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D. Abdo, S. Burgess, G. Coleman and K. Osborne

LONG-TERM MONITORING OF THE GREAT BARRIER REEF

Standard Operational Procedure • Number 2,
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PREFACE

The Australian Institute of Marine Science's Long-term Monitoring Program annually monitors the cover of benthic organisms, reef fish abundance and crown-of-thorns starfish populations on various reefs of the Great Barrier Reef. Both reef fish and assemblages of benthic organisms are monitored using permanently marked transects. This is Standard Operational Procedure number nine, produced by the Long-term Monitoring Program at the Australian Institute of Marine Science. This volume details the procedures for the use of video to sample reef benthos along permanent transects and for analysis of video transects in the laboratory using AVTAS, a software system developed at the Institute. Further details of the Long-term Monitoring Program are described in Sweatman et al. (2001) or go to http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html

INTRODUCTION

The major objective of the sessile benthic component of the Long-term Monitoring Program (LTMP) is to monitor the status of benthic coral reef communities, and to detect and quantify major spatial and temporal changes in the cover of a variety of benthos types. This is achieved through an underwater video technique developed at the Australian Institute of Marine Science (AIMS).When underwater video was first incorporated into surveys it was a relatively new method used to quantify percentage cover of reef benthos (Carleton and Done 1995). In recent years underwater video has replaced the time consuming line intercept method (Marsh et al. 1984;Loya 1978). This video method has the advantage of requiring less diving time than the line intercept method and also provides a permanent record of the reef benthos (the video tape) that may be revisited. This survey technique can be used in most diving conditions, even when visibility is limited, and is an easy method for a competent diver to learn. The purpose of this Standard Operational Procedure document is to be an explicit account of the methods presently used by the LTMP at AIMS. As a consequence, some aspects of the manual are specific to the equipment used in this program. This Standard Operational Procedure is also intended to act as a guide for other users who wish to use videography to monitor the benthic communities of coral reefs (also see the Video Transects FAQ web page on the AIMS website at http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html).

SAMPLING DESIGN

Benthic coral reef communities are surveyed annually by the AIMS LTMP. The surveys occur within six sectors of the Great Barrier Reef (Cooktown/Lizard Island, Cairns, Townsville, Whitsunday, Swain and Capricorn Bunker sectors), which are defined according to latitude. Within each of these sectors, reefs are classified according to their position across the continental shelf (shelf position). With the exception of the Capricorn Bunker and the Swains sectors, three shelf positions (inner, mid and outer) have been identified. Shelf position is determined by the position of the reef relative to the coast and continental slope, with inner shelf reefs closest to the coast. Three reefs are nested within each of these shelf position/sector combinations. In the Capricorn Bunker sector, only outer shelf reefs are represented, with four reefs being surveyed. In the Swains sector there are no inner-shelf reefs represented, however five mid-shelf reefs and two outer-shelf reefs are represented.

On each reef a single habitat, the northeast flank of the reef, is surveyed. This habitat is defined as the first stretch of continuous reef with a slope less than vertical, when moving in a clockwise direction from the back reef zone towards the reef front. The selection of a common habitat allows comparisons to be made between reefs, both within and between sectors and shelf positions. Within the northeast flank habitat, three sites were originally selected at each reef, and five permanently marked, 50 m long transects were set-up. Transects are located along the reef slope, lying roughly parallel to the reef crest at a depth between 6 and 9 m's. Each transect is marked at the beginning and at the end with a star-picket and at 10 m intervals with steel reinforcing rods (10 mm diameter). A tape stretched between the star-pickets and rods marks the centre line of each transect. Each star-picket is labelled with an aluminium tag (identifying the transects as belonging to AIMS project 221). The GPS position of the star-picket at the beginning of the first transect for each site is recorded in a database. This star-picket is also marked with a subsurface buoy to aid in locating the site. Further details of this sampling design can be found in Sweatman et al. (2001) or at http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html

Benthic surveys are conducted on the upper slope side of the centre line of the transect, approximately 50 cm from tape. The video camera is held at a consistent distance from the substrate (approximately 20 cm). The resulting video belt transect to be analysed is approximately 25 cm by 50 m.

USING UNDERWATER VIDEO TO SURVEY REEF BENTHOS

The following procedures are used by the AIMS LTMP as a standard survey method for sessile benthic communities using underwater video. They are specific to the objectives of the program but may be easily modified to satisfy other research objectives.
The video technique has three components; Personnel, Equipment and Equipment Preparation and Maintenance; the Field Sampling procedure; and the Laboratory Sampling of videotapes.

Personnel

A minimum of three people are required for the collection of sessile benthic data using this survey technique. One person is required to lay a tape measure along the centre line of each transect and a second person to follow filming the transect. The third person is required to remain in the boat as a divers attendant and surface support.

However, benthic surveys are normally conducted by the AIMS LTMP concurrently with visual census surveys of reef fish, surveys of coral mortality and the presence of Crown-of-thorns starfish and *Drupella* along the same transects.

In these circumstances, two additional people are required with the one person conducting the visual fish surveys and the second conducting SCUBA searches for Crown-of-thorns starfish and *Drupella*. The procedures for visual fish surveys and SCUBA searches are detailed in the Standard Operational Procedure No. 3 (Halford and Thompson 1994) (or found at *http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html*) and the Standard Operational Procedure No. 1 (Bass and Miller 1996) (or found at *http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html*) respectively.

Trip information

Before departure a record of the trip number, cruise code and the last sequence number of previous video tapes (e.g. M658) should be made from the database to ensure that tapes recorded on the upcoming field trip are labelled correctly and in sequence with previous tapes.

Equipment

The following list of equipment is required for the collection of sessile benthic data using underwater video.

List of equipment required

In the field

- Hand held Geographical Positioning System (GPS) (datum set to WGS-84)
- Two complete sets of SCUBA diving equipment
- Underwater slate, pencil and data sheets
- 5 × 50 m fibreglass measuring tapes
- Waterproof camera carry case (for transporting housing and camera to sites)

Waterproof carry case for video housing containing:

- Underwater housing
- A few 5^{c} pieces
- Users guide and set up instructions for Gates underwater housing
- Orange non-silicone O-ring
- Black lens O-ring
- Screws for attaching camera to housing base plate
- Spare O-rings

Waterproof camera carry case containing:

- Sony Digital video camera (DCR-TRV950E) with lens cap
- Sony DVM60EX2 cassettes or other professional miniDV video cassettes (2 cassettes per reef)
- Sony BC-VM50 battery charger
- Sony InfoLITHIUM M Series battery pack (2)
- Sony AC power adaptor and mains lead
- A/V connecting cable
- S-video cable
- USB cable
- iLink (DV interface) cable
- Remote control for camera
- Instruction manual for video camera
- MiniDV player
- Video data sheets (3 per reef) (Appendix I)

- Blower brush
- Lens cleaning tissue
- Lens cleaning fluid
- Lens cleaning cloth
- Lens polishing spray
- Cotton buds
- Video head cleaning cassette (Sony DVM12CL)
- Silicone grease

In the laboratory

- Large television monitor
- Digital video cassette recorder/player
- Personal computer (with DVD player, video card and preferably a hardware DVD decoder)
- AVTAS video data entry software system

Preparation of equipment

Instructions to prepare the housing and video camera are given below, however, for a more comprehensive coverage of housing and video camera features refer to the relevant manufacturer's instruction manual and operation procedures. A summary of housing and camera set up and maintenance procedures (Quick Set-up and Maintenance Procedures) is provided at the end of this section.

Recharging the video camera battery packs

Prior to the use of the video cameras, battery packs should be completely recharged. InfoLITHIUM batteries used with the digital Sony cameras do not require discharging prior to recharging. Batteries should always be charged after the day's activities have been completed.

Battery packs maybe recharged using either an AC Adaptor/charger or an AC Adaptor, and battery packs should be recharged on a flat surface without vibration. When the remaining battery indicator on either the camera or the Adaptor/charger shows the battery to be completely charged, a NORMAL charge level is achieved. To fully charge the battery, which allows longer than normal use of the battery pack, leave the battery pack charging until FULL appears on the display window. FULL charging takes approximately one hour longer than NORMAL charging.

Recharging the battery packs using the AC Adaptor

With the battery pack attached to the video camera connect the AC power adaptor to the camera and the AC power adaptor to the mains lead and the power supply. Set the Power switch on the camera to OFF. The remaining battery time is indicated on the LCD display window. Charge until either a NORMAL or FULL charge level is achieved. Remove the AC power adaptor before using the video camera.

Recharging the battery packs using the AC Adaptor/charger

Remove the battery pack from the video camera and attach the battery to the AC Adaptor/charger. The battery pack is attached to the adaptor by sliding the battery into the adaptor so that the arrow on the battery slides towards the right of the Adaptor/ charger. Ensure the switch on the adaptor/charger is switched to CHARGE. If the battery is inserted correctly a diagram of a battery filling up will appear on the LCD screen. To display the life of the battery or the time to either FULL or NORMAL Charge on the LCD display screen, press the Display Charge button nearest the LCD display screen.

Underwater video housing preparation

1. Open the housing by firstly releasing the latch on the top of the housing and then simultaneously releasing the latches on the sides of the housing. Latches are released by depressing the centre bar release on the catch while lifting the lever. Care should be taken when releasing latches from the catch hook on the front half of the housing to avoid scratching the housing paint. Dust and particulate matter should be removed from inside the housing with a lens cloth and from the lens, eyepiece and colour filter using the blower brush. Both sides of the lens, eyepiece and colour filter should be wiped carefully using a circular motion starting at the centre of the lens and working to the edge using a small amount of cleaning fluid on a lens cleaning tissue. The lens cover should then be replaced.

2. The orange non-silicon O-ring should be removed from the housing using a toothpick or similar non-metal device and checked for cracks and scratches. The O-ring and the O-ring groove should then be cleaned with either a non-lint tissue (e.g. lens tissue) or cotton bud and a small amount of cleaning fluid. Carefully place the O-ring back into the groove without twisting.

   ***Note**: O-ring grease must **not** be applied to this O-ring.*

3. The black O-ring within the lens port should also be cleaned and is accessed by removing the lens port. To remove the lens port, turn the port so that the small

alignment dots on the port and similar dots on the housing are approximately ¼ of a turn apart from each other. When the alignment dots are in this position the bayonet tabs on the port should align with corresponding slots on the housing and should then pull straight out. The black O-ring should then be removed and cleaned in the same way as the orange non-silicon O-ring. Pure silicone lubricant or silicone grease should then be applied by applying a little silicone between thumb and forefinger and then running the entire loop of the o-ring between fingers several times coating the entire surface with a film of lubricant. Carefully place the O-ring back into the groove without twisting, taking care not to place grease on the lens. During the course of fieldwork O-rings need to be removed once per week for cleaning.

4. Withdraw all controls as far as they can be withdrawn to allow for the camera to be easily placed within the housing.

Video camera preparation

1. Place the video camera on a clean flat surface and carefully attach a fully charged battery pack to the rear of the video camera. Check the lens and viewfinder eyepiece and clean if necessary. Extend the viewfinder backwards by sliding it gently towards the back of the camera.

2. Insert a miniDV videocassette into the camera, ensuring that the copy protect switch is off and that you have closed the cassette hatch by pushing the Push button.

   ***Note**: If inserting a cassette already containing some footage, ensure the tape is at the correct place to ensure footage is **not** taped over, and/or, it is important to ensure there are **no** empty frames after the previously recorded footage as the camera will restart the time code on the tape.*

3. Slide the lock switch (on the side of the power switch) to its locked position stop the selection of the Memory/Network setting. This is to stop the accidental selection of Memory/Network setting and recording video onto the camera's Memory Stick.

4. Set the camera to Auto focus by placing the Focus button located near the front of the camera to Auto.

5. Select the desired camera shutter speed according to the day's conditions. This is achieved by pushing the Shutter button located at the rear of the camera on the left hand side. Using the Sel/Push/Exec button scroll through the menu until desired speed shows on the display panel. Scroll up or down until 120 is shown and then place the Auto Lock Selector switch, located at the left rear of the camera, to Hold.

   ***Note**: The camera shutter speed should **normally** be set to 120. However, if light conditions are high then set the shutter speed to a maximum of 150. Moreover, if light conditions are low the shutter speed should not be set any less than 100.*

6. Once the chosen settings have been set turn the Power switch to off and remove the camera lens cover. The camera is now ready to be placed into the housing.

7. The Sony TRV950 cameras are permanently mounted on a removable base plate. The camera is mounted into the housing via the base plate by using a small screw and a five-cent piece. Carefully mate the housing halves by lining up the alignment pins and holes and hooking the three safety latches. Close both side latches simultaneously and then the top latch.

8. Check all controls for proper alignment and access to buttons by pushing all control levers inwards and moving left/right or up/down and ensure that the eyepiece of the camera and the viewfinder of the housing are aligned. If a control lever does not move a button, withdraw the lever, reposition and try again. Initially you may have to open the housing and reposition levers and close the housing again to get some buttons to work. With practice, however, it becomes possible to manipulate the levers so that opening the housing after closure is unnecessary.

9. Approximately 60 seconds of footage should be recorded on each new videocassette to assist with the dubbing of the videocassettes. This should be done in the laboratory to ensure all housing controls are operational and the camera is recording properly.

10. Turn the camera off and place the housing in a closed cracked camera case in a non air-conditioned environment to acclimatise for a short period of time before the camera case is sealed. This ensures condensation on the lens is kept to a minimum. The camera case should be sealed before moving to the boat.

Pre-filming checks

Before entering the water remove the lens cover from the housing. After entering the water, but before descending on each dive, ensure that the equipment is functioning properly.

1. Check the housing for leaks. A leak is best detected by looking inside the housing from the viewfinder while holding the lens down as you submerge the housing. Any water entering the housing will pool at the lens. If a leak is detected return to the boat, locate the leak and inspect the camera for water damage. A habit should be made of occasionally looking inside the housing to check for leaks, particularly if the housing encounters any knocks or impacts.

2. Check the video camera functions (i.e. On/Off, Record and Zoom controls).

3. Check that there is no condensation in the front lens port or the viewfinder. If condensation is present, delay filming until it disappears.

4. Ensure the zoom button is set to full wide-angle (W), indicated in the viewfinder when the Zoom lever is moved

5. Ensure the Colour Filter is positioned so that it covers the lens entirely and does not obscure any part of the camera view by using the lever located under the lens at the front of the housing.

Equipment maintenance

After every use

1. Immediately after leaving the water, the lens cover of the housing should be replaced and the housing stored in a closed waterproof camera carry case.

2. Wash salt water from the housing with freshwater paying particular attention to controls and recesses around the O-ring seals. This is best done by submerging the sealed housing in a container such as a nally bin filled with freshwater for as long as possible. If the housing is not opened between dives there is no need to remove the housing from the fresh water until the camera is required.

3. Remove the housing from the water and dry with a clean towel. Leave the housing in a safe, clean, airy, salt-free environment to dry completely.

   ***Note**: It is **important** to keep wet and dry areas separate in the vessels' laboratory. This ensures that any electronic equipment does not become damaged.*

4. Wipe carefully around the O-ring seals of the housing before opening, so that no water falls onto the video camera upon opening. Open the housing by simultaneously releasing the two latches on the sides of the housing and then the latch on the top of the housing. Withdraw all control levers on the outside of the housing before carefully removing the back half of the housing. Carefully wipe any water on the mating surfaces of the two housing halves.

***Note**: **Do not** open the housing where salt spray is present.*

5. Remove the mounting screw attaching the base plate to the housing using a five-cent piece and remove the camera from the housing.

6. Carefully wipe all water from the housing halves and leave in a safe, clean, salt free environment to dry completely.

7. Rewind the videotape, remove it from the video camera and **switch the copy protect switch on** to prevent recording over the data. Indicate on the tape cover any situations where any non-standard filming occurred, e.g. repeated or incomplete transects, transects out of order or with false starts and any additional footage taken. Label the tape cover with reef name, site details, date of filming and a tape number (issued consecutively to tapes used for survey reefs) using a **permanent marker pen**. Store the video tapes in a waterproof camera case at all times.

8. Remove the battery and recharge it. Place the lens cap on the camera and return it to its case. Always store the video camera and housing in their cases when not in use.

Regular maintenance

Video camera

1. Heads of the video camera
   Clean the video heads with a Sony DVM12CL head-cleaning cassette after approximately 10 hours of use. Alternatively, clean the video camera heads if the Cleaning Cassette message appears in the viewfinder or the filmed picture becomes fragmented (see instruction manual)

   ***Note**: **Do not** overuse the head cleaning tape as its abrasive nature may damage the heads.*

2. Servicing of video camera
   The video cameras should be serviced at approximately 30-hour intervals, or when problems are detected.

Housing

1. **O-rings**
   O-rings, between housing halves and between the housing and lens port should be removed for storage and closely examined for nicks, scratches etc. If any are detected the O-ring should be replaced, otherwise the O-ring should be cleaned as previously described. Some O-rings in the Gates housing are inaccessible, such as those inside the mechanical control lever shafts. These require light lubrication with silicone lubricant after the housing has been used approximately twenty times. Apply a little lubricant to the shaft and move the control lever in and out several times. All O-rings should all be replaced after 2 years regardless of the amount of use.

2. **Lens, colour filter and viewfinder**
   The lens, colour filter and viewfinder of the housing should be checked for dust and cleaned before each use. If scratches appear on either the lens or the colour filter these should be replaced, as scratches may affect the quality of video footage.

Equipment storage

Camera
When not in a housing, cameras should always be stored in an air-conditioned environment in a closed but cracked waterproof carry cases with lens cover in place. Camera cases should be closed to protect the camera, but cracked to allow air circulation.

Housing
While the housing and camera is being transported to the survey site, the camera should be stored in a closed waterproof camera carry case with the lens cover in place. Between dives and when batteries do not require recharging or cassettes do not require changing before the cameras next use, the housing is best kept in a water-filled Nally bin to avoid corrosion. When the camera is not in the housing, the housing should be stored opened with lens cover in place in a cracked waterproof carry case. When not in use the housing handles should be removed from the housing. The orange non-silicon O-ring between housing halves should also be removed during storage.

Quick setup procedures

This section in designed for people who are experienced in the set up of their housing and cameras. The summary may be used as a reminder for those who have not conducted video surveys for a while and do not feel confident in the set up of their equipment. In addition, this summary may be printed out separately, stored with the camera and housing and used as a checklist to ensure no steps in the preparation of the equipment are forgotten. The same applies to the camera troubleshooting guide.

Camera set-up
The camera should be set-up and placed in housing in a clean, salt free and air conditioned environment and placed in waterproof case for transport to site. When the housing is not in use the lens cover should be in place.

1. Place camera on clean flat surface and clean lens and eyepiece

2. Attach a fully charged battery onto the rear of camera

3. Switch camera into Camera mode using the Camera/Off/VCR switch

4. Insert a videocassette and close the cassette hatch by pushing the PUSH button.

   ***Note**: If inserting a cassette already containing some footage, ensure the tape is at the correct place to ensure footage is **not** taped over, and/or, it is important to ensure there are **no** empty frames after the previously recorded footage as the camera will restart the time code on the tape.*

5. Place Focus button at front of camera in Auto position

6. Place Auto Lock selector to the centre unlocked position and select the desired shutter speed. This is achieved by pushing the shutter button on the back of the camera and then using the Sel/Push/Exec button scroll through the menu until the right shutter speed is on the display panel. The shutter speed is **normally** set to 120.

   ***Note**: If high light conditions are expected then select a shutter speed of a maximum of 150. Moreover, if light conditions are expected to be low then select a shutter speed of not less than 100.*

7. After selecting the desired shutter speed place the Auto Lock selector back into the hold position.

8. Turn the camera off.

Housing set-up

When opening the housing open the top latch first and then the two side latches simultaneously. When closing the housing use the latches in reverse order and close the two side latches simultaneously and then close the top latch.

1. Open the housing.

2. Withdraw all controls from the outside of the housing so that the camera may easily slide into the housing.

3. Gently slide camera into front half of housing, until the lip of the base plate stops on the edge of the housing and secure using a small screw and a five-cent piece (tighten firmly but **do not** over tighten).

4. Check orange O-ring is clean and not damaged. Mate housing halves and close latches (side latches simultaneously then top latch).

5. Push the control levers in and check On/Off, Rec/STBY, Zoom and Still Photo controls work. If these do no work, withdraw controls, reposition and push back in and try again. If controls still do not work, open housing, align controls and try again.

6. Place the housing into a waterproof case.

Before entering water and descending

1. Remove the lens cover.

2. Check the red filter is in place.

3. Check that the controls work (i.e. On/Off, Rec/STBY, Zoom).

4. Place camera in wide-angle mode (using the zoom control).

5. Check the shutter speed is still set at required level (normally set at 120).

Camera troubleshooting guide

Table 1. Troubleshooting guide for common video camera problems

Problem	**Possible cause**	**Solution**
Camera power turned off or Start/Stop not operating	Operating in Camera mode on Standby for more than 5 min or camera not in Camera mode	Set Power switch to Off and then Camera mode
Camera not focussing	Camera on Manual focus setting	Change focus to Auto using lever on front left of housing
	Not enough light available	Remove camera from housing and adjust shutter speed
	Poor water clarity	Aim camera at a contrasting image, e.g. coral
	Condensation on lens	Wait for condensation to disappear
	Dust etc. on housing and/or camera lens or colour filter	Remove camera from housing and clean housing and camera lens and colour filter
Picture partially obscured	Colour filter not positioned correctly Camera base has come loose from housing mount or is not attached	Ensure colour filter is positioned correctly Open housing and attach camera to base firmly
"Cleaning Cassette" message flashing in viewfinder	Heads of video camera require cleaning	Wait for message to disappear and finish filming if possible. Clean heads of video camera before next use
"No tape" symbol flashing in viewfinder	No cassette tape inserted Cassette door not closed properly	Ensure cassette is inserted Close cassette door by pushing the Push button firmly
A symbol flashing in the viewfinder	Battery pack is low, or the videotape is finished or close to finished, etc.	Refer to camera Instruction Manual for comprehensive list of symbols

Field sampling procedure

The following section outlines the procedure for undertaking sessile benthic surveys of a permanent monitoring site. This procedure assumes that fish surveys and SCUBA searches are being conducted concurrently as outlined in the Standard Operational Procedure No. 3 (Halford and Thompson 1994) and Standard Operational Procedure No. 1 (Bass and Miller 1996) and outlined below. If fish surveys and SCUBA searches are not conducted concurrently then the procedure can be followed without the fish observer.

1. The site is located from the surface using a hand held GPS and/or past knowledge of the surrounding reef topography. On reaching the general area a snorkel diver locates the beginning of the first transect, marked with a star-picket and sub-surface marker buoy. The site is then marked temporarily with a surface buoy attached to a 30m rope and drop weight. The boat is then anchored slightly away from the site so that the anchor does not damage the first transect and, if conducting fish censuses, divers entering the water do not swim across transects and disturb fish before the census begins.

2. Four divers enter the water and the diver's attendant remains in the boat. The first diver (fish observer) is equipped with a slate, pencil, data sheets and one fibreglass tape. The second diver (tape layer) carries five, 50 m tapes. The third diver (benthic observer/video person) is equipped with the video camera, slate with pencil and data sheet (Appendix I). The forth diver (SCUBA searcher) is equipped with a slate, pencil and data sheet.

3. Beginning at the first star-picket of transect one, the fish observer conducts the 50 m by 5 m fish surveys by swimming along the centre line of the transects using the star-pickets and reinforcing rods as guides. The observer counts all non-Pomacentrid fish within the area 2.5 m's either side of the centre line.

4. The tape layer follows approximately 15 m's behind the fish observer, laying a tape measure along the centre line of the transect. The tape is attached to the star-picket at the beginning of the transect, then wrapped once around each reinforcing rod and attached to, or as close as possible to, the last star-picket.

5. The SCUBA searcher then follows approximately 15 m's behind the tape layer recording the presence of Crown-of Thorns Starfish, Drupella etc. as outlined in Standard Operational Procedure Number 1 (Bass and Miller 1996). The benthic observer then follows behind the SCUBA searcher, filming each transect.

6. Each pair of divers operate as a buddy pair, therefore buddy pairs may become separated, but divers of a buddy pair remain within constant visual contact. This distance will depend on water clarity and may have to be adjusted throughout a dive depending on diving conditions.

7. Upon completion of the five, 50 m by 5 m transects by the fish observer and the tape layer, the fish observer returns along the same transects (which are now marked with a tape along the centre line) undertaking a census of the Pomacentrid fish. The tape layer follows at least 15 m's behind the fish observer leaving the tapes to be collected by the SCUBA searcher.

8. Upon completion of the 5th transect the SCUBA searcher and benthic observer return along the transects, with the SCUBA searcher collecting the tapes as they return. During this time the benthic observer films any benthic specimens of note from along the transects that may be difficult to identify when viewing the tape. This information is recorded on the data sheet.

9. Following completion of the work, each buddy pair leaves the water together having regrouped at the beginning of transect one.

   Note: Due to current Australian scientific diving standards this sampling routine may need to be adapted depending on the location of the dive site to the nearest hyperbaric chamber. This may involve shortening dive times by swapping divers after transect five.

Recording video data for each transect

1. **The data sheet**
   a. Fill out the details identifying the transect including: the reef name, date, site number, transect number, and recorder's name, on the left-hand side of the video data sheet (Appendix I).
   b. On the right hand side of the data sheet record the time code shown in the viewfinder (e.g. T1 00:01:00).
   c. Press record on the video camera and record the video data sheet details for several seconds, so the transect can be identified for analysis from the videotape.

2. **The panoramic shot**
   a. The panoramic shot can be recorded without switching the camera off after filming the video data sheet. This shot needs to include the star-picket and tape measure, so the person videoing may need to wait for the person laying the tape to move a distance from the star-picket before commencing filming.
   b. Video a panoramic shot along the transect (showing the tape and star-picket) and then the reef surrounding the start of the transect. The emphasis should be on recording the general structure of the reef, following the reef substrate at all times.
   c. Turn in a clockwise direction, to record the reef slope, ending at the initial view. This should take approximately 30 seconds. Move slowly, holding the video camera as steady as possible for the best result.

   ***Note**: **Avoid** recording open water or a small area of the reef (<5 m radius) beneath you, as this may not represent the reef area. Also **avoid** sudden changes in the distances from video camera to subject that will cause the image to be blurred, due to the time lag for the automatic focus to adjust.*

3. The transect

a. While holding the camera approximately 50 cm from the substrate switch the camera to manual focus using the control lever on the front left hand side of the housing. Making sure the focal length displayed in the bottom left hand corner of the viewfinder is between 0.5 m and 1 m.

b. Record the time code showing in the viewfinder on the data sheet next to the transect number after the panoramic shot is complete (e.g. T1 00:01:00). If footage is accidentally filmed between the panoramic shot and filming of the transect, the time code may need to be re-recorded on the datasheet.

c. Press record, and video the base of the star-picket for several seconds, then move approximately 50 cm to the right of the star-picket and continue along the transect staying 50 cm to the right of the measuring tape. An area not including the tape measure is videoed as the reflective nature of the measuring tape can adversely affect the exposure of the video camera. The camera lens should be kept parallel to the reef substrate at a distance of approximately 20 cm.

d. Follow the tape along the transect. At the end of the transect move towards the final star-picket and record it for several seconds to indicate the end of the transect. Stop recording and leave the camera on Standby.

e. Record the time code showing in the viewfinder at the end of the transect on the data sheet (e.g. T1 00:01:00 - 00:05:00:24). This information allows easy calculation of the time interval required for tape analysis in the laboratory and also allows you to adjust your filming speed if necessary.

f. If any extra footage is taken between transects or at the end of a site, this should also be recorded on the data sheet. Any mistakes made during filming should also be noted on the video data sheet.

4. **Speed of recording**
   It should take approximately 4 to 5 minutes to video a 50 m transect. The time will vary depending on the topographic complexity of the reef and the water conditions, such as surge or current. It is important to maintain a constant speed while recording any one transect. Speed at any point along a transect can be determined by checking the video counter and should be checked occasionally during each transect. Constant and correct filming speed in different conditions is however, something that is achieved through practice.

5. **Timing**
   On the Great Barrier Reef it is recommended that video recording takes place between the hours of 08:00 and 15:30 for best lighting conditions. These times can be extended during summer months.

6. **Problems**
   The measuring tape that marks the centre of the transect does not always follow the contours of the reef, especially when there is a crevice or gap in the structure of the reef. If the tape does not follow the substrate, a decision must be made which determines the path to take with the camera. The film path chosen should be the one that requires least deviation from the tape path (not more than 3 m) while maintaining a constant distance of approximately 20 cm from the substrate. With broad or deep crevices it is not always possible to stay within 3 m of the tape and still have the camera approximately 20 cm from the substrate. In this situation remain at the same depth contour and cross the crevice at the narrowest point within 3 m of the tape.

Data management

Before video transects are analysed, all DVD discs should be backed up to ensure data is not lost due to a disc being damaged. One copy of the DVD disc containing the video frames and still images is sent National Archives for archiving, the other copy is kept in the video analysis room at AIMS. In addition, the original AIMS LTMP videocassettes are stored in a fire proof safe at AIMS.

LABORATORY SAMPLING

Prior to video analysis

Input of data from video data sheet

To allow video transects to be analysed using the AVTAS software, the time codes for the start of the panorama and the start and finish time codes of each transect ("video frames") recorded on each video data sheet must be accurately entered into a Microsoft Access© database. This database is available at *pearl**monshare**database**programs**reefmon3.mdb*. Data should be entered by the recorder of the data to ensure data are not entered incorrectly due to difficulties in reading unfamiliar handwriting and should be entered as soon as possible after the data is collected. At the same time, the time interval between frames to be analysed should be checked to be ensure start and finish frames have been entered correctly. This interval should be between 5 and 10. If this is not the case the data should be checked to ensure time codes have been entered correctly. Any situations where non-standard filming occurred, e.g. repeated or incomplete transects, transects out of order or with false starts should also be recorded in the database in the COMMENTS field. Any additional footage taken should also be recorded in the database in the COMMENTS field.

Uploading video frames data

When all the video frames data for a trip is entered, the database should be renamed *<CRUISE_CODE>frames.mdb* and transferred to *pearl**monshare**database**data* for uploading to the Oracle database. The database administrator completes uploading using the program *pearl**monshare**database**programs**upload2000.mdb*.

The database administrator will then create the script files for extracting the video from DV tapes using the program *monshare**database**programs**DVExtract.exe*. This program creates two files for each tape in the directory *c:\temp*. All of these files need to be copied to the Apple Macintosh computer. The apple script files (*.sc) should be copied to the folder "Back up scripts" on the desktop. The Final Cut Pro batch capture files (*.cap) should be copied to the directory 20GB/Backup/fcp.

Transferring still and video frames to DVD discs

The process of getting stills and video frames from videotape onto a DVD disc involves importing the images into the Apple Power Mac G4 computer and exporting them (writing) to a DVD disc.

***Note**: All operations occur on the "20GB" hard drive on the Apple computer.*

1. Importing video tape images to the Apple computer

   Each videotape has a corresponding program file ("Script"). The script file runs the procedure for copying images to the 20GB hard drive. The script also runs the procedures for the conversion of images to mpeg files ("*mpegout*") and still files ("*frames*"). These script files have already been written for each videotape and placed in the 20GB hard drive. To open the specific script, first start the "Script Editor". To start the Script Editor select:

   a. The "Apple" icon on the menu bar on the top left hand corner of the screen.
   b. From the drop down menu select "Recent Applications".
   c. Then on the Recent Applications menu select Script Editor

   The Script Editor window will appear as a small subdivided window. To select the correct script, choose:

   a. The "File" menu located on the top of the screen.
   b. From the drop down menu select "Open Script" (this gives a directory of scripts under the folder "Backup").
   c. Now select the desired file, which will correspond to name of the reef (e.g. Davies1 refers to the first two sites for Davies reef).
   d. After selecting the correct script its text will appear in the lower half of the Script Editors subdivided window. The script is now ready to run.
   e. Press "Run".
   f. Follow the prompts (e.g. "insert tape number XXXX into the tape player").

   ***Note**: Before starting the next step with OK, check the tape number and make sure the tape is neither at the very start nor at the very end (i.e. fast forward or rewind the tape into the middle a little).*

1. Press "OK".

   ***Note**: If an error occurs during the process, refer to the DVD troubleshooting section.*

   The process of copying the images into the 20GB hard drive will continue for some time (upwards of 1 hour). At the end there will be a prompt to copy the second tape of images from the series in to the 20GB hard drive. For the normal LTMP surveys, the images from the first videotape would be written to a DVD disc at this stage before repeating the process for the second videotape. This is because the LTMP surveys require two DVD's for each reef (15 transects in total), corresponding to the two videotapes for each reef. However, for surveys with fewer transects, images from both videotapes can likely be written onto a single DVD for each reef.

2. Writing images and video frames to a DVD disc using the Apple computer
   a. Click on the Apple logo (located on the top left hand corner of screen). On the drop down menu select Recent Applications. In this menu choose "Roxio Toast Titanium".
   b. In the Roxio Toast Titanium program window click on the "New DVD" button. Then type in a name (e.g. *ReefNameVisitNo*).
   c. Click on the "Add" button. Then browse to the "*20GB/Backup/*" directory. Choose the sub-directory "Frames" within this tree (This appends the frames to the DVD).
   d. Repeat the above procedure (Steps a. to c.) to add the video frames to the DVD disc. Browse to the directory "*20GB/Backup/mpegout*". If this is DVD number 1, choose to add sites 1 and 2 to the DVD disc (e.g. choose "*Reefname VisitSiteTransect.mpg"* where site = 1 and 2). If this is DVD number 2, choose to add site 3 to the DVD disc (e.g. choose "*ReefnameVisitSiteTransect.mpg"* where site = 3).

   ***Note**: To select multiple files use the shift button.*

   e. Having chosen files to add to the DVD disc, the program takes you back to main screen.
   f. Select the "Record" button. The DVD drive will then open. Insert a blank DVD disc and close the DVD drive. Wait for approximately 30 sec to respond to prompt to continue, and then choose the OK button.

Dvd transfer troubleshooting

Each script used in transferring still images and video frames from the videocassettes to DVD disc performs three tasks:

a. Capture video from the tape (Using Final Cut Pro).
b. Export stills (Using Final Cut Pro).
c. Export video (Using Digital Media Press).

The most likely step to cause an error during the transfer process is during exporting of the still images (Task b.). Capturing the video from the tape (Task a.) is a very time consuming process, so re-running of this task should be avoided if possible. If an error occurs during the exporting of the still images (Task b.):

a. Reboot the computer.
b. Delete everything from the directories (e.g. *Frametmp1*, *Frametmp2*, *Frametmp3* etc.).
c. Open the Script Editor.
d. Open the relevant Script. Two sections of code will need to be deleted from this script, and can be located by looking for the following:

START OF CODE TO BE DELETED

END OF CODE TO BE DELETED

e. Run the script again.

Set-up of laboratory equipment

Analysis is performed using a desktop computer (PC). The computer should have the AVTAS software installed, access to the network (to allow uploading and downloading to the database), a DVD drive and preferably a hardware DVD decoder (a software decode can be used but it does not provide the best display of the video). It is also possible to connect an external TV monitor is to the computer to aid in analysis of the video transect.

Connecting an external TV monitor

To connect the TV monitor to the computer, a S-video cable is connected to the S-video slot on the TV monitor and to the video out slot on the back of the computer. Depending on the set up used (i.e. with or without external TV monitor) the display options need to be changed accordingly in both AVTAS and the DVD decoder.

Adjusting the AVTAS display settings

1. Select the drop down "Database" menu in the AVTAS "Sample Table" window (Figure 1).

2. Select "Edit Defaults".

3. In the dialogue box, scroll across until the "TV Display" column is visible.

4. Adjust this according to the set up (i.e. Y when a external TV monitor is used or N if no external monitor is used).

5. Once all changes have been completed press the "Save and Close" button on the dialogue box.

Adjusting the DVD decoder display settings

1. Select the windows "Start" menu.

2. Select the "Programs" menu.

3. Select the computers DVD decoder menu. The make of DVD decoder may differ between computers (e.g. VideoLogic or RealMAGIC).
4. On the DVD decoders drop down menu select to access the decoder "configuration" settings.

5. Click on the "Advanced" button and then select the "Video Output" button.

6. In the video output window, select the "TV" button.

7. Click OK in the video output window once all settings have been chosen, then click OK in the configuration window.

Downloading video frames data
The computer with the AVTAS software contains a directory called AVTAS5. This directory contains a database called *Avtas.mdb*. All reef monitoring transects are stored in *Avtas.mdb*. Start the AVTAS program. To check what database AVTAS is connected to look on the title bar of the AVTAS program window. If required connect to the relevant database by pressing the "Change Database" button. Download the video frames from the Oracle database by choosing the "AIMS" menu and selecting "Download Frames", then enter the correct cruise code.

Analysis of the video transect

The video transects are systematically sampled by identifying the benthos occurring at fixed points along the transect to the highest taxonomic level possible. Five fixed points are sampled at a fixed time interval, calculated so that along each transect the benthos lying under 200 data points are identified. The AVTAS software is used to analyse the video transects and during analysis the data are saved automatically into a Microsoft Access© database. In order to eliminate confounding in data analyses due to observer biases, transects from each reef are analysed by three observers. Each observer analyses the same numbered transects at each reef.

To analyse a video transect

1. **The sample table**
   a. Enter the AVTAS program. The sample table screen will appear (Figure 1).
   b. Click on the "AIMS" menu and select "Upload". In the Upload dialogue window select the "Update Upload Flag".
   c. Place the desired reefs DVD into the computers DVD drive.
   d. To select a transect to analyse, click on the "Table View" tab in the AVTAS Sample Table window. Scroll through the list, selecting the desired transect. Alternatively, select the "Filter" tab in the AVTAS Sample Table window. This

allows for specific transect to be filtered via Visit, Sector, Cruise Code, To Analyse or Reef Number. Once you have selected the desired transect, select the "Form View" tab. Then enter your initials in the "Analysed By" field and tab across to automatically fill in the date in the "Analysis Date" field.

Note: It is important to check that you have the correct DVD disc in the computer's DVD drive in order to analyse the chosen transect. This can be checked in the "Filename" field in the From View tab. It is also important to check that the "Video Source" field indicates File/Photo otherwise data on the DVD disc will not be accessed by AVTAS.

2. The data table

a. For each frame the benthos occurring under each point needs to be identified in the same order each time, starting at the top left hand point. The next point identified is the top right, then the centre, the bottom left and finally the bottom right point. Identify the benthos occurring under each of the five points on the monitor and enter a specific numeric code into AVTAS for the benthos occurring under each point. This is done by entering the numeric code directly or via the drop down list on the right hand side of the Data table (Figure 2).
b. For each frame, substrate type is only recorded for the first point (top left hand point). This is recorded in a separate substrate category in AVTAS, and acts as a sub-sample of the points to give a detailed morphological picture of each transect.
c. A description of the benthos that each video code represents is stored in the reference table (Appendix III).
d. Continue this procedure until the final frame is reached and the video transect analysis is complete.
e. Remove the DVD disc, put it in its case and store in the data cabinet.

3. Uploading analysed data

When you have finished analysing, upload your data to the Oracle database by selecting the "AIMS" menu and choosing "Upload". In the Upload dialogue window select the "Upload All Analysed" button.

4. The species/benthos code reference table

There are several thousand species of hard corals, soft corals, sponges and algae on reefs of the Great Barrier Reef. However, most cannot be identified to

species with certainty from a paused video image. Therefore, benthos are identified to the highest taxonomic level possible and are assigned a unique code describing both its life form and species combination. The substrate type (e.g. sand, rock) on which the benthos is on is also recorded. Each species code and life form combination has a numeric video code, which is used to simplify data entry. A list of the species codes and video codes used are listed in the reference table (Appendix III). The reference table is structured in a hierarchy so that once the data are entered they can be retrieved from the database at six classification levels; benthic group, benthic life form, family, genus, species and substrate type.

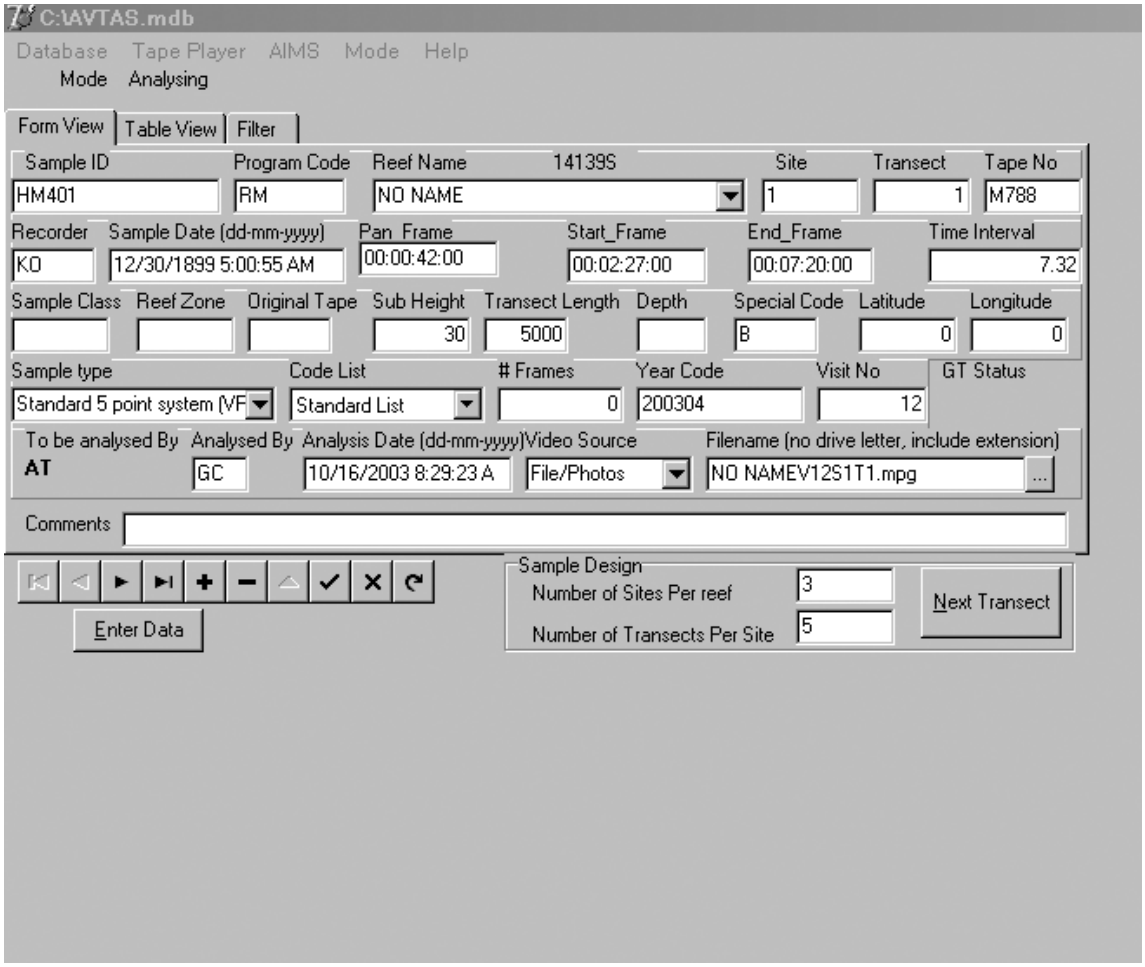

Figure 1. Sample table screen

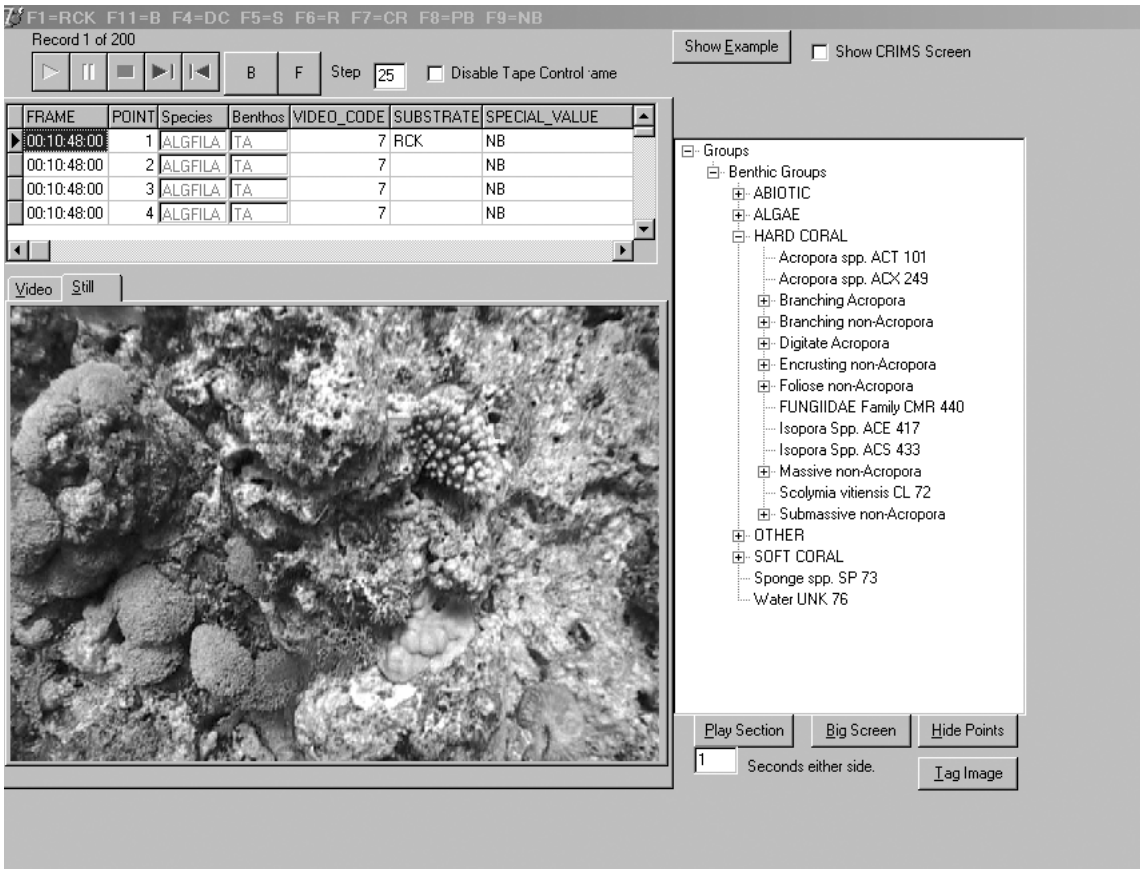

Figure 2. Data table screen

Benthic and species codes used in video analysis

The benthic group is the most often used level in data analysis. It is divided into a further nine groups, which can be subdivided into benthic life forms. The benthic group and life forms are based on the ASEAN codes for the Line Intercept Transect technique (English et al. 1994) with a few changes. The nine benthic groups and life forms within these groups are shown (Table 2) and described below. The identification of benthos is facilitated by the use of a dichotomous key of life forms found below and A Coral Reef Handbook (Mather and Bennett 1993), Corals of Australia and the Indo-Pacific (Veron 1993) and C-Nav (found at *http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html*).

Table 2. Structure of benthic group codes and their component benthic life forms.

BENTHIC GROUP								
Abiotic (AB)	Hard coral (HC)	Soft coral (SC)	Coralline algae (CA)	Macro algae (MA)	Turf algae (TA)	Sponge (SP)	Other (OT)	Indeterminate (IN)
DC	ACX	SC	CA	HA	TA	SP	OT	IN
RCK	ACB			MA			UNID	W
R	ACD			AO				
S	ACE							
	ACS							
	ACT							
	CB							
	CE							
	CF							
	CM							
	CS							
	CMR							
	CL							

1. Abiotic (AB)

This benthos group is used when there is no biotic life form present on the substratum. These benthic codes are not generally used very often as most reef surfaces are covered in a benthic form of some sort. The substrate that the benthos is on or attached to is recorded in the database in a separate substrate category. This category provides a more detailed morphological picture of each transect.

Dead coral (DC) — Recently dead coral that has a white or off-white colour and not yet colonised by turfing algae.

Reefal substrate (RCK) — Substrate not colonised by visible benthic organisms. Rarely seen except where the reef has recently undergone exfoliation e.g. due to a cyclone, or where terrestrial rocks have not been colonised.

Rubble (R) — Fragments of dead hard coral >0.5 cm but <15 cm in diameter which are not consolidated into a hard or stable substrate.

Sand (S) — Ranging from fine silt to calcareous sediment to *Halimeda* spp. fragments, <0.5 cm in diameter.

2. Scleractinian Coral (Hard Coral, HC)

Benthic codes

All hard corals are assigned a benthic life form category. These are defined below (adapted from (Wallace 1999;Veron 1993)).

Acropora corals	Growing parts of the colony characterised by an obvious axial apical corallite surrounded by radial corallites
Bottlebrush (ACX)	Colonies have small branchlets with both primary and secondary branching arising from main arborescent branches e.g. *A. echinata*.
Branching (ACB)	Colonies have both primary and secondary open branching, where branches are generally narrower than they are long e.g. *A. grandis*.
Digitate (ACD)	Short, protruding, vertically orientated digit like branches arising from an encrusting base e.g. *A. humilis*, or a coral recruit of this genus.
Tabulate (ACT)	Horizontal plates with a small area of basal attachment, where the colony is at least twice as wide as they are high e.g. *A. hyacinthus*.
Encrusting (ACE)	Colonies adhere and encrust the substrate and have very little vertical growth e.g. *A. palifera*.
Submassive (ACS)	Colony surface forms columns and/or ridges and may have encrusting edges e.g. *A. cuneata*.
Non-*Acropora* corals	Growing parts of the colony not characterised by an obvious axial apical corallite surrounded by radial corallites
Branching (CB)	Arborescent corals with open primary and secondary branching where branches are generally narrower than they are wide e.g. *Seriatopora hystrix*.

Encrusting (CE)	Colonies that adhere and encrust the substrate e.g. *Pavona varians*.
Foliaceous (CF)	Colony leaf-like in appearance or composed of flattened sheets which may be fused or convoluted to form whorls e.g. *Echinopora lamellosa*.
Massive (CM)	Colony is of generally solid construction and the same shape in all directions (hemispherical in shape) e.g. *Platygyra daedalea*, *Porites spp*.
Submassive (CS)	Colony has knobs, protrusions or columnar structures or rounded and more than 50% of the colony raised indiscreetly from the underlying substratum e.g. *Scapophyllia cylindrica*, *Stylophora pistillata*, *Pocillopora damicornis*.
Mushroom (CMR)	Unattached easily moved solitary Fungiid coral.
Solitary (CL)	Attached or unattached solitary non-Fungiid coral e.g. *Cynarina lacrymalis*.

Species codes

Hard corals are identified to the highest taxonomic level possible and are assigned a unique species code. Some species are readily identified on the video, such as *Diploastrea heliopora* and *Coeloseris mayeri*, and are therefore assigned a seven letter species codes, e.g. DIPHELI and COEMAYE respectively. The first three letters in the species code are derived from the genera and the last four letters from the species name, a system developed for the ASEAN-Australia Living Coastal Resources project (English et al. 1994). Other corals may only be identifiable to genera and are therefore assigned a generic species code. e.g. ACRSPP (*Acropora* species). Other corals may only be identifiable to family level and a code describing this family is therefore used e.g. Faviids (FVDSPP). It is often difficult to differentiate these families into genera from the videotape. If a hard coral cannot be identified to a family it is assigned the species code CORSPP (coral species) and consequently this is not included when retrieving data at the family, genera or species level.

3. Soft Coral (SC)

Benthic codes

All soft corals are assigned the soft coral (SC) benthic code, this group includes gorgonians unlike the ASEAN life forms (English et al. 1994).

Species codes

The soft corals (SC) are identified to family and genera where possible. Each family, genera and species group have a unique code. Where a soft coral cannot be identified to family or genus level it is assigned the generic soft coral species code (SOFSPP) species code.

4. Algae

Algae are divided into three benthic groups, Coralline algae, Macroalgae and Turfing algae. Both the Coralline algae and Turfing algae groups contain only one code each (CA and TA respectively), while the Macroalgae group contains three codes. Algae are not identified to genera or species level, but are place in the above benthic groups, which correspond to functional groups.

Coralline Algae (CA)

This category includes all substrate and rubble covered with coralline algae (CA).

Macroalgae (MA)

Macroalgae are identified as having distinguishable structures such as fronds, stalks and holdfasts. The macroalgae are identified to genera if possible. At the benthic life form level there are three categories:

Halimeda spp. (HA)	Macroalgae of the genus *Halimeda*.
Macroalgae (MA)	Includes all macroalgae with structure features >5 cm in size, e.g. *Sargassum*, *Caulerpa* and *Chlorodesmis*.
Algal Other (AO)	Algae with some structural features which are <5 cm in size. This group also includes red encrusting algae and algae that cannot be identified in more detail, but are not turfing algae.

Turf Algae (TA)

Turf algae encrust the substrate and have no distinguishable structural features (TA).

5. Sponge (SP)
Includes all sponges (SP). They are not identified to a higher taxonomic level.

6. Other (OT)

Benthic codes
All identifiable organisms not placed in any of the above categories are given the benthic code Other (OT). Any unknown benthic organisms are given the unidentified benthic code (UNID).

Species codes
All organisms given the other benthic code are either given a more detailed species code, e.g. Anemones are given the species code OTHANEM and Zoanthids, OTHZOA. If the organism identified does not have its own species code it is given the generic species code (OTH).

7. Indeterminate (IN)

This benthic group is divided into two codes that are used when nothing can be confidently identified under a point.

Water (W) — Where the substrate is more than 1m from the camera and therefore the benthos cannot be identified.

Indeterminate (IN) — This code is used in a number of circumstances.

a. Basal substrate is undefined (indeterminate)

b. Poor image quality - data point obscure.

c. If the benthos is obscured by a diver's hand or measuring tape

8. Bleaching
This category is divided into three codes and is used to record the bleaching status of the benthos identified under a point.

No Bleaching (NB)	This is the default code for this category, and indicates the colony identified has no signs of bleaching.
Partial Bleaching (PB)	Organisms are fluorescent in colour or not completely white. Soft tissue is still present in bleached colonies but may not be obvious on video images.
Bleaching (B)	Organisms are completely white or almost completely white. Soft tissue is still present in bleached colonies but may not be obvious on video images.

Dichotomous key for the identification of benthic life forms used in the video transect method

1. a. There is no object directly below and within 1m of a point …. W
   b. There is an object directly below and within 1m of a point …. go to 2

2. a. The image is clear and the benthos can be identified …. go to 3
   b. The image is not clear and can therefore not be identified …. IN

3. a. It is not known what the benthos is lying under a point …. UNID
   b. The benthos lying under a point can be identified …. go to 4

4. a. The life form under the point a alive or is a living organism …. go to 5
   b. The life form under the point is not alive or a living organism …. go to 28

5. a. The life form is a coral (includes both soft and hard colonial and non-colonial life forms, consisting of polyps each with radial symmetry and a mouth surrounded by tentacles) …. go to 6
   b. The life form is not a coral …. go to 21

6. a. The coral has a calcium carbonate (limestone) skeleton (i.e. is it a hard coral) …. go to 7
   b. The coral has a soft body or an architecture not of calcium carbonate …. SC

7. a. Growing parts of the coral colony are characterised by obvious axial apical polyps …. go to 8

b. There is no obvious axial polyp on the growing edge of the coral colony …. go to 15

8. a. The point of colony attachment is visible …. go to 9
   b. The point of colony attachment is not visible …. go to 13

9. a. The point of attachment is narrower than the main body of the colony …. go to 13
   b. The colony has an encrusting base …. go to 10

10. a. The colony is an Isoporid with one or multiple axial polyps per branch …. go to 11
    b. The colony is not an Isoporid and always has one axial polyp per branch …. go to 12

11. a. The colony encrusts the substrate and < 50% of the colony is raised above the general profile of the substratum …. ACE
    b. The colony encrusts the substrate but > 50% of the colony consists of mounds, ridges or columns or the colony consists of robust rudimentary branches with short branchlets growing off the main branch …. ACS

12. a. The colony has short digit like vertically oriented branches growing from an encrusting base …. ACD
    b. The colony does not consist of digit like vertically oriented branches growing from an encrusting base …. go to 13

13. a. The colony is plate like and at least twice as wide as it is high. Branches are densely packed or anastomosed …. ACT
    b. The colony is not plate like and twice as wide as it is high with densely packed or anastomosed branches …. go to 14

14. a. The colony is characterised by open secondary branching, where branches are generally narrower than they are long …. ACB
    b. The colony consist of main branches from which small branchlets are given off and is “bushy” or “bottlebrush” in appearance …. ACX

15. a. The colony consists of one polyp attached to the substratum or an unattached polyp with a pointed base …. CL
    b. The colony does not consist of a single polyp attached to the substratum or an unattached polyp with a pointed base …. go to 16

16. a. The colony is discretely raised from the substratum with the point of attachment narrower than the main body of the colony …. go to 17
    b. The colony is not discretely raised from the substratum with the point of attachment generally as wide or wider than the bulk of the colony …. go to 19

17. a. The colony is characterised by open secondary branching with branches generally being narrower than they are long …. CB
    b. The colony is characterised by either ill defined or no secondary branching or the colony consists of leaf like or flattened sheets …. go to 18

18. a. The colony is leaf-like in appearance or composed of flattened sheets that may be fused or convoluted to form whorls …. CF
    b. The colony consists of robust rudimentary branches with short branchlets growing off the main branch …. CS

19. a. The coral is not attached to the substratum and is easily moved …. CMR
    b. The coral is attached to the substratum …. go to 20

20. a. The colony is generally prostrate, in intimate contact with the substrate and less than 50% of the colony raised above the general profile of the substratum …. CE
    b. The colony has more than 50% of its structure raised above the substratum …. go to 21

21. a. Colony is of generally solid construction and the same shape in all directions (hemispherical in shape) …. CM
    b. Colony has knobs, protrusions or columnar structures or rounded and more than 50% of the colony is raised above the general profile of the underlying substratum …. CS

22. a. The life form an algae …. go to 24
    b. The life form is not an algae …. go to 23

23. a. The life form is a simple attached organism with no polyps and a soft flexible or sponge like skeleton consisting of small spicules with small openings (ostia) …. SP
    b. The life form is not the above …. OT

24. a. The algae consist of fine hair like filaments with no defined structure encrusting the substratum …. TA
    b. Algae does not consist of fine hair like filaments but is either encrusting or has some defined structure …. go to 25

25. a. The algae is green in colour calcified with the thallus being composed of disclike segments …. HA
    b. The algae may or may not be calcified but is not composed of disclike segments …. go to 26

26. a. The algae is strongly calcified with no clear structure to the thallus, usually pink to grey in colour, typically encrusting, sometimes forming small ridges and small branching structures …. CA.
    b. The algae are not strongly calcified, pink or grey in colour and typically forming small ridges and small branching structures …. go to 27

27. a. The algae is erect, has clearly defined macroscopic structures > 5 m in size (eg. frond, stalk and holdfast) …. MA
    b. The algae has no clearly defined macroscopic structures or has defined macroscopic structures < 5 m in size …. AO

28. a. The substratum is unconsolidated or consisting of fragments < 15 cm in diameter …. go to 29
    b. The substratum is consolidated or consisting of fragments > 15 cm in diameter …. go to 30

29. a. The substratum consists of coral or rock fragments < 15 cm in size …. R
    b. The substratum consists of coral or rock fragments < 0.5 cm …. S

30. a. The substratum consists of bare rock, with no cover of turf algae, coralline algae, or other macroscopic fouling organisms …. RCK
    b. The substratum is composed of white coral skeleton with little visible algal growth …. go to 31

31. a. The substratum is composed of a white coral skeleton or is part of a colony with a sharp edge or boundary between the white area and the surrounding living area of the colony …. DC
    b. The substratum is composed of a white coral skeleton. The colony is bleached but still alive as evidenced by a graduation of colour or pigmentation around the border of the white area …. B and goes to 6

TRAINING OTHERS IN THE USE OF UNDERWATER VIDEO

Training personnel in the use of underwater video to survey reef benthos can be achieved by supervising trainees as they follow the instructions in this manual. Competency with underwater video techniques requires familiarity with the video camera and housing, and proficiency in SCUBA diving (especially buoyancy control). Skill and consistency in filming at a constant height and speed along the transect is achieved through familiarity with using the equipment underwater, confidence and experience.

Extensive training is required for consistent analysis of video footage. Analysis requires an understanding of AVTAS software and proficiency in the identification of sessile reef benthos. Discussing and scrutinising video images of benthic organisms in the laboratory with the trainee will facilitate accuracy. The use of training resources such as C-Nav (found at *http://www.aims.gov.au/pages/research/reef-monitoring/reef-monitoring-index.html*) will also help to ensure accurate identifications of benthic organisms. Training should cover the following components:

1. **Preparation of the video equipment**
   a. Care and maintenance of camera equipment before, during and after field work.
   b. Operation of video camera and housing.

2. **Sampling reef benthos using underwater video technique**
   a. Learning the correct sampling protocol.
   b. Practice to attain constant swim speed and camera position.
   c. Practice to choose best filming path along the transect.

3. **Data entry**
   a. Cataloguing of tapes
   b. Entry of time codes from data sheet to Microsoft Access© database
   c. Use of the AVTAS database.
   d. Use of training software to standardise identification of benthos
   e. Practice in the identification of common benthic organisms of particular habitats before transect analysis

Most of these objectives can be met by supervision of trainees in the field and the laboratory.

QUALITY CONTROL

To maintain data accuracy and confidence in both video interpretation and observer precision it is necessary to undertake quality control practices within the AIMS LTMP. Quality control is undertaken by a new observer before analysis of video transects and by all benthic observers on an annual basis.

Initial training

To ensure data integrity is maintained when a new observer begins analysis, a new observer is required to complete three observer comparison transects and obtain 90% agreement at family level with existing observers before they begin analysing transects. Fifteen transects are haphazardly selected from the videotapes recorded during one year of the monitoring program to be used in an observer comparison study. From these transects, three transects representing reefs within each cross shelf position are chosen. Transects are chosen from the three shelf positions to ensure an observer is competent at identifying the benthos present on reefs at each shelf position.

The start and end frames and the time interval between frames analysed by the original observer, are retrieved from the Microsoft Access© database. These transects are then analysed as described above. As the video footage used is frame accurate, observers are able to analyse the same points on videotapes as identified by previous observers.

Once the new observer has completed the three chosen transects, the AVTAS system is used to calculate the number and the percentage of points wrongly analysed at each classification level, i.e. benthic group, benthic life form, family, genus, species and substrate. At the level of family, if 90% or greater agreement between the original and new observer is obtained (excluding point errors where the discrepancy is due to the point falling on the border of two organisms) then analysis by the new observer may begin. If less than 90% agreement is achieved at this level then the new and an experienced observer examine each point and the discrepancies discussed. An assessment is then made as to whether the new observer is required to undertake more training before analysis of video transects may begin.

Annual training

To ensure data integrity each observer completes three observer comparison transects annually. This is conducted in the same manner as the initial observer comparison for a new observer. In addition, observers complete identifications of various still images of reef benthos. The images are a selection of common and unique benthos regularly encountered during the AIMS LTMP surveys within the Great Barrier Reef.

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ACKNOWLEDGEMENTS

The video technique detailed above was initially devised at AIMS by Dr Terry Done. This survey method has been established as a standard monitoring method by the AIMS Long-term Monitoring Program and has been modified using the experience gained from the application of the technique. We would like to thank Cathie Page, Rachelle Ninio, Debbie Bass, Caroline Christie, Stephen Neale and Will Oxley for their input into both the development of this technique and the previous versions of this document.

APPENDIX I

The video data sheet

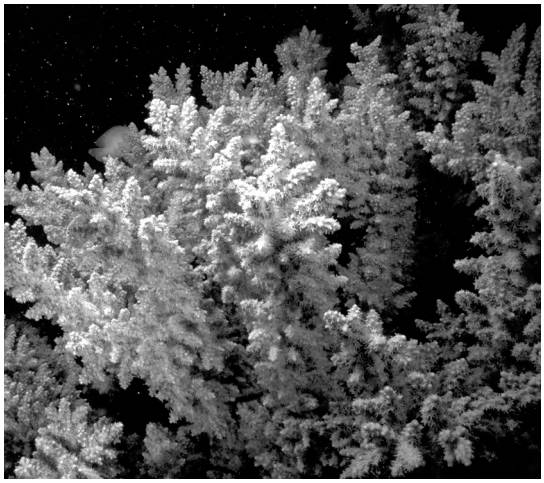
AIMS Long-term Monitoring Program - Video Data Sheet

Cruise Code Date: Reef: Site: 1 2 3 Transect: 1 2 3 4 5 Filmed by:	Transect	Counter

Comments:

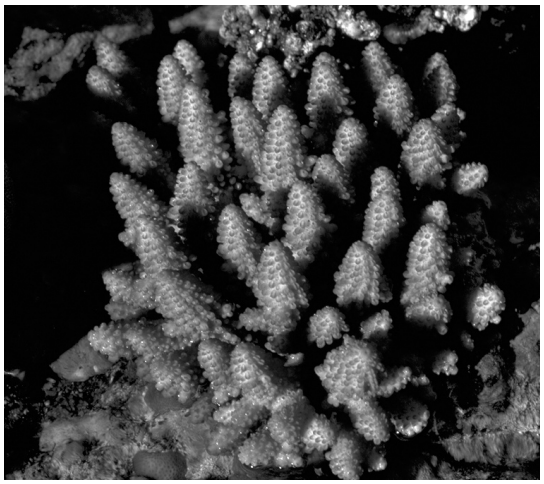
APPENDIX II

Benthic life form categories of hard corals

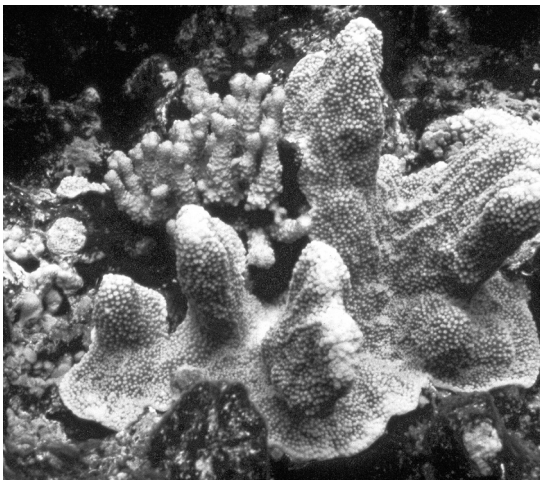


Bottlebrush Acropora (ACX)

Branching Acropora (ACB)

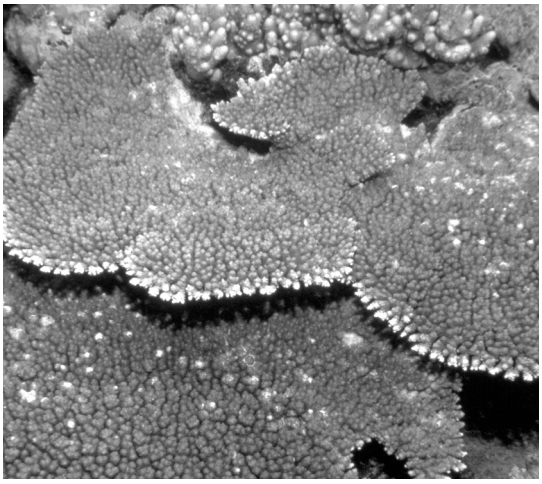


Digitate Acropora (ACD)

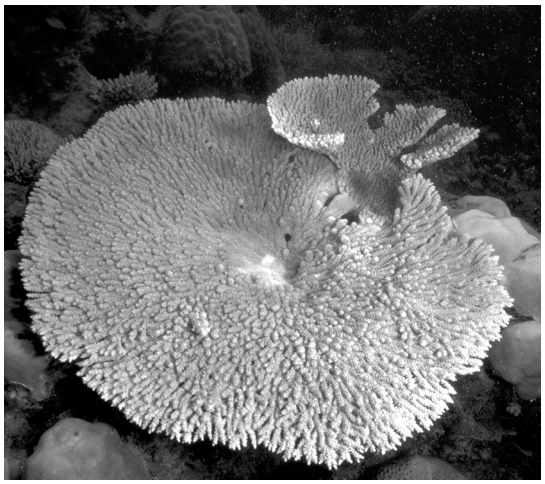


Submassive Acropora (ACS)

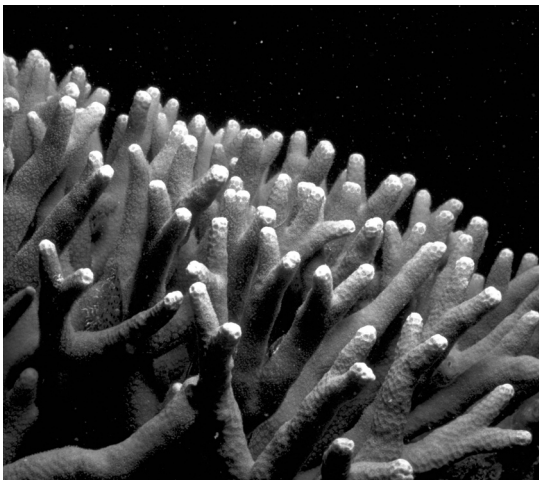
Encrusting Acropora (ACE)



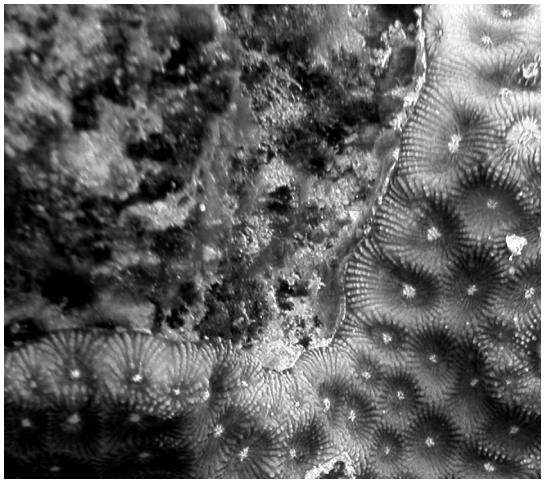
Tabulate Acropora (ACT)



Tabulate Acropora (ACT)

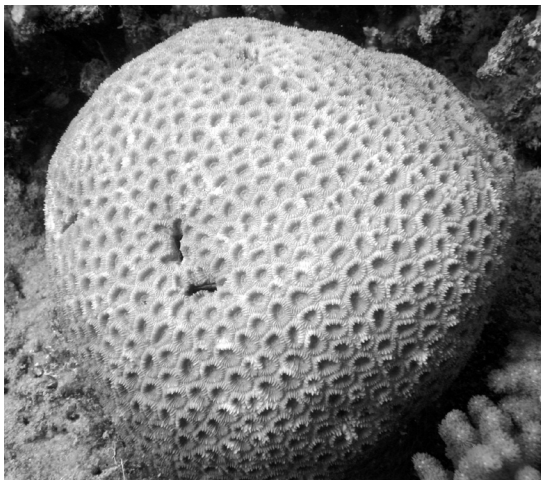


Branching non-Acropora (CB)

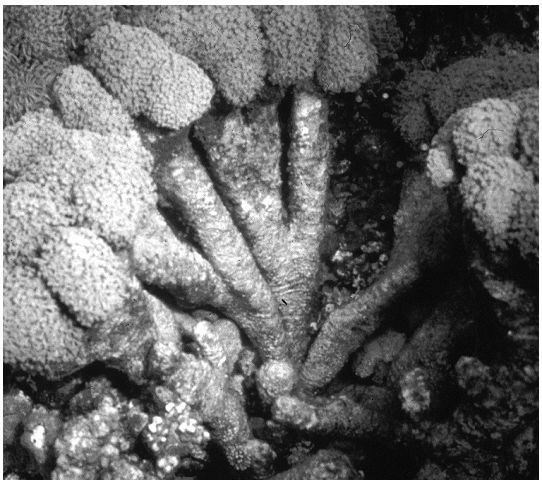


Encrusting non-Acropora (CE)

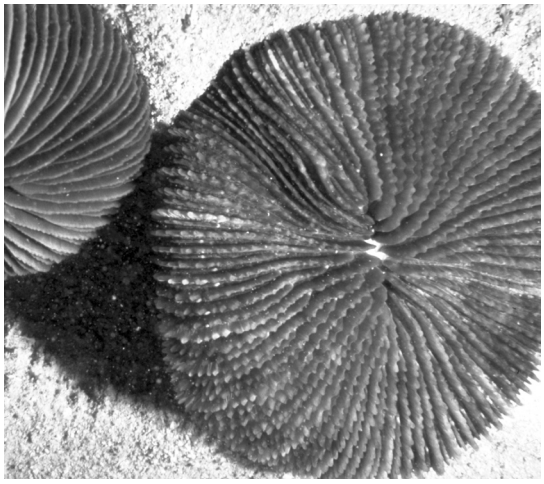
Foliaceous non-Acropora (CF)



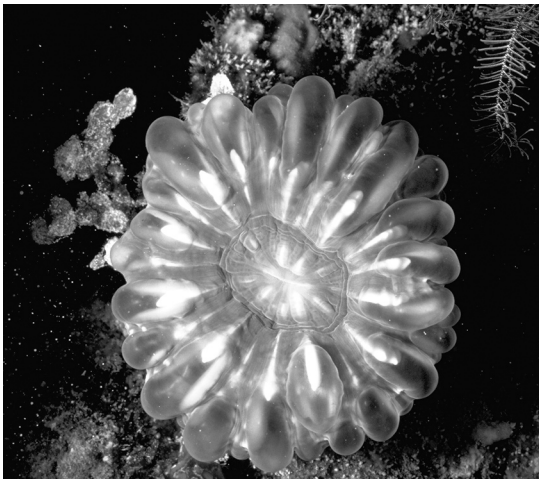
Massive non-Acropora (CM)



Submassive non-Acropora (CS)



Mushroom Coral (CMR)



Solitary Coral (CL)

APPENDIX III

Species/benthos codes reference table

Species Code	Species Description	Video Code	Benthos Code	Benthos Description	Group Code	Group Description
ABIDC	Dead standing coral (white)	149	DC	Dead coral (recent)	AB	Abiotic
ABIRUBB	Rubble	2	R	Rubble	AB	Abiotic
ABISAND	Sand	1	S	Sand	AB	Abiotic
ABWATER	Water	76	UNK	Unknown	IN	Indeterminate
ACASPP	*Acanthastrea* spp.	245	CM	Massive non-*Acropora*	HC	Hard coral
ACHHORR	*Acrhelia horrescens*	214	CB	Branching non-*Acropora*	HC	Hard coral
ACRREC	*Acropora* spp. recruit	279	ACD	Digitate *Acropora*	HC	Hard coral
ACRSPP	*Acropora* spp.	249	ACX	Bottlebrush *Acropora*	HC	Hard coral
ACRSPP	*Acropora* spp.	169	ACD	Digitate *Acropora*	HC	Hard coral
ACRSPP	*Acropora* spp.	140	ACB	Branching *Acropora*	HC	Hard coral
ACRSPP	*Acropora* spp.	101	ACT	Tabulate *Acropora*	HC	Hard coral
ALGCORA	Coralline algae	14	CA	Coralline algae	A	Algae
ALGFILA	Filamentous algae	7	TA	Turf algae	A	Algae
ALGHALI	*Halimeda* spp.	111	HA	*Halimeda*	A	Algae
ALGMAFL	Fleshy Macro Algae	412	MA	Macroalgae	A	Algae
ALGSPP	Algae Other	442	AO	Algae Other	A	Algae
ASTSPP	*Astreopora* spp.	54	CM	Massive non-*Acropora*	HC	Hard coral
CARFAM	Fam Caryophyllidae	430	CM	Massive non-*Acropora*	HC	Hard coral
CAUFURC	*Caulastrea furcata*	159	CS	Submassive non-*Acropora*	HC	Hard coral
COEMAYE	*Coeloseris mayeri*	44	CM	Massive non-*Acropora*	HC	Hard coral
CORREC	Coral spp. recruit	285	CE	Encrusting non-*Acropora*	HC	Hard coral
CORSPP	Non-*Acropora* coral	43	CB	Branching non-*Acropora*	HC	Hard coral
CORSPP	Non-*Acropora* coral	190	CF	Foliose non-*Acropora*	HC	Hard coral
CORSPP	Non-*Acropora* coral	152	CS	Submassive non-*Acropora*	HC	Hard coral
CORSPP	Non-*Acropora* coral	80	CM	Massive non-*Acropora*	HC	Hard coral
CORSPP	Non-*Acropora* coral	36	CE	Encrusting non-*Acropora*	HC	Hard coral
DIPHELI	*Diploastrea heliopora*	26	CM	Massive non-*Acropora*	HC	Hard coral
ECHSPP	*Echinopora* spp.	320	CF	Foliose non-*Acropora*	HC	Hard coral
ECHSPP	*Echinopora* spp.	315	CB	Branching non-*Acropora*	HC	Hard coral
ECHSPP	*Echinopora* spp.	157	CE	Encrusting non-*Acropora*	HC	Hard coral
ECLSPP	*Echinophyllia* spp.	137	CE	Encrusting non-Acropora	HC	Hard coral
FAVSPP	*Favia* spp.	78	CM	Massive non-*Acropora*	HC	Hard coral

FUNFAM	FUNGIIDAE Family	440	CMR	Mushroom coral	HC	Hard coral
Species	Species	Video	Benthos	Benthos Description	Group	Group
Code	Description	Code	Code		Code	Description
FVDSPP	*Favid* spp.	174	CE	Encrusting non-*Acropora*	HC	Hard coral
FVDSPP	*Favid* spp.	166	CM	Massive non-*Acropora*	HC	Hard coral
FVSSPP	*Favites* spp.	203	CE	Encrusting non-*Acropora*	HC	Hard coral
FVSSPP	*Favites* spp.	9	CM	Massive non-*Acropora*	HC	Hard coral
GALSPP	*Galaxea* spp.	431	CM	Massive non-*Acropora*	HC	Hard coral
GALSPP	*Galaxea* spp.	414	CE	Encrusting non-*Acropora*	HC	Hard coral
GARPLAN	*Gardineroseris planulata*	16	CM	Massive non-*Acropora*	HC	Hard coral
GONSPP	*Goniopora* spp.	192	CM	Massive non-*Acropora*	HC	Hard coral
GOSSPP	*Goniastrea* spp.	47	CM	Massive non-*Acropora*	HC	Hard coral
HEPCOER	*Heliopora coerulea*	231	SM	Massive Soft Coral	SC	Soft coral
HYDSPP	*Hydnophora* spp.	416	CB	Branching non-*Acropora*	HC	Hard coral
HYDSPP	*Hydnophora* spp.	151	CM	Massive non-*Acropora*	HC	Hard coral
HYDSPP	*Hydnophora* spp.	86	CS	Submassive non-*Acropora*	HC	Hard coral
ISOSPP	*Isopora* Spp.	433	ACS	Submassive *Acropora*	HC	Hard coral
ISOSPP	*Isopora* Spp.	417	ACE	Encrusting *Acropora*	HC	Hard coral
LESSPP	*Leptoseris* spp.	419	CF	Foliose non-*Acropora*	HC	Hard coral
Species	Species	Video	Benthos	Benthos Description	Group	Group
Code	Description	Code	Code		Code	Description
LESSPP	*Leptoseris* spp.	418	CE	Encrusting non-*Acropora*	HC	Hard coral
LOBSPP	*Lobophyllia* spp.	22	CM	Massive non-*Acropora*	HC	Hard coral
MERSPP	*Merulina* spp.	434	CF	Foliose non-*Acropora*	HC	Hard coral
MERSPP	*Merulina* spp.	420	CS	Submassive non-*Acropora*	HC	Hard coral
MILSPP	*Millepora* spp,	24	CME	*Millepora*	OT	Other
MONSPP	*Montipora* spp.	156	CE	Encrusting non-*Acropora*	HC	Hard coral
MONSPP	*Montipora* spp.	218	CS	Submassive non-*Acropora*	HC	Hard coral
MONSPP	*Montipora* spp.	187	CF	Foliose non-*Acropora*	HC	Hard coral
MORSPP	*Montastrea* spp.	162	CM	Massive non-*Acropora*	HC	Hard coral
MYCELEP	*Mycedium elephantotus*	81	CE	Encrusting non-*Acropora*	HC	Hard coral
OTH	Other organisms	212	OT	Other organisms	OT	Other
OTHANEM	Anemone	94	OT	Other organisms	OT	Other
OTHASCI	Ascidian	5	OT	Other organisms	OT	Other
OTHHYDR	Hydroid	68	OT	Other organisms	OT	Other
OTHTSPP	*Tridacna* spp.	116	OT	Other organisms	OT	Other
OTHZOAN	Zoanthid	6	ZO	Zoanthid	OT	Other
OULSPP	*Oulophyllia* spp.	421	CM	Massive non-*Acropora*	HC	Hard coral
PACSPP	*Pachyseris* spp.	422	CF	Foliose non-*Acropora*	HC	Hard coral
Species	Species	Video	Benthos	Benthos Description	Group	Group
Code	Description	Code	Code		Code	Description

PAVSPP	*Pavona* spp.	424	CS	Submassive non-*Acropora*	HC	Hard coral
PAVSPP	*Pavona* spp.	425	CE	Encrusting non-*Acropora*	HC	Hard coral
PAVSPP	*Pavona* spp.	423	CF	Foliose non-*Acropora*	HC	Hard coral
PECSPP	*Pectinia* spp.	426	CF	Foliose non-*Acropora*	HC	Hard coral
PLASPP	Platygyra spp.	49	CM	Massive non-*Acropora*	HC	Hard coral
POCDAMI	*Pocillopora damicornis*	57	CS	Submassive non-*Acropora*	HC	Hard coral
POCSPP	*Pocillopora* spp.	427	CS	Submassive non-*Acropora*	HC	Hard coral
PODCRUS	*Podabacia crustacea*	144	CE	Encrusting non-*Acropora*	HC	Hard coral
PORSPP	*Porites* spp.	153	CS	Submassive non-*Acropora*	HC	Hard coral
PORSPP	*Porites* spp.	398	CB	Branching non-*Acropora*	HC	Hard coral
PORSPP	*Porites* spp.	96	CE	Encrusting non-*Acropora*	HC	Hard coral
PORSPP	*Porites* spp.	41	CM	Massive non-*Acropora*	HC	Hard coral
SCACYLI	*Scapophyllia cylindrica*	27	CS	Submassive non-*Acropora*	HC	Hard coral
SCOVITI	*Scolymia vitiensis*	72	CL	Solitary coral	HC	Hard coral
SERSPP	*Seriatopora* spp.	429	CB	Branching non-*Acropora*	HC	Hard coral
SOFAST	*Asterospicularia* spp.	297	SL	Lobate Soft Coral	SC	Soft coral
SOFGORG	Gorgonia	33	SA	Arborescent Soft Coral	SC	Soft coral
SOFLOBO	*Lobophytum* spp.	42	SE	Encrusting Soft Coral	SC	Soft coral
SOFNED	Family Nephtheidae	444	SC	Soft coral	SC	Soft coral
SOFSARC	*Sarcophyton* spp.	83	SCC	Capitate Soft Coral	SC	Soft coral
SOFSINU	*Sinularia* spp.	130	SAE	Arb & Enc Soft Coral	SC	Soft coral
SOFSPP	Soft coral spp.	64	SC	Soft coral	SC	Soft coral
SOFSPP	Soft coral spp.	413	SE	Encrusting Soft Coral	SC	Soft coral
SOFXED	Family Xeniidae	443	SC	Soft coral	SC	Soft coral
SPOSPP	Sponge spp.	73	SP	Sponge	SP	Sponge
STYPIST	*Stylophora pistillata*	30	CS	Submassive non-*Acropora*	HC	Hard coral
SYMSPP	*Symphyllia* spp.	53	CM	Massive non-*Acropora*	HC	Hard coral
TUBSPP	*Tubastraea* spp.	210	CS	Submassive non-*Acropora*	HC	Hard coral
TUPMUSI	*Tubipora musica*	65	SM	Massive Soft Coral	SC	Soft coral
TURSPP	*Turbinaria* spp.	67	CF	Foliose non-*Acropora*	HC	Hard coral
UNID	Can't tell	18	OT	Other organisms	OT	Other

AUSTRALIAN INSTITUTE OF MARINE SCIENCE
Cape Ferguson, Queensland, Australia.
PMB No. 3, Townsville Mail Centre, Q. 4810
Telephone: (07) 4753 4444
Facsimile: (07) 4772 5852
Internet: www.aims.gov.au