

Survey Methods Manual



Authors: Ruth Thurstan, Jason Flower, Maria Beger, Christine Dudgeon, K-le Gomez Cabrera, Juan Ortiz, Eva Kovacs, Jennifer Loder, Megan Saunders, Josh Passenger, Diana Kleine and Chris Roelfsema.



Preferred citation: Thurstan, R., Flower, J., Beger, M., Dudgeon, C., Gomez, K., Ortiz, J., Kovacs, E., Loder, J., Saunders, M., Passenger, J., Kleine D. and Roelfsema, C (2014). Survey Methods Manual Unidive Point Lookout Ecological Assessment (PLEA). The University of Queensland Underwater Club, Brisbane, Australia.

1. Introduction	4
2. General Methods	5
2.1 Survey Weekend	5
2.2. Preparation	7
2.3. Survey Sequence	7
2.4. Survey considerations and safety	8
2.5. Survey Equipment for 2 dives per trip	9
2.6. Survey Equipment for weekend	9
3. Study Site and Transect Location	10
4. Fish identification	11
4.1. Survey Method	11
4.2. Fish Families ID	12
4.3. Fish Species Indicators ID	12
4.4. Data Entry	13
5. Substrate and Benthic	13
5.1. Survey Method	13
5.2. Categories	14
5.3. Data Entry	15
6. Coral Health Chart	15
6.1. Survey Method	15
6.2. Data Entry	15
7. Invertebrate survey	16
7.1. Survey Method	16
7.2. Categories	16
7.3. Data Entry	16
8. Impacts	17
8.1. Survey Method	17
8.2. Categories	17
8.3. Data Entry	17
9. Species List	18
9.1. Survey Method	18
9.2. Data Entry	18
10. Mapping	18
10.1. Survey Method	18
10.2. Data Entry	18
11. Georeferenced Photo Transect	19

11.1. Method	19
11.2. Data Processing and analysis	19
12. Acknowledgements	20
13. References	20
14. Appendices – Project forms	20

1. Introduction

This manual will describe the standard survey methods used for the Unidive PLEA project organized by the members of Unidive (the University of Queensland dive club). This manual is based on user manuals created for the Unidive Coastcare project (McMahon et al. 2002), and in mapping the habitats of the critically endangered grey nurse shark (Ford et al. 2003). The survey methods are based on these previous volunteer projects and the globally recognized Reef Check (www.reefcheck.org) and Coral Watch (www.coralwatch.org) methods.

Between 2001-2002 Unidive conducted the first ecological assessment of flora and fauna at the Point Lookout dive sites, located on North Stradbroke Island in southeast Queensland. In 2002-2003 UniDive conducted the Grey Nurse Shark Habitat Mapping Project. The Point Lookout dive sites comprise a number of rocky outcrops and reef ecosystems that support and attract a diverse range of marine flora and fauna. Prior to 2002 a number of recreational and commercial activities took place at the Point Lookout sites that could potentially impact upon the ecological health of the area. These included SCUBA diving, specimen collection, aquarium collection, anchor damage, recreational and commercial fishing.

Since the initial surveys took place several changes have occurred in the management of the Point Lookout area. Flat Rock has been protected from extractive activities (i.e., all recreational and commercial fishing and collection activities) and anchoring by vessels unless they are moored on the permanent markers now in place. The number of dive operators visiting the area, in particular, Shag Rock, has increased. Large-scale natural impacts have also occurred, for example, the 2011 Queensland flood. Despite this, no surveys have taken place at a comparable scale to the 2001-2002 Unidive surveys.

The aim of the Unidive PLEA project is to repeat the ecological assessment of flora and fauna at the Point Lookout dive sites and report on the changes present when compared with 2001. These results will be communicated to the wider community and to government agencies. The survey methods will be directly comparable to the surveys undertaken in 2001-2002. In 2014 Unidive will undertake 2 training weekends and 4 survey weekends, each with 24 divers assessing the 3 most commonly dived locations; Shag Rock, Manta Ray Bommie and Flat Rock. The following activities are planned for each location, with surveys to be repeated across the four weekends with data thus showing any seasonal variations:

(a) Broad scale mapping: georeferenced underwater video/photo will be used to map each dive site, its major features and regions (depth profiled), the types of communities present and the location of unique species/impacted areas.

(b) Transect surveys: 6 x 20 m transects will assess the substrate type, extent of damage or impact, species distribution and abundance at each of the three sites. Photos will also be captured for each transect during the 4 survey weekends.

(c) Photo and video libraries will be collated for documenting the project, creating a species list and for publication purposes.

2. General Methods

2.1 Survey Weekend

Two training and four survey weekends will take place throughout the year to ensure that fauna at each site are surveyed in the different seasons. Three regions (Flat Rock, Shag Rock and Manta Ray Bommie; Fig. 1) will be surveyed using broad scale mapping techniques and fauna and substrate surveys along transect lines deployed at a depth of 10 m below chart datum. Two separate areas at Flat Rock and Shag Rock will be surveyed and results will be compared to the 2001-2002 survey findings. One new site at Manta Ray Bommie will also be surveyed.

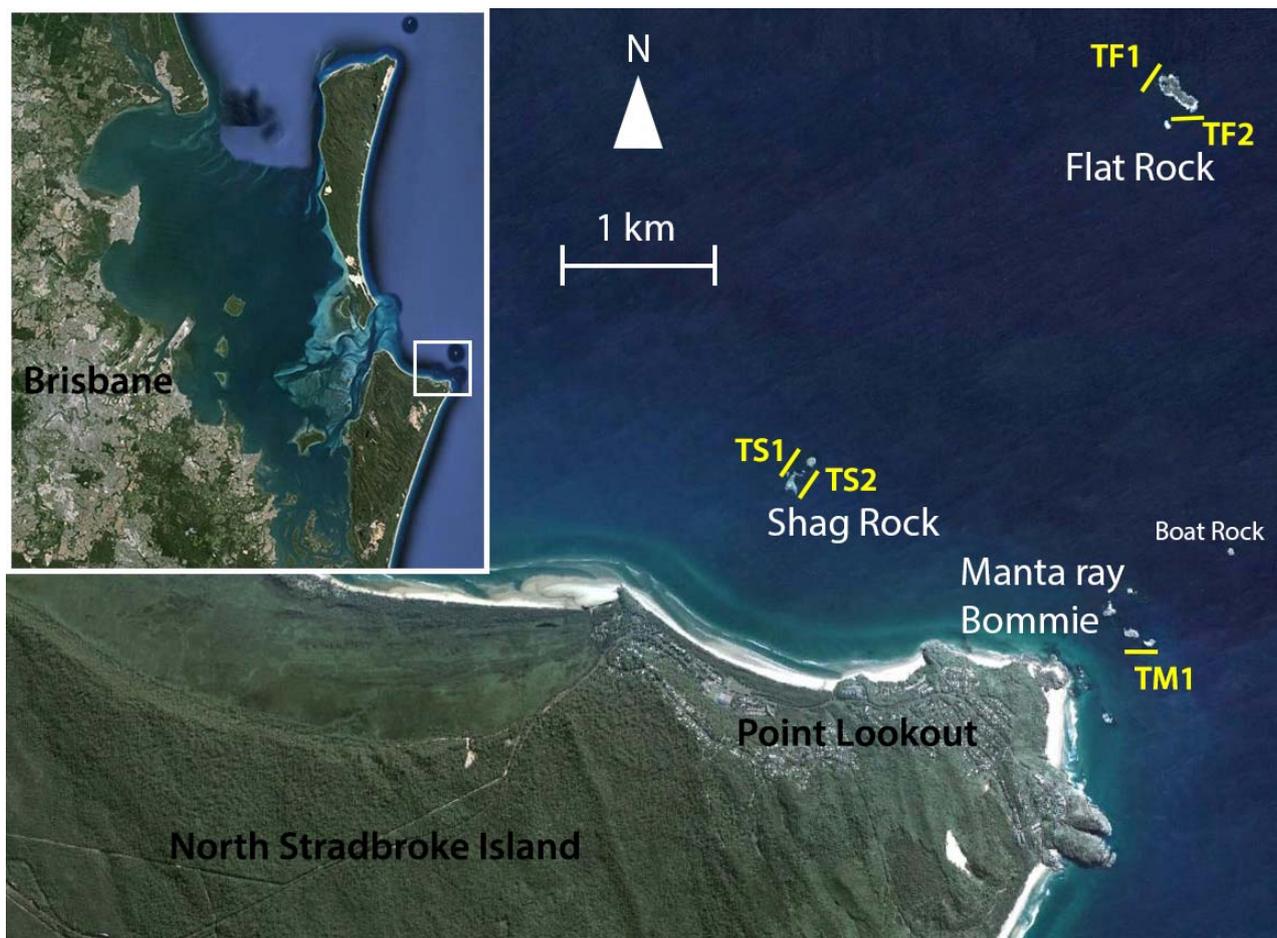


Figure 1. Map of survey sites at Point Lookout with approximate locations and orientations of transects

At each survey location, permanent markers will be laid along a length of 70 m; at 0 m, 25 m and 50 m. Within this 70 m length, three 20 m long line transects will be deployed and surveyed (Fig 2). Each 20 m transect will follow the designated depth contour, separated from the next transect by a 5 m gap.

Transect line for fish, invertebrates, substrate and impacts is 70 m, divided into 3 segments:



Figure 2. Transect line

For each survey, 6 pairs of divers will undertake mapping and/or transect surveys to identify the species present and major features of each site. Along each transect target invertebrate species will be identified, impacts (human and natural) will be detected, substrate types will be identified and percentage cover calculated, target fish species and families will be identified and abundance calculated, coral health surveys and mapping of sites will be undertaken.

During the weekend there will be 8 dives conducted, divided over 2 trips per day, a morning and afternoon trip. To ensure appropriate transfer of data and survey equipment between trips and correct storage of data collected several jobs need to be assigned. A dive leader per boat will be assigned to organise diving and survey activities.

Data Officer

The data officer is responsible for ensuring all data sheets come on the survey weekend, that completed data sheets are copied using a camera and entered into a computer, and that data sheets are properly stored after the weekend.

The data officer distributes and collects data sheets with the help of data cops.

Data Cops

Every trip has a data cop assigned, who is responsible for placing data sheets on slates before dives and collecting them after each dive and storing them in dedicated folders. Once onshore the data cops need to provide the data sheets to the data officer, or transfer remaining sheets to the data cop for second trip. See Appendix A for further details.

Survey Equipment Officer

The survey equipment officer is responsible for all survey equipment coming on the survey weekend and ensures that survey equipment is ready to be used before going on each trip. They will distribute and collect survey equipment with the help of gear cops.

Gear Cops

Every trip gets assigned a gear cop, who is responsible for handing out survey equipment before each dive and collecting them after a dive and storing them in a dedicated box. Once onshore the box needs to be handed over to the gear cop of the next boat, or needs to be cleaned and stored at a dedicated location

Dive Officer

The dive officer is responsible for collating the participants' forms, medical forms, safety forms, and liability forms before the trip. They bring on the trip the dive logs, clip boards, and onshore O2 kit. They also provide dive leaders with the dive log for each trip and check the completeness of the dive log after the trip. Finally they take a photo of the log and store both the hard and soft copy in a dedicated location.

2.2. Preparation

To ensure that good quality data is collected, each diver has attended lecture sessions to understand the survey methods used and to assist in correctly identifying flora, fauna and impacts. Each diver will be required to pass an exam (80% pass mark) and take part in a training weekend where they will be instructed in underwater mapping, surveying and species identification techniques.

Prior to the survey weekend, permanent markers will be set up at the 5 survey sites to mark the locations of the start of each 20 m segment of transect. The position of each permanent marker will be recorded using GPS, underwater features and bearings. These markers will be removed at the end of the 2014 survey season.

2.3. Survey Sequence

Buddy pairings will generally consist of a core diver (CD) and non-core dive (NCD). Ideally, a core diver is a diver with survey experience, whilst non-core divers can be those with limited dive or survey experience but who can conduct simple tasks underwater. Buddy pairs will conduct their dives in the following order:

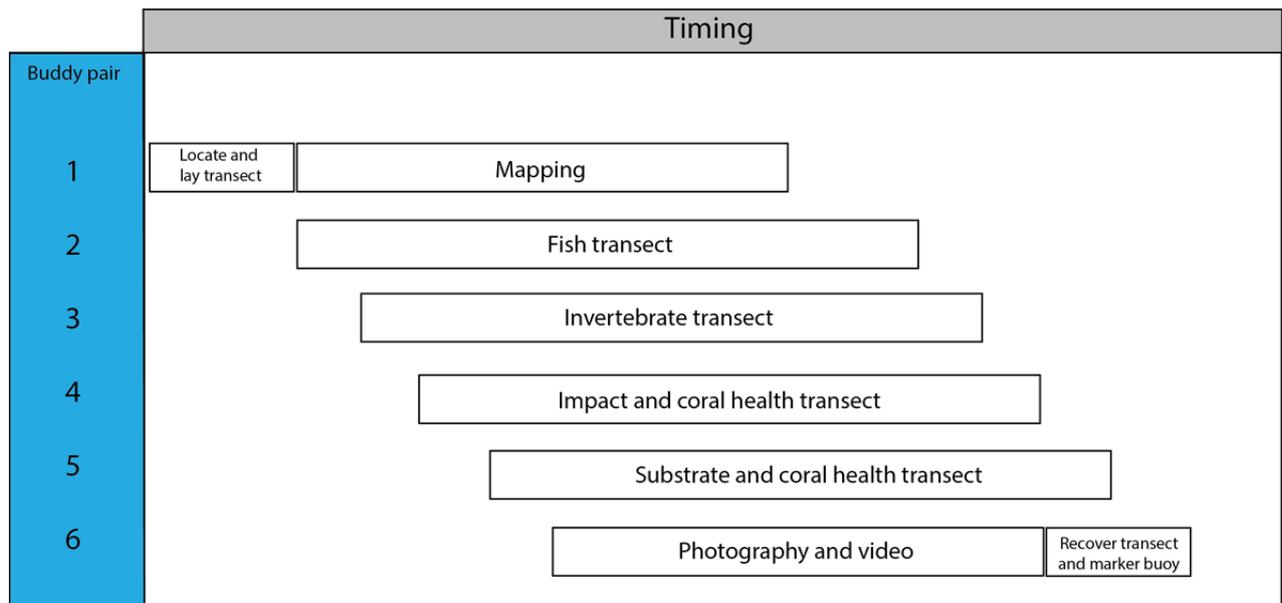
1. Mapper (CD) and buddy (NDC)
2. Fish species (CD) and fish family identification (CD)
3. Invertebrate identification (CD) and buddy (NCD)
4. Impact identification (CD) and coral health (NCD)
5. Substrate identification (CD) and coral health (NCD)
6. Photographer (CD) and video (NCD)

Buddy pairs enter the water as per the order stated, with each pair completing final checks as those ahead of them enter the water. As the previous buddy pair descends, the next buddy pair enters the water to await the start of their dive.

Dive activities will proceed as follows (see Fig 3 for summary):

- Buddy pair 1 descend with transect line and surface float/anchor equipment, followed by buddy pair 2. Buddy pair 1 will find the start of the transect, and if conditions are suitable they will deploy a surface float at the beginning of the first transect to help other divers find the start point. Diver 1 of buddy pair 1 will roll out the transect tapes and diver 2 will commence the georeferenced photo transect survey, at which point they will leave the transect to commence broader mapping of the site. Once buddy pair 1 is out of sight allowing fish to return, buddy pair 2 will follow to commence the fish count.
- After buddy pairs 1 and 2 descend, buddy pair 3 descends at the float, and starts the invertebrate identification survey, ensuring that they do not overtake the divers conducting the fish survey.
- After buddy pair 3 descends, buddy pair 4 descends at the float, and starts the impact identification survey.

- After buddy pair 4 descends, buddy pair 5 descends at the float and starts the substrate and coral health survey.
- After buddy pair 5 descends, buddy pair 6 descends to video the transects and photograph divers conducting the surveys.
- At the end of the dive, buddy pair 6 will recover the transect tape and marker float. They must ensure sufficient reserves of air/time remain in order to carry this out and make a safe return to surface.



Maximum dive time is 50 minutes

Figure 3. Sequencing of divers on a survey

Each dive buddy pair will spend no longer than 50 minutes underwater, with a maximum of 10 m depth for the transect survey and 20 m depth for the mapping surveys. Upon completion of the first dive a one-hour surface interval will take place and divers will then undertake a survey at a second site. Two waves of divers (Team A and Team B) will run throughout the day, with the aim to survey each of the 5 transects at the 3 sites by the end of the trip (Figs. 4,5, and 6). Team A will conduct two surveys during the first wave and Team B will conduct one survey and use their second dive for any uncompleted or extra work. On the second day the two teams will swap and Team B will complete the two morning survey dives.

2.4. Survey considerations and safety

Safety will be paramount in all dives conducted. Divers will all dive in pairs and will be required to maintain good contact and awareness with their buddy throughout, including regular checking of their own and their buddy's air. To facilitate good practice, divers will be required to fill in their dive time and air remaining on their data sheets at the end of every 20 m transect. Divers must surface with a minimum pressure of 50 bar in their tanks. All divers must remain within their no-decompression limits and surface on or before the 50 minute mark.

During the dives, divers should be aware of their position and orientation in the water. Good buoyancy and trim (remaining in a horizontal position) is required at all stages of the dive, but in particular when positioning markers, rolling out transect tapes, when making notes on data sheets and whilst taking photographs or video. Divers will have the opportunity to practice these skills during the training weekend. All gear (e.g., cameras, slates, pressure gauge and alternative air source devices) should be positioned so that they are neatly stowed and will not make contact with the substrate.

2.5. Survey Equipment for 2 dives per trip

- 2 x sets of:
 - o Mapping data sheet with slate
 - o Fish species data sheet with slate
 - o Fish family data sheet with slate
 - o Substrate data sheet with slate
 - o Invert data sheet with slate
 - o Impact data sheet with slate
 - o Coral health chart
- 1 x set of spare data sheets
- 2 x photo transect camera
- 3 x 50 m Survey tapes (includes a spare)
- 1 x GPS in dry bag and real
- 1 x magna doodle
- 1+1 spare plumb line
- Box with spares (pencils, rubber, rubber bands, pencil sharpener)
- Dive log
- Copy of permit
- Copy of insurance
- Map of transect location
- Cheat sheets

2.6. Survey Equipment for weekend

- Survey equipment for 2 dives per trip (as above), with sufficient data sheets for all trips
- Laptop(s) to download data, cameras and GPS
- ID books
- White board
- White board markers
- UniDive PLEA banner
- UniDive PLEA stamp
- Spares
 - o Slates
 - o Pencils
 - o Rubbers
 - o Pencil sharpeners
 - o Rubber bands

3. Study Site and Transect Location

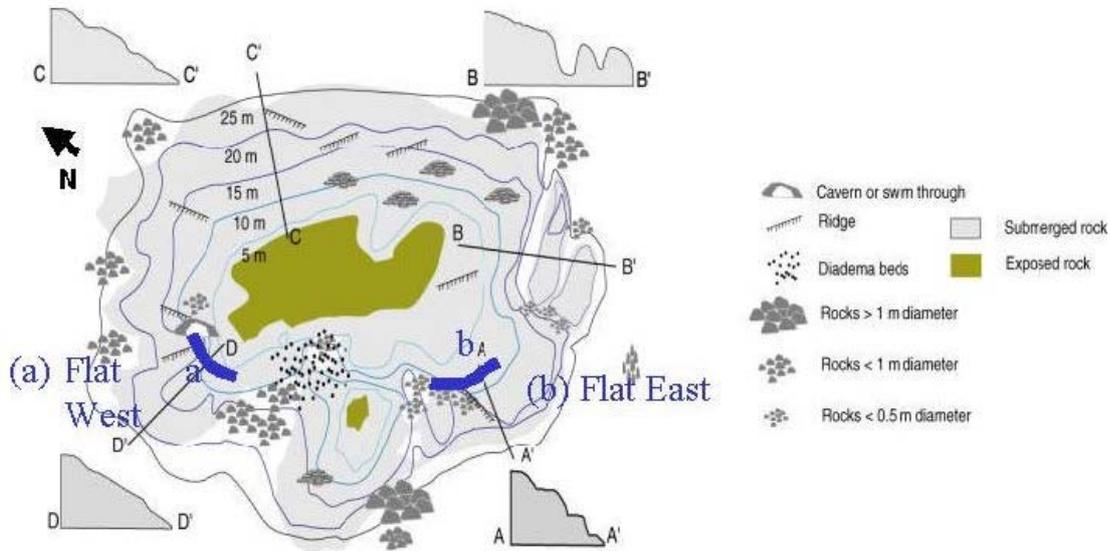


Figure 4. Flat Rock map showing transect locations (in blue). Cross-section cut-away views shown by solid black lettered lines.

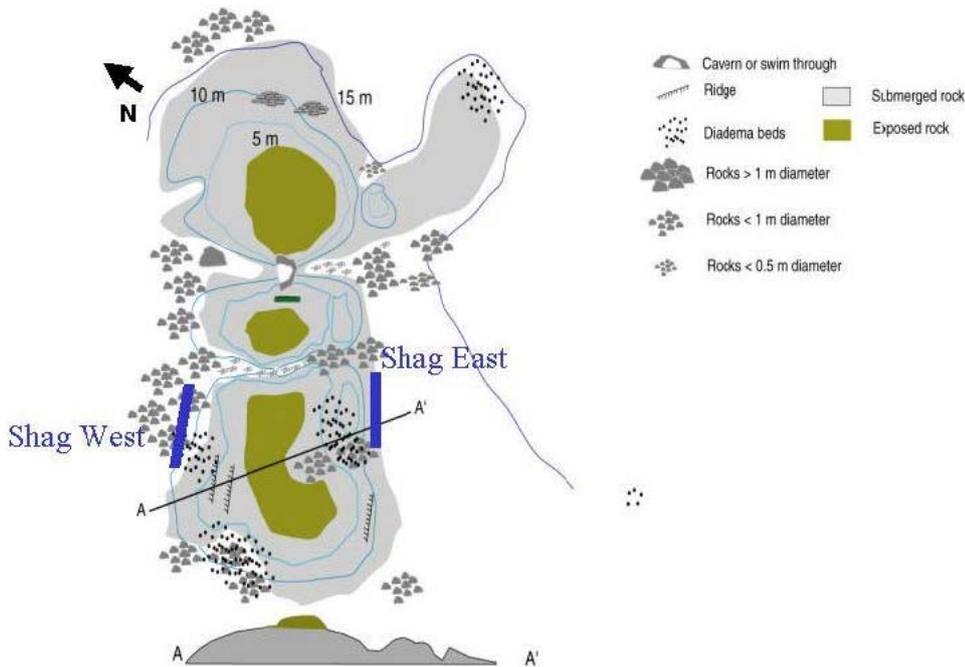


Figure 5. Shag Rock map showing transect locations (in blue). Cross-section cut-away views shown by solid black lettered lines.

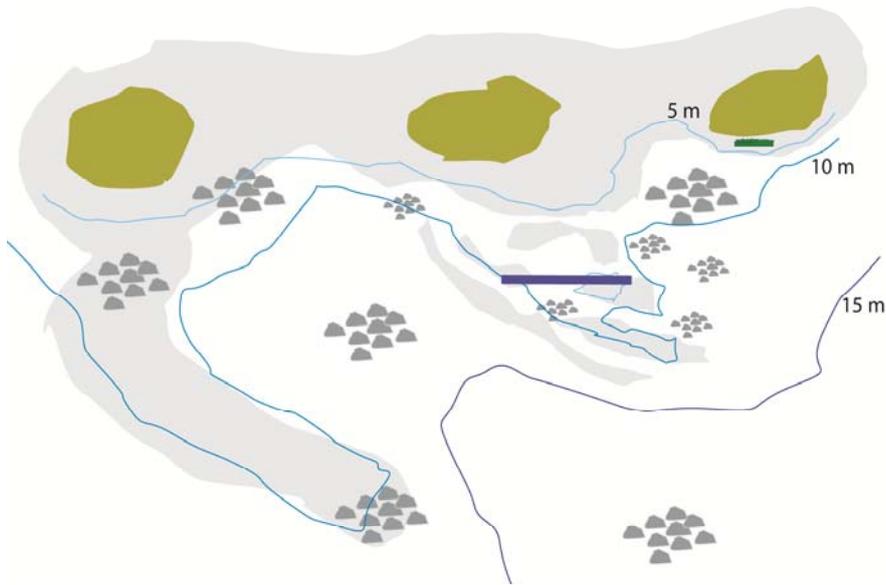


Figure 6. Manta Ray Bommie map showing transect locations (in blue).

4. Fish identification

4.1. Survey Method

Fish populations are assessed using visual census along the 3 x 20 m transects. The divers in this buddy pair will each carry a data sheet: a fish families and an indicator species data sheet.

Each transect will be 5 m wide (2.5 m either side of the transect tape), 5 m high and 20 m in length (see Fig. 7). Each diver in the buddy pair assigned to count fish will be given a different task. One diver will count the target fish families and the other will count indicator species as highlighted on the data sheets. Both divers will swim adjacent to each other whilst proceeding to the end of each transect. Divers should aim to cover each 20 m transect in 7-10 minutes.

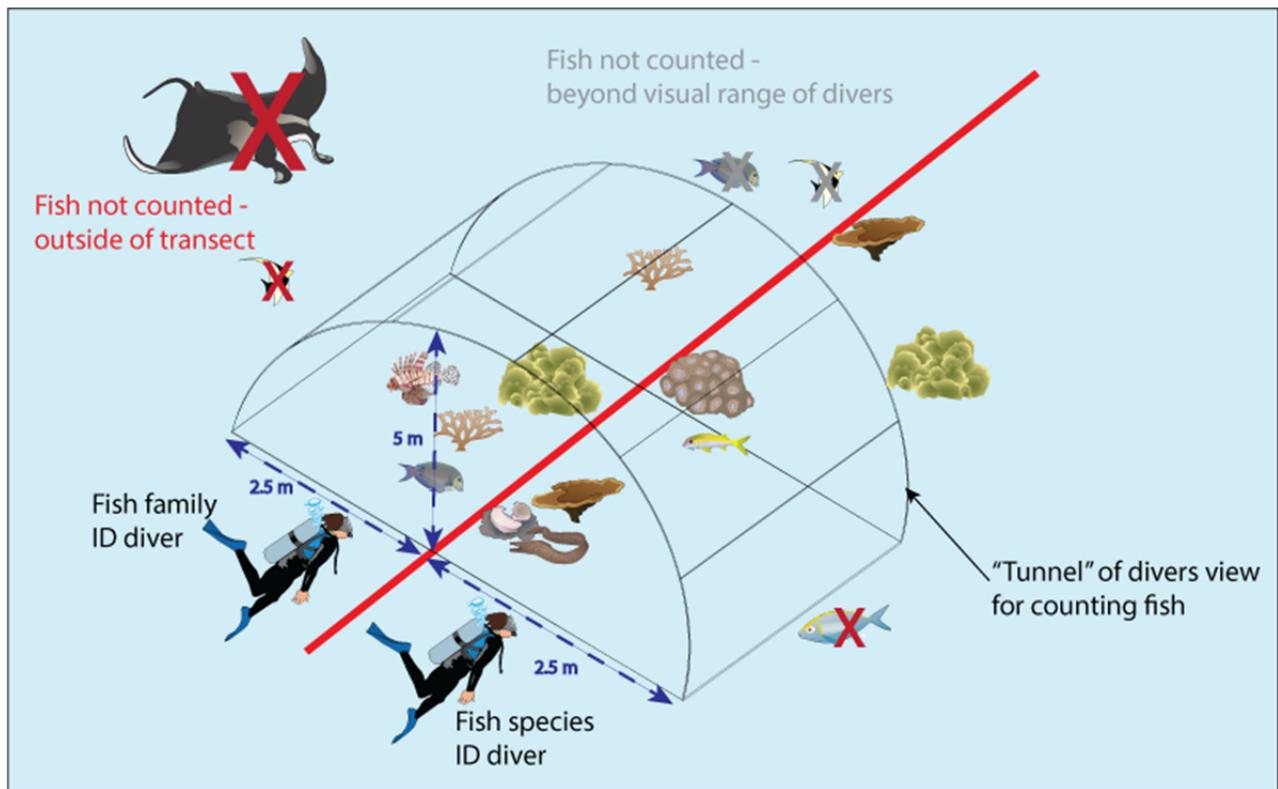


Figure 7. Fish transect survey showing wire-frame of "diver's view". Note fish outside of "diver's view" may subsequently enter view and be counted, e.g. manta ray

An initial survey will be conducted as divers pause and count fish in a section of the transect well within the bounds of visibility (e.g., using the 5 m mark on the transect tape). During this first scan of the section most of the mobile fish (e.g., wrasse, parrotfish) should be counted. Once these mobile species have been recorded the observer moves along the centre of the transect searching for the more cryptic and slower moving target species which were obscured from view by the structure of the reef during the initial count of the area. This process is repeated for each transect section.

Fish entering the transect during, or after, that area of transect is counted are not included as they were not present during the initial count.

4.2. Fish Families ID

Fish families have been chosen that are indicative of the ecological health of the ecosystem and that are easily identified by their body shape.

For data sheet, see Appendix B.

4.3. Fish Species Indicators ID

Fish species have been chosen as those typically targeted by recreational and commercial fishers or targeted by aquarium collectors. Fish species that you consider rare or otherwise

special should also be recorded at the bottom of the data sheet. Take pictures of the fish if you are unsure of its species or if you suspect it is rarely observed in the area.

For data sheet, see Appendix C.

4.4. Data Entry

Fish surveys are abundance counts, so individuals from each of the target fish families or indicator species that are observed within each transect should be tallied individually on the data sheet. Air and dive time must be completed at the end of each transect and entered onto the data sheet.

5. Substrate and Benthic

5.1. Survey Method

Substrate surveys will be conducted using the point sampling method, with the goal to collect percentage cover estimate of substrate types and benthic organisms. To assist the diver in accurately determining the substrate below the tape and to reduce bias, the diver will gently place a plumb line (a weighted line) upon each 0.5 m point and identify the substrate it lands upon. At each 0.5 m interval (beginning on 0.0 m and ending on 19.5 m), the diver gently lowers the plumb line and records the substrate/benthic category directly below (Fig. 8). This procedure is repeated for the remaining two transect segments.

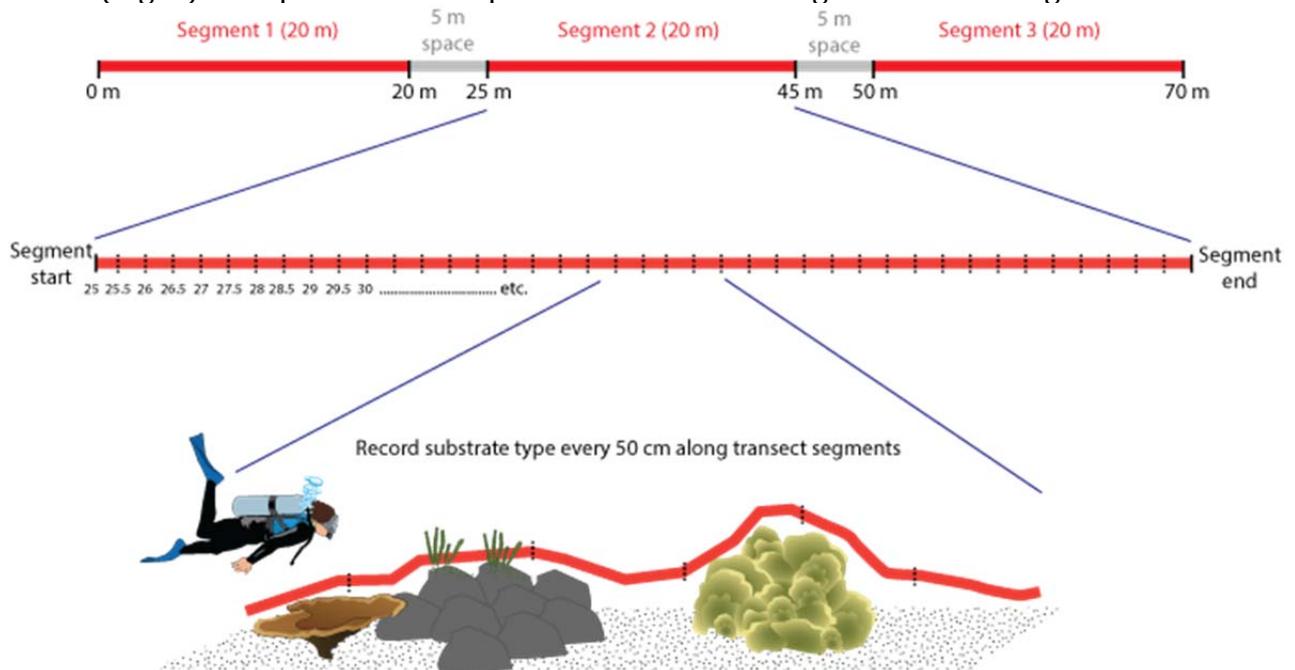


Figure 8. Break-down of substrate survey. Points every 0.5 m of transect line are recorded, with a plumb line used to avoid bias.

Where hard or soft coral are bleached (tissue must be present!), include the substrate type and add a lower-case 'b'. If uncertain, take a photo and include photo number on the data sheet.

5.2. Categories

Categories include various growth forms of hard coral and soft coral, key species/growth forms of algae, other living (i.e., sponges, cyanobacteria), recently killed coral and non-living substrate types (i.e., bare rock, sand, rubble, silt/clay). A description of the growth forms is included below for quick reference, also see Appendix D for data sheet.

Hard coral

- Other/unknown (HC)
- Massive (HM): Coral which is generally covering a hard substrate and has cover thickness of several cm to maybe 10 cm. Often boulder shaped.
- Encrusting (HE): Coral overgrowing hard substrate and has cover thickness of not more than several cm. Edges 'hug' the reef substrate.
- Branching (HBR): Contain secondary branches (a branch growing from another branch).
- Foliose (HF): Contains delicate-looking leafy, solid disk or plates, which lift up at the edges.
- Plate like (HP): Coral which consists of a continuous area with small fused branches. Plate corals do not have gaps within the plate itself and grow from a single stalk.

Soft coral

- Other/unknown (SC)
- Ornate (SCO): Coral which characterises itself by little tree-like shapes (max 20 cm) which are often purple or yellow/green. The stem of the tree has little white lines called spicules.
- Leathery cover (SCL): These coral often are compared to giant cauliflowers or broccolis; appear leathery when polyps are not feeding.
- Zoanthids (SZ): Non-reef building, will close when wafted.

Recently killed coral (KC) defines coral that has died within the past year. The coral may be standing or broken into pieces, but appears fresh, white with corallite structures still recognizable, only partially overgrown by encrusting algae. If recently killed coral has turf algae or macro algae present, label it as KCTA and KCA respectively.

Sponges (SP) contain irregular holes on their surface which will not close when wafted, they are relatively stiff.

Cyanobacteria (CY) often 'smothers' other substrate and may be brightly coloured.

Other (OT) includes anything not in a particular substrate category i.e., ascidians, hydroids, gorgonians, calcareous algae, tube worms, anemones etc. However, if anything is in great abundance, make a note of it on the bottom of the data sheet.

Algae

- Encrusting (CA): Very thin cover (few cells thick) upon the surface of rocks. Has the appearance that the rock has been painted (usually red/pink colour).
- Turf algae (TA): Community of small/short (<3cm) algae forming a mat over the surface of the rock.
- Asparagopsis (AS): Light purple to brown in colour, often forms relatively dense stands but can also be solitary. Fronds are soft with many short branches and moves around easily with water movement. Shaped like asparagus stalks.

- Lobophora (LB): Flat rounded/lobed leaves. Usually light brown in colour and may have vertical radiating darker lines.
- Padina (PA): Leaves shaped like pencil shavings, chalky coating, horizontal bands across the leaf.
- Laurencia (LA): Thin red branches, long axis with smaller lateral branches.
- Halimeda (HA) Calcareous flat, green leaves.
- Ulva (UV): Green lettuce-like leaves.
- Filamentous (FL): Made up of many fine filaments.
- Caulerpa rasemosa (CL): Looks like green grapes.
- Caulerpa taxifolia (CT): Mostly grows on sand/mud, looks like green feathers.
- Sargassum (SG): Elongated leathery leaves, may have small air-filled bladders/sacs.
- Turbinaria (TU): trumpet/cone shaped leaves with spiky edges, grows from a single long stalk.
- Lyngbya (LY): Technically not an algae but can look like a filamentous algae, usually brown and looks like tangled hair.

Non-living

- Rock (RC): Any hard substratum including shells of clams, dead coral that is more than about 1 year old, i.e. worn down so that few corallite structures are visible and bare rock. When rock is covered in turf or encrusting coralline algae, label it as TA and CA respectively.
- Rubble (RB): Includes broken coral, shell pieces and rocks (often laying over sand) between 0.5 and 15 cm diameter. If it is larger than 15 cm it is rock, smaller than 0.5 cm it is sand. Rubble is mobile and can move in strong currents.
- Sand (SD): Small sediment particles that fall quickly to the bottom if disturbed.
- Silt/Clay (SI): Sediment that remains in suspension if disturbed.

5.3. Data Entry

Substrate surveys are point counts, undertaken at every 0.5 m. Air and dive time must be completed at the end of each transect and entered onto the data sheet.

6. Coral Health Chart

6.1. Survey Method

Coral health charts developed by scientists at UQ will be used to measure the health of corals and extent of coral bleaching. Divers will select individual coral colonies (to a maximum of 20 colonies) along the 3 transects. For each colony the diver will use the coral health chart to record the darkest and lightest colour gradient present. The colour code corresponding to the health chart will be inputted into the spreadsheet and the coral type (branching, boulder, plate or soft) will be recorded.

For coral health chart and more detailed instructions, see www.coralwatch.org.

6.2. Data Entry

Data is to be entered directly onto the coral health chart.

7. Invertebrate survey

7.1. Survey Method

Target invertebrate populations are assessed using visual census along the 3 x 20 m transects. One diver in the buddy pair will carry a data sheet with the key invertebrate species to be counted.

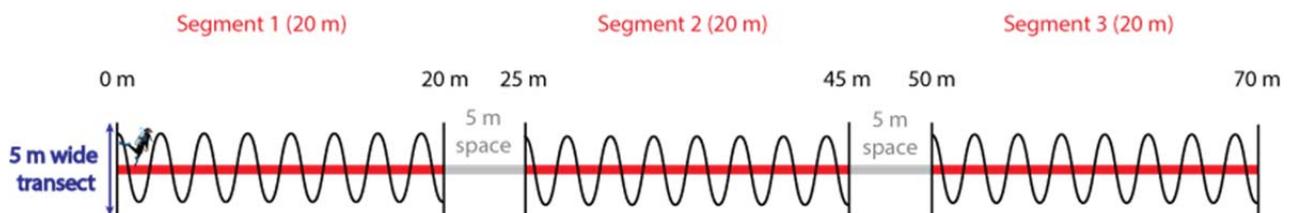


Figure 9. Invertebrate transect

Each transect will be 5 m wide (2.5 m either side of the transect tape) and 20 m in length. The diver surveying invertebrates will proceed along the transect conducting a 'U-shaped' search pattern, covering 2.5 m on either side of the transect tape (Fig. 9). Divers should aim to cover each 20 m transect in 7-10 minutes. Many invertebrates will be located in crevices within the rocky reef, so divers should take care to inspect under and among corals or overhanging substrate. Beware of buoyancy and trim whilst doing this.

7.2. Categories

Target species to be counted include 3 sea cucumber species, 3 urchin species, 3 gastropods, 2 lobster species and the banded coral shrimp. If urchins are present in numbers too high for counts of individuals to be feasible, divers may estimate the abundance of these species within the transect. Divers are also to count the number of anemones within the transect area and separate those with and without anemone fish present. Additional species to be identified and measured if present (using a pre-marked slate as a guide) include the crown of thorns starfish and giant clams. Crown of thorns are to be measured across their diameter, including legs. Clams are to be measured along the longest length of their shell, i.e. along the opening.

For data sheet categories, see Appendix E.

7.3. Data Entry

Invertebrate surveys are abundance counts, so each individual is tallied up for each transect. Crown of thorns starfish and giant clams are also measured to the nearest 5 cm. Air and dive time must be completed at the end of each transect and entered onto the data sheet.

8. Impacts

8.1. Survey Method

Three main impacts have been selected as indicators of reef health:

- Bleaching (including the % of each colony that is bleached and % of colonies bleached in each 20m transect)
- Disease
- Coral damage (including anchor, dynamite, cyanide, trash, other)

In addition, the following scars will also be surveyed:

- *Drupella* coral scars
- Crown of thorns coral scars
- Other unknown coral scars

Target impacts are assessed using visual census along the 3 x 20 m transects. Each transect will be 5 m wide (2.5 m either side of the transect tape) and 20 m in length. The diver surveying impacts will proceed along the transect conducting a 'U-shaped' search pattern, covering 2.5 m on either side of the transect tape (Fig 10). Divers should aim to cover each 20 m transect in 7-10 minutes.

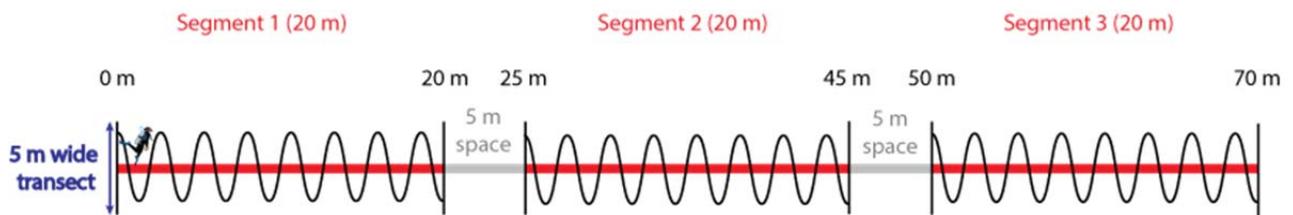


Figure 10. Impact transect

8.2. Categories

Categories include coral bleaching (tissue still present, possible gradation of colour), coral damage (anchor damage or other – anchor damage can only be classed as such if the anchor is present or if the damage is undeniably characteristic), coral disease, coral scars (*Drupella*, crown of thorns or other – can only categorise as *Drupella* or crown of thorns if these species are present upon the coral) and trash, identified as either fishing line, fishing nets or debris.

For data sheet, see Appendix F.

8.3. Data Entry

Impact surveys are percentage cover (only for coral bleaching) and counts (for all other incidents of impacts). For coral bleaching the percentage of each individual coral colony bleached is estimated (so surveyors may have record multiple percentages to be averaged upon completion), as is the total percentage of coral bleached for each 20 m transect (one figure that diver should complete this at the end of each transect). Note: if the diver records any bleached colonies, then they should include a figure for overall coral population

bleaching too. Other impacts e.g., damage, disease, scars and trash are counts. If unsure, divers should follow the key on the bottom of the data sheet to help determine the correct impact to record. In cases of uncertainty or suspected coral disease, photos should also be taken and the number of each photo recorded on the data sheet for analysis after the dive. Air and dive time must be completed at the end of each transect and entered onto the data sheet.

9. Species List

9.1. Survey Method

Species lists will be gathered during the whole survey season using two approaches.

- 1) Photo and video: divers will take pictures of any living feature for identification purpose.
- 2) Experienced and knowledgeable identifiers will go on dedicated dives to find and record as many species as possible.

9.2. Data Entry

Photos and video will be stored by the photo officer and placed online; two people will then assign and verify the species. A species list will then be entered into a spread sheet.

10. Mapping

10.1. Survey Method

Divers undertaking the mapping of each site will be the first buddy pair to descend. One diver will be holding a line attached to a GPS marker floating on the waters surface. This diver will maintain tension on the line throughout the dive to ensure the GPS is positioned above the buddy pair. After laying out the transect tape, they will conduct a roving survey to a maximum depth of 20 m, searching for characteristic features of the site. These may include swim-throughs, gullies or trenches, rocky outcrops, caverns and pinnacles. At every feature they identify the core diver will write down the time, depth, height, width of the feature and substrate type. The divers will then pause to ensure that enough time has passed for the GPS to record several positions (30 seconds), before moving on to the next feature.

10.2. Data Entry

GPS coordinates will be downloaded and checked against data sheets. Feature information and waypoints will be entered into the track list and data will be transformed and imported into ArcGIS. GIS points and annotated field drawings will be used to generate a final map of each of the dive sites.

11. Georeferenced Photo Transect

11.1. Method

Georeferenced photos will be gathered along the five transects, consisting of photos at 1 m intervals. 0.5 m from the substrate, while towing a dry bag in which a standard GPS is logging the track of the transect. For more detail see georeferenced photo transect manual (Roelfsema et al. 2009).



Figure 11: Conceptual model of georeferenced photo transects.

Before commencing a survey:

- For synchronization post-dive, an initial photo prior to beginning the transect needs to be taken of the GPS screen which shows the time.
- When taking photos along the transect the camera needs to remain at a consistent height, this is done with the help of a plumb line. The plumb line will be calibrated by holding the camera above the ground so the picture will encompass a 1x 1 m footprint.
- The GPS need to be set on tracking mode so it stores its position every 2 seconds.

11.2. Data Processing and analysis

After the survey the GPS and camera will be downloaded using DNR Garmin GPS software the photos will be provided with a GPS coordinate.

Photos will be analysed for composition using the software Coral Point Count with excel extension (CPCe) (Kohler & Gill 2006). Twenty four points will be randomly distributed, and each point will manually be given an substrate or benthic category, following the same classes as assigned in the field (see substrate survey) (Roelfsema et al. 2009).

12. Acknowledgements

Redland City Council provided funding for the UniDive PLEA Marine Conservation project as part of the Community Grants Program to assist the Redlands Community. Sibelco Stradbroke Sand Mining also provided funding for the project. In-kind support is gratefully acknowledged from Stradbroke Ferries by providing subsidised transport to and from the island for each trip and Point Lookout SCUBA Charter for a significant reduction in price for accommodation and diving. General support comes from UQ: Centre for Marine Science; Biophysical Remote Sensing Group; Shark and Ray Research Group; Moreton Bay Research Station, QCIF Other: Reef Check Australia; Coral Watch; Grey Nurse Shark Watch, Manta Lodge and Quandamooka Land Council.

13. References

Ford S., Langridge, M., Roelfsema, C.M., Bansemer, C., Pierce, S., Gomez, K., Fellegara, I., McMahon, K., Keller, M., Joyce, K.E., Aurish, N. & Prebble, C (2003). Surveying Habitats Critical to the Survival of Grey Nurse Sharks in South-East Queensland. Unidive, The University of Queensland Underwater Club, Brisbane, Australia.

Kohler, K. & Gill, S.M (2006). Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. *Computers & Geosciences*, 32(9), pp.1259–1269.

McMahon, K., Bansemer, D. L. C., Fellegara, I., Keller, M., Kerswell, A., Kwik, J., Longstaff, B., Roelfsema, C.M., Thomas, J. & Stead, J (2002). A baseline assessment of the flora and fauna of North Stradbroke Island dive sites, Queensland. Coastcare Project. Unidive, The University of Queensland Underwater Club, Brisbane, Australia.

Roelfsema, C.M. & Phinn, S.R (2009). A manual for conducting georeferenced photo transects surveys to assess the benthos of coral reef and seagrass habitats version 3.0. Centre for Remote Sensing and Spatial Information Science, The University of Queensland, Brisbane, Australia.

<http://ww2.gpem.uq.edu.au/CRSSIS/publications/GPS Photo Transects for Benthic Cover Manual.pdf>

14. Appendices – Project forms

<u>Appendix A.</u>	<u>Data Delegates Additional Information</u>
<u>Appendix B.</u>	<u>Fish Families</u>
<u>Appendix C.</u>	<u>Fish Species Indicators</u>
<u>Appendix D.</u>	<u>Substrate</u>
<u>Appendix E.</u>	<u>Invertebrates</u>
<u>Appendix F.</u>	<u>Impacts</u>
<u>Appendix G</u>	<u>Mapping</u>
<u>Appendix H</u>	<u>Gear Check List</u>

Appendix A.

Data Delegates

1. For each double dive we require a data delegate.
2. DD 1 and DD3 may be the same person for the weekend.
3. DD2 and DD4 may be the same person for the weekend.

Data delegate jobs:

Saturday morning dives (DD1)

- Load survey sheets onto slates (Friday night)
- Log date, location, survey type and person acquiring the data prior to diving (Friday night) On return, remove data sheets from slates, hand empty slates to DD2 (Saturday afternoon dives)
- Take pictures of sheets
- Rinse sheets and hang to dry
- Ensure all data is entered by buddy pairs prior to the return of the afternoon divers (supervise if necessary and chase up those that are waiting)
- Back up data

Saturday afternoon dives (DD2)

- Acquire empty slates from Saturday data delegate 1 (DD1) and load survey sheets onto slates
- Log survey type and person acquiring the data prior to dive
- On return, remove data sheets from slates, hand empty slates to DD3 (Sunday morning dives)
- Take pictures of sheets
- Rinse sheets and hang to dry
- Ensure all data is entered by buddy pairs prior to sleepy-by time (supervise if necessary and chase up those that are waiting)
- Back up data

Sunday morning dives (DD3)

- Load survey sheets onto slates (Saturday night)
- Log survey type and person acquiring the data prior to dive (Saturday night)
- On return, remove data sheets from slates, hand empty slates to DD4 (Sunday afternoon dives)
- Take pictures of sheets
- Rinse sheets and hang to dry
- Ensure all data is entered by buddy pairs prior to return of afternoon divers (supervise if necessary and chase up those that are waiting)
- Back up data

Sunday afternoon dives (DD4)

- Acquire empty slates from Sunday data delegate 1 (DD3) and load survey sheets onto slates
- Log survey type and person acquiring the data prior to dive
- On return, remove data sheets from slates
- Take pictures of sheets
- Rinse sheets and hang to dry
- Ensure all data is entered by buddy pairs prior to departure (supervise and (really) chase up those that are waiting)
- Back up data
- Pack all slates and sheets appropriately

Data Entry By Buddy Pairs

- * Entry much is faster if done in pairs – one reading, one entering
- * Data integrity is high if entered by the individuals that collected the data
- * Use computer ‘hub’ in front house
- * Once entered – take pic of sheets
- * Erase sheets

Data Delegate LOG

NAME: _____

TASKS

- Log owners of tasks for your tracking**
- Load sheets onto slates prior and between dives**
- Rinse data sheets in fresh water and dry**
- PHOTOGRAPH EACH DATA SHEET for quality control (record camera used: _____)**
- UPLOAD PHOTOS TO HARD DRIVE (record hard drive)**
- Ensure data is entered by buddy pairs**

Date: __/__/__ **Hard drive used for photos:** _____

Circle: Saturday/Sunday Morning/Afternoon

Task	Owner
Mapper 1	
Mapper 2	
Fish Families	
Fish Species	
Inverts	
Impacts	
Substrate	
Coral Health	

Data Entry CHECKLIST

- **ENTER DATA** in buddy pairs - **RECORD** which computer was used
- **TAKE PHOTO** of data sheet - **RECORD** which camera was used
- **ERASE** data sheet and **FILE** in “out box”

Date:

Circle: Saturday/Sunday

Morning/Afternoon

Task	Owner (Buddy Pair)	Data on which computer	Photo Taken with which camera	Erase Sheet and file in out box
Mapper 1				
Mapper 2				
Fish Families				
Fish Species				
Inverts				
Impacts				
Substrate				
Coral Health				

Appendix B. Fish Families

UNIDIVE PLEA - FISH INDICATOR FAMILY				
Name:		Time in:	Time out:	
Buddy Name:		Air in:	Air out:	
Team:		Date:		
Survey site:		Transect number:		
Indicator Family		Segment 1 (0-20 m)	Segment 2 (25-45 m)	Segment 3 (50-70 m)
 ANGELFISH				
 BUTTERFLY FISH				
 CODS/GROUPERS				
 DAMSEL FISH				
 EMPERORS				
 GOAT FISH				
 LEATHERJACKETS				
 LION/STONE FISH				
 MORAYS				
 PARROTFISH				
 PORCUPINE FISH				
 PUFFERFISH				
 RABBITFISH				
 SNAPPERS				
 SURGEONFISH				
 SWEETLIPS				
 STINGRAYS				
 TRIGGER FISH				
 WRASSE				
 WOBBERGONG				
	Leopard shark			
	Bamboo shark			
	Grey nurse shark			
		Time:	Time:	Time:
		Air:	Air:	Air:

Appendix C. Fish Species Indicators

UNIDIVE PLEA – FISH INDICATOR SPECIES						
Name:		Time in:		Time out:		
Buddy Name:		Air in:		Air out:		
Team:		Date:				
Survey site:		Transect number:				
Indicator Species		Segment 1 (0-20 m)	Segment 2(25-45 m)	Segment 3 (50-70 m)		
	<i>Moorish Idol</i>					
	<i>Keyhole Angelfish</i>					
	<i>Barred Soapfish</i>					
	<i>Flagtail Triggerfish</i>					
	<i>Black-saddled Toby</i>					
Butterflyfishes						
	<i>Bluespot</i>					
	<i>Guenthers (Crochet)</i>					
	<i>Orange (Klein's)</i>					
Damselfishes						
	<i>Bigscaled Scalyfin</i>					
	<i>Indopacific Sergeant</i>					
	<i>Buffalofish</i>					
	<i>Coral Sea Gregory</i>					
	<i>Blue damsels</i>					
	<i>Black bar devil</i>					
Wrasses and morwongs						
	<i>Sunset + Moon wrasse</i>					
	<i>Cleaner Wrasse</i>					
	<i>Red Morwong</i>					
	<i>Magpie Morwong</i>					
Silvery large fishes in groups						
	<i>Happy Moments Rabbitfish</i>					
	<i>Sixplate Sawtail</i>					
	<i>Silver drummer</i>					
<i>Rarities: frogfish/ boxfish/ seahorse/ barracuda</i>						
		Time:	Time:	Time:		
		Air:	Air:	Air:		

Appendix D. Substrate

UNIDIVE PLEA – Substrate									
Name:			Time in:		Time out:				
Buddy Name:			Air in:		Air out:				
Team:			Date:						
Survey site:			Transect number:						
Living									
<i>Algae (+ r if on rubble)</i>			<i>Coral (+ b if bleached)</i>				<i>Other living</i>		
 CA: Encrusting			HC: Coral Other-Unknown		SC: Soft Coral Other - Unknown		SP: Sponge		
			HM: Massive		SCL: Leathery		OT: Other		
 TA: Turf (furry mat)			HE: Encrusting		SCO: Ornate		CY: Cyanobacteria		
			HBR: Branching		SCZ: Zoanthids		RKC: Recently killed coral		
 AS: Asparagopsis (purple feathers)			HF: Foliose				KCY: RKC + CY		
			HP: Plate		*= Damaged		KTA: RKC + Turf		
Non-Living									
SI: Silt/clay			RB: Rubble		RC: Bare Rock		SD: Sand		
DATA									
Segment 1			Segment 2			Segment 3			
0 – 20m			25 – 45m			70m			
0.0		10.0	25.0		35.0	50.0		60.0	
0.5		10.5	25.5		35.5	50.5		60.5	
1.0		11.0	26.0		36.0	51.0		61.0	
1.5		11.5	26.5		36.5	51.5		61.5	
2.0		12.0	27.0		37.0	52.0		62.0	
2.5		12.5	27.5		37.5	52.5		62.5	
3.0		13.0	28.0		38.0	53.0		63.0	
3.5		13.5	28.5		38.5	53.5		63.5	
4.0		14.0	29.0		39.0	54.0		64.0	
4.5		14.5	29.5		39.5	54.5		64.5	
5.0		15.0	30.0		40.0	55.0		65.0	
5.5		15.5	30.5		40.5	55.5		65.5	
6.0		16.0	31.0		41.0	56.0		66.0	
6.5		16.5	31.5		41.5	56.5		66.5	
7.0		17.0	32.0		42.0	57.0		67.0	
7.5		17.5	32.5		42.5	57.5		67.5	
8.0		18.0	33.0		43.0	58.0		68.0	
8.5		18.5	33.5		43.5	58.5		68.5	
9.0		19.0	34.0		44.0	59.0		69.0	
9.5		19.5	34.5		44.5	59.5		69.5	
Time			Time			Time			
Air			Air			Air			
Remarks:									

Appendix E. Invertebrates

UNIDIVE PLEA - INVERTEBRATES

Name:	Time in:	Time out:
Buddy:	Air in:	Air out:
Team:	Date:	
Survey site:	Transect number:	



		Segment 1 (0-20m)	Segment 2 (25-45m)	Segment 3 (50-70m)	photo NO.
Anemone 	With Fish				
	Without Fish				
Banded Coral Shrimp 					
COTS 	≤ 5cm				
	6-15cm				
	16-25cm				
	> 25cm				
Giant Clams 	≤ 10cm				
	10-20cm				
	20-30cm				
	30-40cm				
	40-50cm				
	> 50cm				
Lobster (spiny & slippery) 					
Shells	Drupella 				
	Triton 				
	Trochus Shell 				
Sea Cucumbers	 Pinkfish				
	 Prickly Greenfish				
	 Prickly Redfish				
Sea Urchins	Collector 				
	Diadema 				
	Pencil 				
		TIME	TIME	TIME	
		AIR	AIR	AIR	

Source: ReefCheck

Appendix F. Impacts

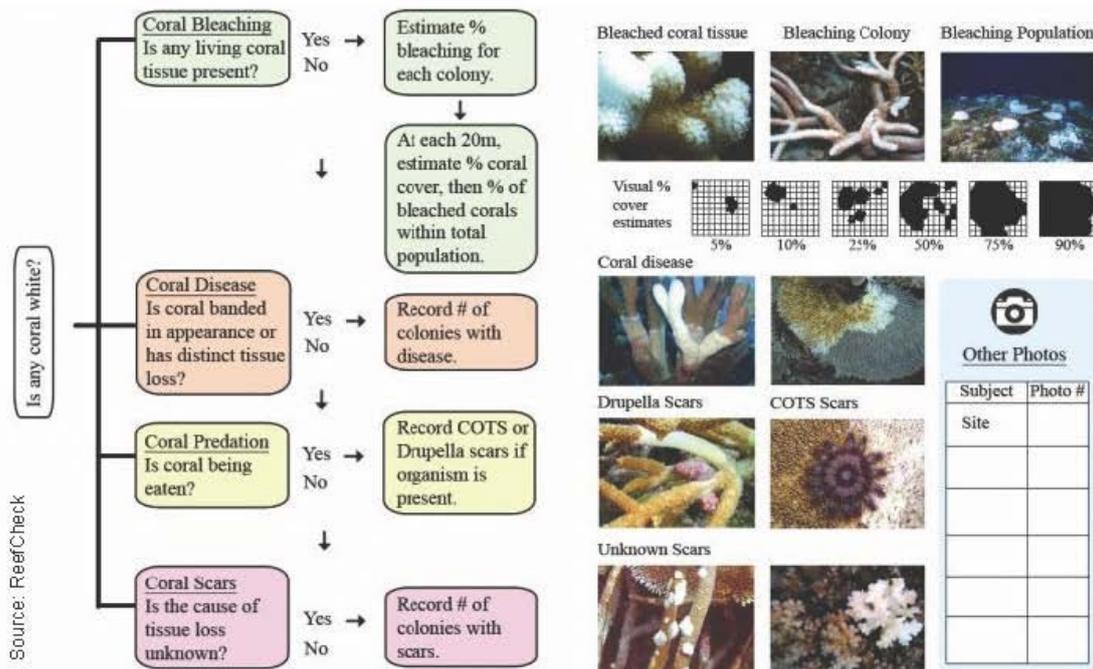
UNIDIVE PLEA - IMPACTS

Name:	Time in:	Time out:
Buddy:	Air in:	Air out:
Team:	Date:	
Survey site:	Transect number:	



		Segment 1 (0-20m)	Segment 2 (25-45m)	Segment 3 (50-70m)	photo NO.
bleaching	Estimate % impact for EACH bleached colony				
	Estimate % total coral population				
damage	Coral damage: Boat / anchor				
	Coral damage: other				
	Coral disease				
coral scars	Crown of Thorns scars				
	Drupella scars				
	Unknown / other scars				
trash	Fishing line				
	Trash: Fish nets				
	Trash: General				
	Rare animals				
		TIME	TIME	TIME	
		AIR	AIR	AIR	

Record 3 dominant algae: 1. _____ 2. _____ 3. _____



Appendix G. Mapping

UNIDIVE PLEA - Mapping			
Name:	Time in:	Time out:	
Buddy Name:	Air in:	Air out:	
Team:	Date:		
Survey site:	Transect number:		
Don't forget time stamp	Start and stop GPS logging		Photo Synch
<p>Don't forget North Arrow and Scale</p>			

Survey and Admin Material (Blue Box)

- **Blue Folder**
 - Risk assessment
 - Water proof paper
 - Data delegate
 - Log
 - Check List
 - Data sheets on water proof paper:
 - Impacts
 - Inverts
 - Substrate
 - Fish Species
 - Fish Families
 - Mapping
 - Dive logs
- **Box big**
 - PLEA Stamp
 - Spare Rubber bands
 - Eraser
 - White Board markers
 - Permanent Marker
 - White board eraser
- **Box Small**
 - Plump lines
 - Spare Rubber pencil holder
- **Lose**
 - Spare Graphite Pencils
 - Duct Tape
 - Zip ties
 - Square Large Banner
 - 2x Rectangle Large Banner
- **2 x Dive roster/folder with spares→ for boat**
 - PLEA Banner A4
 - Cheat sheets: Fish, Invert, Substrate Impact
 - Permit
 - Dive Log
 - Spare pencil with rubber
 - Pencil to write
 - Eraser
 - Pencil sharpener
 - Plump weight

Survey Material (Red Box)→ for boat

- 10 x Data slates
 - Rubber bands
 - Pencil and rubber attachment
 - line with carabin
- 2 x Magna Doodle
- 3 x Tape 50 m
- 2 x Reals 30 m
- 1 x yellow canister with:
 - Graphite pencil with rubber
 - Eraser
 - Pencil sharpener
 - 3x plump weight
- 5 x Coral Health Charts with slate and pencil

Other (no specific box)

- Extension cord
- Power board
- External hard drives
- Laptops
- Float with dive flag
- White board

Mapping gear

- 2 x GPS
- Camera with wide angle lens
- Down load cables
- Drybag with float for towed GPS
- Real
- Magna doodle