144	Red Sub	28/03/20019	Aldabra	N1	Sample Collection
145	ADCP	29/03/2019	Astove	W1	Data Collection
146	Multibeam	29/03/2019	Astove	W1	Data Collection
147	CTD	29/03/2019	Astove	W1	Data Collection
148	Niskin Bottle	29/03/2019	Astove	W1	Sample Collection
149	Neuston Net	29/03/2019	Astove	W1	Sample Collection
150	Neuston Net	29/03/2019	Astove	W1	Sample Collection
151	Neuston Net	29/03/2019	Astove	W1	Sample Collection
152	ROV	29/3/2019	Astove	W1	Exploratory dive
153	Yellow Sub	29/03/2019	Astove	W1	Aborted
154	Red Sub	29/03/2019	Astove	W1	Aborted
155	Hydrophone	29/03/2019	Astove	W1	Data Collection
156	Multibeam	29/03/2019	Astove	W1	Data Collection
157	CTD	30/03/2019	Astove	W1	Data Collection
158	Niskin Bottle	30/03/2019	Astove	W1	Sample Collection
159	Red Sub	30/03/2019	Astove	W1	Sample Collection

160	Yellow Sub	30/03/2019	Astove	W1	Transect
161	Hydrophone	30/03/2019	Astove	W1	Data Collection
162	Multibeam	30/03/2019	Astove	W1	Data Collection
163	SCUBA	30/03/2019	Astove	W1	Transect
164	ROV	30/03/2019	Astove	W1	Aborted
165	Neuston Net	30/03/2019	Astove	W1	Sample Collection
166	Neuston Net	30/03/2019	Astove	W1	Sample Collection
167	Neuston Net	30/03/2019	Astove	W1	Sample Collection
168	ROV	30/03/2019	Astove	W1	Transect
169	ADCP	28/03/2019	Aldabra	N1	Data Collection
170	CTD	31/03/2019	Astove	W1	Data Collection
171	Niskin Bottle	31/03/2019	Astove	W1	Sample Collection
172	Yellow Sub	31/03/2019	Astove	W1	Transect
173	Red Sub	31/03/2019	Astove	W1	Sample Collection
174	ROV	31/03/2019	Astove	W1	Aborted
175	ROV	31/03/2019	Astove	W1	Sample Collection
176	Hydrophone	31/03/2019	Astove	W1	Data Collection
177	Neuston Net	31/03/2019	Astove	W1	Sample Collection
178	Neuston Net	31/03/2019	Astove	W1	Sample Collection
179	Hydrophone	01/04/2019	Astove	W1	Data Collection
180	CTD	01/04/2019	Astove	W1	Data Collection
181	Niskin Bottle	01/04/2019	Astove	W1	Sample Collection
182	ROV	01/04/2019	Astove	W1	Transect
183	Red Sub	01/04/2019	Astove	W1	Photogrametry
184	Yellow Sub	01/04/2019	Astove	W1	Transect
185	ROV	01/04/2019	Astove	W1	Transect
186	Dive/SSample Collectionrkel	01/04/2019	Astove	W1	Photogrametry
187	CTD	02/04/2019	Transit	Transit	Data Collection
188	Niskin Bottle	02/04/2019	Transit	Transit	Sample Collection
189	CTD	03/04/2019	Alphonse	N1	Data Collection
190	Niskin Bottle	03/04/2019	Alphonse	N1	Sample Collection
191	Yellow Sub	03/04/2019	Alphonse	N1	Transect
192	Red Sub	03/04/2019	Alphonse	N1	Photogrametry
193	Hydrophone	03/04/2019	Alphonse	N1	Data Collection
194	Yellow Sub	03/04/2019	Alphonse	N1	Transect
195	Hydrophone	04/04/2019	Alphonse	N1	Data Collection
196	CTD	04/04/2019	Alphonse	N1	Data Collection
197	Niskin Bottle	04/04/2019	Alphonse	N1	Sample Collection
198	Multibeam	04/04/2019	Alphonse	N1	Data Collection
199	Red Sub	04/04/2019	Alphonse	N1	Sample Collection
200	Neuston Net	04/04/2019	Alphonse	N1	Sample Collection

201	Neuston Net	04/04/2019	Alphonse	N1	Sample Collection
202	Neuston Net	04/04/2019	Alphonse	N1	Sample Collection
203	ADCP	03/04/2019	Alphonse	N1	Data Collection
204	Hydrophone	05/04/2019	Poivre	E1	Data Collection
205	ADCP	05/04/2019	Poivre	E1	Data Collection
206	CTD	05/04/2019	Poivre	E1	Data Collection
207	Niskin Bottle	05/04/2019	Poivre	E1	Sample Collection
208	Multibeam	05/04/2019	Poivre	E1	Data Collection
209	Neuston Net	05/04/2019	Poivre	E1	Sample Collection
210	Neuston Net	05/04/2019	Poivre	E1	Sample Collection
211	Neuston Net	05/04/2019	Poivre	E1	Sample Collection
212	ROV	05/04/2019	Poivre	E1	Exploratory dive
213	Red Sub	05/04/2019	Poivre	E1	Sample Collection
214	Yellow Sub	05/04/2019	Poivre	E1	Transect
215	Multibeam	05/04/2019	Poivre	E1	Data Collection
216	CTD	05/04/2019	Poivre	E1	Data Collection
217	CTD	06/04/2019	Poivre	E1	Data Collection
218	Niskin Bottle	06/04/2019	Poivre	E1	Sample Collection
219	Yellow Sub	06/04/2019	Poivre	E1	Transect
220	Hydrophone	06/04/2019	Poivre	E1	Data Collection
221	Red Sub	06/04/2019	Poivre	E1	Sample Collection
222	Yellow Sub	06/04/2019	Poivre	E1	Transect
223	Neuston Net	06/04/2019	Poivre	E1	Sample Collection
224	Neuston Net	06/04/2019	Poivre	E1	Sample Collection
225	Neuston Net	06/04/2019	Poivre	E1	Sample Collection
226	CTD	07/04/2019	Poivre	E1	Data Collection
227	Niskin Bottle	07/04/2019	Poivre	E1	Sample Collection
228	Red Sub	07/04/2019	Poivre	E1	Quadrats
229	SCUBA	07/04/2019	Poivre	E1	Transect
230	Yellow Sub	07/04/2019	Poivre	E1	Transect
231	Red Sub	07/04/2019	Poivre	E1	Sample Collection
232	SCUBA	07/04/2019	Poivre	E1	Sample Collection
233	Neuston Net	07/04/2019	Poivre	E1	Sample Collection
234	Neuston Net	07/04/2019	Poivre	E1	Sample Collection
235	Neuston Net	07/04/2019	Poivre	E1	Sample Collection
236	Hydrophone	08/04/2019	D'Arros*	N1	Data Collection
237	ADCP	08/04/2019	D'Arros*	N1	Data Collection
238	Multibeam	08/04/2019	D'Arros*	N1	Data Collection
239	CTD	08/04/2019	D'Arros*	N1	Data Collection
240	Niskin Bottle	08/04/2019	D'Arros*	N1	Sample Collection
241	Neuston Net	08/04/2019	D'Arros*	N1	Sample Collection

242	Neuston Net	08/04/2019	D'Arros*	N1	Sample Collection
243	Neuston Net	08/04/2019	D'Arros*	N1	Sample Collection
244	Neuston Net	08/04/2019	D'Arros*	N1	Sample Collection
245	ROV	08/04/2019	D'Arros*	N1	Exploratory dive
246	Yellow Sub	08/04/2019	D'Arros*	N1	Transect
247	Red Sub	08/04/2019	D'Arros*	N1	Sample Collection
248	Hydrophone	08/04/2019	D'Arros*	N1	Data Collection
249	Multibeam	08/04/2019	D'Arros*	N1	Data Collection
250	Hydrophone	09/04/2019	D'Arros*	N1	Data Collection
251	CTD	09/04/2019	D'Arros*	N1	Data Collection
252	Niskin Bottle	09/04/2019	D'Arros*	N1	Sample Collection
253	Yellow Sub	08/04/2019	D'Arros*	N1	Transect
254	Red Sub	09/04/2019	D'Arros*	N1	Sample Collection
255	ROV	09/04/2019	D'Arros*	N1	Aborted
256	ROV	09/04/2019	D'Arros*	N1	Photogrametry
257	Snorkel	09/04/2019	D'Arros*	N1	Photogrametry
258	Neuston Net	09/04/2019	D'Arros*	N1	Sample Collection
259	Neuston Net	09/04/2019	D'Arros*	N1	Sample Collection
260	Neuston Net	09/04/2019	D'Arros*	N1	Sample Collection
261	Hydrophone	10/04/2019	D'Arros*	N1	Data Collection
262	CTD	10/04/2019	D'Arros*	N1	Data Collection
263	Niskin Bottle	10/04/2019	D'Arros*	N1	Sample Collection
264	ROV	10/04/2019	D'Arros*	N1	Transect
265	Red Sub	10/04/2019	D'Arros*	N1	Sample Collection
266	Yellow Sub	10/04/2019	D'Arros*	N1	Transect
267	ROV	10/04/2019	D'Arros*	N1	Aborted
270	Yellow Sub	11/04/2019	D'Arros*	N1	Transect
271	Red Sub	11/04/2019	D'Arros*	N1	Photogrametry
272	CTD	11/04/2019	D'Arros*	N1	Data Collection
273	Niskin Bottle	11/04/2019	D'Arros*	N1	Sample Collection
274	ADCP	11/04/2019	Desroches	S1	Data Collection
275	Multibeam	12/04/2019	Desroches	S1	Data Collection
276	CTD	11/04/2019	Desroches	S1	Data Collection
277	Niskin Bottle	11/04/2019	Desroches	S1	Sample Collection
278	Neuston Net	11/04/2019	Desroches	S1	Sample Collection
279	Neuston Net	11/04/2019	Desroches	S1	Sample Collection
280	CTD	12/04/2019	Desroches	S1	Data Collection
281	Niskin Bottle	12/04/2019	Desroches	S1	Sample Collection
282	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
283	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
284	ROV	12/04/2019	Desroches	S1	Exploratory dive

285	Red Sub	12/04/2019	Desroches	S1	Photogrametry
286	Yellow Sub	12/04/2019	Desroches	S1	Transect
287	Hydrophone	12/04/2019	Desroches	S1	Data Collection
288	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
289	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
290	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
291	Neuston Net	12/04/2019	Desroches	S1	Sample Collection
292	Hydrophone	13/04/2019	Desroches	S1	Data Collection
293	CTD	13/04/2019	Desroches	S1	Data Collection
294	Niskin Bottle	13/04/2019	Desroches	S1	Data Collection
295	Yellow Sub	13/04/2019	Desroches	S1	Transect
296	Red Sub	13/04/2019	Desroches	S1	Sample Collection
297	Yellow Sub	13/04/2019	Desroches	S1	Transect
298	Multibeam	13/04/2019	Desroches	S1	Data Collection
299	Red Sub	13/04/2019	Desroches	S1	Sample Collection
300	Hydrophone	14/04/2019	Desroches	S1	Data Collection
301	Niskin Bottle	15/04/2019	Desroches	S1	Sample Collection
302	CTD	15/04/2019	Desroches	S1	Data Collection
305	ROV	14/04/2019	Desroches	S1	Sample collection
306	SCUBA	14/04/2019	Desroches	S1	Transect
307	Yellow Sub	14/04/2019	Desroches	S1	Transect
309	Red Sub	14/04/2019	Desroches	S1	Sample Collection
310	Hydrophone	15/04/2019	Desroches	S1	Data Collection
311	Yellow Sub	15/04/2019	Desroches	S1	Transect
312	Red Sub	15/04/2019	Desroches	S1	Sample Collection
313	Hydrophone	16/04/2019	Desroches	S1	Data Collection
314	CTD	16/04/2019	Desroches	S1	Data Collection
315	Niskin Bottle	16/04/2019	Desroches	S1	Sample Collection
316	Red Sub	16/04/2019	Desroches	S1	VIP dive
316	CTD	17/04/2019	Desroches	S1	Data Collection
317	Yellow Sub	16/04/2019	Desroches	S1	VIP dive
318	ROV	16/04/2019	Desroches	S1	Sample Collection
3xx	ROV	17/04/2019	Desroches	S1	Sample Collection

* D'Arros location refers to samples and data collected at St Joseph.

2- Biological samples summary table

Table: *Number of benthic biological samples collected at each site at each depth (including hard coral).*

	Number of biological samples collected at each depth					
Site	10m	30m	60m	100-120m	250m	350m
Alphonse N1	0	0	4	4	5	0
Aldabra N1	3	9	6	6	3	0
Aldabra W1	1	7	0	6	0	0
Astove W1	0	3	7	4	5	0
Poivre E1	30	4	7	5	5	0
***D'Arros S1**	0	5	6	6	5	1
Desroches N1	16	4	4	6	4	1

* D'Arros location refers to samples and data collected at St Joseph.

3 – Summary table of video transects collected

Table: *Number of benthic and pelagic video transects completed at each depth at each site.*

All Benthic Transects (Including, Subs, ROV, MiniROV, SCUBA)						All Pelagic Transects (Including, Subs, ROV, MiniROV, SCUBA)					
Site	**Depth**					**Site**	**Depth**				
	10m	30m	60m	100-120m	250m		10m	30m	60m	100-120m	250m
Alphonse N1	3	4	4	3	3	**Alphonse N1**	3	4	4	3	4
Aldabra N1	3	3	4	3	3	**Aldabra N1**	3	3	2	3	3
Aldabra W1	3	6	3	3	3	**Aldabra W1**	3	6	3	3	4
Astove W1	2	3	3	3	6	**Astove W1**	2	3	3	3	4
Poivre E1	3	3	3	3	3	**Poivre E1**	3	3	3	3	3
***D'Arros N1**	0	3	5	3	3	***D'Arros N1**	0	3	5	3	3
Desroches S1	3	3	3	4	3	**Desroches S1**	3	3	3	4	3

* D'Arros location refers to samples and data collected at St Joseph.