LONG-TERM MONITORING

OF THE

GREAT BARRIER REEF

Status Report

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by

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Executive summary

The Great Barrier Reef (GBR) has great economic importance as well as immense aesthetic value, contributing an estimated $5.8 billion to the Australian economy, principally through tourism and other recreational activities as well as fisheries in the Great Barrier Reef and adjoining areas. Inscription on the World Heritage List recognises the area's global significance and entails regular reporting on its status. Information about natural variability of populations is essential for informed management. The AIMS Long-term Monitoring Program is designed to provide information on population trends in key groups of organisms (particularly crown-of-thorns starfish, corals and reef fishes) on appropriate spatial scales over the length and breadth of the Great Barrier Reef World Heritage Area (GBRWHA). The results contained within this report are intended to be a primary source of strategic information for the Great Barrier Reef Marine Park Authority (GBRMPA), the Commonwealth Government lead agency for matters concerning the care and development of the GBRWHA.

This report presents a synthesis of monitoring data collected up to the 2007 field season. Data from 2006 and 2007 have not been reported previously.

Broad scale manta tow surveys have been made in 11 latitudinal sectors spanning the length of the GBR for a period of 21 years (1986-2007) and have significantly increased our understanding of the crown-of-thorns starfish (COTS) phenomenon. The perimeters of 104 reefs were surveyed using manta tow in 2006; the figure for 2007 was 98 reefs.

Intensive surveys on reefs in six sectors began in the 1993 field season. Benthic organisms and fishes were surveyed annually on fixed sites within one habitat on each survey reef from 1993 until 2005. A new zoning plan for the GBR Marine Park was implemented in 2004 and in 2006, the pattern of surveys was changed, so that the original core monitoring reefs were surveyed every other year (odd years), while in the alternate years starting in 2006, a different series of reefs was surveyed in order to assess the effects of rezoning the GBRMP on biodiversity. This involved surveying matched pairs of reefs, one of which was rezoned as a no-take area in 2004 while the other remained open to fishing. The new survey reefs were distributed across much of the GBR: groups of paired reefs were selected near Cairns and Innisfail, near Townsville, near Mackay, in the Swain Reefs and in the Capricorn – Bunker group. Thus sites on 56 reefs were surveyed in 2006 and on 46 reefs in 2007.

Major results were:

Crown-of-thorns starfish

The percentage of reefs on the GBR with outbreaks of COTS has fluctuated but has been declining as the third recorded wave of outbreaks fades: there were Active or Incipient Outbreaks on 6% of the 104 reefs surveyed in 2006 and on 4% of 98 reefs surveyed in 2007. The highest percentage of reefs with Active or Incipient Outbreaks recorded in the 21 years of surveys was 17%, recorded in 1987, 1999 and 2000.

The overall density of COTS on the GBR A shows a similar pattern. The overall mean number of COTS per tow was 0.13 in 2006 and 0.04 in 2007. This was lower than in 2005 when the overall mean was 0.14 COTS per tow. For comparison, the highest overall mean number of COTS per tow on the GBR during the last major wave of COTS outbreaks was 1.17 in 1988.

Details of the recent distribution of COTS are as follows:

- The numbers of reefs with outbreaks and the densities of COTS decreased in the Townsville, Pompey and Swain sectors between 2005 and 2007 and no Active or Incipient Outbreaks were recorded in these sectors in 2007. This is the first time that no outbreaks have been recorded in the Swain sector since surveys began in the mid 1980s.
- There were Active or Incipient Outbreaks on a several reefs in the Cape Upstart sector and one reef in the Whitsunday sector in 2007, probably representing the extent of the southward drift of the third wave of outbreaks that was first seen near Lizard Is in 1993.
- Average densities of COTS increased slightly on reefs in the Cape Grenville sector and there was one reef with an Active Outbreak in the Princess Charlotte Bay sector in 2006, but these sectors were not surveyed in 2007.
- There were no significant changes in COTS densities within the other six GBR sectors.

Coral Cover

The salient changes on the Great Barrier Reef over the fifteen years to 2007 reflect the impact of COTS and cyclones, and to a lesser extent bleaching and disease, on reef communities and their subsequent recovery from such disturbances. Based on the 2006 and 2007 survey years, the third recorded wave of COTS outbreaks appears to be abating. There have been few cyclones and limited bleaching, indicating a period of recovery and growth. The exception is the increased reports of coral disease, particularly in regions with high coral cover.

Key results were:

- The highest mean values for cover of living coral on the perimeter of reefs (henceforth: reef-wide live coral cover) that were surveyed in 2006 and 2007 were on reefs in the Capricorn- Bunker sector (43 and 35% respectively). The recorded values for reef-wide live cover were higher (65% and 41% respectively) in the outer shelf region in the Pompey sector, but only one reef (Ben Reef) was surveyed.
- Lowest values for reef-wide live coral cover (7% and 8%) in 2006 and 2007 were found on reefs in the Innisfail sector, where large COTS populations were recorded in the recent past as well as mass bleaching in 1998. Cover on inshore reefs in the Townsville sector was similarly low (8% in each year).
- Surveys of permanent survey sites on northeast faces of 46 reefs in 2007 found that cover of hard coral was also highest in the Capricorn Bunker sector (55%), followed by reefs in the mid- shelf region of the Whitsunday sector (46%). These regions have been recovering from storm damage over the 15 years of intensive surveys.
- Hard coral cover on permanent survey sites was lowest on the mid-shelf reefs of the Townsville sector (12%) in 2007. Many of these reefs had been affected by COTS outbreaks in previous years, though the number of active outbreaks in the subregion has declined.
- Hard coral cover declined sharply on the permanent survey sites in the outer shelf region of the Cooktown - Lizard Is. Sector. Coral cover increased initially from a low level following damage by storms in the late 1980s, reaching very high values in 2000. After a period of stability, coral cover has halved in the past two years. Dislodged corals suggest that this was partially due to storm damage, but it is also the cumulative effect of relatively high levels of coral disease. Reefs in the subregion are dominated by tabulate *Acropora* spp. and have had relatively high incidence of the coral disease white syndrome
- Reefs in the Capricorn - Bunker sector have also been recovering from storm damage over the survey period and now have high coral cover which has been stable in recent years. These reefs are also dominated by tabulate *Acropora* spp...
- Hard coral cover on the permanent survey sites in the inner regions of the Cairns sector declined in the late 1990s due to coral bleaching, storms and COTS. Coral cover increased up to 2007.
- Severe Tropical Cyclone Larry passed over the Innisfail sector in March 2006, but caused limited damage on mid-shelf and outer shelf reefs, in part because it moved quickly and also because coral cover was already low after extensive COTS outbreaks in the late 1990s.
- The trends in occurrence of coral diseases have been uneven. The occurrence of white syndrome declined in most subregions after a peak in 2003, but then returned to intermediate levels in 2006 and 2007. This occurred particularly in the

Cooktown-Lizard Is sector and on outer shelf reefs in the Cairns, Townsville and Capricorn-Bunker sectors.

Reef fishes

While abundance of many groups of fishes showed significant long term and current trends in various regions, there were only a few instances where a majority of groups in a region showed a consistent trend, these are usually related to changes in coral cover:

- The majority of larger, more mobile fish families, and damselfish genera, increased in abundance over the 13 years of surveys in the Capricorn-Bunker sector. Several groups, such as surgeonfishes, butterflyfishes, parrotfishes, wrasses and coral associated damselfishes continued to increase in 2006 and 2007. Coral cover increased greatly in this region from very low levels recorded in 1989; the changes in fish assemblages reflect this.
- In other sectors, most families of larger mobile fishes showed little net change in abundance over the 15 years of surveys. Most families also did not change in abundance over the last two surveys.
- In other sectors, changes in abundance of most damselfish genera were not consistent within regions over the 13 years of surveys. Based on the last two surveys, more damselfish genera increased than decreased, particularly in the Cooktown-Lizard Is and Whitsunday sectors.

Effects of rezoning the Great Barrier Reef Marine Park in 2004

In 2006 the AIMS LTMP incorporated a new component to look at the effects of rezoning as these develop, by surveying 4-6 matched pairs of midshelf and outer shelf reefs in each of 5 regions of the GBR. The reefs have been surveyed once in 2006, 18-24 months after the new zoning took effect. Surveys found that the numbers of coral trout, the primary target species of commercial fishers, were higher on no-take reefs than on reefs that were open to fishing in all five regions by an average of 54%.

1. Introduction

Background

The Australian Institute of Marine Science set up a long-term monitoring program for the Great Barrier Reef (GBR) in 1992. The program is based on some previous monitoring initiatives on smaller scales and represents the first concerted attempt to assess a range of ecological variables across most of the GBR. In 1993 the Long-term Monitoring Program (LTMP) became a task in the Cooperative Research Centre for Ecologically Sustainable Use of the Great Barrier Reef and subsequently the Cooperative Research Centre for the GBR World Heritage Area. In 2006 the program was further modified, so that the LTMP core reefs were to be surveyed in alternate years, alternating with surveys of a different set of reefs chosen to investigate the effects of rezoning the GBR Marine Park in 2004. The program is now a component of the Marine and Tropical Sciences Research Facility (Project 1.1.2).

Scope and limitations of the program

The objective of coral reef monitoring is to track change. Coral reefs are always changing through natural processes such as recruitment, growth, mortality and disturbance by storms. A major function of the LTMP is to document status and to describe changes in reef communities on the GBR. The GBR World Heritage Area (GBRWHA) includes the GBR Marine Park, administered by the Commonwealth of Australia, and a small area owned by the State of Queensland. About 2% of the GBRWHA is not declared as Marine Park. The Great Barrier Reef Marine Park Authority (GBRMPA) is the lead agency for GBRWHA issues and principal adviser to the Commonwealth Government on care and development of the GBR Marine Park. Information from the AIMS LTMP contributes significantly to the GBRMPA's reporting on the status of the GBRWHA as required by the World Heritage Commission of UNESCO and the forthcoming Outlook Report for the GBR. It also allows park managers to place small scale, site-specific changes in the context of changes that are observed over much larger scales. This provides some perspective on the importance and significance of site-specific status and change.

The specific objectives of the Program are:

- to monitor the status and changes in distribution and abundance of reef biota on a large scale.
- to provide environmental managers with a context for assessing impacts of human activities within the GBR Marine Park and with a basis for managing the GBR for ecologically sustainable use.
- to examine the effects of rezoning the GBR Marine Park on biodiversity (in alternate years)

The program addresses long-term regional change in benthic assemblages, reef fishes and crown-of-thorns starfish on coral reefs of the GBR. It does not address associated habitats: mangroves, seagrass beds and areas of soft substrate between reefs. Intensive sampling of benthic organisms and reef fishes is concentrated in one habitat, the northeast face of each survey reef, but the perimeter of each reef is also surveyed by manta tow to give a reef-wide estimate of hard coral cover.

Structure of this report

This report describes changes on a large scale that includes most of the GBR (Section 3), at a subregional scale (section 4) and at individual reef scale (Section 5). A brief summary of preliminary findings of monitoring the effects of rezoning the GBR in 2004 are given in Section 6.

Data from broadscale manta tow surveys are presented from 1986 to 2007. Data from intensive sampling of reef fish and benthic communities and are presented from 1993 to 2007. Data from 2006 and 2007 have not been reported previously.

This and previous reports are now available on the AIMS web site along with up to date results of recent surveys:

http://www.aims.gov.au/reef-monitoring

2. Methods

Program design

The AIMS Long-term Monitoring Program was initiated in 1993 and is designed to track changes in reef communities over time across the subregions of the GBR. In this context, reefs in a "subregion" are those that lie in one of three positions across the shelf (inshore, mid-shelf, outer shelf) within one band of latitude (a sector). Surveys by the Long-term Monitoring Program involve three tasks: manta tow surveys for crown-of-thorns starfish (COTS) and reef-wide coral cover (broadscale surveys), surveys of sessile benthic organisms, initially using video, but replaced by multiple still images in 2007, and visual counts of reef fishes. Broadscale surveys cover reefs in 11 sectors. Reefs are only surveyed intensively in six of the sectors. The data that are collected by each task are listed in Table 2.1. The program was modified in 2006. Analyses of trajectories of coral cover on the survey reefs showed that little information would be lost if surveys were made every second year. This approach made it possible to extend the program to monitor the effects of the major rezoning of the GBR Marine Park in 2004 by surveying an appropriate set of different reefs in alternate years. The objective of rezoning the

Table 2.1: Summary of Measurement Variables for each of the LTMP tasks.

Task	Description	Variables Measured
Broadscale Surveys	Manta tow surveys around entire reef perimeter (reefs in 11 sectors)	Crown-of-thorns starfish counts; estimates of cover of live hard and soft coral, dead coral, other incidental observations (e.g. coral bleaching, giant clams, reef aesthetics)
SCUBA search	Visual search along fixed transects at selected sites in one reef habitat (reefs in 6 sectors)	Search for agents of coral mortality: adult and juvenile COTS, *Drupella* spp., coral diseases
Benthic Organisms	Video records or multiple still images along fixed transects at selected sites in one reef habitat (reefs in 6 sectors)	Percent cover of all identifiable sessile benthic organisms
Fishes	Visual surveys on fixed transect at selected sites in one reef habitat (reefs in 6 sectors)	Counts of most mobile and non-cryptic fish species (see Appendix C)

GBR Marine Park was to conserve biodiversity by ensuring that at least 20% of each of a full range of “bioregions” was protected. Since this entailed a large increase in the “no-take” areas of the GBRMP and peoples’ lives and livelihoods were affected, it was imperative that the effects of rezoning were monitored. The same sampling methods were used to survey sites on different sets of reefs for each of the programs.

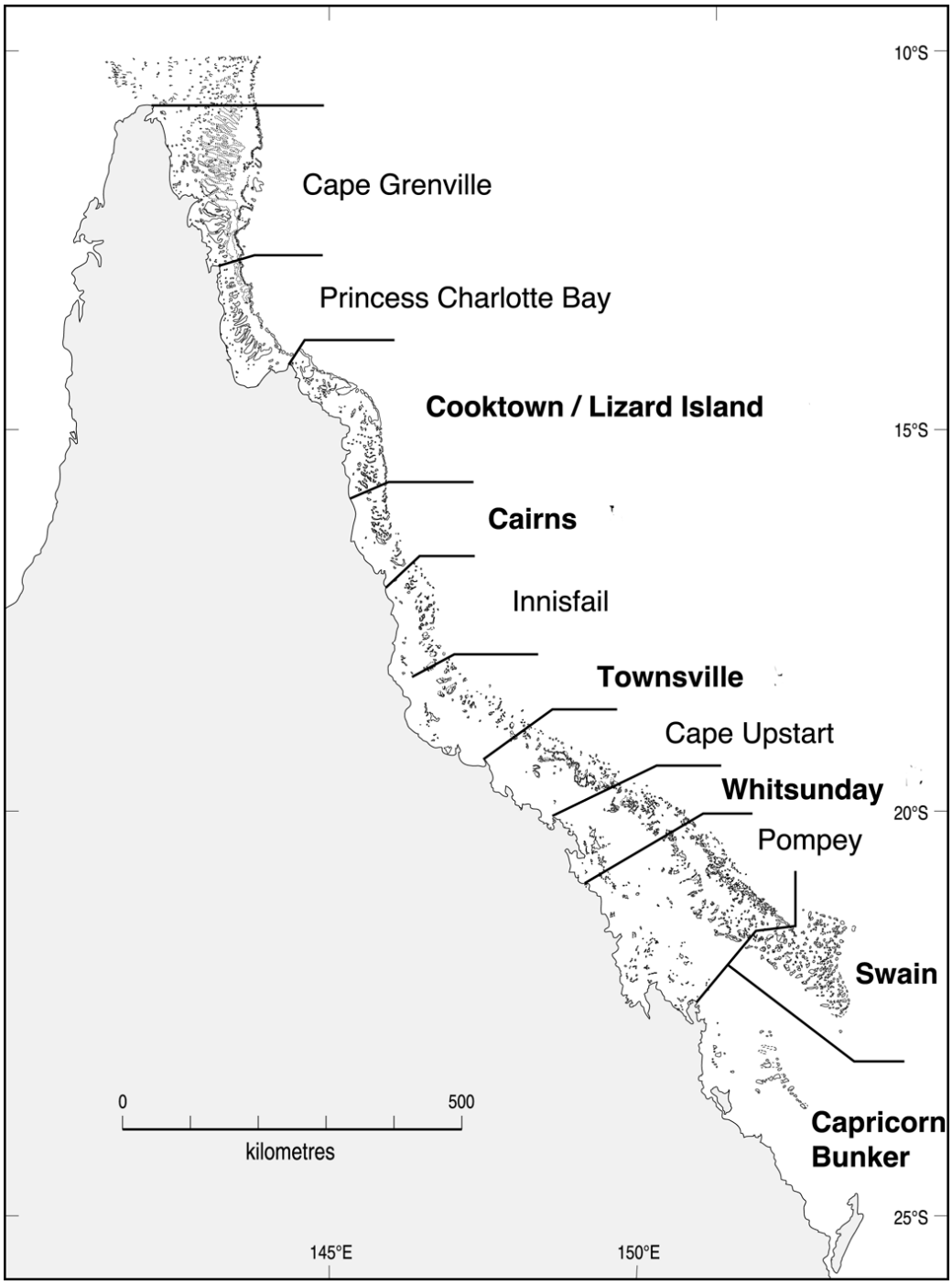

Figure 2.1 Map of the GBR showing the locations of latitudinal sectors. The six sectors where LTMP core survey reefs are located are shown in bold face.

Selection of reefs

Long-term Monitoring reefs

Initially, 52 “core” reefs were selected for annual survey. The reefs were widely distributed throughout the GBR and spanned the variation in composition of coral and fish communities (Done 1982, Williams 1982), which are known to be greater across the GBR from the coast to the Coral Sea, than they are along its length.

The core reefs were selected within six of the 11 cross-shelf sectors (Fig. 2.1) that had been identified for broadscale, manta-tow surveys for COTS (Bainbridge et al. 1994). Where possible, in each sector, three or more reefs were selected in each of three positions across the continental shelf: inshore, middle shelf and outer shelf.

There are no inshore or middle shelf reefs in the Capricorn Bunker sector. Also, the innermost reefs in the Swains sector are more than 100 km from the mainland and so are not subject to coastal influences. These innermost Swain reefs are therefore grouped with middle shelf reefs in this report.

The core survey reefs were chosen from the reefs within each region (sector by shelf position combination) for logistical and historical reasons. Because of the non-biological nature of the selection criteria, the survey reefs are likely to be representative of the reefs in each of the regions. The number of core survey reefs has since been reduced to 46 because some reefs could not be sampled reliably on a regular basis.

Each year an additional 55 reefs from the 11 sectors are scheduled to be surveyed using manta tow only. Some of these reefs are surveyed every year (key reefs); others are surveyed every third year (cycle reefs). These manta tow reefs take second priority to core survey reefs and the full set of surveys is rarely completed because of bad weather and limited ship time. Maps and a listing of reefs surveyed in 2006 and 2007 are given in Appendices A and B.

In order to assess the effects of the new zoning plan, pairs of mid-shelf and outer shelf reefs were identified that had both been open to fishing prior to 2004, but one reef in each pair had been rezoned as a no-take area in 2004 while the other reef remained open to fishing. Reefs in each pair were located close to each other, were in the same bioregion identified by the Representative Areas Program and had similar geomorphology of the NE reef face. Only a small minority of the existing AIMS Long-term Monitoring Program survey reefs were rezoned as no-take areas in 2004 after having been open to fishing before then.

Six pairs of mid-shelf or outer shelf reefs with the appropriate zoning history were selected in each of four localities close to centres of population: Cairns-Innisfail, Townsville, Mackay and the Swain Reefs, and four pairs of reefs were selected in the Capricorn-Bunker Group.

Sampling methods

Both the Long-term Monitoring Program and the program to monitor the effects of rezoning the GBRMP use the same survey procedures. Survey reefs are sampled in two stages (Fig. 2.2). Fishes and benthic organisms are surveyed intensively along transects at three sites in a habitat that is standardised across the survey reefs. The sites are located in the first stretch of continuous reef (excluding vertical drop-offs) to be encountered when following the perimeter from the back reef zone towards the front reef in a clockwise direction. The sites are usually situated on the northeast flank of the reef. Sites are separated by at least 250 m where possible. The entire perimeter of each reef is surveyed using manta tows, providing a reef-wide context for the intensive surveys.

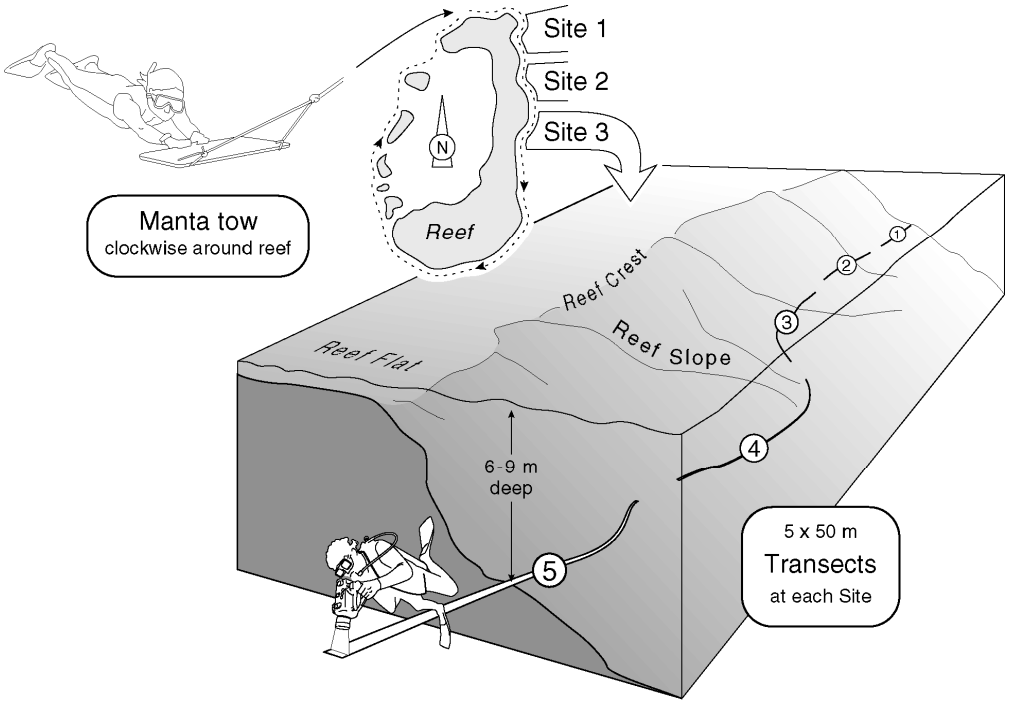

Figure 2.2: Schematic arrangement of sampling effort on a core survey reef.

There are five 50 m transects within each site. These transects were initially laid haphazardly, roughly following depth contours with 10 - 40 m between them. Transects are permanently marked with a star picket at each end and with lengths of reinforcing rod at 10 m intervals. Transects run parallel to the reef crest at about 6-9 m depth (Fig. 2.2). Surveys are made between July of one year and June of the next year. The reefs in each sector are surveyed at about the same time each year in a series of five or six cruises that alternate to the north and the south of Townsville.

In this report, annual surveys are referred to by the year in which the field season ended: thus surveys made between July 2005 and June 2006 are referred to as 2006 surveys.

Similarly, surveys made between July 2006 and June 2007 are referred to as 2007 surveys.

Fifty-six reefs were sampled for fish and benthos in 2006 for the effects of rezoning of the GBRMP. In 2007, 46 core reefs were sampled (Appendix B). Perimeters of 104 reefs were surveyed by manta tow in 2006 (Appendix B). Perimeters of 98 reefs were surveyed by manta tow in 2007.

Quality control

It is important to maintain consistency in the way data are collected and processed, so that differences that appear over time reflect differences in the populations of reef organisms rather than changes in observers or in sampling. Each part of the program has quality control measures in place, but one general approach has been to produce a series of Standard Operational Procedures (SOPs, Table 2.2). These document current methods of data collection and processing in considerable detail. They are reviewed at least every two years and updated as necessary. Current SOPs are available in electronic form via the AIMS web page (www.aims.gov.au/reef-monitoring).

Table 2.2: Titles of standard operational procedures. These are available in electronic form at www.aims.gov.au/reef-monitoring

Broadscale surveys	Miller IR, Coleman G and Abdo D (2004) Crown-of-thorns starfish and coral surveys using the manta tow and SCUBA search techniques. Standard Operational Procedure No. 8, AIMS, Townsville. 38 pp.
Fishes	Halford AR and Thompson AA (1996) Visual census surveys of reef fish. Standard Operational Procedure No. 3, AIMS, Townsville. 24 pp.
Benthos	Adbo, D, Burgess, S and Osborne K (2004) Surveys of benthic reef communities using underwater video. Standard Operational Procedure No. 9, AIMS, Townsville. 48 pp.
Data handling	Baker VJ and Coleman GJ (2000) A guide to the Reef Monitoring database. Standard Operational Procedure No. 5, AIMS, Townsville. 72 pp.

Data storage and access

Data are entered using a number of purpose-designed data entry and checking programs. All data are stored in an Oracle™ database at AIMS. The structure of the database is described in Baker and Coleman (2000).

Methods for individual tasks

Broadscale surveys

AIMS began broadscale surveys of the Great Barrier Reef in the mid-1980s. These surveys were incorporated into the LTMP in 1992. The primary objective of the broadscale surveys is to detect and monitor populations of COTS on the Great Barrier Reef. Manta tow surveys also include estimates of percent cover of living hard corals, living soft coral and recently dead hard coral, allowing assessment of the impact of COTS outbreaks and other large-scale disturbances. This report presents coral cover and COTS data from 18 years of broadscale surveys on the GBR.

Sampling techniques

Broadscale surveys use the manta tow technique as described by Miller et al. (2003) and English et al. (1997). At each reef, two teams work in opposite directions around the reef to survey about half the perimeter each. A team consists of a boat driver and an observer who is towed behind the boat on a manta board. At two-minute intervals the boat stops, allowing the observer to record the data for that tow (Table 2.3)

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Table 2.3: Primary variables recorded every 2 minutes during a manta tow survey. See Miller et al. (2004) for more details.

Variable	Data recorded	Categories
Number of COTS	number observed	actual counts
Size class of COTS	size class	A = juvenile (<25cm) B = adult (≥25cm)
Presence of feeding scars	abundance categories	A = absent (0) P = present (1-10) C = common (>10)
Live coral Dead coral Soft coral	estimated cover (11 categories)	0 = 0% 1- = >0-5% 1+ = >6-10% 2- = >11-20% 2+ = >21-30% 3- = >31-40% 3+ = >41-50% 4- = >51-62% 4+ = >63-75% 5- = >76-87% 5+ = >88-100%
Visibility	distance categories (scale of 1-4)	1 = <6m 2 = 6-12m 3 = >12-18m 4 = >18m

Quality control

Quality control occurs in two stages. First, all observers are trained before participating in the broadscale surveys (see Miller et al. 2004). Second, where time permits, on each sampling trip, a sub-sample of reefs is surveyed by two observers following the same towpath. This gives a measure of the variability between observers, which is necessary because the precision of observers varies continually (Moran and De'ath 1992). When observers show signs of bias (Miller and Müller 1997) they are retrained.

Data handling and analysis

Percent cover of living hard and soft coral and dead hard coral is calculated from the manta tow results by representing each cover category by the mid-point of its range. Coral cover, the number of COTS per reef and the average number of COTS per tow are used to assess the outbreak status of each reef (Fernandes 1991; Moran and De'ath 1992). There are four categories: Active Outbreak (AO), Incipient Outbreak (IO), Recovering (RE), or No recent Outbreak (NO). An Active Outbreak occurs when starfish densities reach levels where loss of coral tissue through starfish feeding is estimated to be faster than the growth of the coral. Definitions of outbreaks have evolved over the time that surveys have been made. Initially, reefs with active outbreaks were those where >40 COTS were recorded over the whole reef perimeter and >30% of hard coral was dead. An examination of manta tow data from reefs of all categories found that 90% of reefs with active outbreaks by these criteria supported >1500 COTS km^{-2} (Moran and De'ath 1992). This corresponds to approximately 0.22 COTS per two-minute tow. After consideration of the relative costs of Type I and Type II errors, the criterion for an Active Outbreak was revised upwards to 1.0 COTS per tow (Lassig and Engelhardt 1995, Engelhardt et al. 1997). This represents a starfish density that is highly likely to cause net decline in corals. In this report the criterion of 0.22 COTS per tow is referred to as "Incipient outbreak" level.

Reef level trends in broadscale data on median live hard coral cover and average COTS density from manta tow surveys were calculated from the visual estimates of the number of COTS per tow and the live hard coral cover per tow. For each reef these data are provided on a per tow basis for the current survey year, to represent variability within a reef, and as reef averages in each survey year, to represent patterns over time. The reef-averaged data are then averaged over all reefs in each sector to provide descriptive summaries for comparison among all sectors of the GBR.

Surveys of sessile benthos

Sampling techniques

Benthic organisms are surveyed on the five marked transects within each site on the core reefs. In 2007 the benthic survey method was changed in that, rather than selecting

frames from a continuous video record, single frames are shot at 1 m intervals using a digital still camera in a housing. The resolution of the resulting frames is much better than frames taken from video records and the cameras are smaller and cheaper than video cameras. Fifty still frames are shot along each 50 m transect with the camera held approximately 50 cm above the substrate. Percent cover of corals and other benthic categories (Table 2.4) is estimated using a point sampling technique, in which approximately 200 systematically dispersed points are sampled from each video transect. Details of the video survey and sampling techniques can be found in the SOP (Jonker et al. in press).

Table 2.4**:** Explanation of benthic categories.

Major Benthic Group	
Hard Corals	Order Scleractinia
Soft Corals	Subclass Alcyonaria
Algae	Macro-algae, turf and coralline algae
Group Other	Other biota
Major Benthic Families	
Acroporidae	Family Acroporidae
Faviidae	Family Faviidae
Pocilloporidae	Family Pocilloporidae
Poritidae	Family Poritidae
Acroporidae Groups	
Montipora	Genus *Montipora*
Acropora tabulate	Genus *Acropora* tabulate life-form
Acropora other	Genus *Acropora,* non-tabulate life-forms

Quality control

Quality control involves training new observers to use the underwater camera effectively in the field followed by initial training in identifying organisms in the recordings and an on-going program monitoring agreement between all observers. The precision of estimates of cover for benthic organisms grouped to different levels of taxonomy has been estimated by Ninio et al. (2003).

Data handling and analysis

For each category of benthic organisms, the mean values (based on the five marked transects) for percent cover at each site in each survey year are used to estimate temporal trends in cover of benthic organisms at each reef. Annual cover values are transformed using the empirical logit transformation before analysis. Temporal trend in the transformed annual estimates of abundance are estimated using linear mixed-effects models. The form of the temporal trend (i.e. no trend, linear, quadratic or smooth

(nonlinear) trend) is determined by model selection (see Appendix I for a technical explanation).

The selected model is then used to estimate the overall trend (over all 13 annual surveys) and current trend for each core survey reef for each benthic category. Substantial increasing or decreasing trends in hard coral cover are defined as absolute annual changes of greater than 3% cover. Smaller changes (i.e. <3%) indicate no substantial trend. The number of reefs showing increasing, decreasing or no trend in hard coral cover were then summed within each sector. The proportions of reefs showing each type of trend were then represented in summary plots to facilitate GBR-wide comparisons.

Surveys of reef fishes

Sampling technique

Fishes of 214 species (Appendix C) are counted on the same five 50 m transects at three sites on each reef where the benthic organisms are surveyed. Larger mobile fishes (141 spp.) are counted in a 5m wide belt transect and then damselfishes (73 spp.) are counted in a 1m wide belt on the return swim along the transects. Since the surveys span the annual recruitment season, 0+ individuals are excluded from counts. Full details of the sampling method are given in the SOP (Halford and Thompson 1996). Total lengths of any coral trout species (Serranidae, *Plectropomus* spp.) recorded within transect belts have been estimated from 1996 onwards. These species are highly sought after by commercial and recreational fishers. Length estimates of other species within the family Serranidae and of fishes within another two families frequently targeted by fishers (Lethrinidae and Lutjanidae) have been recorded since 2006.

Quality control

All observers cross-calibrate their counts during each field season. Estimating the cut off point for 0+ individuals and rules for exclusion or inclusion of individuals crossing transect boundaries are particularly important. During surveys, estimates of the desired transect widths are tested for accuracy using a tape measure at the end of each transect. Each field season observers also calibrate their underwater estimations of fish lengths using plastic models of coral trout.

Counts are entered into a database at the end of each day's diving using specially written programs that trap simple errors. When data for all transects on a reef have been entered, the new data are compared with counts from previous years using a linear model to check for unlikely values. This allows observers to check for misidentifications.

Data handling and analysis

Counts were summed over the five transects, giving estimates of abundance at each of the three sites in the one area of each reef. As in previous Status Reports (Oliver et al. 1995, Sweatman 1997, Sweatman et al. 1998, Sweatman et al. 2000, Sweatman et al. 2001, Sweatman et al. 2004, Sweatman et al. 2005), larger species have been grouped into families and damselfishes (Family Pomacentridae) have been grouped into genera. This increases the power of the analyses, but complicates interpretation. Individual taxa are considered too rare to test if their average density was less than one per transect in any year.

To look at trends in abundance of fishes on individual reefs, the abundances for each site are log transformed [ln(y + 1)] to reduce the influence of abundant taxa and to stabilise variances for analyses. Linear mixed-effects models are then used to estimate the temporal trend in the transformed annual estimates of abundance. The form of the temporal trend (i.e. no trend, linear, quadratic or smooth (nonlinear) trend) is determined by model selection (see Appendix I for a technical explanation). The selected model is then used to estimate the overall trend (over all 11 annual surveys) and current trend for each core survey reef. Substantial increasing or decreasing trends are defined as proportional annual changes greater than 10%. Smaller proportional changes (i.e. <10%) are considered to indicate no substantial trend. The number of families of larger species, or the number of genera of smaller damselfishes on each reef that showed increasing, decreasing or no trend are then summed and those numbers are summed over all reefs within each sector. The resulting proportions of each group of fishes showing each type of trend are represented in summary plots to facilitate GBR-wide comparisons.

Surveys of agents of coral mortality (SCUBA search)

Sampling technique

A diver swims with the intensive survey team and records COTS, classified as juvenile, small or large adult starfish, COTS feeding scars, *Drupella* spp., *Drupella* spp. feeding scars, unknown scars, percentage of corals that are bleached and the numbers of colonies with five categories of coral disease that occur in a 2 m wide belt that is centred on the survey tapes. Full details of the sampling method are given in the SOP (Miller et al. 2003).

Quality control

All observers cross-calibrate their counts and categories of coral disease during a dedicated field trip at the start of each field season.

Data handling and analysis

Summary data are given on the reef pages.

3. Reefs of the Great Barrier Reef: general trends

The aim of this section is to summarise the broad pattern of changes throughout the GBR. Trends in populations of organisms in regions of the GBR depend on the history of large-scale disturbances and the time that has been available for recovery. The principal disturbances in recent years have been due to crown-of-thorns starfish activity as the third recorded wave of outbreaks has continued to progress southward.

The analyses (Methods, Appendix I) of percent cover of benthic organisms and abundances of fishes on individual reefs identified two types of trends: average trends over the thirteen annual surveys, and current trends: those evident over the two years prior to the 2005 survey. Trends for the GBR are summarised here by considering the proportions of core survey reefs in each sector that show increasing, decreasing, or no substantial trends in cover of hard coral and abundance of reef fishes (see explanatory box below).

The crown-of-thorns starfish (COTS), *Acanthaster planci*, is an important cause of coral mortality when populations build up to outbreak levels. AIMS staff have monitored COTS populations since 1986. The results of these surveys are summarised in Fig. 3.1. Populations of the starfish have decreased in the Townsville sector and no outbreaks were recorded in 2007 though there were low COTS numbers on some reefs. There were a few reefs with outbreaks in the Cape Upstart and Whitsunday sectors. This is consistent with observations of previous waves of outbreaks, where the incidence of reefs with new active outbreaks moved south over time. The mechanism is assumed to be southward transport of larvae by the East Australian Current. Outbreaks in the Swains appear to occur independently of the main southward moving wave of COTS infestations. For the first time since surveys began, none of the survey reefs in the Swains sector had COTS outbreaks in 2007.

There has been a general increase in hard coral cover in the Capricorn-Bunker sector over the 13 surveys (Fig. 3.2). Storms removed much of the coral from these reefs in 1988 (Fig. 3.1), but by 2003 the intensive survey sites in the Capricorn-Bunker sector had the highest coral cover values in any region. The rate of increase in coral cover has slowed since 1999 and may be declining, in part from coral disease. Outer shelf reefs in the Cooktown-Lizard Is. sector showed a similar recovery through the early years of the program, but coral cover has declined sharply since 2004 due in part to coral disease. The general situation in the Swain sector was that coral cover had increased, on average, on reefs without COTS, though in coral cover declined dramatically on the Swain reefs with COTS outbreaks. Coral cover on reefs in the Cairns and Whitsunday sectors has changed little over the 13 years of surveys.

The general increasing trend in abundance of larger, more mobile reef fishes in the Capricorn-Bunker sector over the past 13 years (Fig. 3.3) was associated with the increase in coral cover and habitat complexity. Most reefs in most sectors showed no net trends in abundances of larger reef fishes over 13 years, but a sizable minority of families showed current increasing trends in the Cooktown-Lizard Is., Cairns and Townsville sectors.

Several genera of damselfishes increased in abundance over the 13 survey years in the Capricorn-Bunker sector in the south and the Cairns and Cooktown-Lizard Is. sectors in the north (Fig. 3.4). The increases in the Capricorn-Bunker sector were associated with the increase in coral cover. Abundances of several damselfish genera increased on reefs in the Cooktown-Lizard Is. and Whitsunday sectors.

Explanation of summary plots

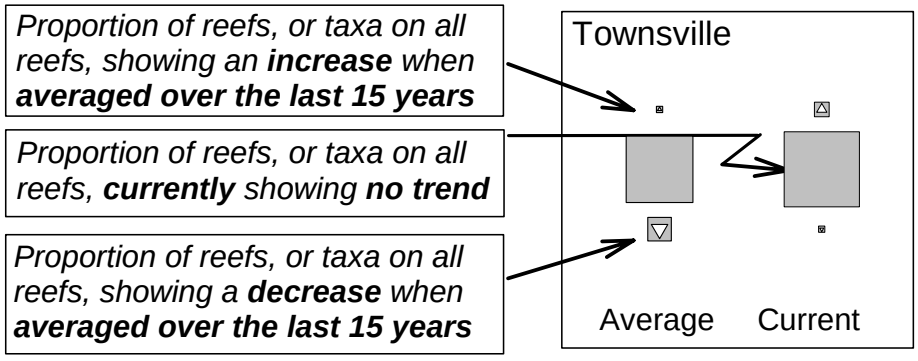
Trends in reef-wide cover of hard coral and in COTS estimated from broadscale surveys are represented by conventional line and bar graphs (Fig. 3.1).

The trends in hard coral cover and in fishes from intensive survey sites on reefs in each sector are represented by two sets of plots. The left hand set of squares represents the average "forced" linear trends over the past fifteen years while the right hand set represents current trends based on average change in the smoothed fitted curve over the last two years of surveys. Dimensions of the three filled squares reflect the proportion of taxa on survey reefs in each sector showing substantial (arbitrarily set at >3% change in hard coral cover and >10% proportional change in fish abundance) increasing trends, decreasing trends or no significant trend. Arrowheads within the squares indicate direction of trend.

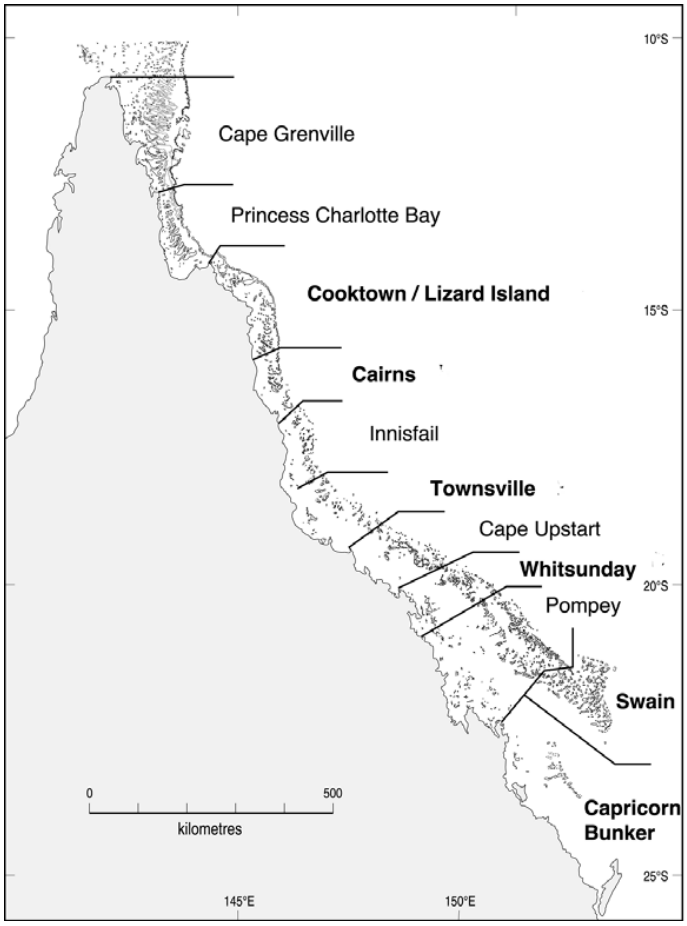
For hard coral cover (Fig. 3.2), the dimensions of the squares represent the proportion of reefs in each sector showing each trend (total = No. of reefs). For fishes (Figs. 3.3, 3.4), the dimensions of the squares represent the proportion of all taxa on all reefs in the sector that showed each trend (total = No. of fish taxa x No. of reefs).

Taxa that were too rare to allow a trend to be estimated were omitted.

An annotated example:



Summary of crown-of-thorns starfish activity on the Great Barrier Reef 1986-2007



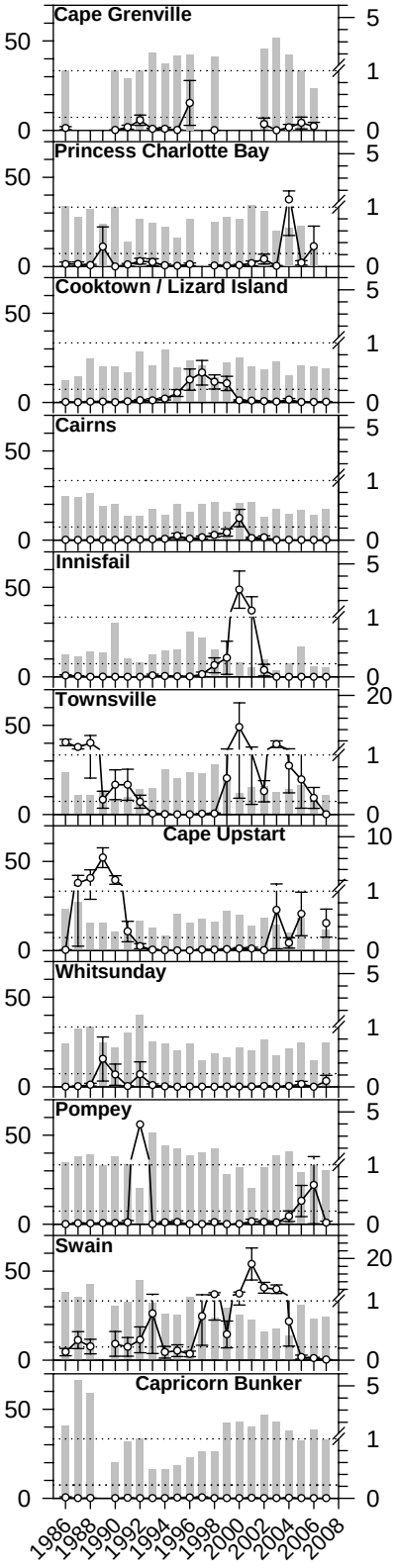
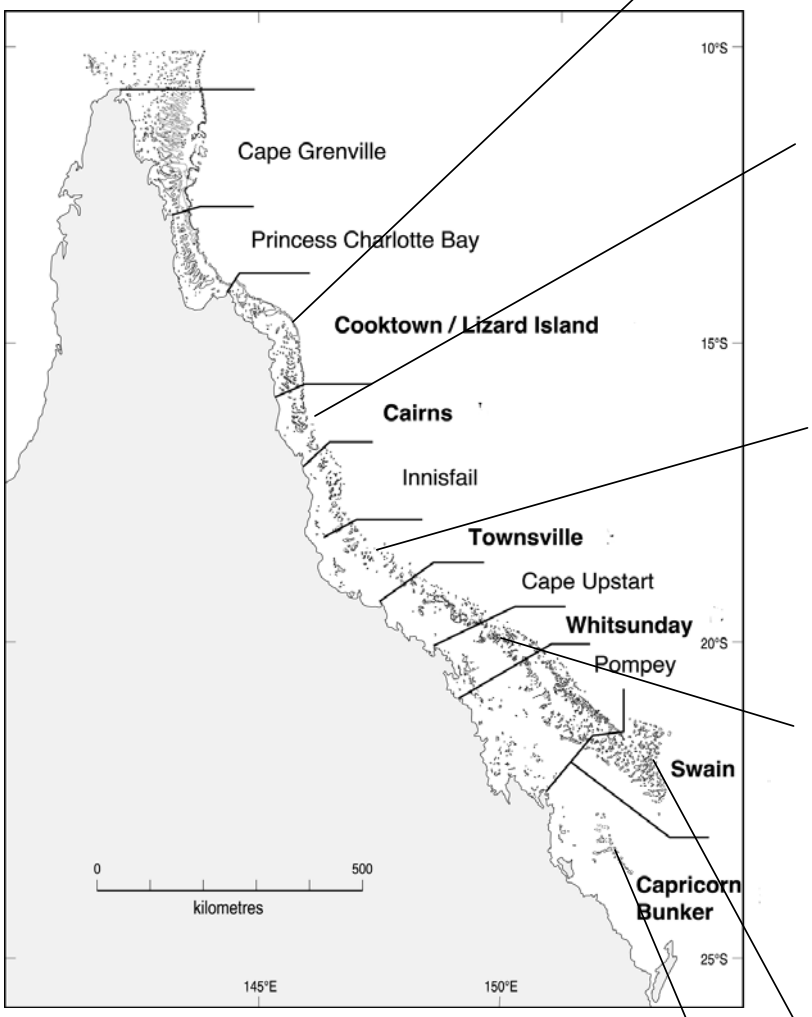
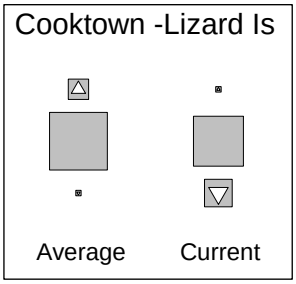
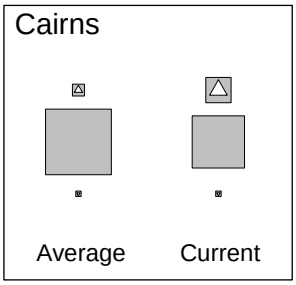


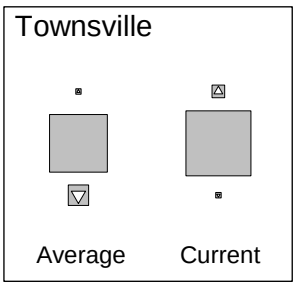
Figure 3.1 Summary of COTS populations and live coral cover for each survey sector on the GBR since 1986. Bar charts show mean live coral cover in each year (left hand axis); line plots show COTS abundances (COTS/tow ±SE) in each year (right hand axis). Lower dotted line = Incipient outbreak level (0.22 COTS/tow), upper dotted line = Active outbreak level (1.0 COTS/tow).

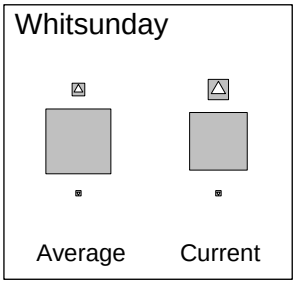
Summary of trends in hard coral cover, 1993-2007

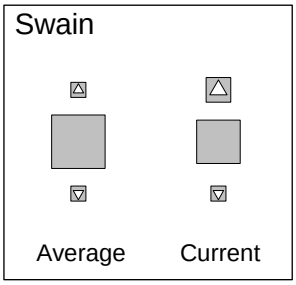












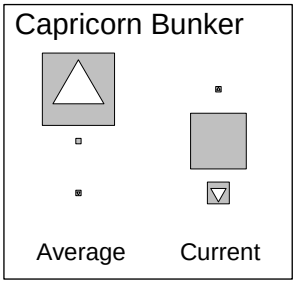
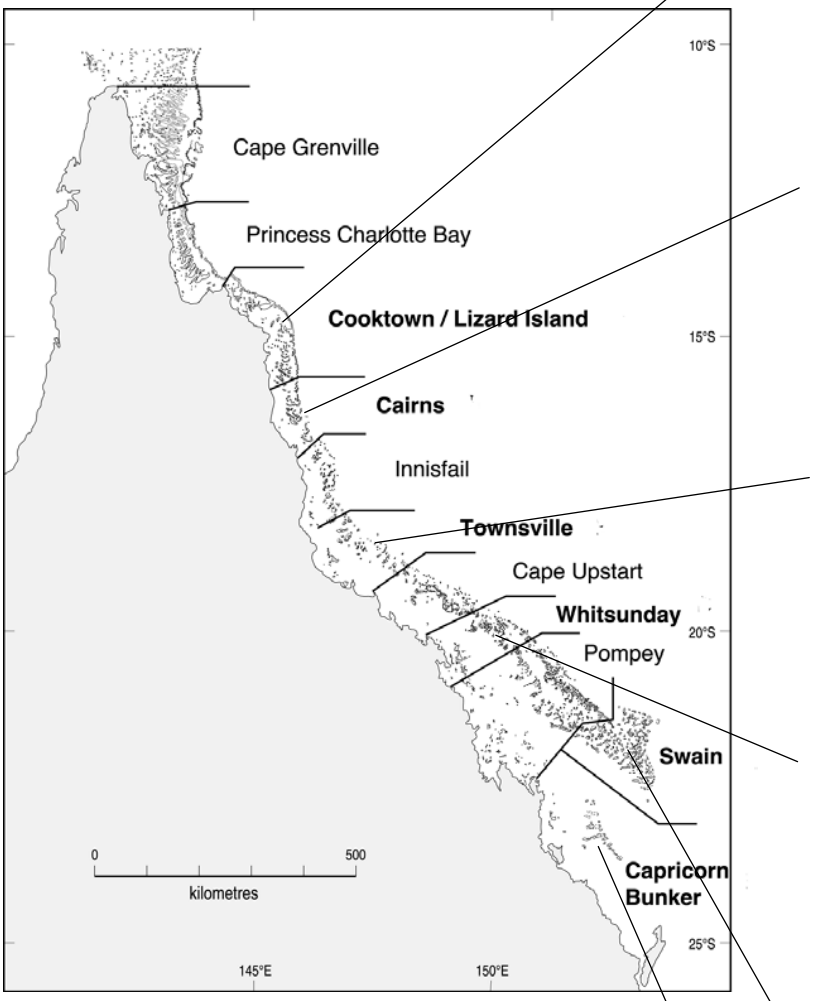
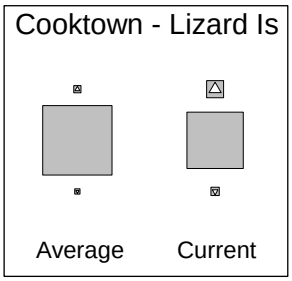
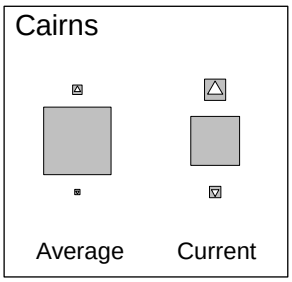


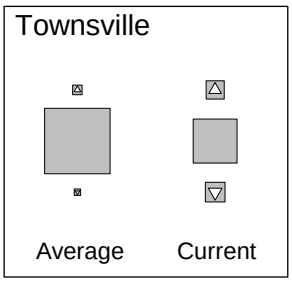
Figure 3.2 Visual summary of trends in hard coral cover on the GBR by sector, based on intensive study sites. Dimensions of each set of three filled squares reflect the proportion of survey reefs in each sector showing substantial (>3%) increasing or decreasing trends or no significant trend. Arrowheads indicate direction of trend. For each sector, the left hand set of squares shows the average trends over the 15 years of surveys; right hand set shows current trends.

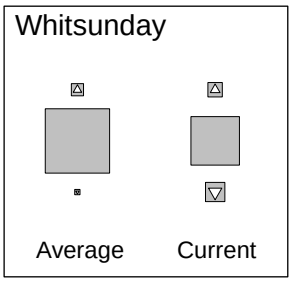
Summary of trends in abundance of larger fishes, 1993 - 2007

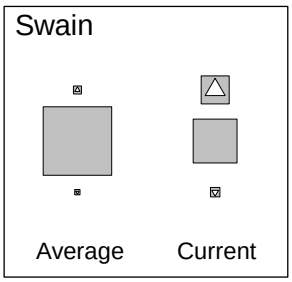












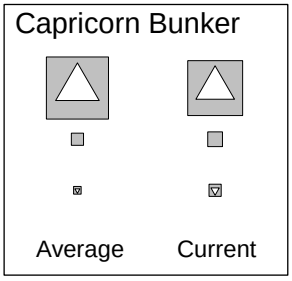
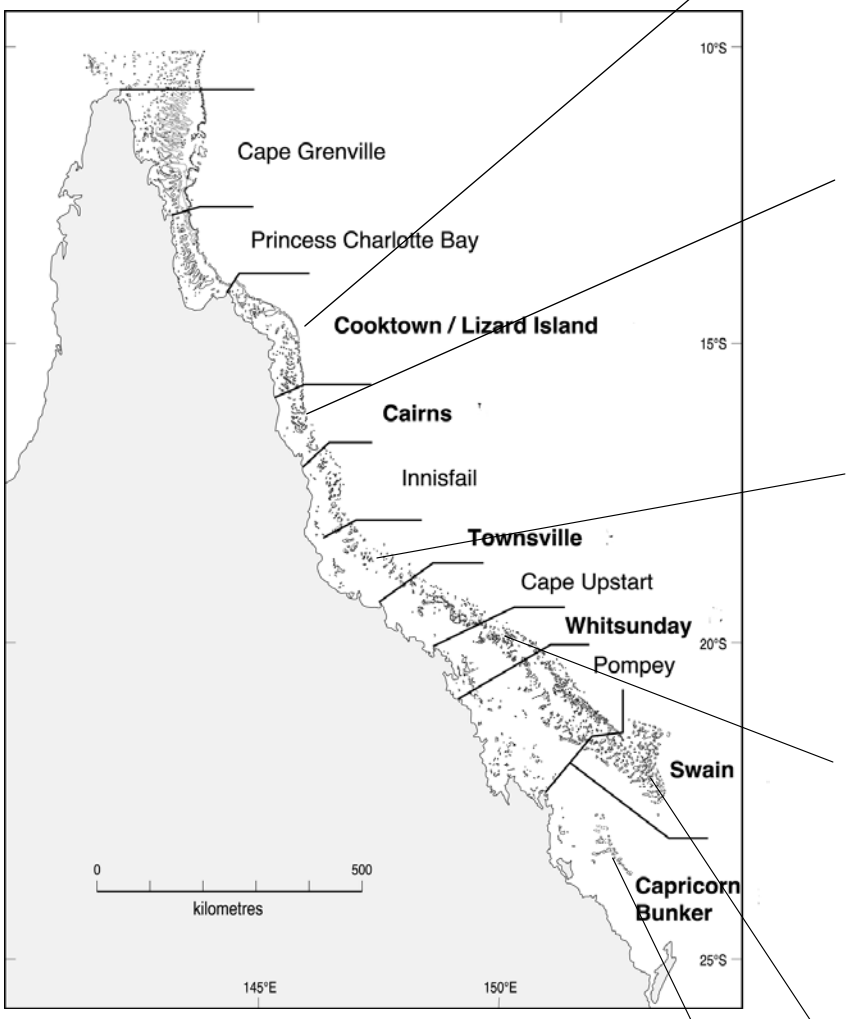
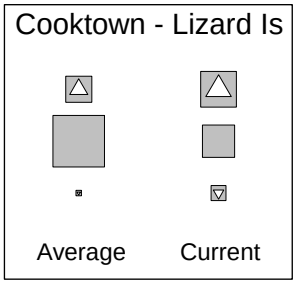
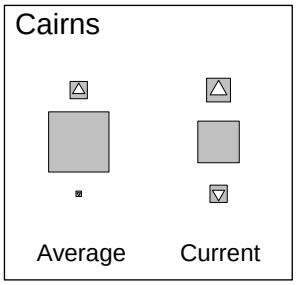


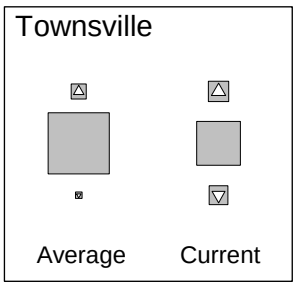
Figure 3.3 Visual summary of trends in abundance of larger reef fishes on the GBR by sector. Dimensions of each set of three filled squares reflect the number of families of larger fishes showing significant ($p<0.1$) increasing or decreasing trends or no significant trend on each reef, summed over all survey reefs in each sector and expressed as a proportion. Arrowheads indicate direction of trend. For each sector, the left hand set shows the average trends over the past six years; right hand set shows current trends. Families that were too rare to test have been omitted.

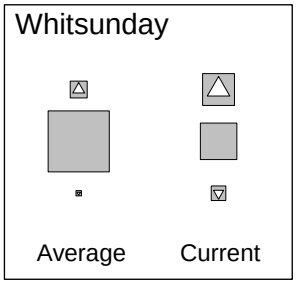
Summary of trends in abundance of damselfishes, 1995-2007

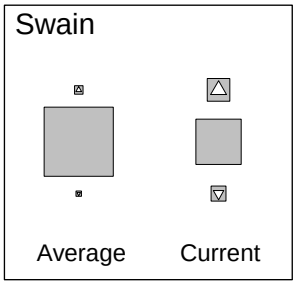












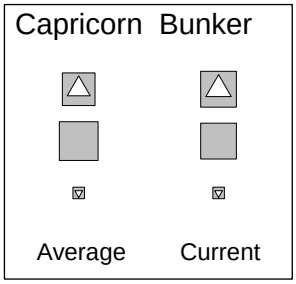


Figure 3.4 Visual summary of trends in abundance of damselfishes on the GBR by sector. Dimensions of each set of three filled squares reflect the number of damselfish genera showing significant ($p<0.1$) increasing or decreasing trends or no significant trend on each reef, summed over all survey reefs in each sector and expressed as a proportion. Arrowheads indicate direction of trend. For each sector, the left hand set shows the average trends over the past six years; right hand set shows current trends. Genera that were too rare to test have been omitted.

4. Reefs of the GBR: subregional status and trends

Explanation of sector summary pages

Trends in COTS (by sector)

The plot shows the proportion of survey reefs where crown-of-thorns starfish (COTS) were recorded (open symbols) and the proportion of survey reefs with Incipient or Active Outbreaks (filled symbols). The numbers above the tick-marks on the X-axis indicate the number of reefs that were surveyed in the sector in each year.

Trends in benthic organisms (by subregion)

Average trends based on the intensive survey reefs in each subregion are presented. For benthic organisms, three plots describe trends in percentage cover over the survey period for the following: major benthic groups, major coral families and Acroporidae. Each plot shows the scatter of mean cover based on survey sites and the fitted trend line. A fourth figure shows the history of coral disease prevalence in a subregion since 1999, when coral disease information was first incorporated in to SCUBA search surveys. The coral disease bar chart shows the total number of hard coral colonies at the intensive survey sites of a reef where signs of white syndrome disease or of black band disease were recorded.

This figure is not shown if no disease has been recorded on reefs in a subregion. The direction of the trend over time is coded in the legend: a period (˙) indicates no trend, a plus sign (+) indicates a positive trend and a minus sign (-) indicates a negative trend. Symbols before the slash refer to the general trend over the entire survey period; symbols after the slash refer to the trend at the time of the most recent survey. Thus, ‘˙/-’ would indicate that a taxon has shown no net trend over the survey period, but that the most recent survey showed a decreasing trend. ‘+/+’ would indicate that a taxon had increased over the survey period and was continuing to do so at the time of the last survey. If no symbols are shown then there were no substantial long-term or short-term trends.

Trends in reef fishes (by subregion)

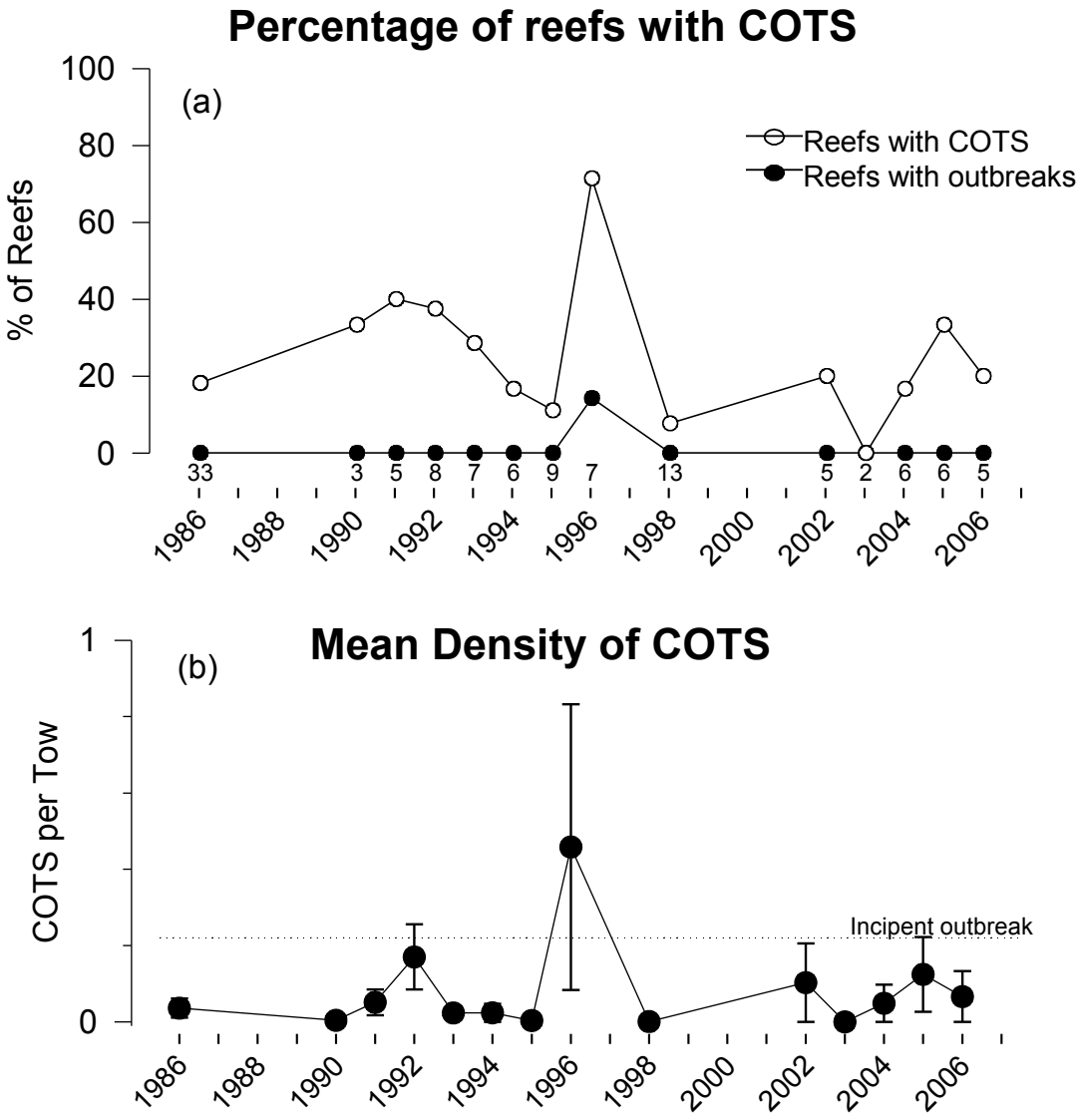
For reef fishes, four plots describe trends in average fish abundance for the subregion over time for reef fish groups. Two plots show trends in the families of large mobile fishes and two plots show trends in damselfish genera. Average trends are coded as for benthic organisms (above).

Cape Grenville Sector

Trends in COTS

No reefs were surveyed in this sector in 2007. Low level COTS activity has been observed in this sector in every survey year except for 2003 when only two reefs were surveyed. COTS numbers reached their highest recorded level in 1996 when an Active Outbreak was recorded at Curd Reef. When last surveyed in 2006 one Incipient Outbreak of COTS was recorded at Quoin Is Reef.

Figure 4.1

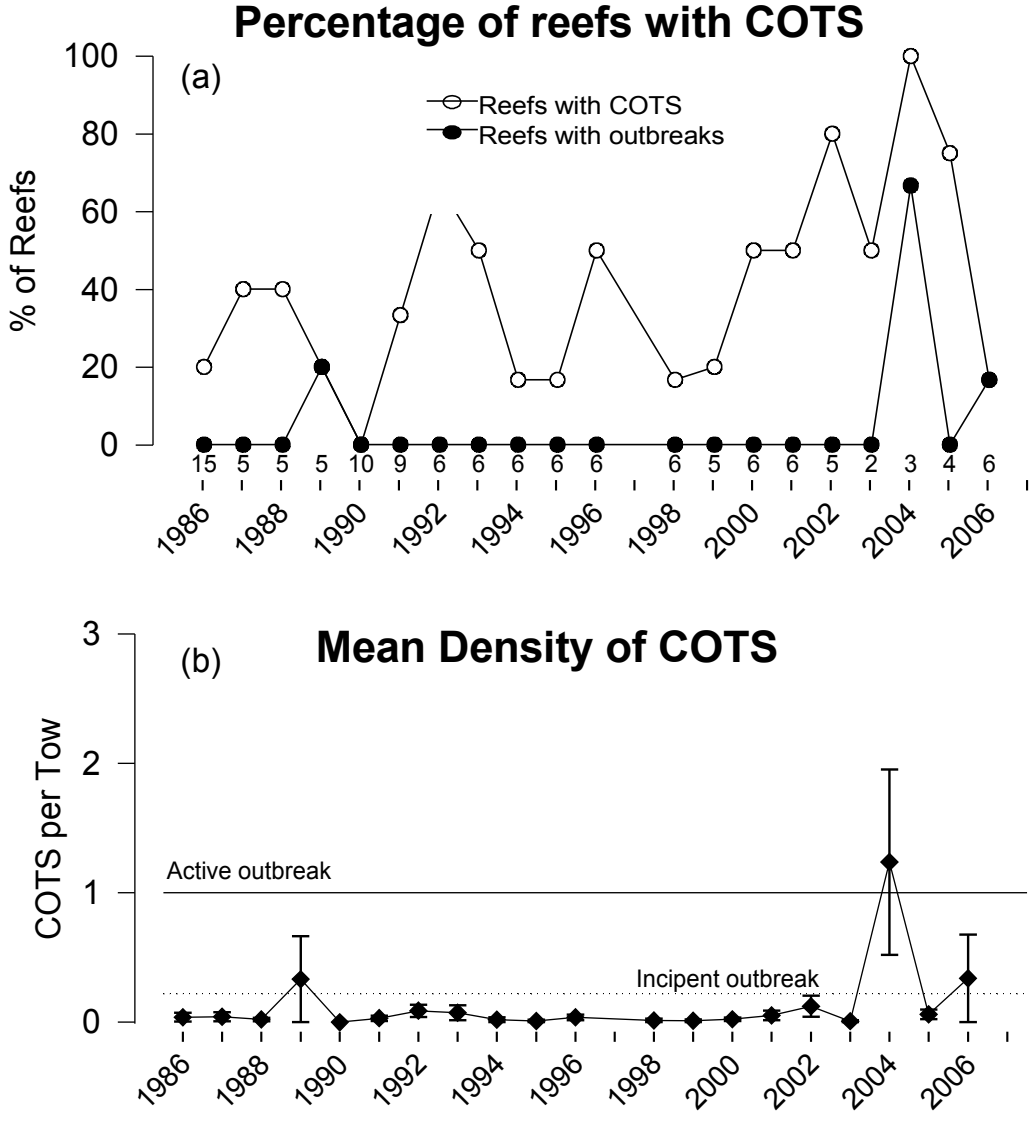


Princess Charlotte Bay Sector

Trends in COTS

No reefs were surveyed in this sector in 2007. Low level COTS activity has been observed in this sector in every survey year except for 1990 when only ten reefs were surveyed. COTS numbers reached there highest recorded level in 2004 when Active Outbreaks were recorded at Davie and Rodda Reefs. When last surveyed in 2006 one Active Outbreak of COTS was recorded at Clack Is Reef.

Figure 4.2

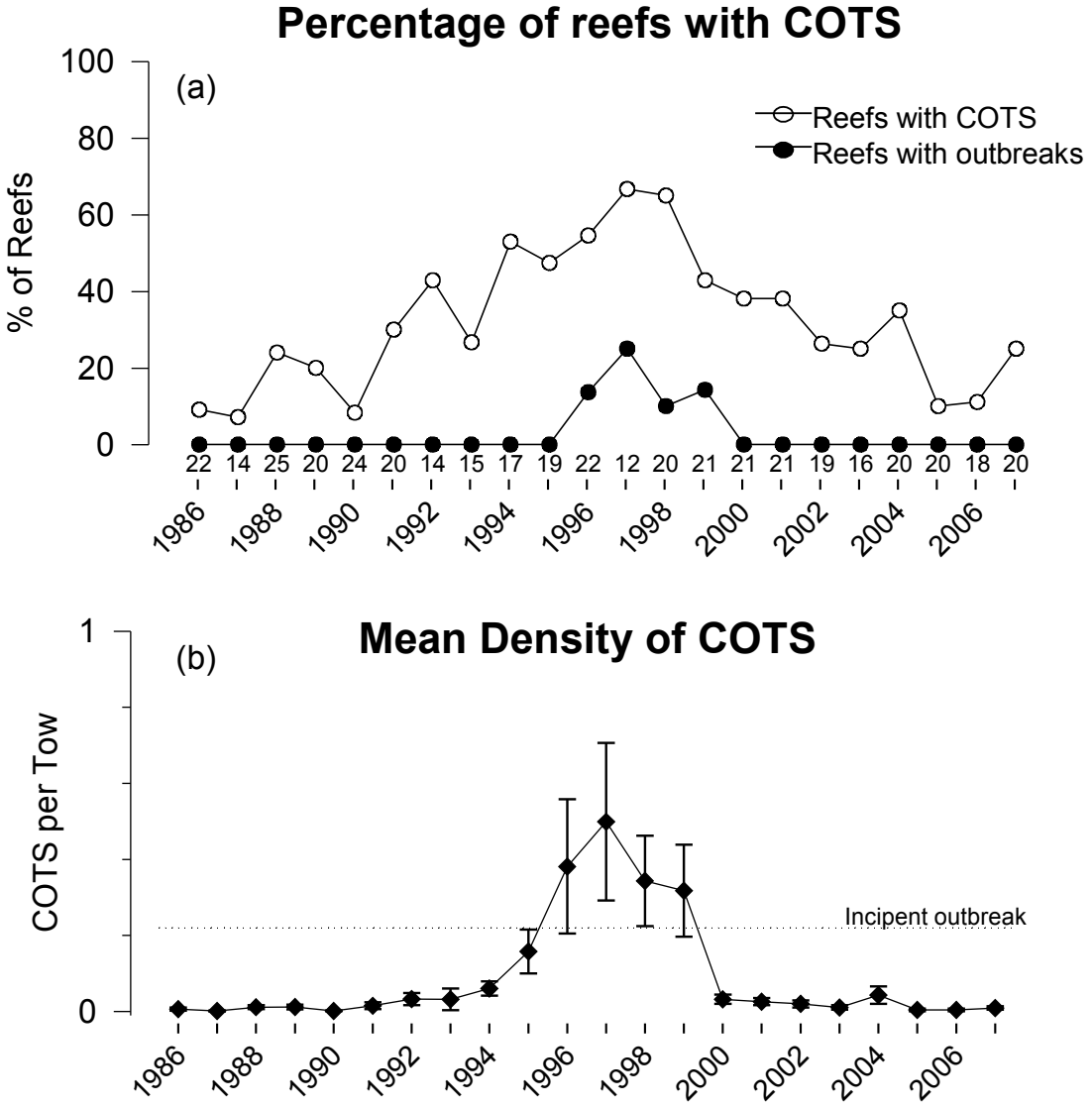


Cooktown / Lizard Island Sector

Trends in COTS

Reefs in this sector were last surveyed in January 2007. COTS have been observed in this sector in every survey year since 1986. COTS populations increased on inshore and mid-shelf reefs through the mid- to late- 1990s before declining by 2000 after reaching a peak in 1997. Small numbers of COTS have been recorded since then but in all cases numbers were well below outbreak levels and too low to cause significant coral mortality. COTS were recorded on five of the 20 reefs surveyed in 2007.

Figure 4.3



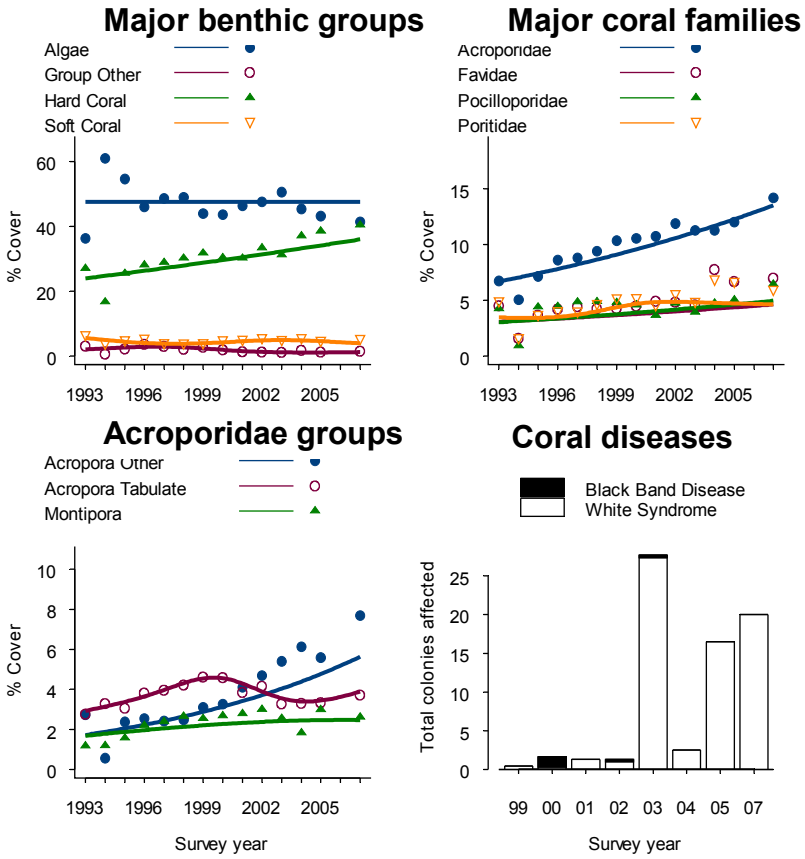
Cooktown / Lizard Island Sector

Inshore subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. There have been small short term fluctuations in hard coral and a long term increasing trend due to changes in *Acropora* spp. Average cover of hard coral in 2007 was 32% at Martin Reef and 49% at Linnet Reef. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 42%.

Figure 4.4



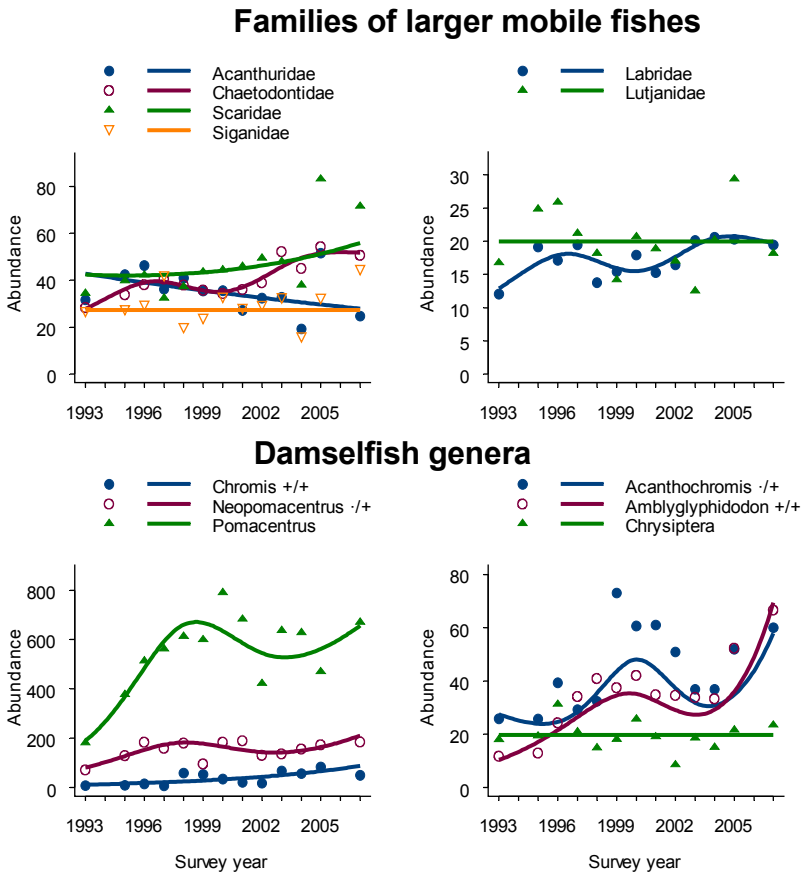
Cooktown / Lizard Island Sector

Inshore subregion

Trends in reef fishes

Abundances of large mobile fish families have shown no consistent long-term increases or decreases. However consistent increases in coral cover have probably contributed to high abundance of Chaetodontidae towards the end of the study period; many chaetodontids are coral dependent and their numbers often track changes in coral cover. Many *Chromis* spp. are also coral dependent and long term increases in their abundance reflect increases in coral cover. Abundances of *Amblyglyphidodon* spp. (driven by *A. curacao* and *A. leucogaster*) and *Acanthochromis polyacanthus*) increased significantly towards the end of the survey period, as on mid-shelf reefs in this sector and in the Cairns sector to the south. These results suggest widespread regional recruitment success of these taxa.

Figure 4.5



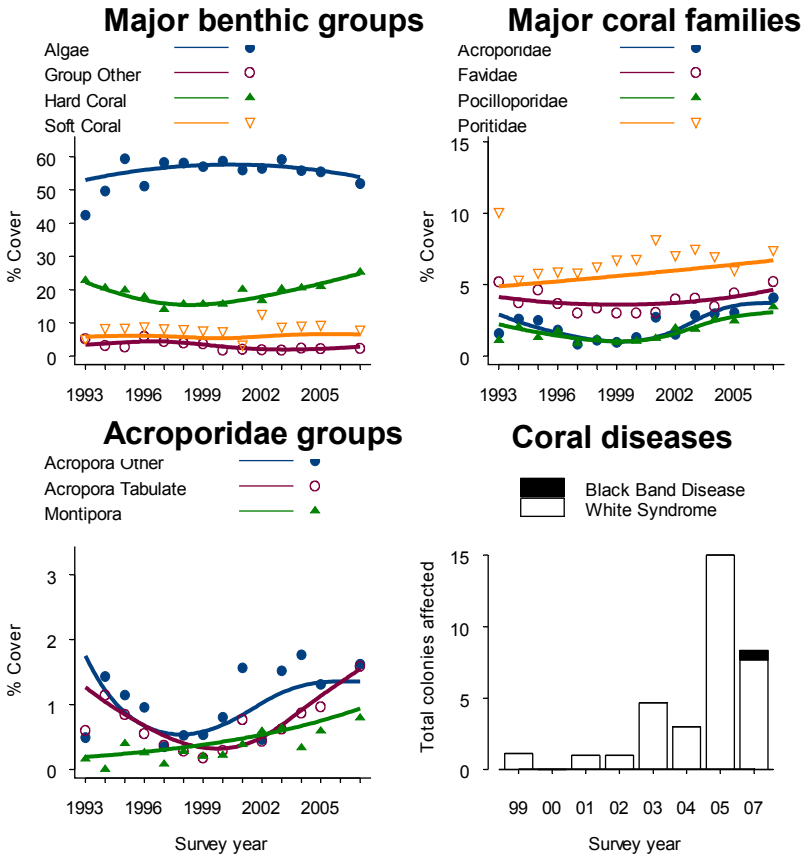
Cooktown / Lizard Island Sector

Mid-shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover increased after declining around 2000 due to COTS, with the main coral families showing a decline or no net change. Average cover of hard coral in 2007 ranged from 21% at Lizard Island Reef to 28% at North Direction Island Reef. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 58%.

Figure 4.6



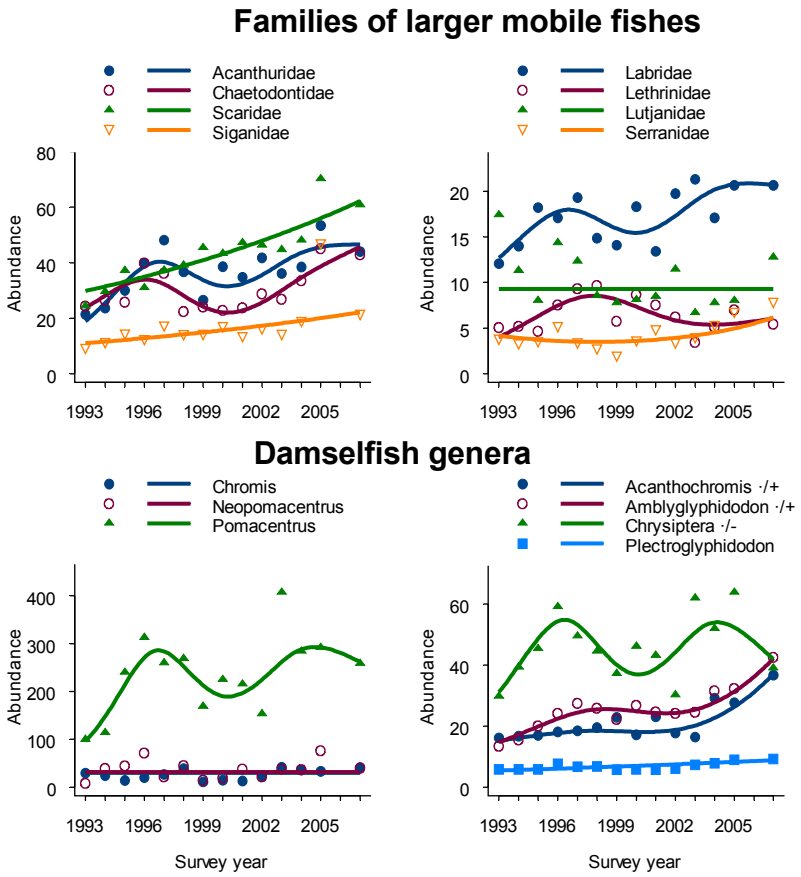
Cooktown / Lizard Island Sector

Mid-shelf subregion

Trends in reef fishes

Reef fish abundances have fluctuated over the study period but there have been no distinct long term trends. These patterns probably reflect natural variation in recruitment and mortality with little added influence from habitat changes; benthic communities were relatively stable over this time. From 2003, three large bodied damselfish species, *Acanthochromis polyacanthus*, *Amblyglyphidodon curacao,* and *Amblyglyphidodon leucogaster* increased in abundance. This also occurred on three mid-shelf reefs in the Cairns sector to the south.

Figure 4.7



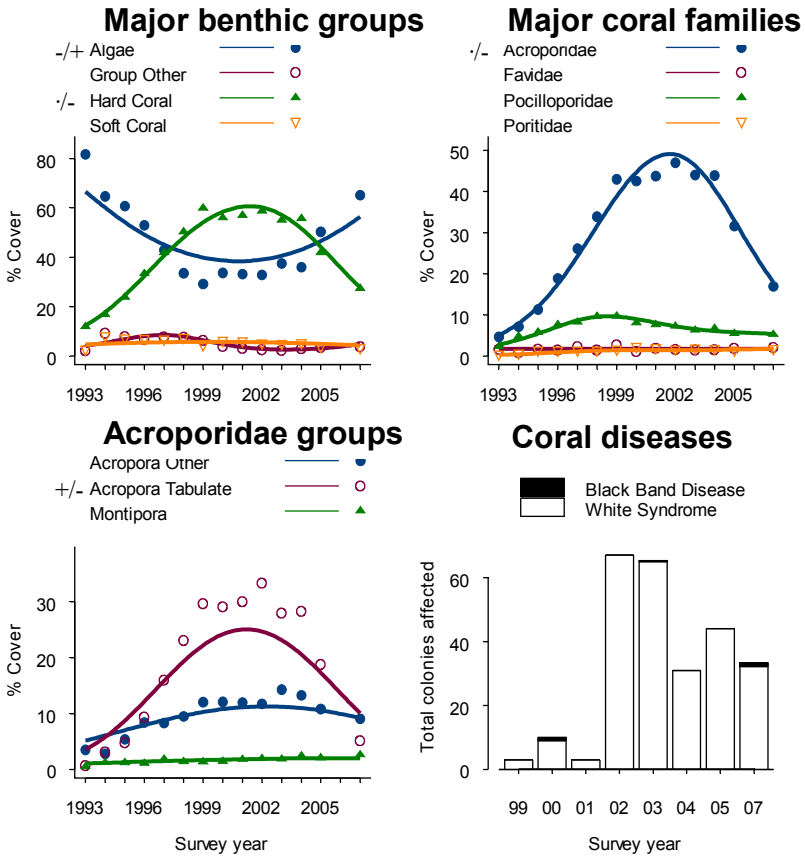
Cooktown / Lizard Island Sector

Outer shelf subregion

Trends in benthic organisms

On the intensive survey sites there no long term trend in hard coral as cover increased and then decreased again after reaching a peak in 1999. Hard coral trends were dominated by changes in *Acropora* spp with recent declines likely due to storm damage and disease. Average cover of hard coral in 2007 ranged from 24% at No Name and Yonge Reefs to 30% at Carter Reef. There was no net change in soft coral cover. In 2007 the average cover of algae was 65%.

Figure 4.8



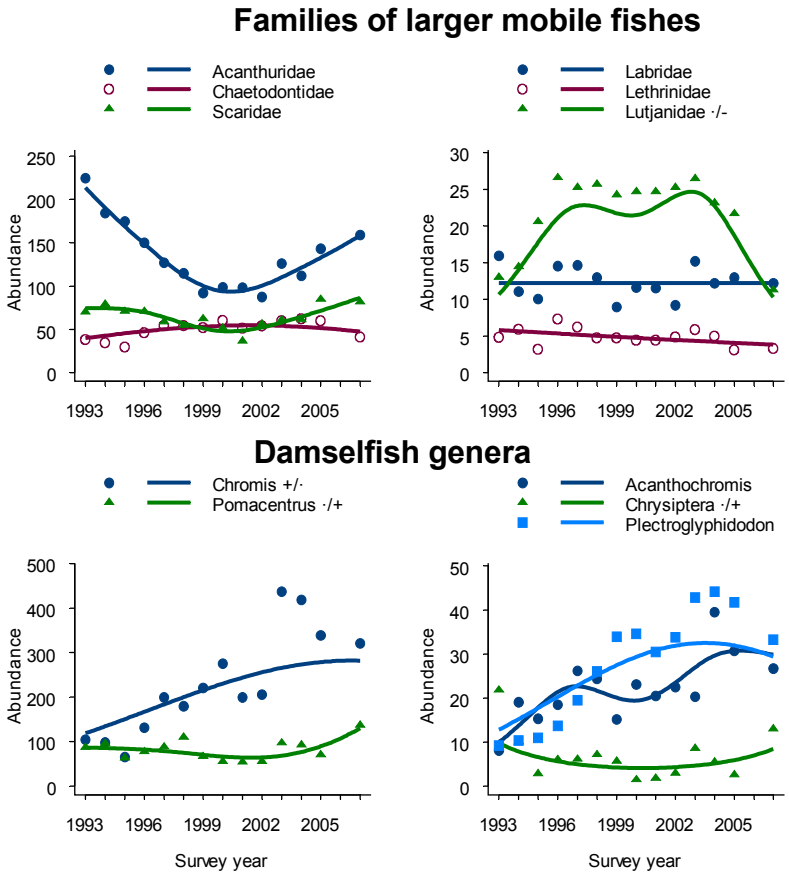
Cooktown / Lizard Island Sector

Outer shelf subregion

Trends in reef fishes

Reef fish taxa have shown a varied array of abundance trajectories over the study period with only one showing any consistent long term trend; abundances of *Chromis* spp. tended to increase over time. In many cases observed patterns were probably linked to dramatic changes in coral cover. Abundance patterns of Acanthuridae and Scaridae mirrored the decrease then increase in cover of algae. Such patterns may reflect a basic response of these herbivorous species (mainly driven by *Acanthurus nigrofuscus*, *A. lineatus*, *Ctenochaetus* spp. and *Chlorurus sordidus*) to varying supplies of their key food resource (turf algae and/or associated detritus). Abundances of Lutjanidae had dropped markedly in 2007 to a 15 year low. These patterns were driven by *Lutjanus gibbus* and *L. bohar* and the cause is unknown. Neither species are targeted by fishers due to the risk of ciguatera poisoning. Two damselfish genera had increased in abundance in 2007 to be at 15 year highs; *Pomacentrus* spp. (mainly *P.lepidogenys* and *P. philippinus*) and *Chrysiptera* spp. (driven by *C.rex*). Unusually successful recruitment appears the likely cause of these patterns.

Figure 4.9

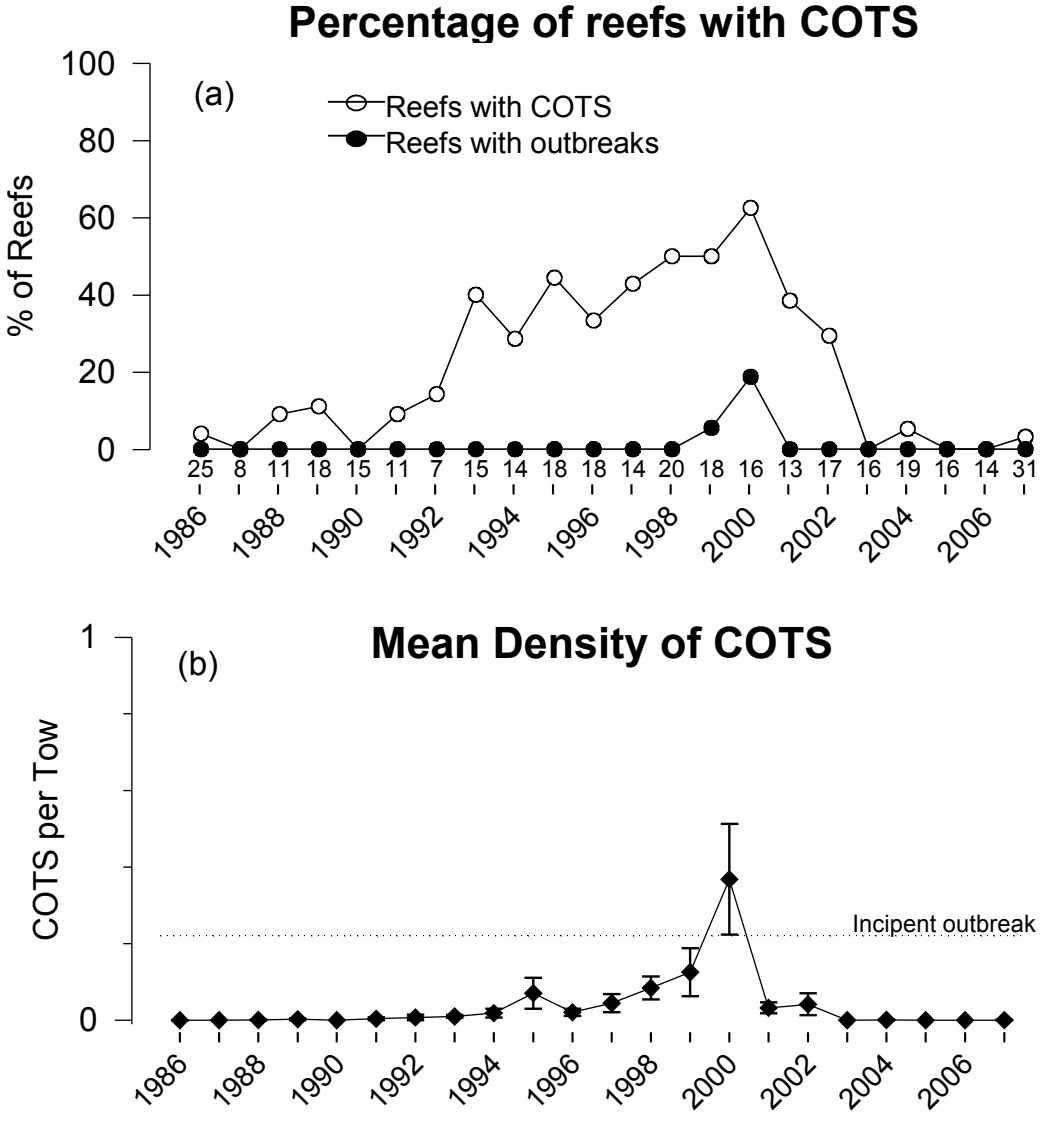


Cairns Sector

Trends in COTS

Reefs in this sector were last surveyed in January 2007.COTS have been observed in the majority of survey years since 1986. COTS populations increased after 1996 before reaching a peak in 2000 and declining by 2003. Small numbers of COTS have been recorded on only two occasions since then. COTS were recorded on only one reef (Rudder Reef) of the 31 reefs surveyed in 2007.

Figure 4.10



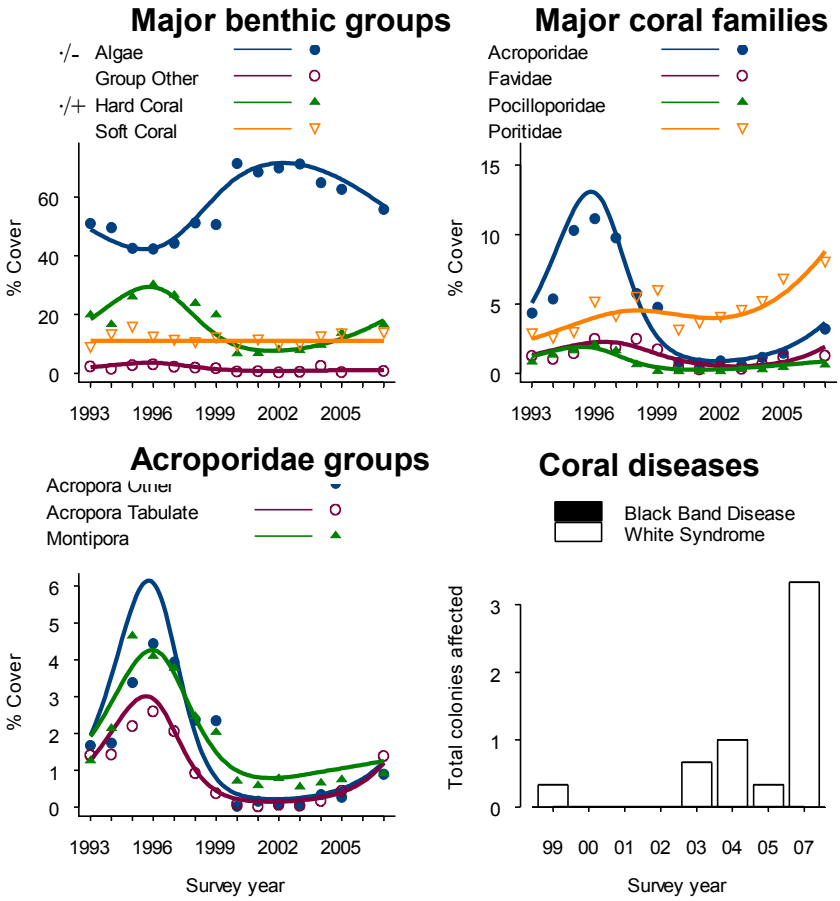
Cairns Sector

Inshore subregion

Trends in benthic organisms

In 2007 cover of hard coral increased on all intensive survey sites following a period of low coral cover around 2000 where the inshore reefs were exposed to cyclones, bleaching and COTS. Average cover of hard coral ranged from 7% at Green Is Reef to 26% at Fitzroy Is Reef. All the major hard coral families either increased or showed no recent change. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 56%.

Figure 4.11



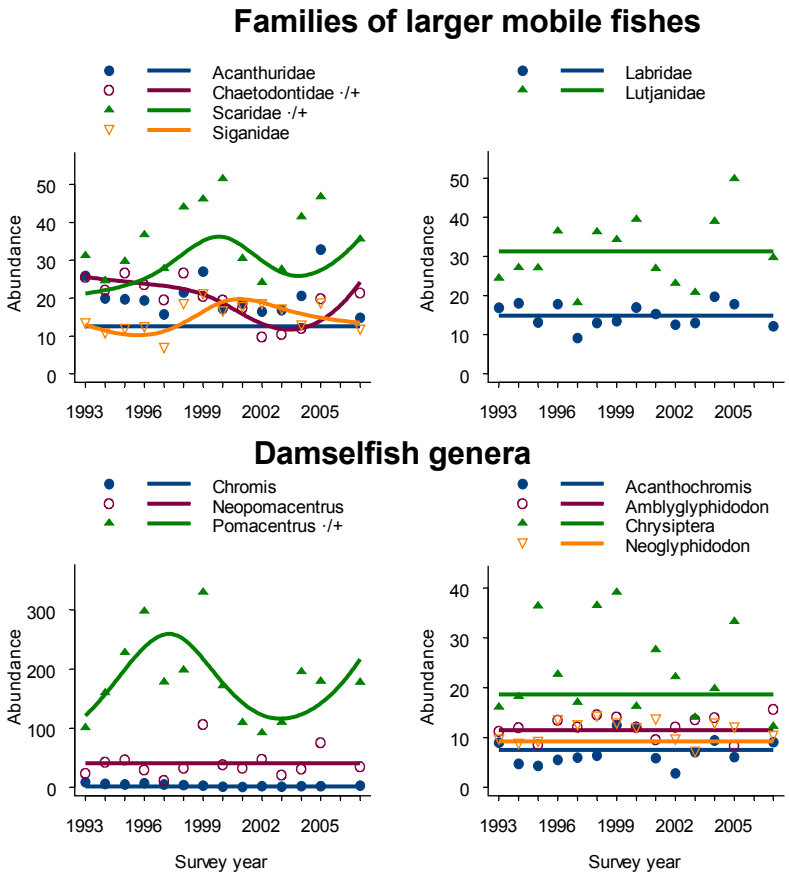
Cairns Sector

Inshore subregion

Trends in reef fishes

There were no consistent long term trends among fish taxa in this region probably due to the large fluctuations in coral habitat that occurred at all three reefs during the study period. Although fish often fluctuated in abundance over the 15 years, mean overall trajectories were mostly stable. In the case of Chaetodontidae and *Pomacentrus* spp., fish abundances tended to track changes in coral cover. Both these taxa include many coral dependent species. Abundances of Scaridae also tended to increase towards the end of the study as coral cover increased.

Figure 4.12



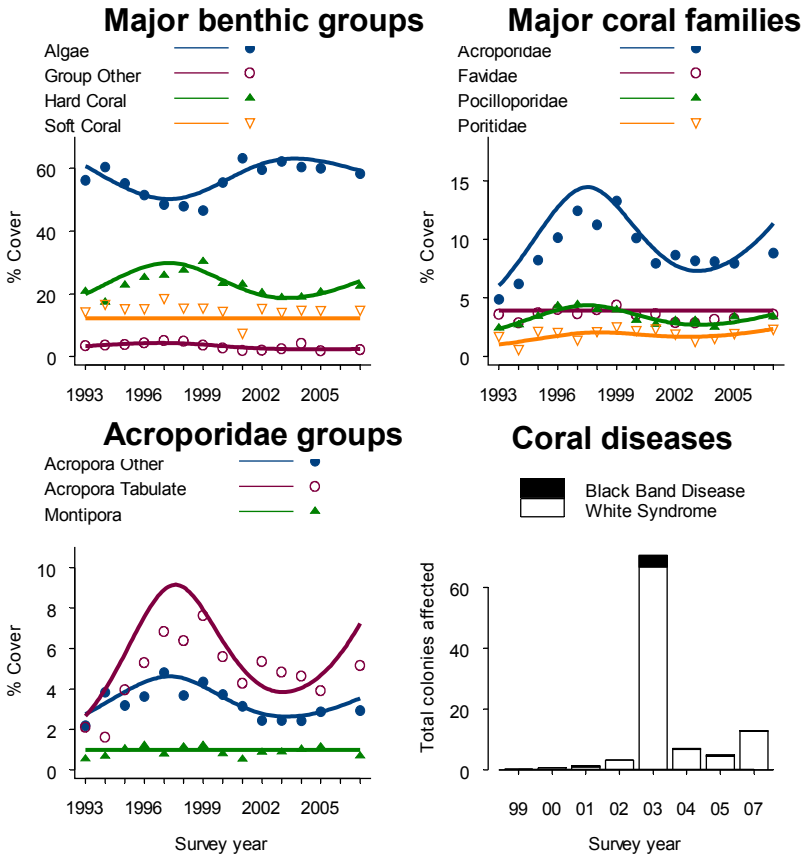
Cairns Sector

Mid-shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover increased from a decline around 2000 with the main coral families showing a similar trend or no net change. Average cover of hard coral in 2007 ranged from 16% at Thetford Reef, which is recovering from a COTS outbreak to 27% at Mackay Reef. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 58%.

Figure 4.13



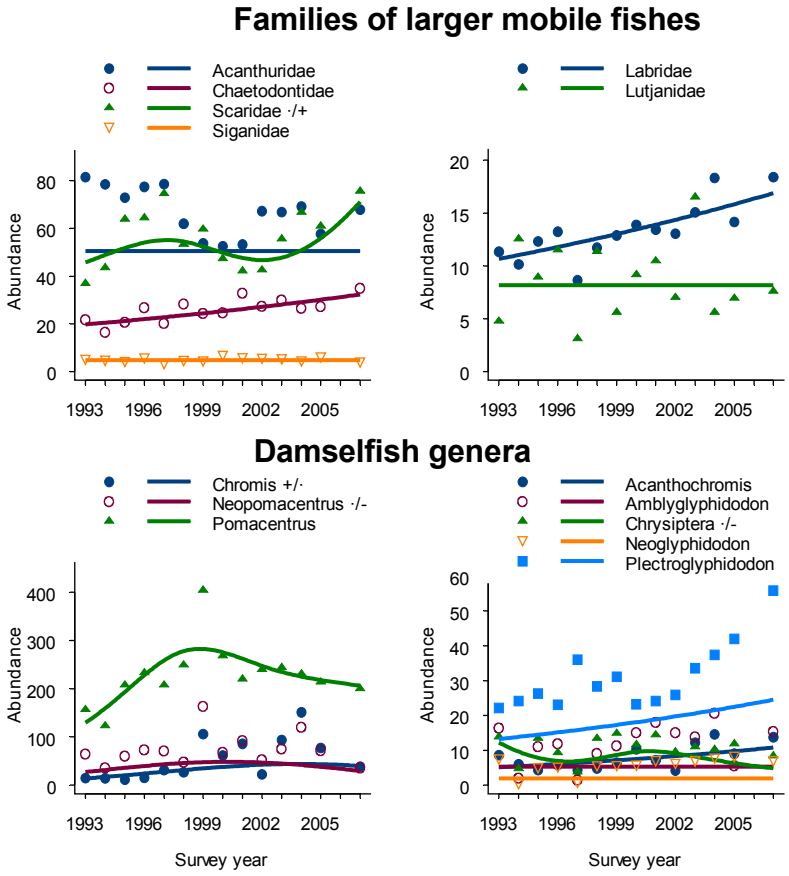
Cairns Sector

Mid-shelf subregion

Trends in reef fishes

Reef fish taxa have fluctuated in abundance over the study period but only one showed any consistent long term trend; abundances of *Chromis* spp. tended to increase over time. Abundances of Scaridae were at a 15-year high in 2007 due in part to increases in *Chlorurus microrhinos* and *Scarus rivulatus*. By 2007 abundances of two damselfish genera (*Neopomacentrus* and *Chrysiptera*) had declined. Numbers of *Neopomacentrus azysron* were particularly affected, being at a 15-year low in 2007. Mean coral cover had declined by 2000 (to a low of 16% at Thetford Reef) but was recovering by 2007 so changes in the benthic community seem unlikely to explain end of survey declines in *N. azysron*.

Figure 4.14



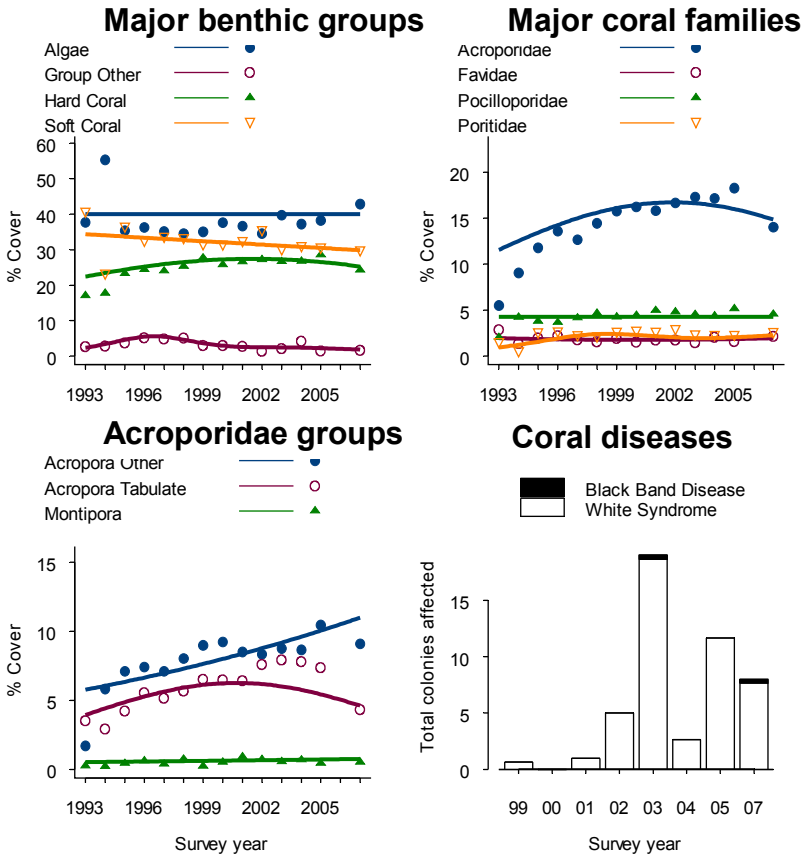
Cairns Sector

Outer shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover increased slightly from when surveys began in 1993 due largely to changes in *Acropora* spp. Average cover of hard coral in 2007 ranged from 19% at Opal Reef to 28% at St Crispin Reef. Averaged over the subregion, soft coral cover has remained higher than hard coral and in 2007 was 30%. In 2007 the average cover of algae was 43%.

Figure 4.15



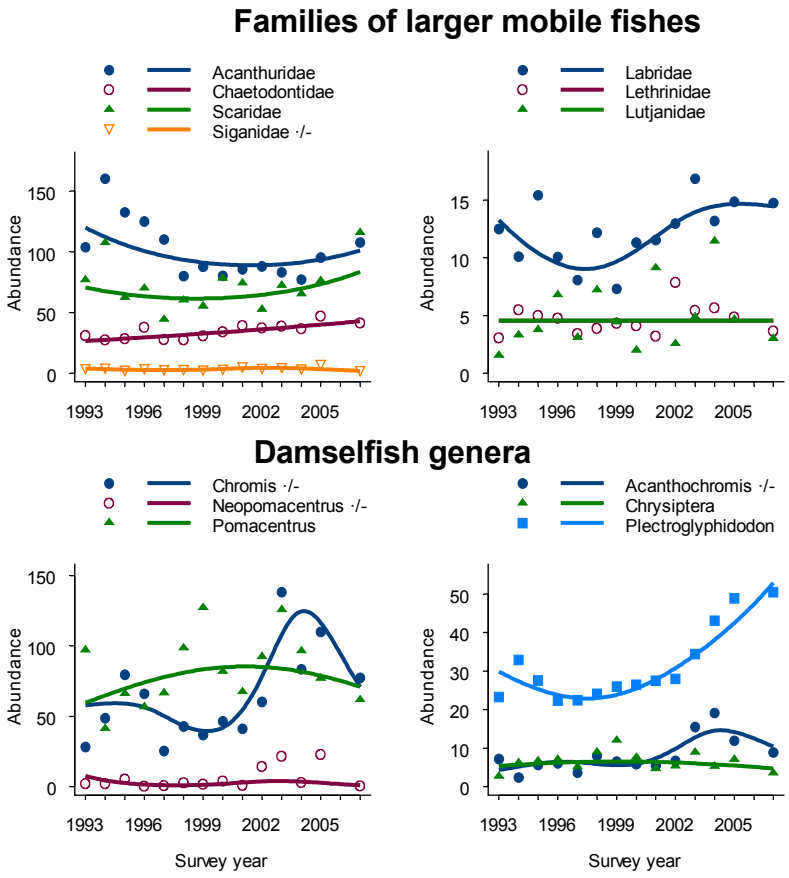
Cairns Sector

Outer shelf subregion

Trends in reef fishes

Patterns of abundance for most fish taxa have remained relatively stable throughout the study period with no long-term consistent increases or decreases. Declining abundance of Acanthuridae had stabilized by 1998 and had begun to increase in 2007. Short-term declines in abundance of three damselfish genera (*Chromis*, *Neopomacentrus* and *Acanthochromis*) at the end of the study period appear likely to reflect natural variation as benthic communities were relatively stable throughout. Increases in abundance of *Plectroglyphidodon* spp. from 2002 were driven by *P. lacrymatus* which farms algae and the highly coral dependent *P. dickii*.

Figure 4.16

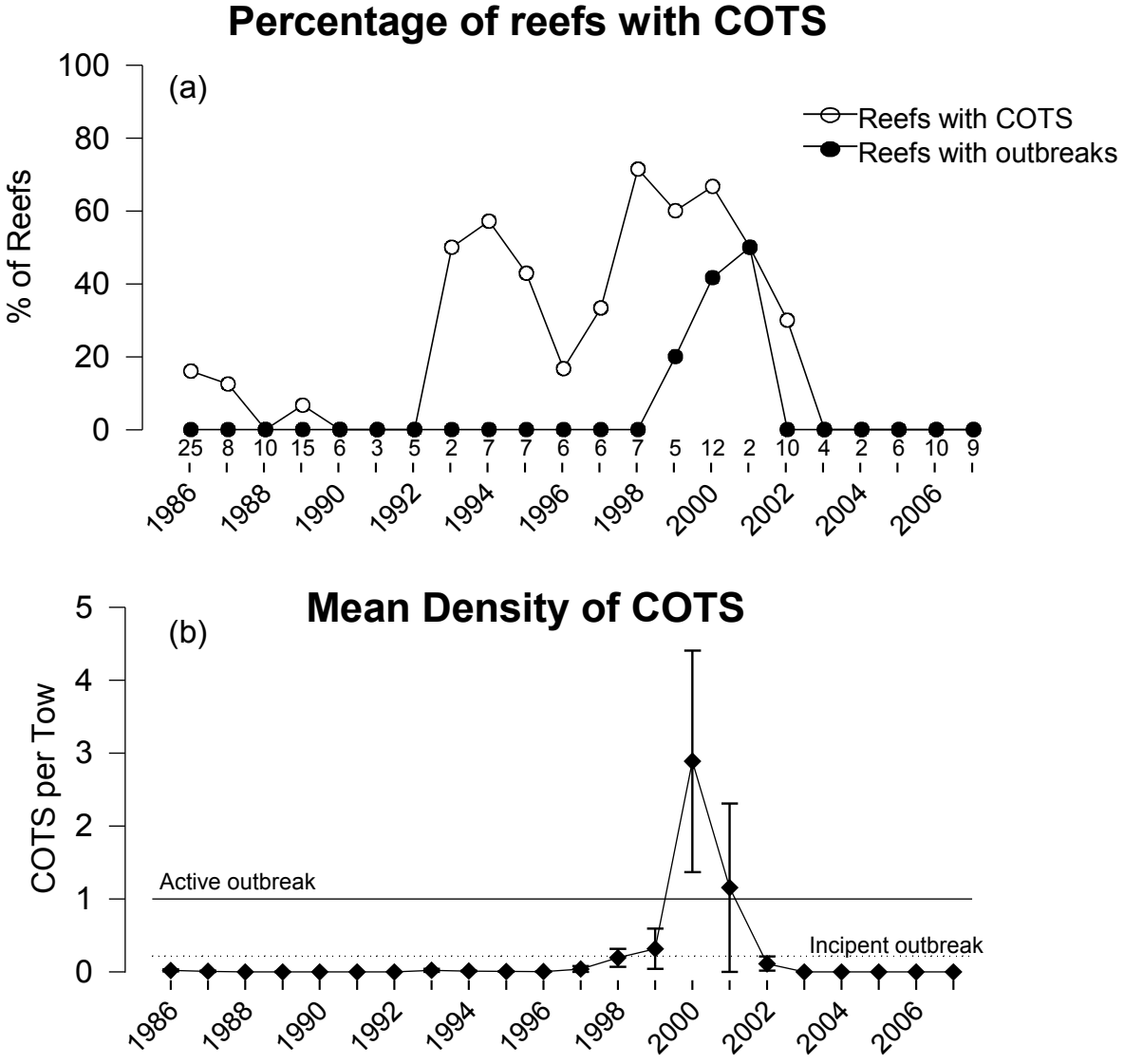


Innisfail Sector

Trends in COTS

Reefs in this sector were last surveyed in January 2007. Low level COTS activity was observed during the first few years of survey between 1986 and 1999. Small numbers of COTS were observed from 1993 until 1998 when there was a large increase in COTS activity. COTS numbers peaked in 2000 well above Active Outbreak densities at a regional scale before declining rapidly in 2002. No COTS have been observed in this sector since 2003.

Figure 4.17

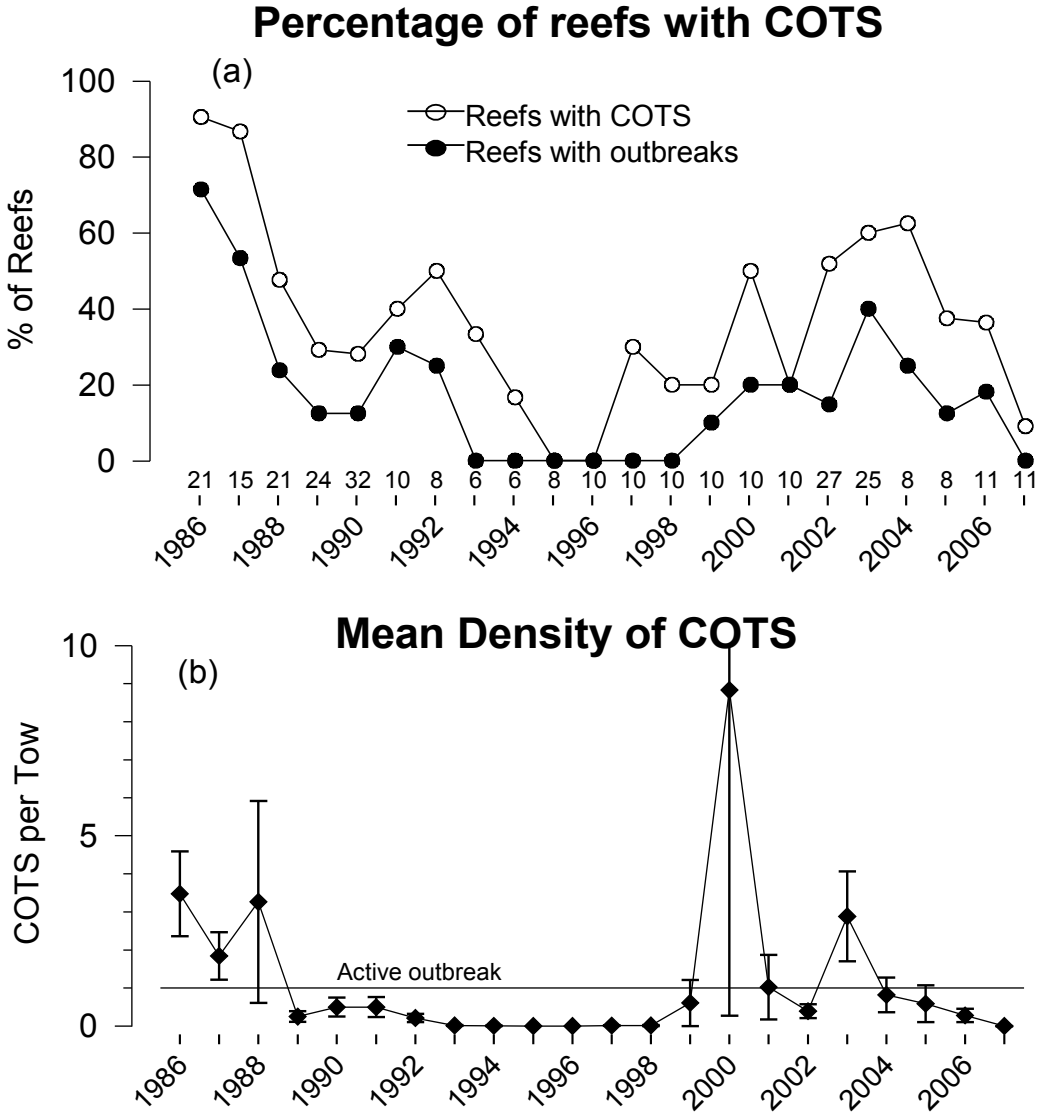


Townsville Sector

Trends in COTS

Reefs in this sector were last surveyed in June 2007. High COTS numbers at Active Outbreaks level over the sector were a feature of the first surveys in 1986. COTS numbers subsequently declined and no COTS outbreaks were recorded after 1993. Despite the lack of outbreaks low numbers of COTS continued to be observed before numbers began to rebuild after 1998. COTS numbers continued to increase beyond Active Outbreak intensities across the sector, peaking in 2000 before declining to below these levels by 2004. No Active Outbreaks were recorded in this sector in 2007 for the first time since1999.

Figure 4.18



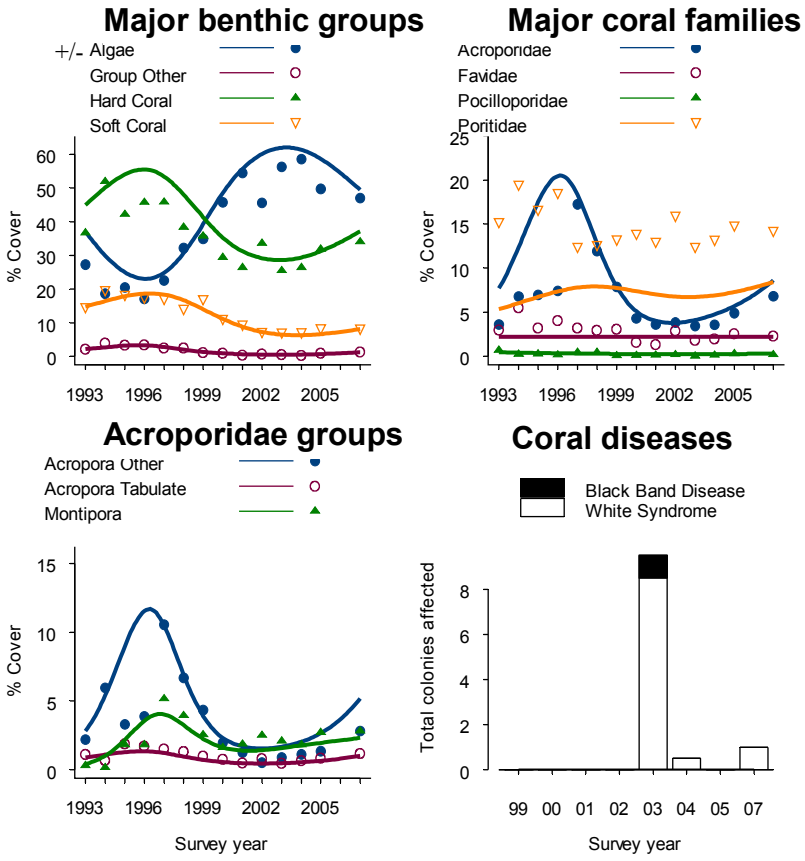
Townsville Sector

Inshore subregion

Trends in benthic organisms

There were no substantial trends in hard coral cover. In 2007 hard coral cover was increasing following a prolonged period of low coral cover where the inshore reefs were exposed to cyclones, bleaching and floods. Average cover of hard coral ranged from 7% at Havannah Is Reef to 49% at Pandora Reef. Changes in hard coral cover have been mostly due to changes in Acroporidae. There was no net change in soft coral cover with the same trend of decline and recovery being evident. There was a substantial change in algal cover both for the entire period of survey and in 2007, indicating that there was a substantial decrease in 2007 from previous levels although algal cover was still higher than in 1993.

Figure 4.19



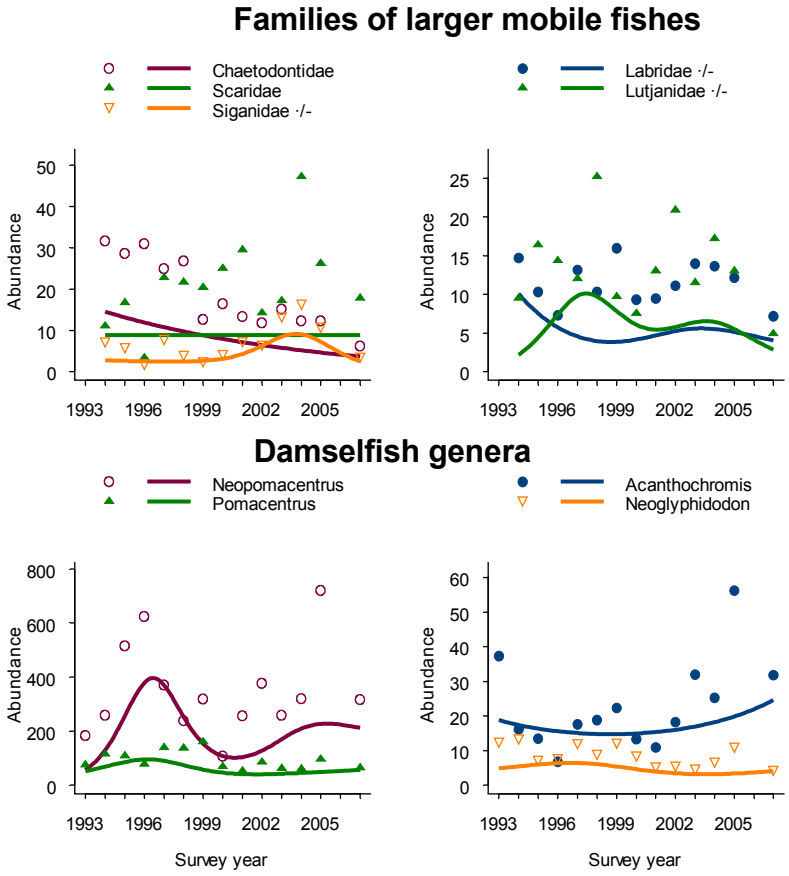
Townsville Sector

Inshore subregion

Trends in reef fishes

Although no fish taxa increased or decreased in abundance consistently, there were marked fluctuations in abundance over time reflecting decreases in coral cover that occurred up to 2001. Certain coral dependent *Chaetodon* spp. (i.e. *C. aureofasciatus*) and *Pomacentrus* spp. (i.e. *P. moluccensis*) suffered major declines as corals declined. In 2007 abundances of many taxa were relatively low with Chaetodontidae, Labridae, Lutjanidae and *Neoglyphidodon* spp. being at 15-year lows. Many of these trends were driven by trends at Havannah Is Reef where coral cover had shown minimal recovery from extensive bleaching and cyclone induced mortality and macroalgal growth was abundant.

Figure 4.20



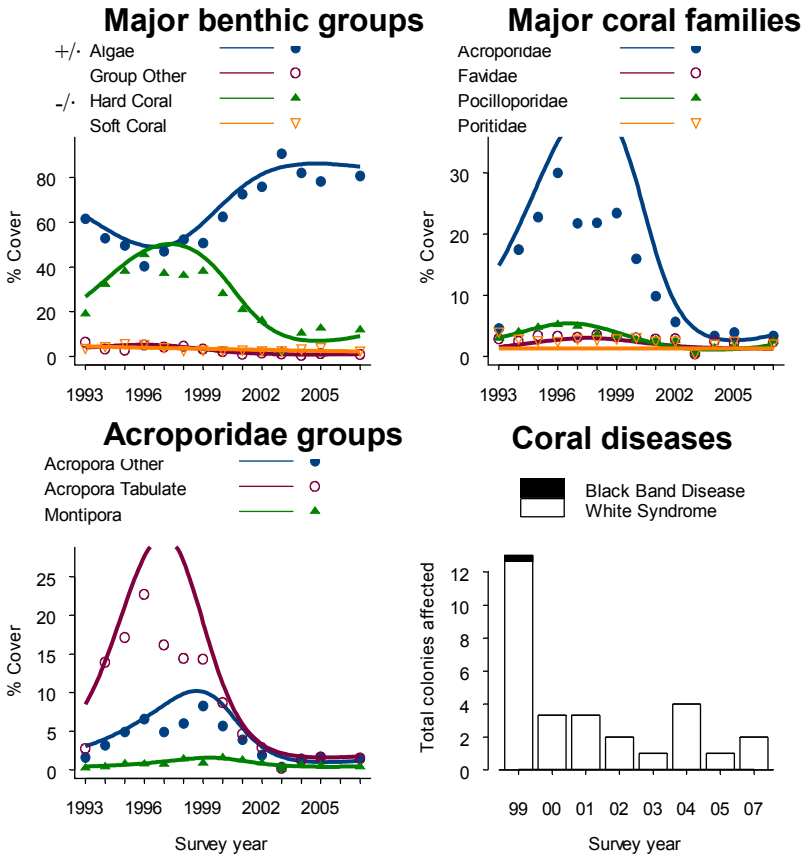
Townsville Sector

Mid-shelf subregion

Trends in benthic organisms

There were substantial declines in hard coral cover on the intensive survey sites due to COTS outbreaks. Hard coral cover decreased from around 1996 with the main coral families all declining or showing no net change. Reefs in this subregion are typically dominated by *Acropora* spp. which are the main drivers of change in hard coral cover. Average cover of hard coral in 2007 ranged from 1% at John Brewer Reef to 28% at Davies Reef. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 81%.

Figure 4.21



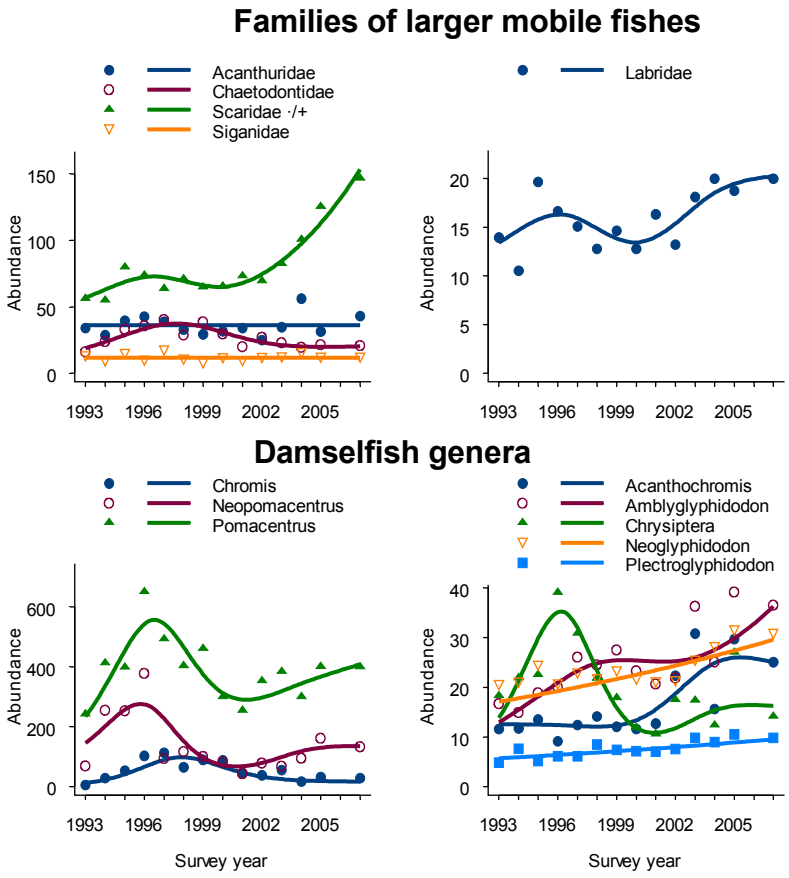
Townsville Sector

Mid-shelf subregion

Trends in reef fishes

Although no fish taxa consistently increased or decreased in abundance there were marked fluctuations reflecting major decreases in coral cover that occurred up to 2003. Abundance of certain coral dependent *Chaetodon* spp. (i.e. *C. baronessa)*, *Chromis* spp. (i.e. *C. atripectoralis*) and *Pomacentrus* spp. (i.e. *P. moluccensis*) declined as corals declined. In contrast, during the later survey period when coral cover was lowest, abundances of the herbivorous Scaridae showed marked increases to a 15-year high in 2007. This trend,most driven by *Scarus rivulatus* and *S. schlegeli*, may reflect the increased supply of algal food.

Figure 4.22



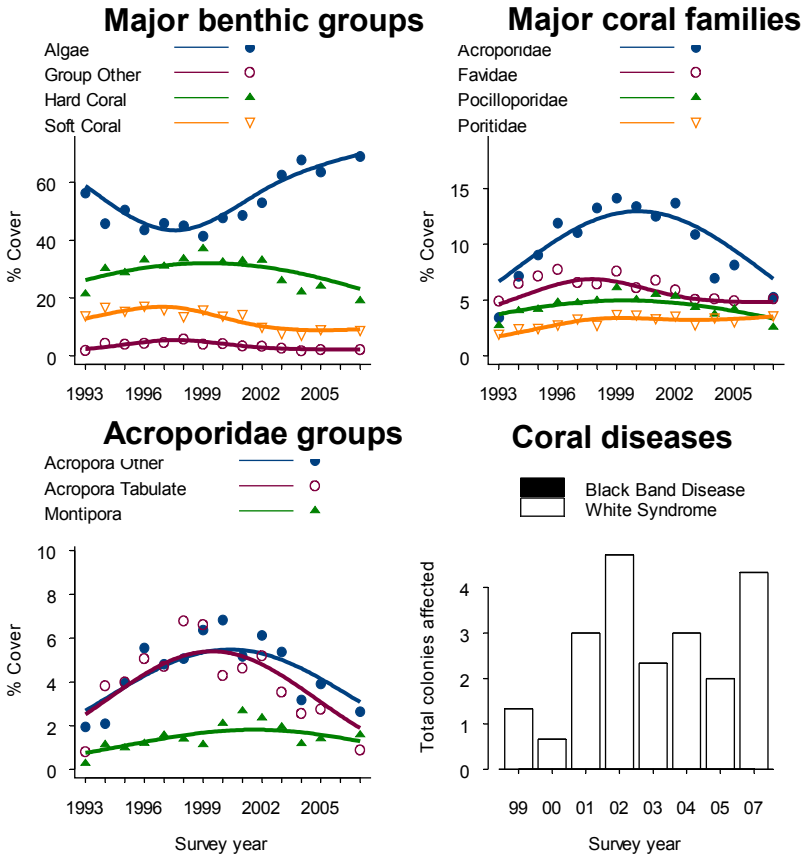
Townsville Sector

Outer shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover increased initially but has been slowly decreasing since 1999 with the main coral families declining or showing no net change. Average cover of hard coral in 2007 ranged from 14% at Chicken Reef which has had COTS outbreaks to 24% at Myrmidon Reef. Reefs in this subregion have been affected by COTS, bleaching, and storm activity. There was no net change in soft coral cover over the survey period, although a small decline was evident as for hard coral cover . In 2007 the average cover of algae was 69%.

Figure 4.23



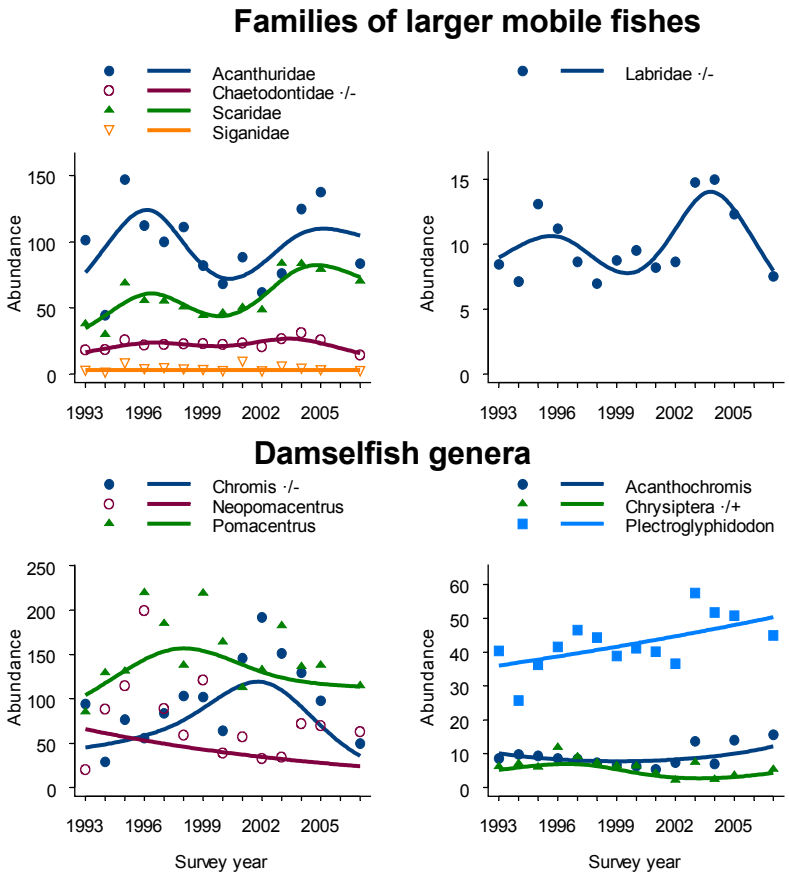
Townsville Sector

Outer shelf subregion

Trends in reef fishes

Although no fish taxa consistently increased or decreased in abundance there were marked fluctuations in abundance over time reflecting decreases in coral cover that occurred from 2002 to 2007. Certain coral dependent *Chaetodon* spp. and *Chromis* spp. declined in abundance as coral cover decreased. In 2007 abundances of *Chaetodon* spp. were at a 15-year low. Abundances of Labridae also declined late in the survey period but in 2007 abundances were still in the range of many previous values. Scaridae abundances were highest when coral cover was lowest and algal cover highest. This trend, driven by a few species, may reflect the increased supply of algal food. Abundances of *Chrysiptera* spp. were increasing in 2007, after reaching low levels in 2004.

Figure 4.24

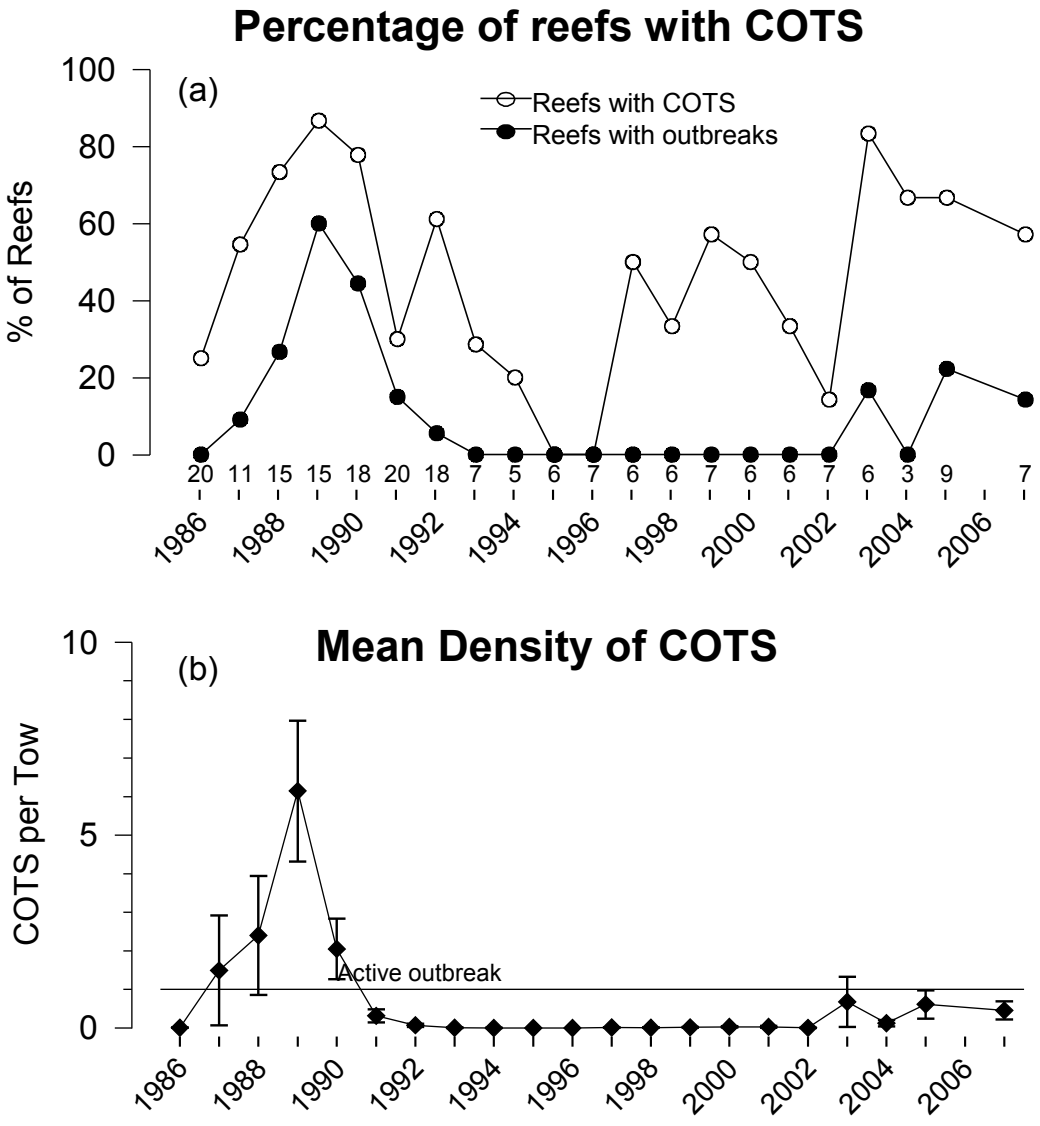


Cape Upstart Sector

Trends in COTS

Reefs in this sector were last surveyed in June 2007. No Active Outbreaks were recorded in this sector during the first year of surveys in 1986. COTS numbers subsequently increased rapidly with COTS numbers exceeding Active Outbreaks levels by 1987. COTS numbers continued to increase, peaking in 1989 before declining below Active Outbreak levels across the sector by 1991. No Active Outbreaks were recorded by 1993 and COTS numbers remained low through to 2002. COTS numbers began to rebuild in 2003 with an Active Outbreak recorded from one (Charity Reef) of six reefs surveyed that year. Active Outbreaks of COTS continue to be recorded from this sector with one Active Outbreak recorded at Shell Reef in 2007. Despite persistent outbreaks on reefs in this sector in recent years, COTS numbers have not reached the intensities recorded during the initial series of outbreaks at the beginning of surveys.

Figure 4.25

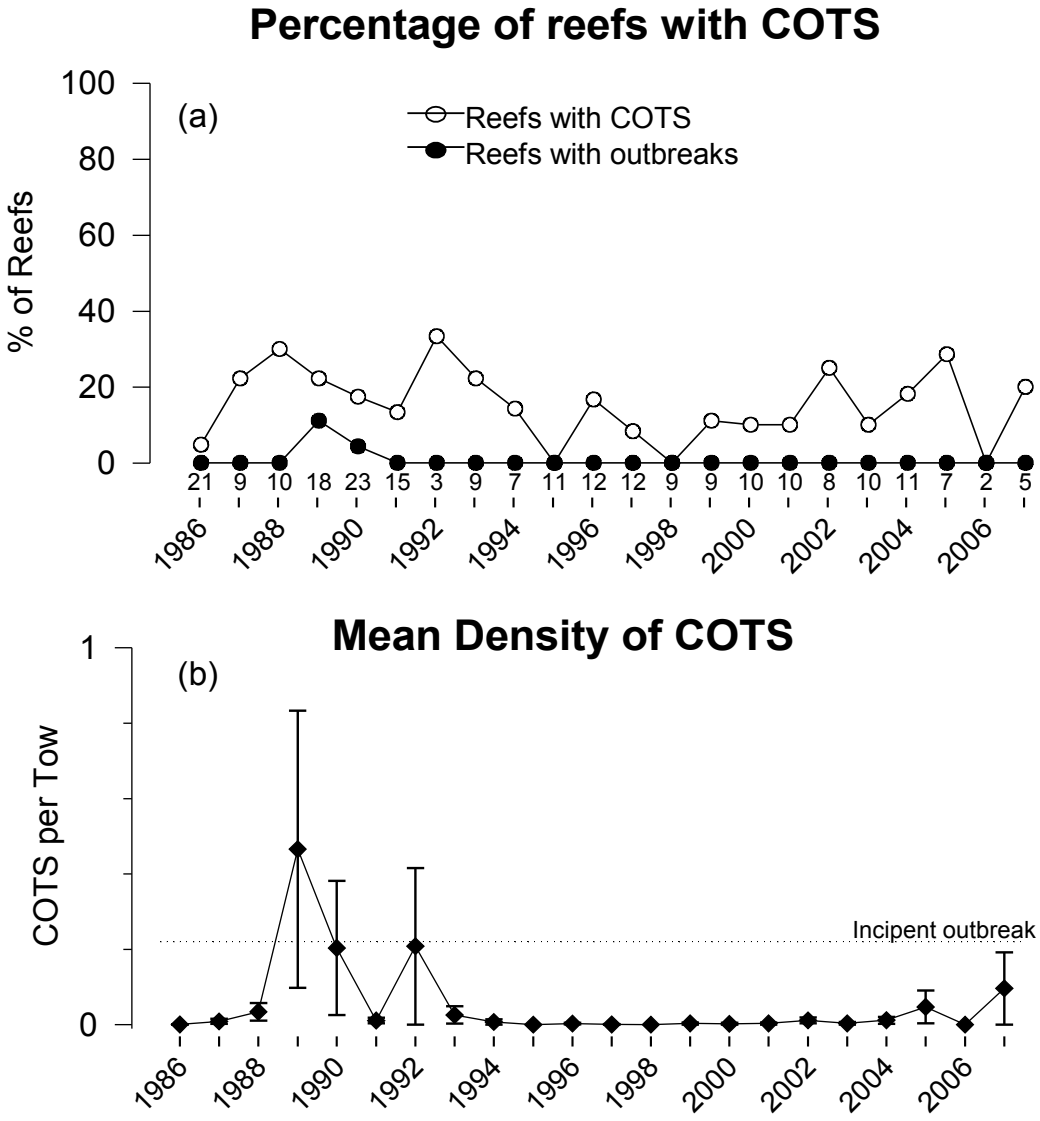


Whitsunday Sector

Trends in COTS

Reefs in this sector were last surveyed in April 2007. No Active Outbreaks were recorded in this sector during the first years of surveys through to 1988. COTS numbers subsequently increased rapidly with COTS numbers exceeding Incipient Outbreaks levels by 1989. COTS numbers subsequently decreased dropping below outbreak levels by 1991. Low numbers of COTS have been recorded in the majority of survey years since then though there have been no Active Outbreaks. There has been a recent increase in COTS activity in this sector with an Incipient Outbreak recorded at Reef 20-104 in 2007.

Figure 4.26



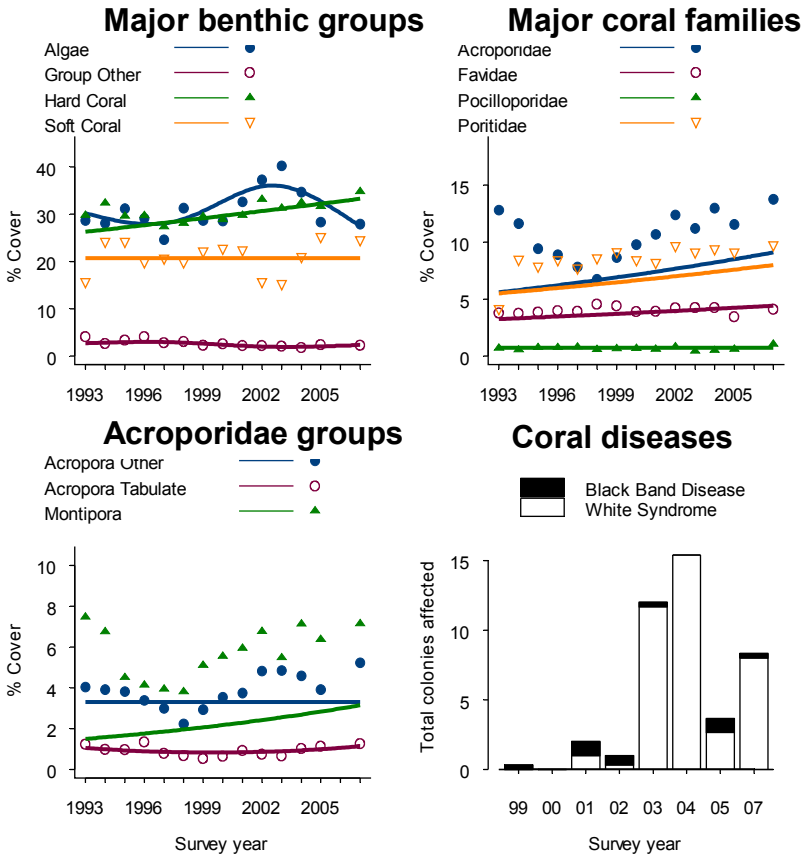
Whitsunday Sector

Inshore subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover mainly reflected changes in Acroporidae. Average cover of hard coral in 2007 ranged from 26% at Border Is Reef to 51% at Hayman Is Reef. There was no net change in soft coral cover over the survey period, fluctuating around 20%. In 2007 the average cover of algae was 28%.

Figure 4.27



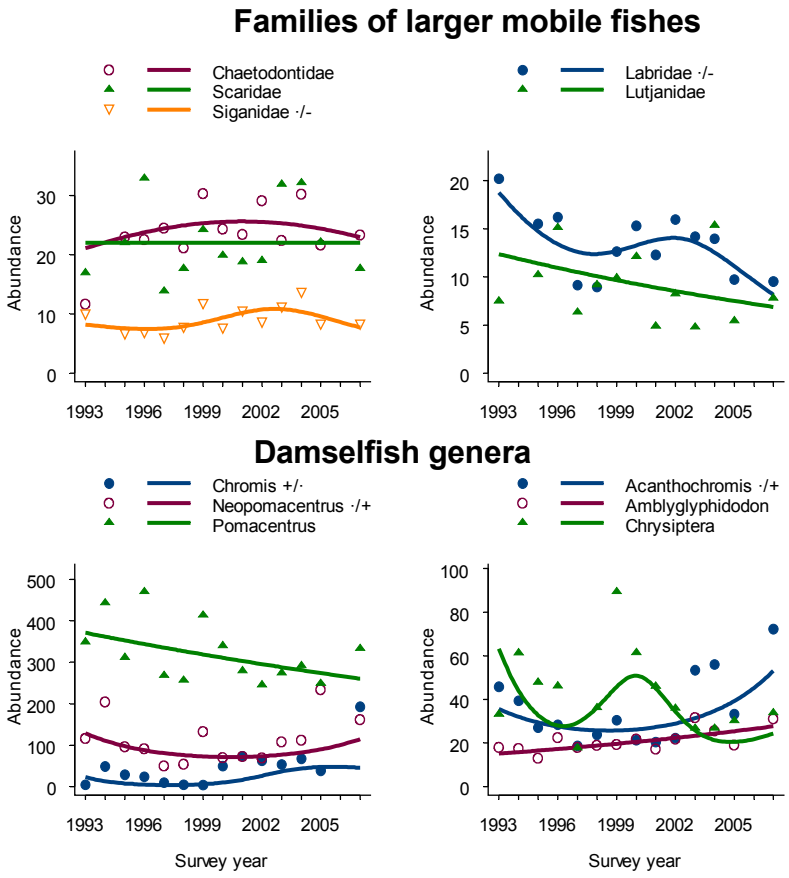
Whitsunday Sector

Inshore subregion

Trends in reef fishes

Abundances of large mobile fish families generally remained stable over the study period with long-term trends. However, towards the end of the survey period abundances of Siganidae and Labridae had decreased but not to extreme levels. Consistent increases in abundance of *Chromis* spp., many of which are coral dependent, reflected consistent increases in coral cover. In 2007 abundance of *Acanthochromis polyacanthus* had increased dramatically to a 15-year high. In 2005, abundances of *Neopomacentrus* spp. had also increased dramatically but declined again by 2007.

Figure 4.28



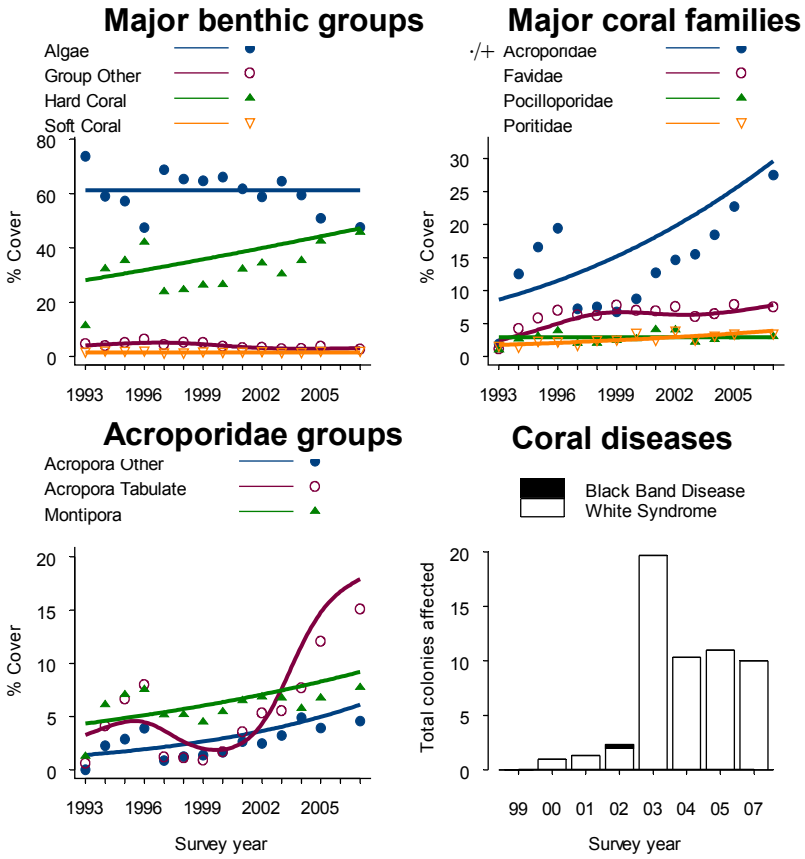
Whitsunday Sector

Mid-shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral cover has tracked changes in Acroporidae, declining due to COTS and storm activity in the 1990s. In recent years there have been no major disturbances and coral cover has been increasing. Average cover of hard coral in 2007 ranged from 41% at Reef 19-131 to 48% at Reef 20-104. There was no net change in soft coral cover over the survey period. In 2007 the average cover of algae was 28%.

Figure 4.29



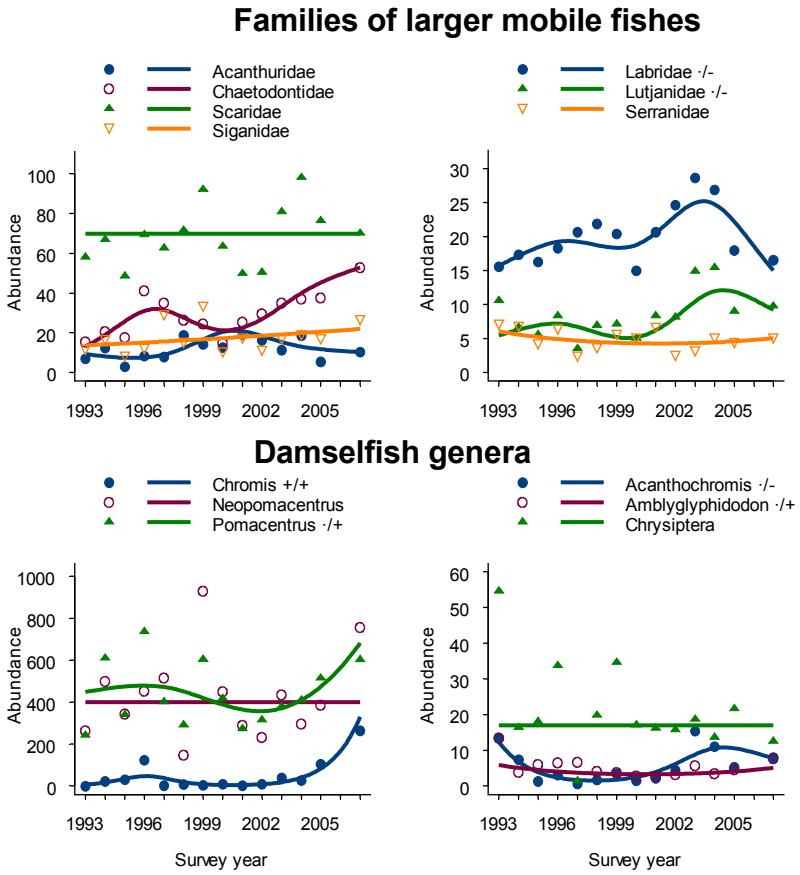
Whitsunday Sector

Mid-shelf subregion

Trends in reef fishes

Although no large mobile fish families showed any consistent long-term trends in abundance there were considerable fluctuations in some taxa. The abundance of Chaetodontidae tended to track changes in coral cover, reflecting the coral dependency of many chaetodontid species. Towards the end of the survey period abundances of Labridae and Lutjanidae had decreased. Even so, labrid and lutjanid abundances in 2007 were still within the previously recorded range. Abundances of *Chromis* spp., *Pomacentrus* spp. and *Amblyglyphidodon* spp. increased towards the end of the survey period, coinciding with the time of greatest coral cover increase. These patterns were caused by a range of coral dependent species including *C. atripectoralis*, *C. ternatensis*, *C. weberi* and *P. moluccensis*. Abundances of *Chromis* spp. and *Amblyglyphidodon* spp. were at a 15-year high in 2007.

Figure 4.30



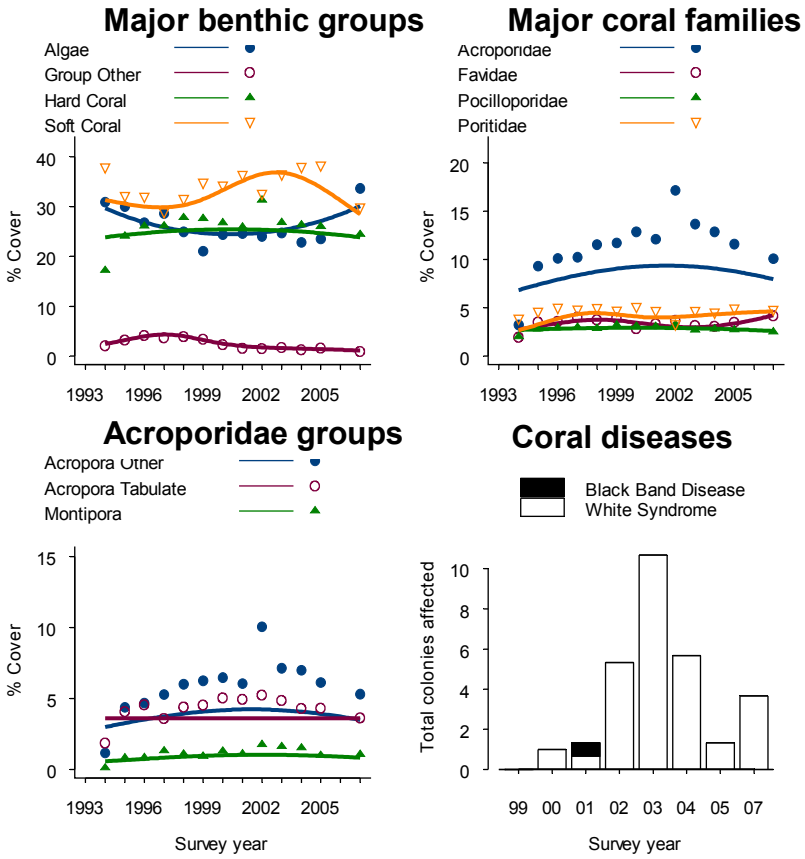
Whitsunday Sector

Outer shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Hard coral has averaged 26% and been stable over the survey period. Average cover of hard coral in 2007 ranged from 17% at Hyde Reef to 38% at Slate Reef. Averaged over the subregion soft coral cover has been consistently more abundant than hard coral and in 2007 was 30%. In 2007 the average cover of algae was 34%.

Figure 4.31



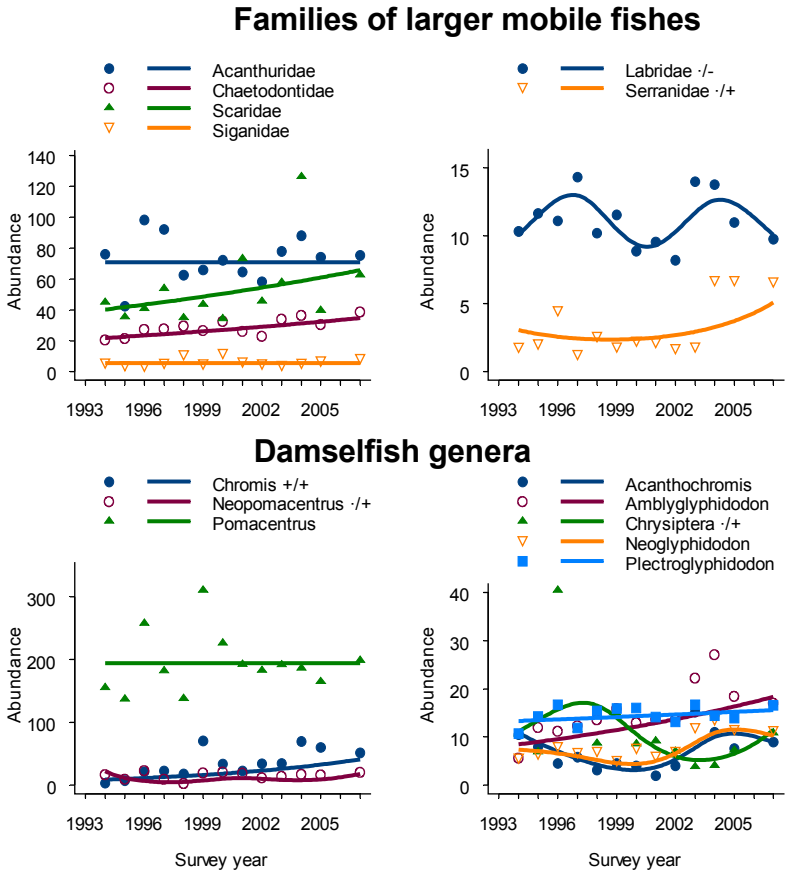
Whitsunday Sector

Outer shelf subregion

Trends in reef fishes

Abundances of large mobile fish families generally remained stable over the study period. However, in 2004 abundances of Serranidae had increased considerably to a survey high and this level was sustained until 2007. This pattern was driven by the commercially important coral trout (*Plectropomus leopardus*). Abundances of most damselfishes were relatively stable over the study period except for *Chromis* spp., that showed consistent increases in abundance, and *Neopomacentrus* spp. and *Chrysiptera* spp. that increased in abundance towards the end of the survey period. In general the stable or increasing abundances of fish taxa in this region reflect low levels of habitat disturbance over a long period.

Figure 4.32

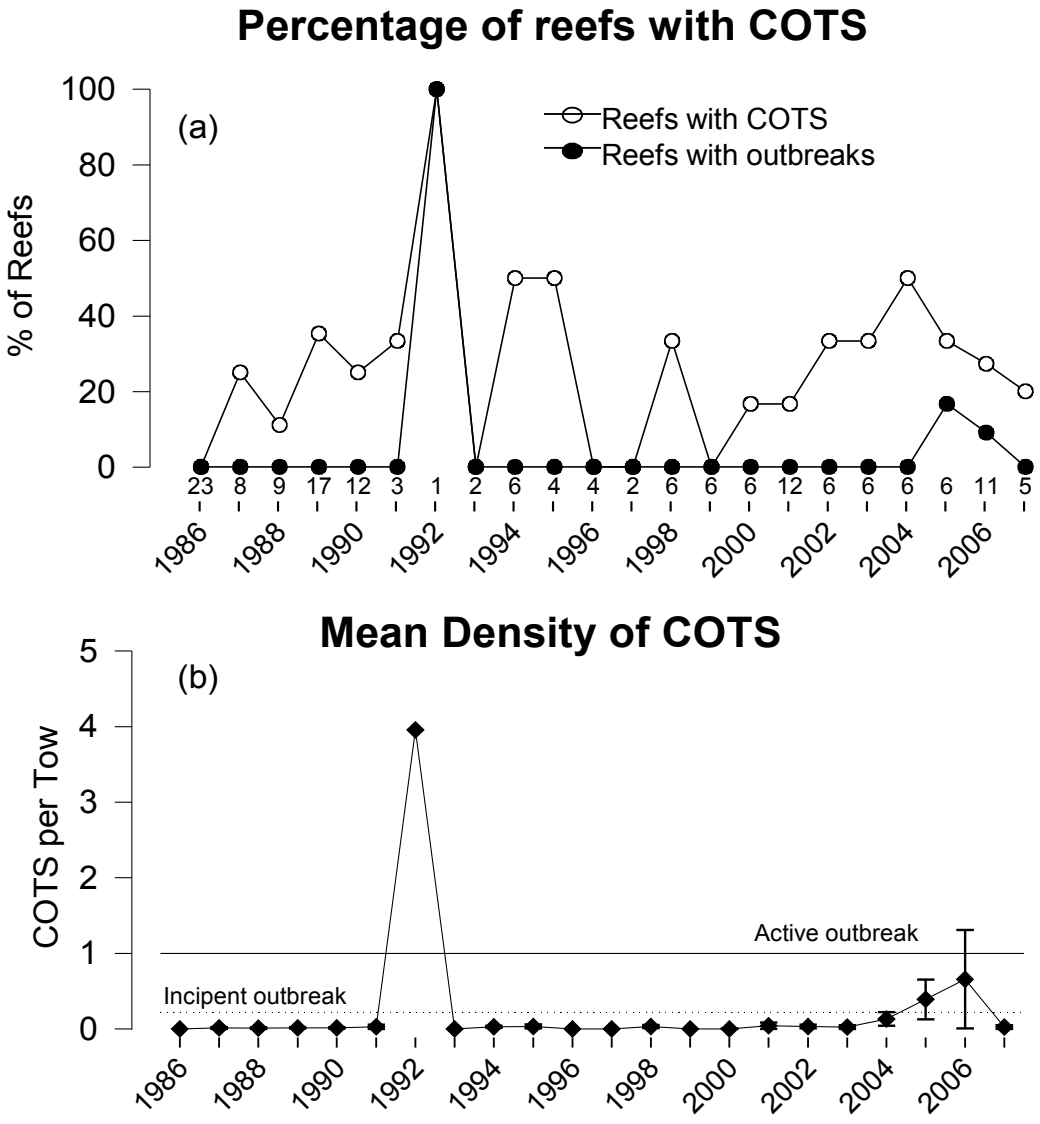


Pompey Sector

Trends in COTS

Reefs in this sector were last surveyed in April 2007. No Active Outbreaks were recorded in this sector during the first years of surveys through to 1992. In that year a single reef was surveyed (Reef 21-155) that had an Active Outbreak so this would be a poor reflection of patterns in the sector as a whole. In general small numbers of COTS well below outbreak levels have been recorded from this sector in the majority of survey years. Between 2004 and 2006 there was an increase in COTS activity in this sector. This was mainly due to an ongoing COTS outbreak on Credlin Reef (from 2004-2006) and Incipient Outbreaks on Briggs Reef (in 2004) and Cannan Reef (in 2005). No outbreaks were recorded from any reefs in 2007 and COTS remained in numbers well below levels that would affect coral cover.

Figure 4.33

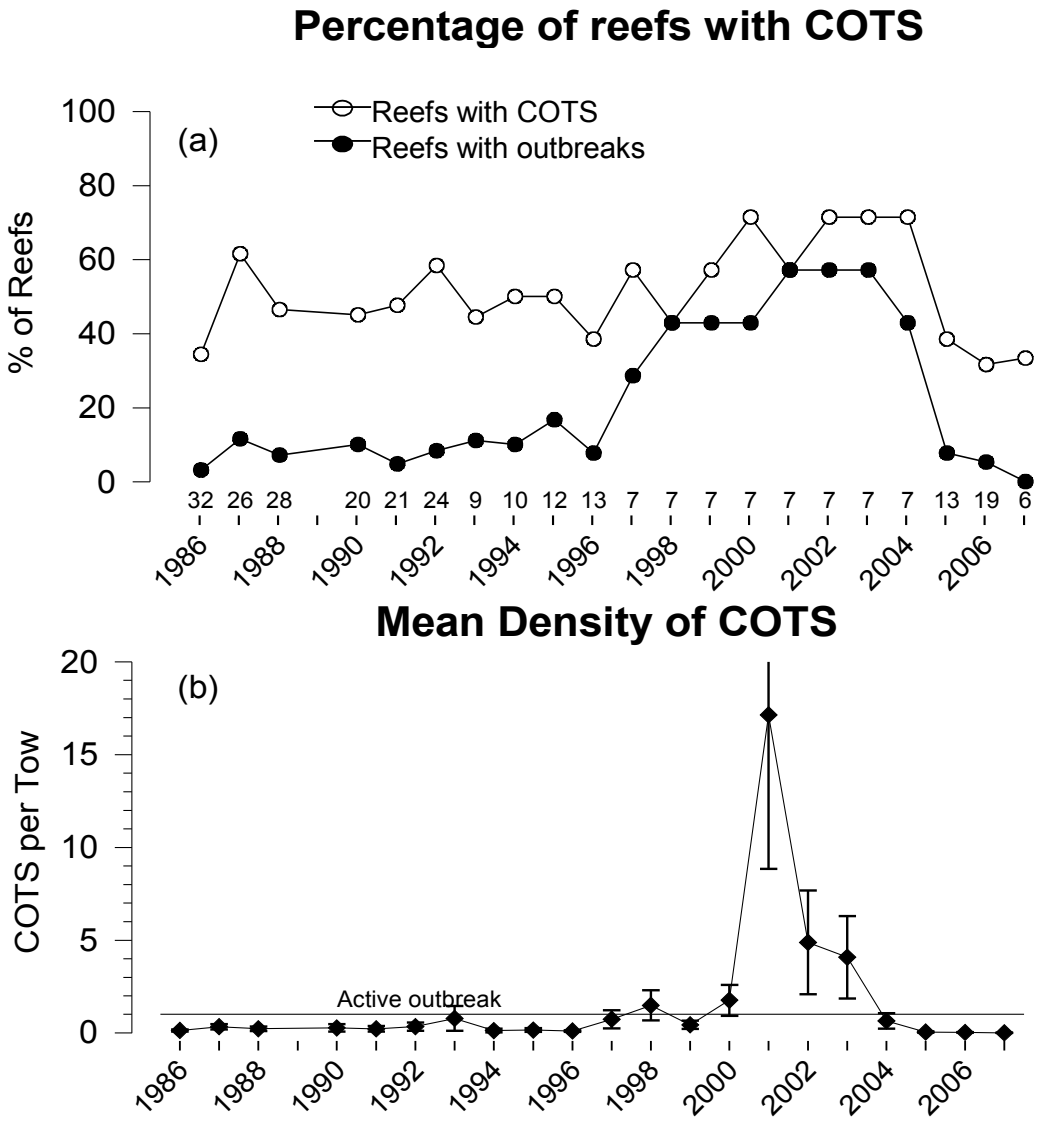


Swain Sector

Trends in COTS

Reefs in this sector were last surveyed in November 2006. COTS have been active on reefs in this sector since the first surveys were conducted in 1986. Individual reefs with Active Outbreak levels of COTS have been recorded in nearly every year of survey. From 1999 there was a marked increase in COTS activity on reefs in this sector exceeding Active Outbreak levels for the sector by 2000. Reefs sustained this high level of COTS activity through to 2003 before dropping below Active Outbreak levels in 2004. COTS activity has continued to decline in this sector since this time. 2007 was the first survey year that no Active COTS outbreaks have been recorded from this sector though some residual COTS activity remains.

Figure 4.34



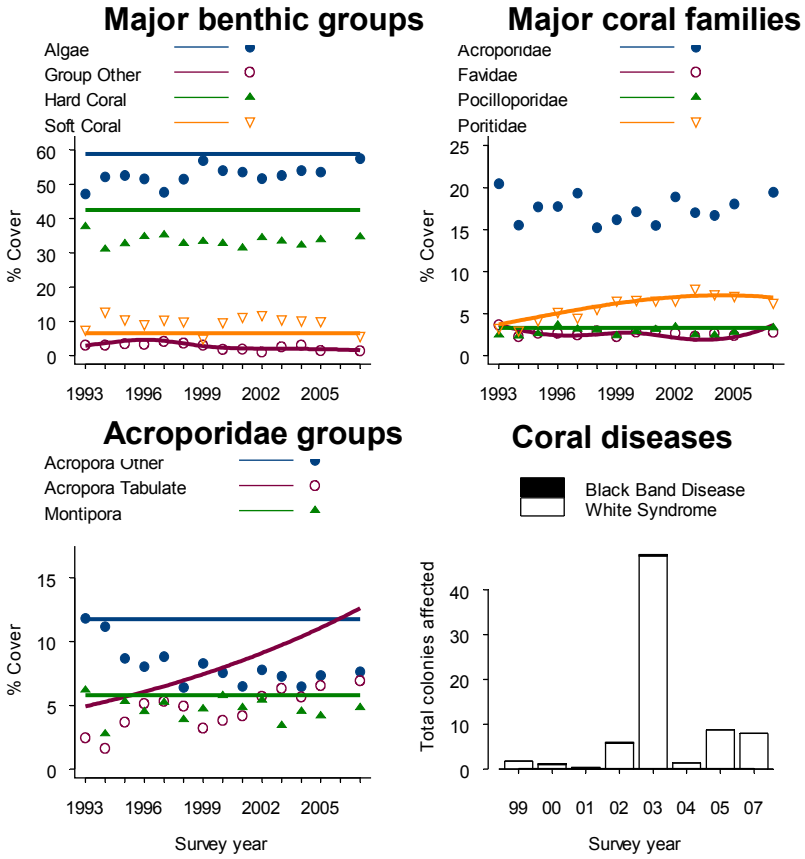
Swain Sector

Mid-shelf subregion

Trends in benthic organisms

The absence of long and short term trends in benthos for Swain mid-shelf reefs reflect the variable timing and intensity of pressures and responses for each reef. Three of the four reefs in the subregion have had COTS outbreaks and in 2007 were in early (Gannet Cay Reef, Horseshoe Reef) or later (Snake Reef) stages of recovery.

Figure 4.35



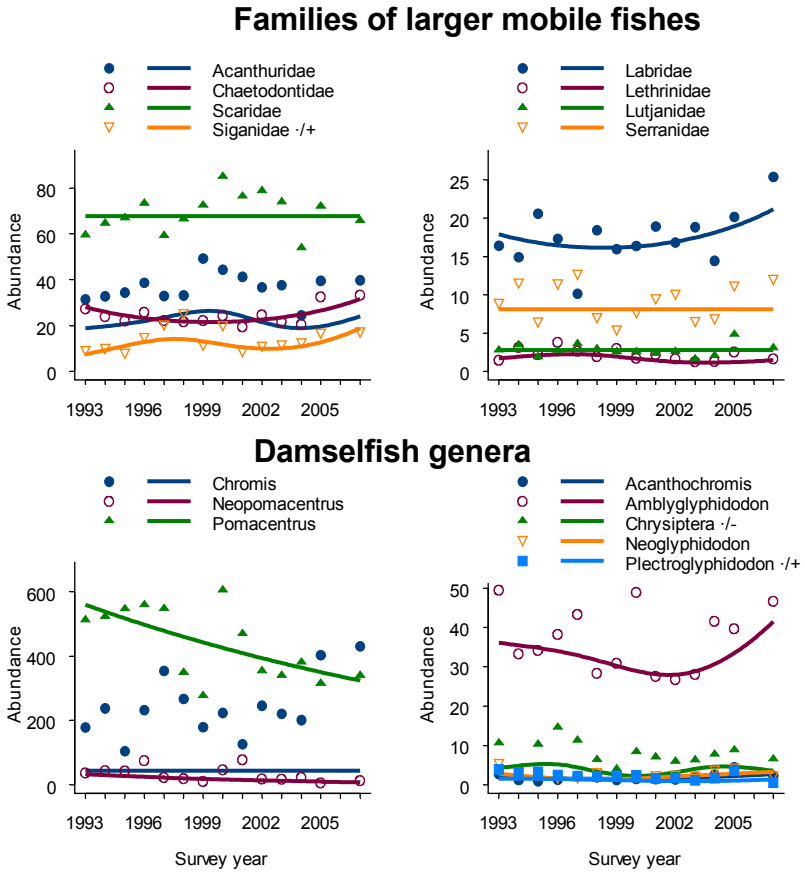
Swain Sector

Mid-shelf subregion

Trends in reef fishes

Fish families and genera appear to have remained generally stable with no consistent long-term trends in abundance. However, this subregion is unusual in having 5 surveys reefs (most have 3) that showed very different coral cover trajectories (increases, stable and high, decreases) and so influenced fish communities in different ways. The average patterns are based on very variable counts and should be interpreted with caution.

Figure 4.36



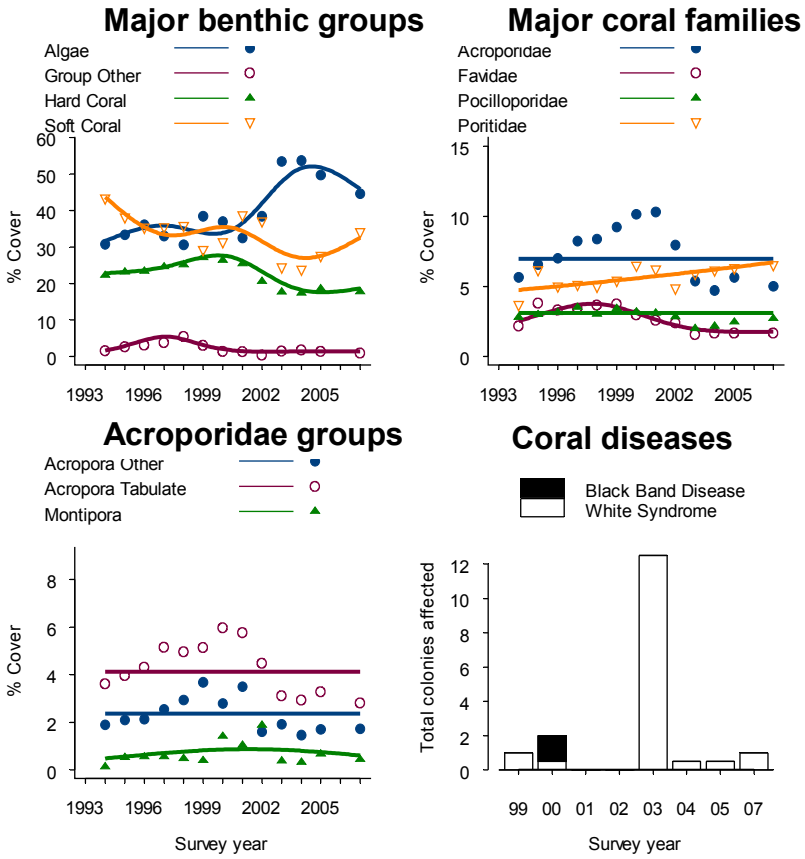
Swain Sector

Outer shelf subregion

Trends in benthic organisms

There were no substantial short or long term trends in benthic cover on the intensive survey sites. Two reefs were surveyed in this subregion. Average cover of hard coral in 2007 ranged from 16% at Turner Cay Reef, which is recovering from a COTS outbreak to 20% at East Cay Reef where coral cover has been stable over the survey period. There was no long term change in soft coral cover which has recovered to previous high levels following 2002 bleaching mortality. In 2007 the average cover of algae was 45%.

Figure 4.37



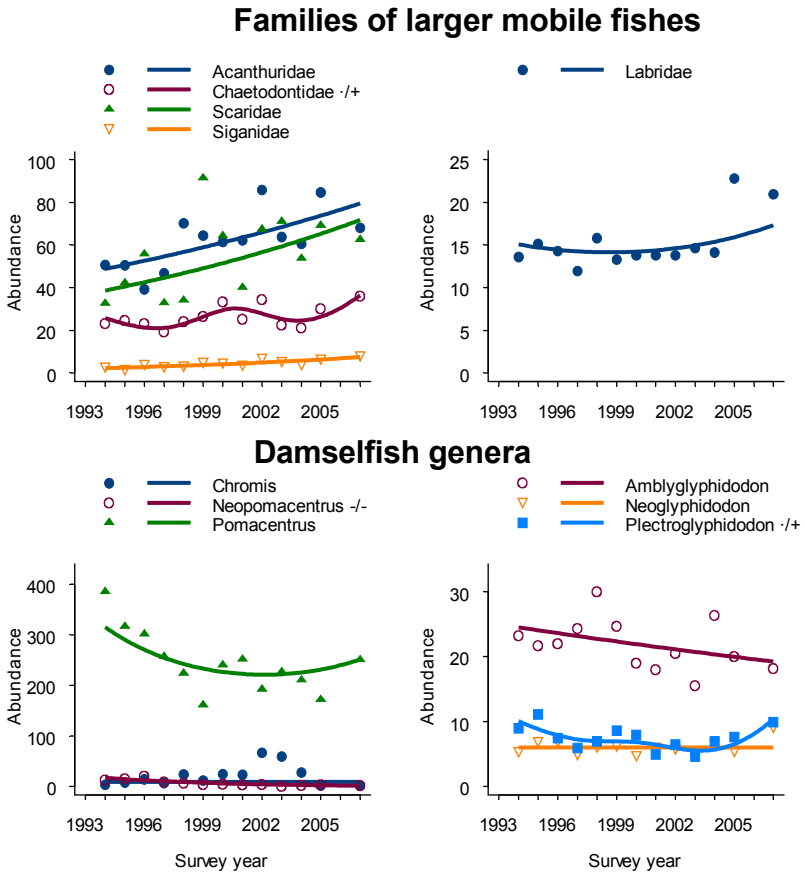
Swain Sector

Outer shelf subregion

Trends in reef fishes

Abundances of most large mobile fish and damselfish taxa have fluctuated over the study period but have shown no long term trends with the exception of *Neopomacentrus* spp. Abundance of this genus (dominated by the small planktivore, *N. azysron*) were low in 2007 having decreased from a high in 2002. Abundance of Chaetodontidae were at a survey high in 2007.

Figure 4.38

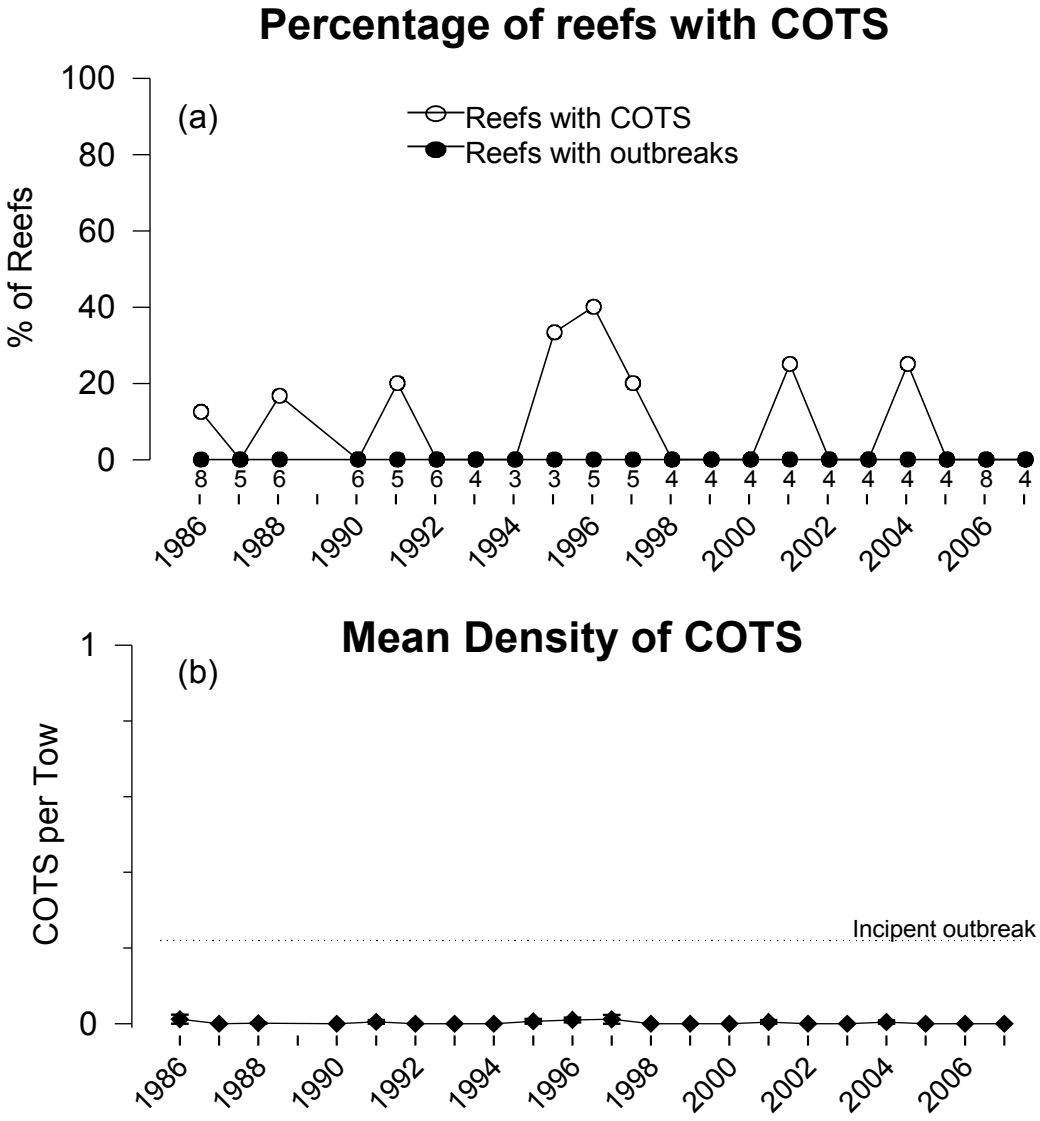


Capricorn Bunker Sector

Trends in COTS

Reefs in this sector were last surveyed in November 2006. No Active Outbreaks have been recorded and only very low numbers of COTS have been sporadically seen on reefs in this sector since 1986. No COTS were observed in 2007.

Figure 4.39



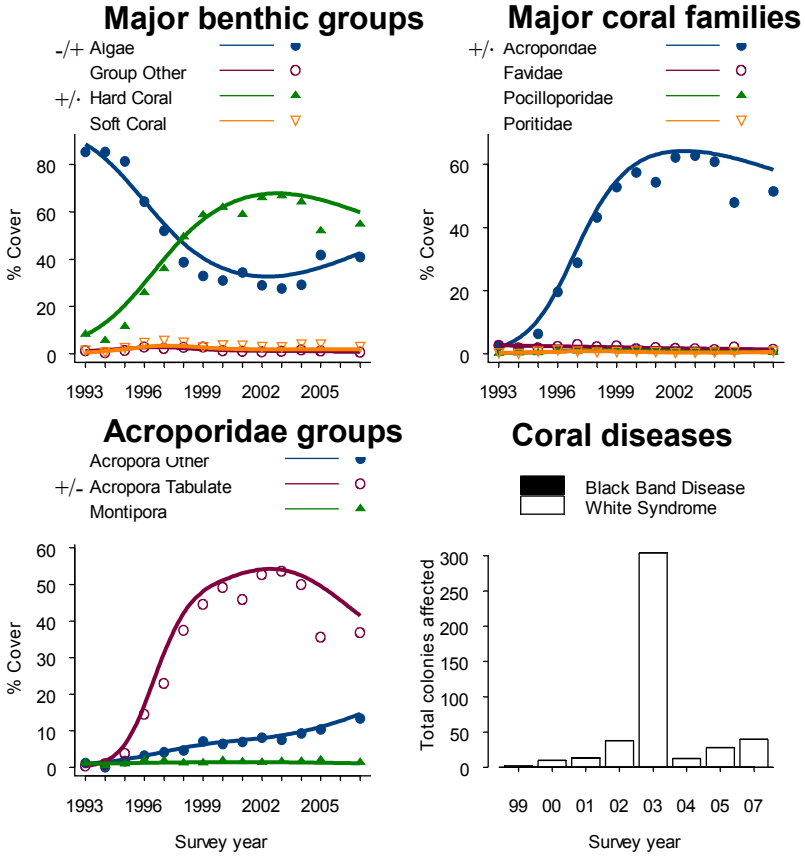
Capricorn Bunker Sector

Outer shelf subregion

Trends in benthic organisms

On the intensive survey sites there was an overall increasing trend in hard coral; cover was very low when surveys began in 1993 and there have been no major disturbances since that time. Hard coral trends tracked changes in *Acropora* spp.. Declines in coral cover since 2004 have been due to declines in tabulate *Acropora* spp. while branching *Acropora* spp. continued to increase. Average cover of hard coral in 2007 ranged from 38% at Broomfield Reef to 77% at Lady Musgrave Reef. There was no net change in soft coral cover which has remained low throughout. In 2007 the average cover of algae was 41%.

Figure 4.40



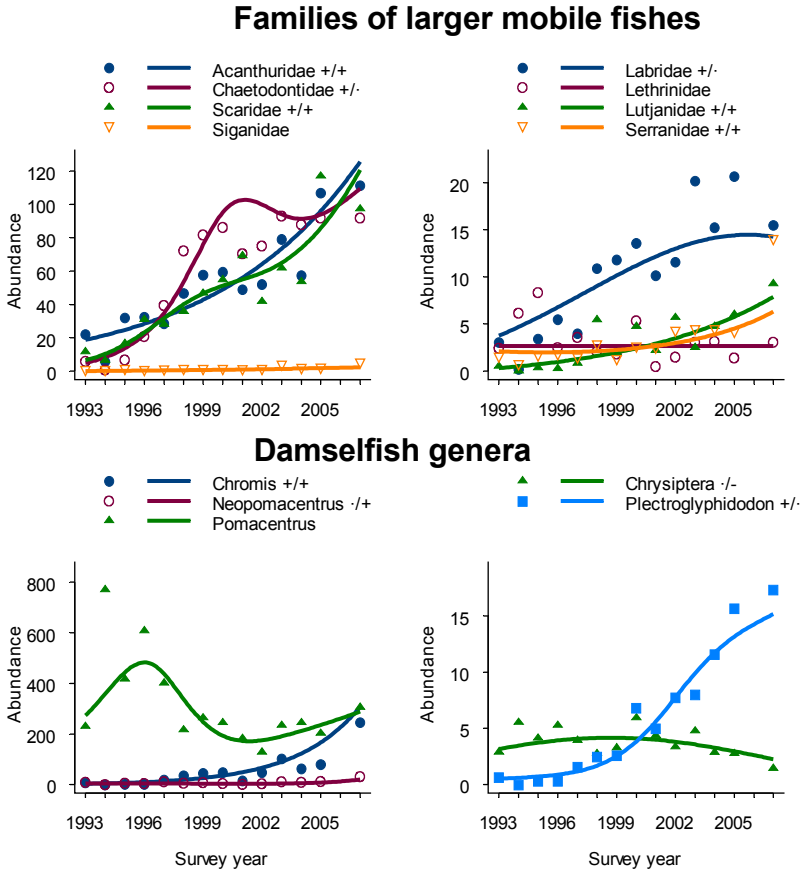
Capricorn Bunker Sector

Outer shelf subregion

Trends in reef fishes

Consistent long-term increases in abundance of the majority of fish taxa reflect recovery of coral communities from an extreme storm event that decimated corals prior to the beginning of surveys. During initial surveys fish communities were unusually depauperate due to the lack of coral habitat but also due to the fact that the underlying substrate on survey sites in this subregion is unusually smooth so corals provided virtually all the habitat complexity. Once corals began to replenish so to did reef fishes. Abundance patterns for *Pomacentrus* spp. were a little different to other taxa; rather than increasing consistently abundances declined then slowly began to increase. This pattern is due to the overwhelming abundance of *P. coelestis* in early years. This pioneer species colonized decimated habitat in huge numbers then as corals began to recover, *P. coelestis* numbers decreased until abundances of other *Pomacentrus* species (that were increasing with coral recovery) began to take over. Abundances of the genus *Chrysiptera* (driven by *C. rex*) had declined towards the end of surveys to a 15-year low. Reasons for this decline are not clear but may be related to repeated recruitment failure on these far southern reefs.

Figure 4.41



5. Reefs of the Great Barrier Reef: status and trends

HOW TO READ A REEF PAGE

This section contains data for each reef surveyed in both the 2006 and 2007 field seasons. An aerial photograph of each reef shows the size and orientation of the reef, the location of intensively surveyed sites and the manta tow path. Dotted lines indicate the manta tow path. Numbered dashes correspond to the tow numbers presented in the 'Coral cover and COTS' histogram. The solid line indicates the area covered by the intensively surveyed fixed transects. The physical geography of the reef is described below the aerial photograph. Reefs are ordered alphabetically within the sectors, with the intensively surveyed reefs first, followed by reefs that are only surveyed by manta tow. The sectors are presented in order from north to south.

Broadscale surveys

The coral cover and COTS histogram shows the coral cover categories recorded by observers for each two minute manta tow for the most recent survey year. This information provides an overview of the status of a reef at the time of its most recent survey in terms of spatial distribution of coral cover and COTS around the perimeter.

The historical coral cover and COTS plot provides an overview of the history of coral cover and of COTS activity over the manta tow survey period. Median coral cover and the average number of COTS per tow recorded for each year are presented. The COTS population 'Incipient Outbreak' level, defined as 0.22 COTS per tow (refer to Section 2), is represented by a dotted line when appropriate. This plot is not presented for reefs that were surveyed using manta tow for the first time in 2006.

Benthic surveys

For the intensively surveyed reefs, where permanent monitoring sites are located, data on benthic organisms and fishes are also presented. For benthic organisms, three plots describe trends in percentage cover over the survey period for the following: major benthic groups, major coral families and Acroporidae groups. Each plot shows the scatter of mean cover based on survey sites and the fitted trend line. The direction of the trend over time is coded in the legend: a period (·) indicates no trend, a plus sign (+) indicates a positive trend and a minus sign (-) indicates a negative trend. Symbols before the slash refer to the general trend over the entire survey period; symbols after the slash refer to the trend at the time of the most recent survey. Thus, '·/-' would indicate that a taxon has shown no net trend over the survey period, but that the most recent survey showed a decreasing trend. '+/+' would indicate that a taxon had

increased over the survey period and was continuing to do so at the time of the last survey.

A fourth figure presents the history of coral disease prevalence on a reef since 1999, when coral disease information was first incorporated in to SCUBA search surveys. The coral disease bar chart shows the total number of hard coral colonies at the intensive survey sites of a reef that exhibited signs of white syndrome disease or of black band disease. This figure is not shown if evidence of disease has not been recorded throughout the intensive survey history of a reef.

Visual fish census surveys

For reef fishes, four plots describe trends of fish abundance over time for reef fish groups where abundance is greater than 5 per site on at least one survey. The plots show changes in mean fish abundance. Two plots show trends in the families of large mobile fishes and two plots show trends in the damselfish genera. The direction of trends are coded in the legend in the same way as for the benthic video surveys.

NOTE: Intensive survey sites at the majority of reefs chosen for monitoring the effects of re-zoning the GBRMP were established and first surveyed in 2006. Therefore, the figures representing percentage cover of the various benthic groups, total number of diseased coral colonies and abundance of the various reef fish groups are bar charts presenting 2006 data only, rather than plots showing trends observed over time.

Cape Grenville

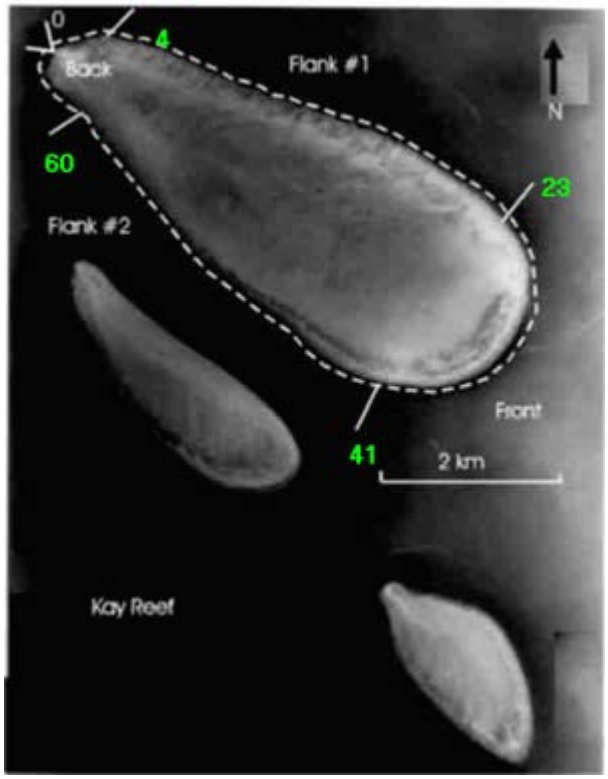
Reef Pages

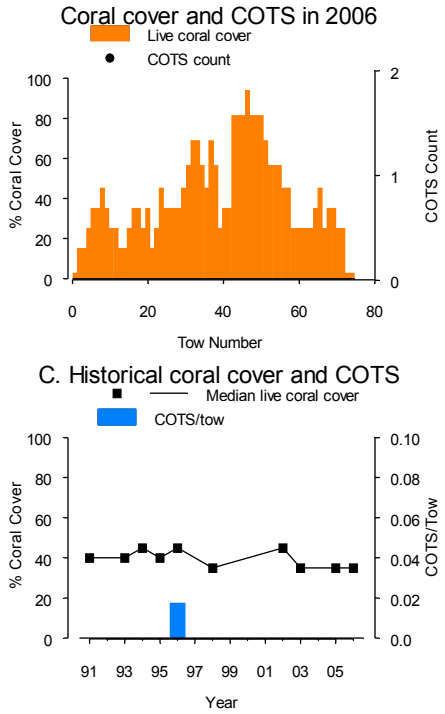
KAY

Kay Reef has been surveyed ten times using manta tow since 1991. Median reef-wide live coral cover has been relatively stable at a high level (31-50%) through to 2006. Whilst small numbers of COTS were recorded in 1996, they were below levels that would be expected to impact reef-wide live coral cover. Kay Reef remained classified as No Outbreak in 2006. No bleaching or signs of black band coral disease were recorded in 2006. Low levels of white syndrome disease were observed, with signs restricted to a few individual coral colonies on the southern flank during manta tow surveys in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.1





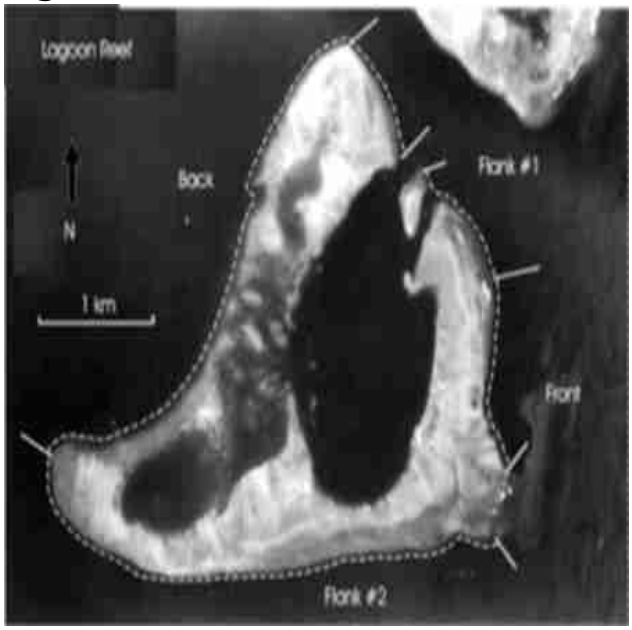
Kay Reef (No. 12-010) is an inshore planar reef with an area of 7.5 sq.km.

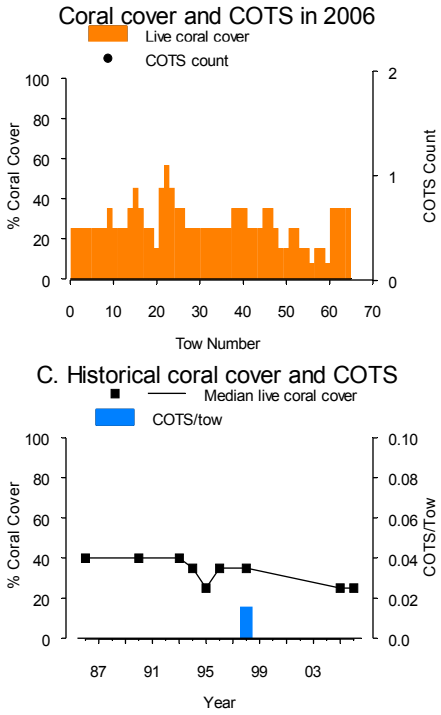
LAGOON

Lagoon Reef has been surveyed nine times using manta tow since 1986. Median reef-wide live coral cover has remained high in the majority of surveys, though it has declined to a moderate (21-30%) level in recent years. Small numbers of COTS were observed on Lagoon Reef during surveys in 1998 but these were well below outbreak levels. Surveys in 2005 recorded a small decrease in reef-wide live coral cover to a moderate level which persists in 2006. The long period between consecutive surveys has made it difficult to pinpoint the factors responsible for the decline. Signs of white syndrome disease were restricted to small numbers of individual colonies around the reef perimeter. No bleaching was observed and no COTS recorded. Lagoon Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.2





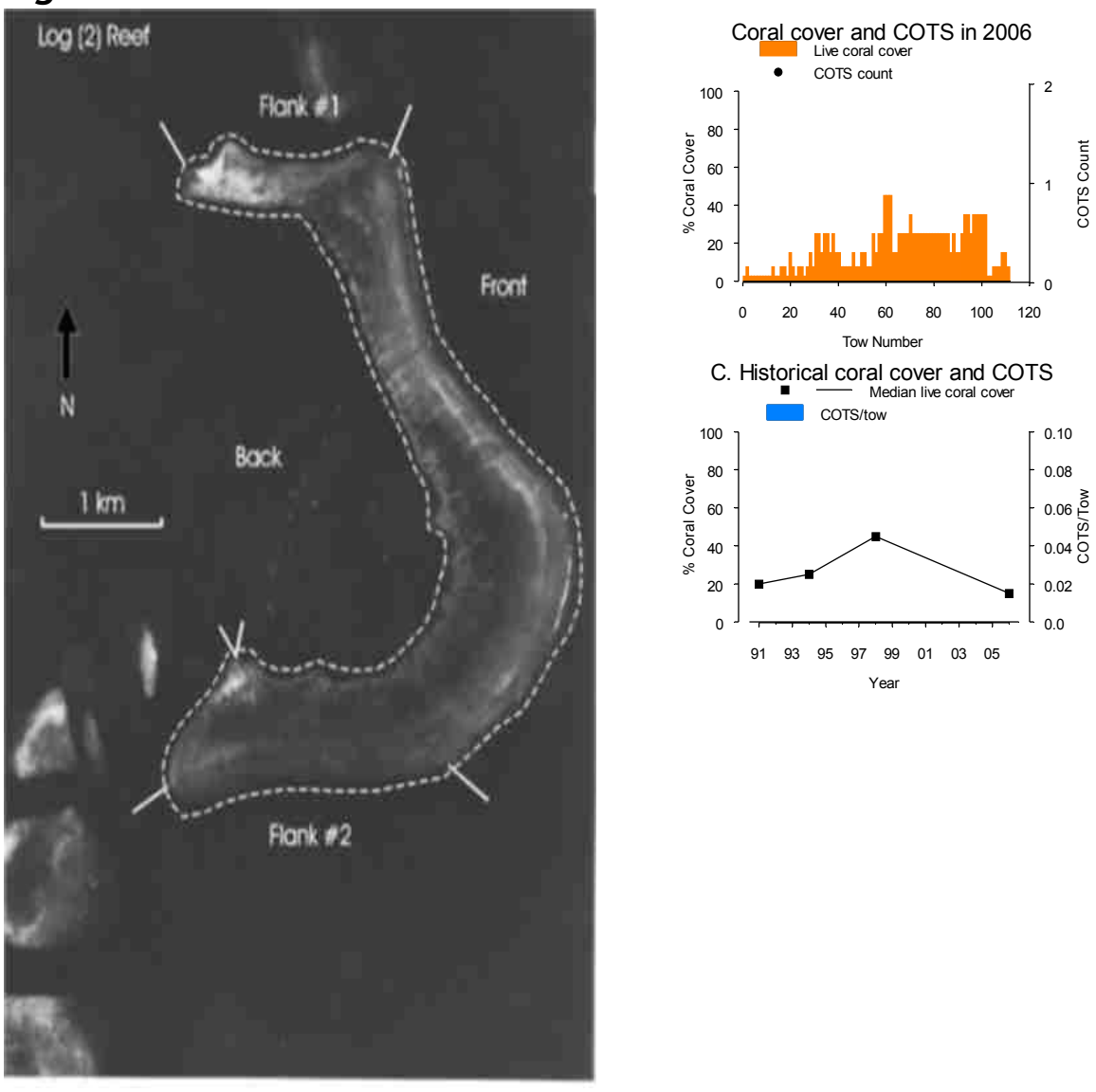
Lagoon Reef (No. 12-061) is an outer shelf lagoonal reef with an area of 7.2 sq.km.

LOG (2)

Log(2) Reef has been surveyed four times using manta tow since 1991. Median reef-wide live coral cover increased over the initial years of survey from a moderate (11-20%) level in 1991 to a high level (31-50%) recorded in 1998. Surveys in 2006 indicate a decline in reef-wide live coral cover to moderate level. The long period between consecutive surveys has made it difficult to pinpoint the factors responsible for the decline though Cyclone Ingrid passed near this reef in March 2005 causing significant damage to many reefs in the region. Old storm damage was observed during surveys and Cyclone Ingrid is a likely candidate for the observed decline in coral cover. Signs of white syndrome disease were restricted to small numbers of individual colonies on the reef back and north flank. No bleaching or signs of black band disease were recorded. No COTS have been observed on this reef during any survey year and Log(2) Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.3



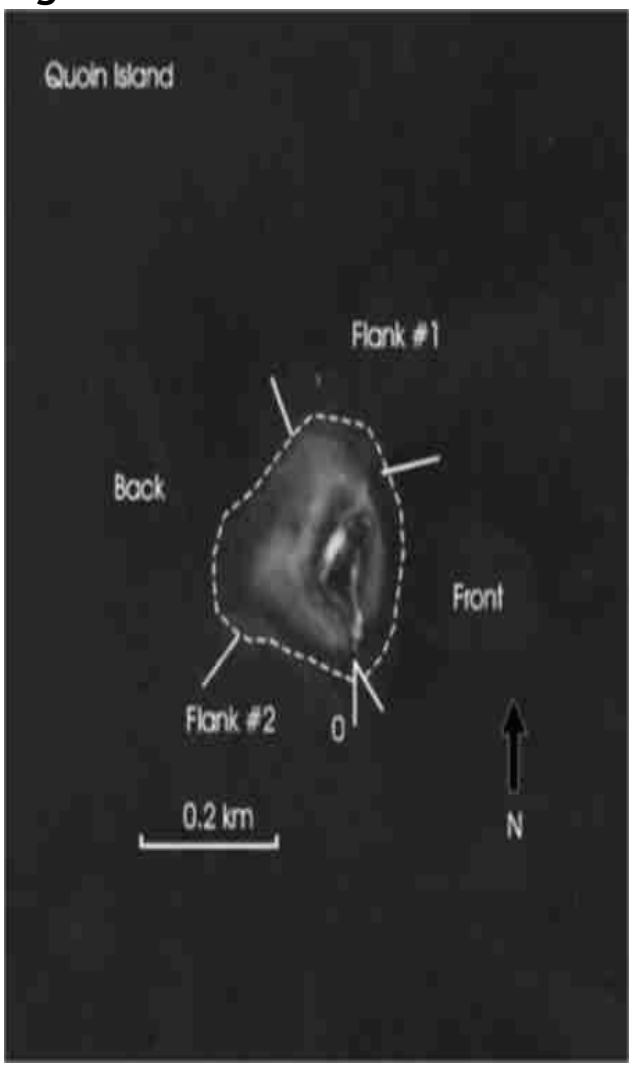
Log (2) Reef (No. 12-107) is an outer shelf ribbon reef with an area of 10.6 sq.km.

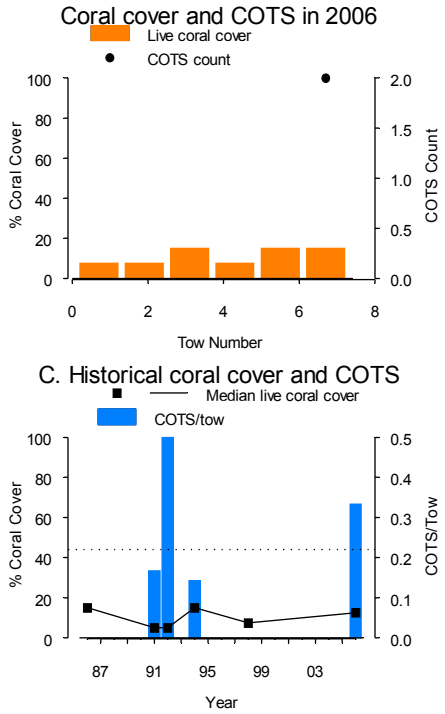
QUOIN IS

Quoin Island Reef has been surveyed six times using manta tow since 1986. Median reef-wide live coral cover has generally been moderate (11-30%) to low (1-10%) on this reef over the history of surveys. This is likely due to small but persistent COTS populations observed on this reef. COTS have been recorded from this reef in four out of the six surveys and the reef was declared an Incipient Outbreak in 1992. Surveys in 2006 indicate reef-wide coral cover is currently moderate (11-20%) with elevated COTS activity on this reef. Quoin Island Reef remained classified as Incipient Outbreak. No bleaching or signs of disease were recorded during manta tow surveys in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.4





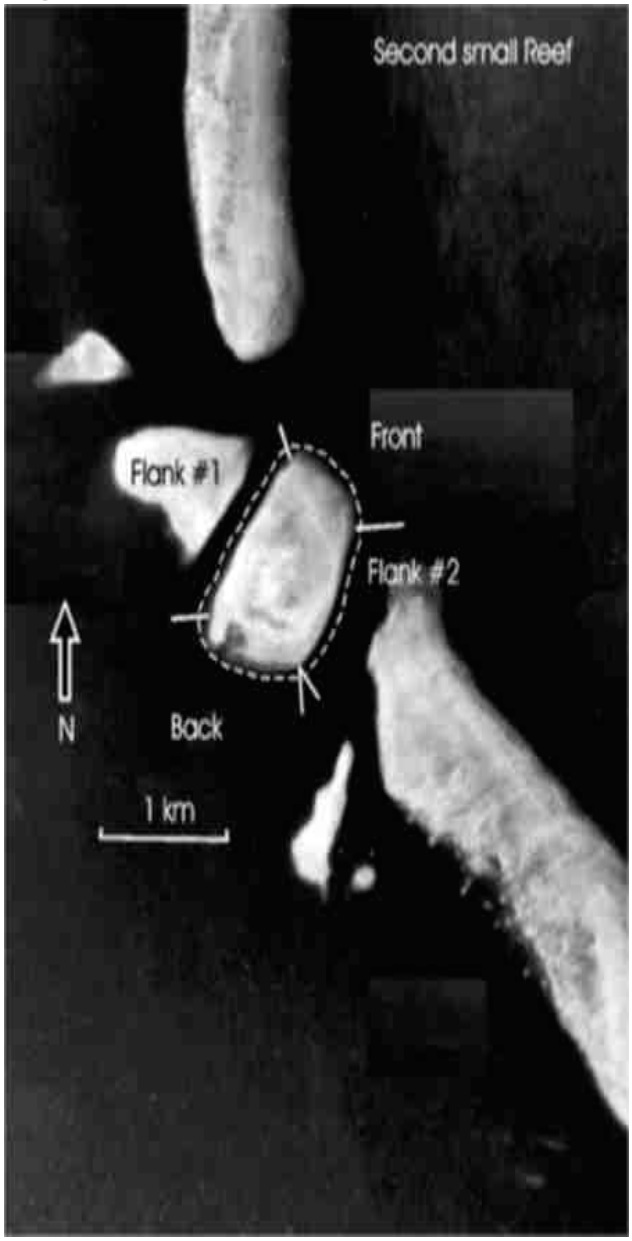
Quoin Is (No. 12-027) is a mid-shelf fringing reef with an area of 0.01 sq.km.

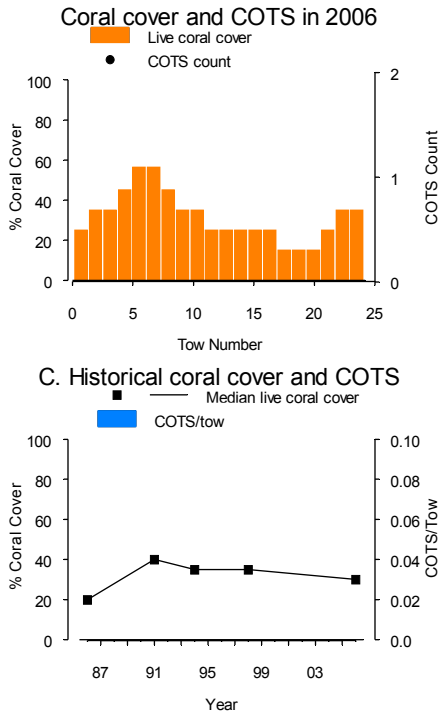
SECOND SMALL

Second Small Reef has been surveyed five times using manta tow since 1986. Median reef-wide live coral cover increased over the initial years of survey from a moderate (21-30%) level in 1986 to a high level (31-50%) recorded in 1991, where it remained in 1998. Surveys in 2006 indicated that reef-wide live coral cover was persisting at a moderate level (21-30%). The long period between consecutive surveys has made it difficult to pinpoint the factors responsible for the decline. Cyclone Ingrid passed near this reef in March 2005, causing significant damage to many reefs in the region and is a likely candidate for the observed decline in coral cover. Signs of white syndrome disease were restricted to small numbers of individual colonies on the reef front and flanks. No bleaching or signs of black band disease were recorded. COTS have not been observed on this reef during any survey year and Second Small Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.5





Second Small Reef (No. 12-098) is an outer shelf planar reef with an area of 1.9 sq.km.

Princess Charlotte Bay

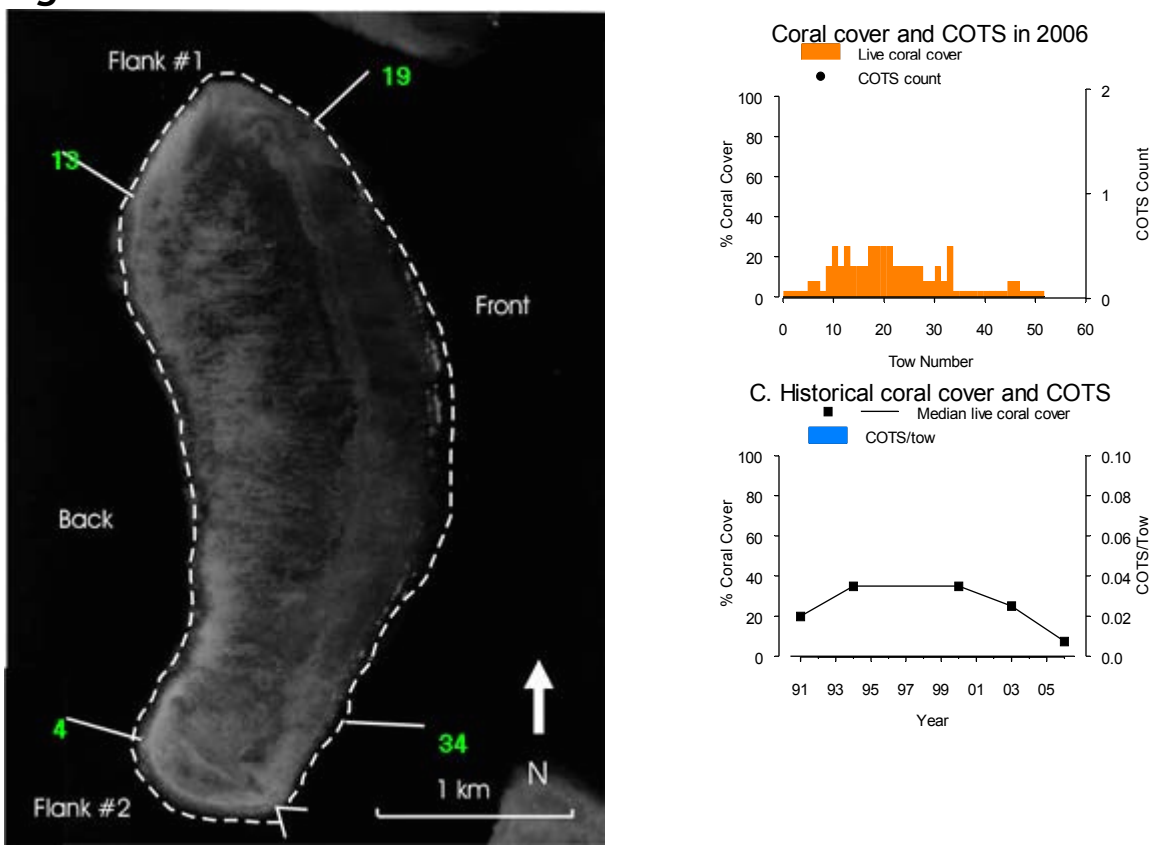
Reef Pages

13-040

Reef 13-040 has been surveyed five times using manta tow since 1991. Median reef-wide live coral cover increased to a high level (31-50%) in 1994, where it remained through to 2003. Surveys in 2006 indicate a marked decline in reef-wide live coral cover. Cyclone Ingrid passed near this reef in March 2005, causing significant damage to many reefs in the region. Recent storm damage was observed during surveys and Cyclone Ingrid is the most likely candidate for the observed decline in coral cover. No COTS have ever been observed during manta tow surveys and the reef remained classified as No Outbreak in 2006. No bleaching or black band disease was observed and white syndrome disease was restricted to small numbers of individual coral colonies on the front and southern flank of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.6



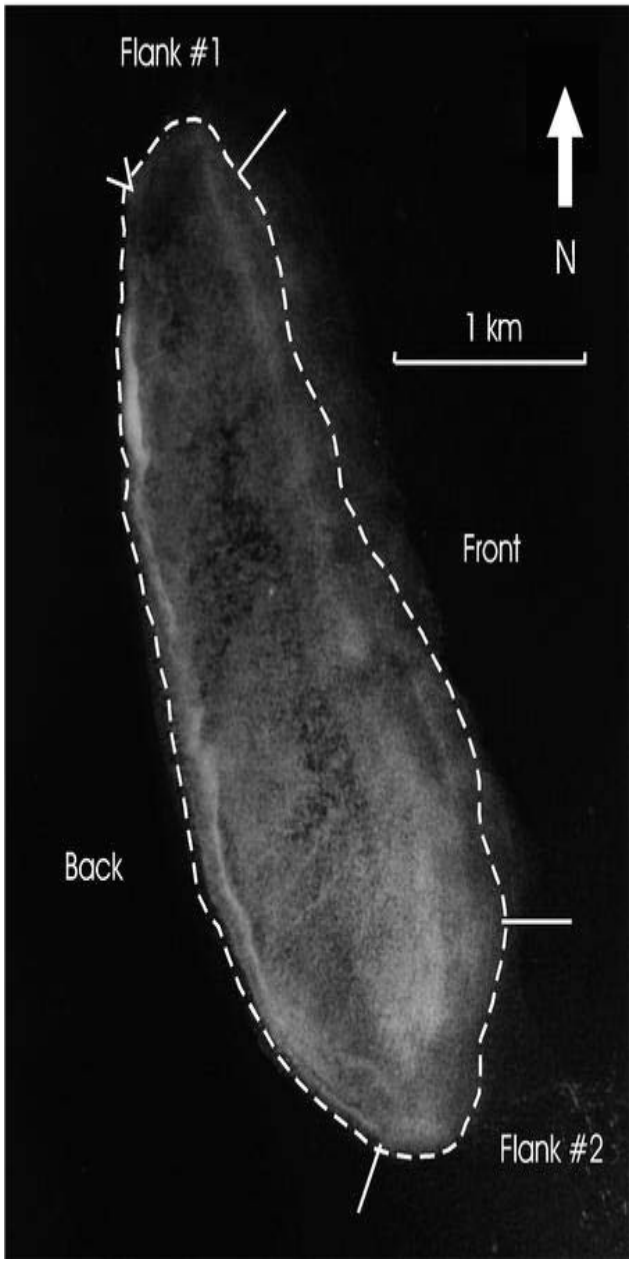
Reef 13-040 (No. 13-040) is an outer shelf planar reef with an area of 3.1 sq.km.

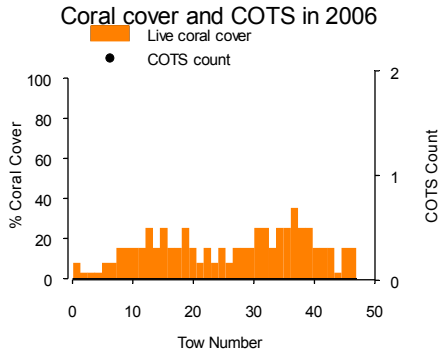
13-121

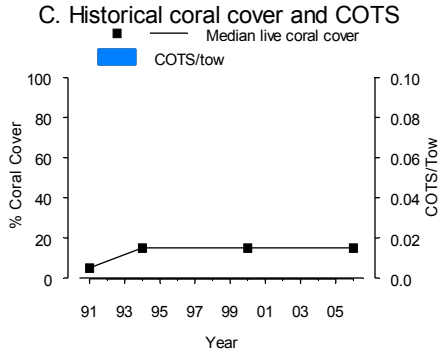
Reef 13-121 has been surveyed four times using manta tow since 1991. Between 1994 and 2006 no change in median reef-wide live coral cover has been recorded, remaining at a moderate (11-20%) level. No COTS have been recorded from this reef and remained classified as No Outbreak. No bleaching or black band disease was observed and white syndrome disease was restricted to small numbers of individual coral colonies on the front and southern flank of the reef during surveys in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.7
Reef 13121







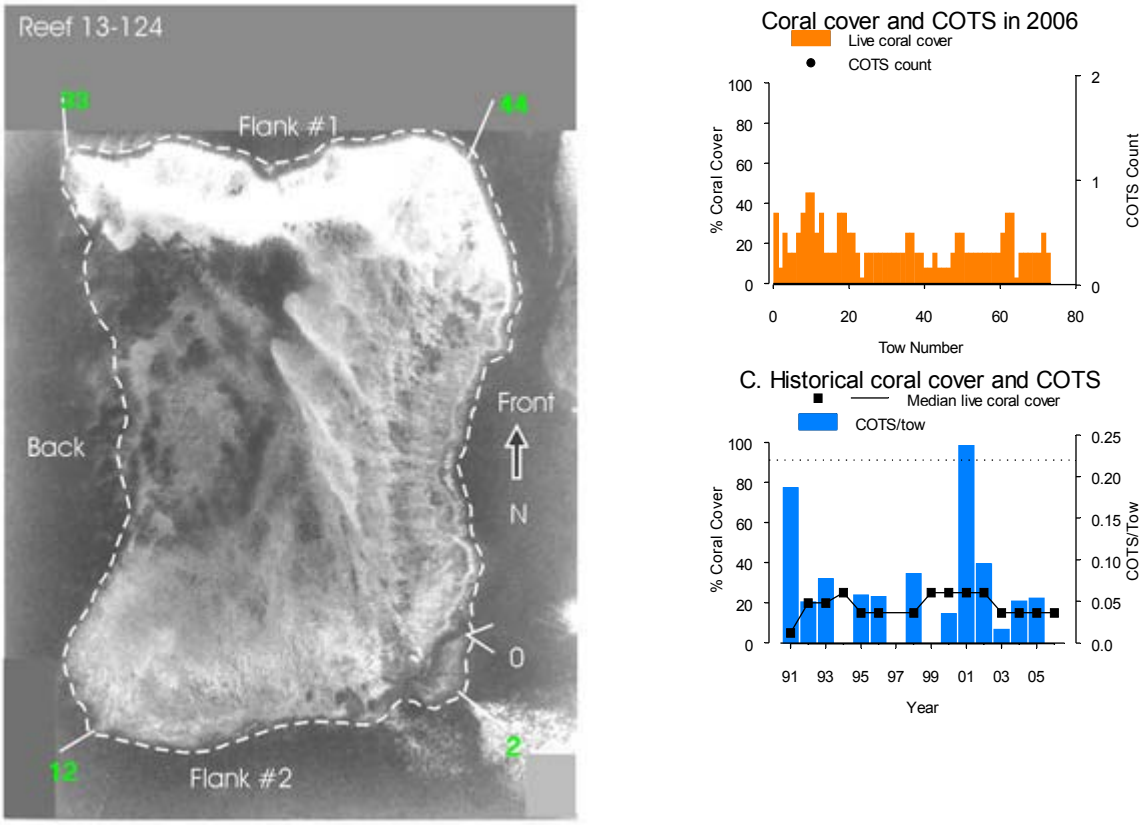
Reef 13-121 (No. 13-121) is an outer shelf planar reef with an area of 3.1 sq.km.

13-124

Reef 13-124 has been surveyed 15 times using manta tow since 1991. Median reef-wide live coral cover has remained at moderate (11-30%) levels. COTS have been consistently recorded on Reef 13-124, though in most years densities have been too low to reduce reef-wide live coral cover. No COTS were observed in 2006 and reef-wide live coral cover remained moderate at 11-30%. Reef 13-124 remained classified as No Outbreak. No signs of bleaching or black band disease were observed during surveys in 2006. Signs of white syndrome disease were restricted to small numbers of individual coral colonies scattered on the back reef and both reef flanks.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.8



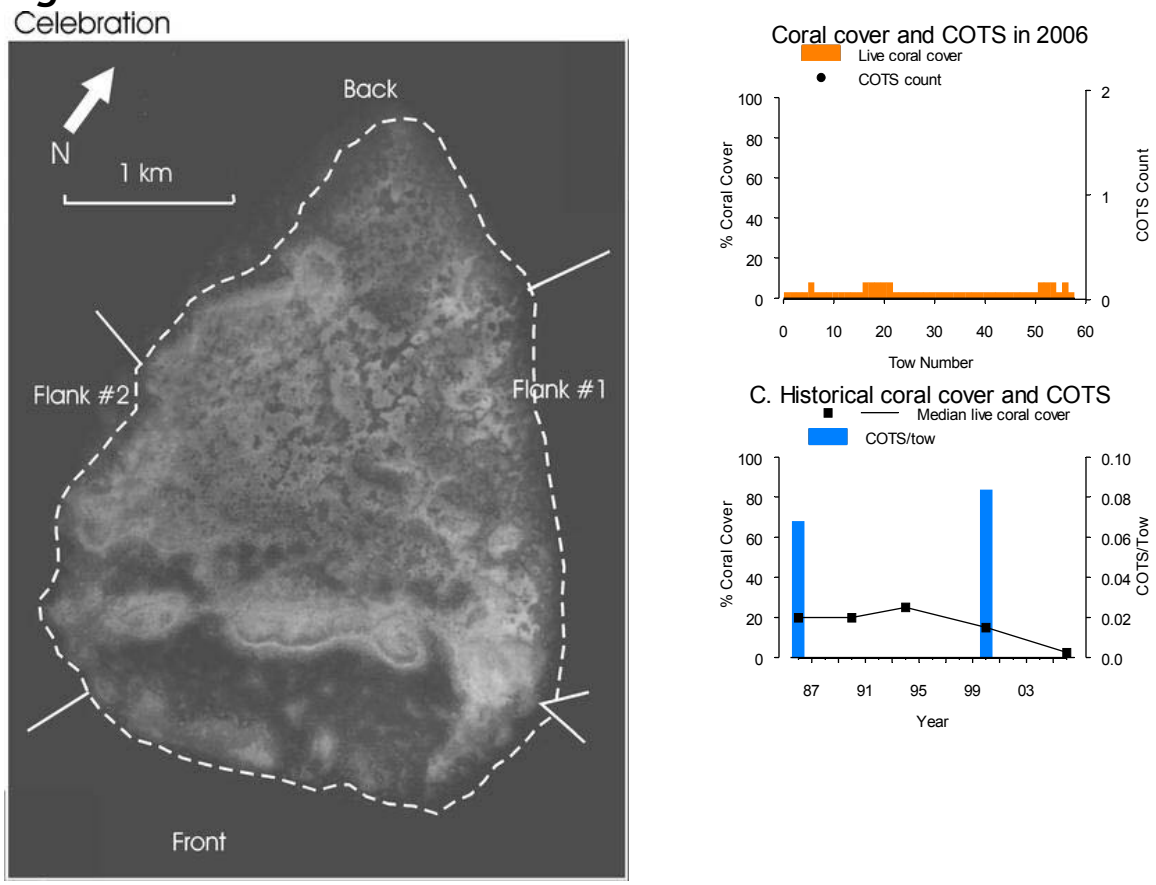
Reef 13-124 (No. 13-124) is a mid-shelf crescentic reef with an area of 11.3 sq.km.

CELEBRATION

Celebration Reef has been surveyed five times using manta tow since 1986. Over the initial years of surveys there was little change in median reef-wide live coral cover which remained at moderate levels (21-30%). Surveys in 2000 revealed small numbers of COTS on this reef but at densities generally considered too low to cause significant reef-wide coral mortality. There were, however, signs of declining coral cover. Surveys in 2006 show reef-wide live coral cover has continued to decline in the absence of COTS and is currently very low (1-5%). Though COTS may have contributed to this continual decline the long period between consecutive surveys makes it difficult to pinpoint the factors responsible. Cyclone Ingrid passed near this reef in March 2005, causing significant damage to many reefs in the region. Storm damage was observed during surveys and Cyclone Ingrid is the most likely candidate for the observed decline in coral cover. No COTS were observed during manta tow surveys in 2006 and the reef remained classified as No Outbreak. No bleaching or black band disease was observed and white syndrome disease was restricted to small numbers of individual coral colonies on the front and southern flank of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.9



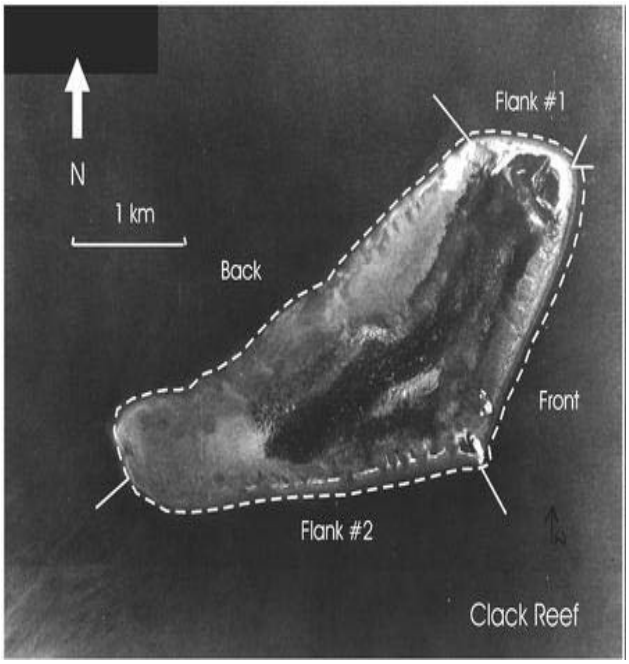
Celebration Reef (No. 13-041) is a mid-shelf patch reef with an area of 10 sq.km.

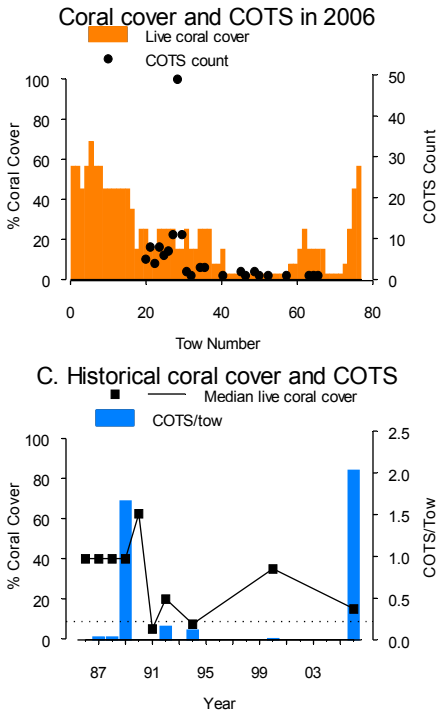
CLACK

Clack Reef has been surveyed 10 times using manta tow since 1986. A high median reef-wide live coral cover (31-40%) and small numbers of COTS characterised the surveys between 1986 and 1988. In 1989 a dramatic increase in COTS numbers was not matched by a decline in coral cover. Surveys in 1990 indicated coral cover had increased to very high levels (51-75%). In the following year, 1991, there was a substantial decline in coral cover to 5-10%. In the absence of COTS the reason for this decline is most likely attributable to Cyclone Ivor, a category 3 cyclone, which passed almost directly over this reef in March 1990. Since this event reef-wide live coral cover increased with a moderate (31-40%) level of cover attained at the time of surveys in 2000. Surveys in 2006 show reef-wide live coral cover had declined on this reef to a moderate level (11-20%). This is almost certainly due to the feeding activity of COTS. Clack Reef was classified as an Active Outbreak in 2006. No bleaching or black band disease was observed in 2006 and white syndrome was restricted to small numbers of individual coral colonies on the northern flank.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.10





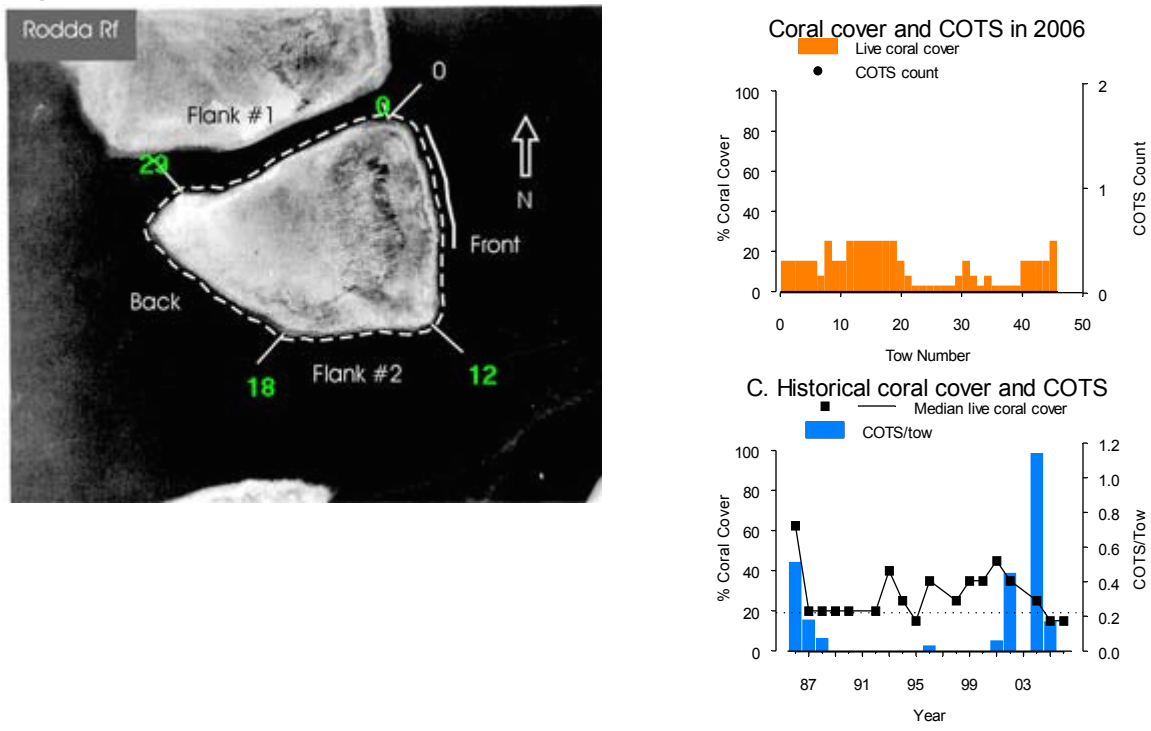
Clack Reef (No. 14-017) is an inshore planar reef with an area of 11.9 sq.km.

RODDA

Rodda Reef has been surveyed 18 times using manta tow since 1986. Data suggests a rapid decline in median reef-wide live coral cover from a very high level (51-75%) in 1986 to a moderate level (11-30%) in 1987, probably due to an outbreak of COTS recorded in 1986. Reef-wide live coral cover remained at a moderate (11-30%) level until 1995 then began to increase. Manta tow surveys in 2002 recorded increased COTS numbers and Rodda Reef was classified as an Incipient Outbreak. COTS numbers continued to increase and the reef was reclassified as an Active Outbreak in 2004. Surveys in 2005 indicated COTS numbers have declined and Rodda Reef was reclassified as Recovering. COTS activity has been responsible for a dramatic decline in reef-wide live coral cover from a high (41-50%) level in 2001 to moderate levels (11-20%) by 2005. Surveys in 2006 indicate coral cover remained moderate on this reef. No COTS, bleaching or black band disease was recorded. Signs of white syndrome disease, restricted to a few scattered colonies, were observed on the front and northern flank of the reef. Rodda Reef remained classified as Recovering.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.11



Rodda Reef (No. 13-127) is an outer shelf planar reef with an area of 4.39 sq.km.

Cooktown / Lizard Island

Reef Pages

CARTER

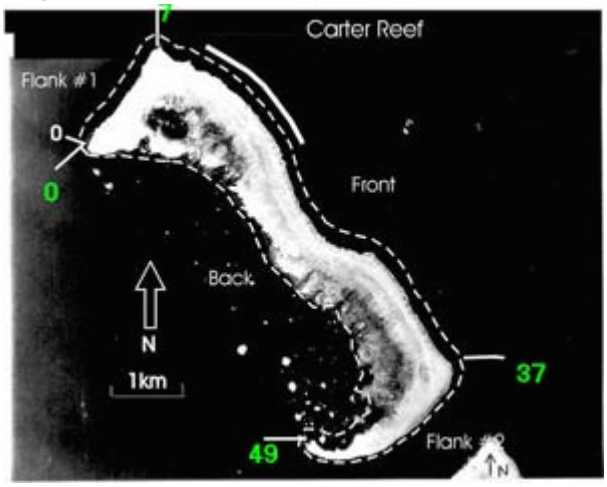
Carter Reef is a Preservation Reef within the GBRMP and has the highest protection status. Carter Reef has a history of manta tow surveys dating back to 1986. Median reef-wide live coral cover remained stable from 1986 to 1990 before dropping appreciably in 1991. Although there were COTS on the reef at this time, numbers were well below the level that results in significant reef-wide coral mortality. The decline in coral cover was almost certainly a result of Cyclone Ivor, which affected the region in March 1990. Massive damage to the windward margin of the reef was observed during the 1991 surveys. Coral cover subsequently recovered on the front reef with reef-wide live coral cover reaching a high level (31-40%) in 2003. Reef-wide coral cover then declined to a moderate (21-30%) by 2005. The reason for this decline was not clear though cyclone damage was observed during previous surveys and Cyclone Ingrid (a category 4 cyclone that passed to the north of the reef in March 2005) is a likely candidate. It is also considered that low level disease (white syndrome) may have also contributed to the observed decline. Very low cover on the sandy back reef also contributes to reducing the reef-wide average. Carter Reef was classified as No Outbreak in 2007 and reef-wide live coral cover was at a moderate (11-20%) level. No bleaching was observed during manta tow surveys though signs of black band disease were recorded from small numbers of individual coral colonies on the front and back reef areas. Signs of white syndrome disease were also observed on corals around the reef perimeter and were particularly prevalent on the front reef and second flank, where more than ten coral colonies per two minute manta tow were affected.

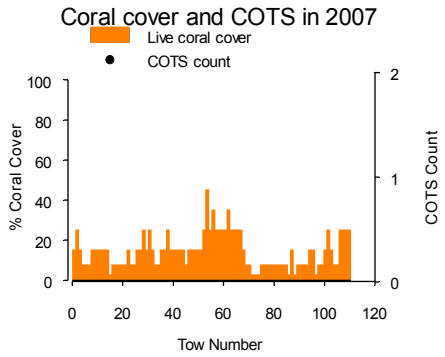
On the intensive survey sites hard coral cover increased rapidly from 13% in 1992 to 67% in 1999. This represents excellent recovery from Cyclone Ivor, which impacted the region in 1990. Hard coral cover decreased rapidly between 2004 and 2007 from 55% to 30%. Tabulate *Acropora* spp. dominated the benthic community with more than 30% cover recorded from 1999 until 2004. In 2005 it decreased to an average cover of 16%, then to 4% in 2007 surveys, the lowest level recorded since 1995. The reduction in tabulate *Acropora* in recent surveys could be a result of storm damage and mortality from disease. In February 2004 Cyclone Fritz passed nearby while the decline to 4% in 2007 surveys maybe from Cyclone Ingrid in March 2005, which passed 100 kilometres to the north of Carter Reef. Soft coral cover has remained around 3% since surveys began. Algal cover had been rising with the concurrent decrease in hard coral cover since 1999 and reached an average cover of 60% in 2007. The density of the corallivorous snail, *Drupella* spp. observed during 2007 surveys was 133/ha. The level of white syndrome was moderate from 2002 to 2003. Disease dropped to low levels in 2004 and remained at this level in 2007. Black band disease was recorded on the survey sites for the first time in 2007.

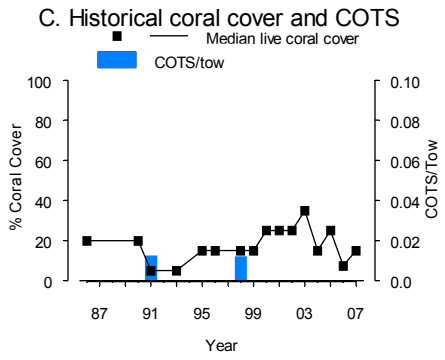
Changes in the fish community over the survey period appeared to be strongly correlated with changes in coral cover. As coral cover increased, the abundance of some herbivorous species decreased and the abundance of certain species that rely on coral for food or shelter increased. Numbers of family Acanthuridae had stabilized in 2007 after a decline in the early years of the study. Most other families of large mobile fishes have remained stable during the study. The general trend for damselfishes has been an increase in abundance for most of the major genera. Surveys in 2007 indicated that the coral affiliated planktivorous *Chromis* spp. had increased in abundance, continuing the general trend observed since surveys began. *Plectroglyphidodon* spp. numbers dropped significantly in 2007 for the first time since surveys began. This is presumably due to a loss of their preferred habitat, *Acropora* spp., which suffered storm damage and persistently low levels of disease between 2004 and 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.12



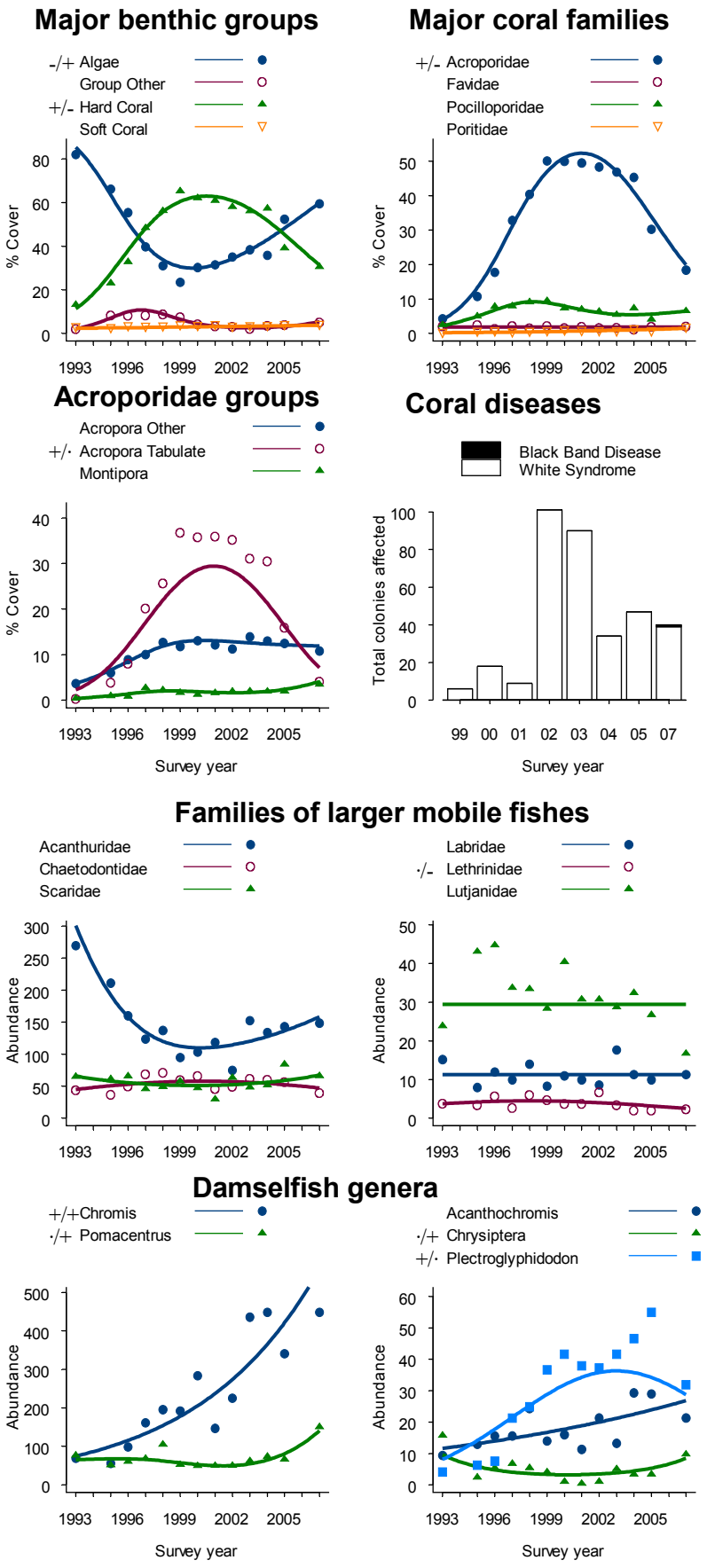




Carter Reef (No. 14-137) is an outer shelf ribbon reef with an area of 13.7 sq.km.

Figure 5.12 (cont.)

Carter was last surveyed in October 2006.



LINNET

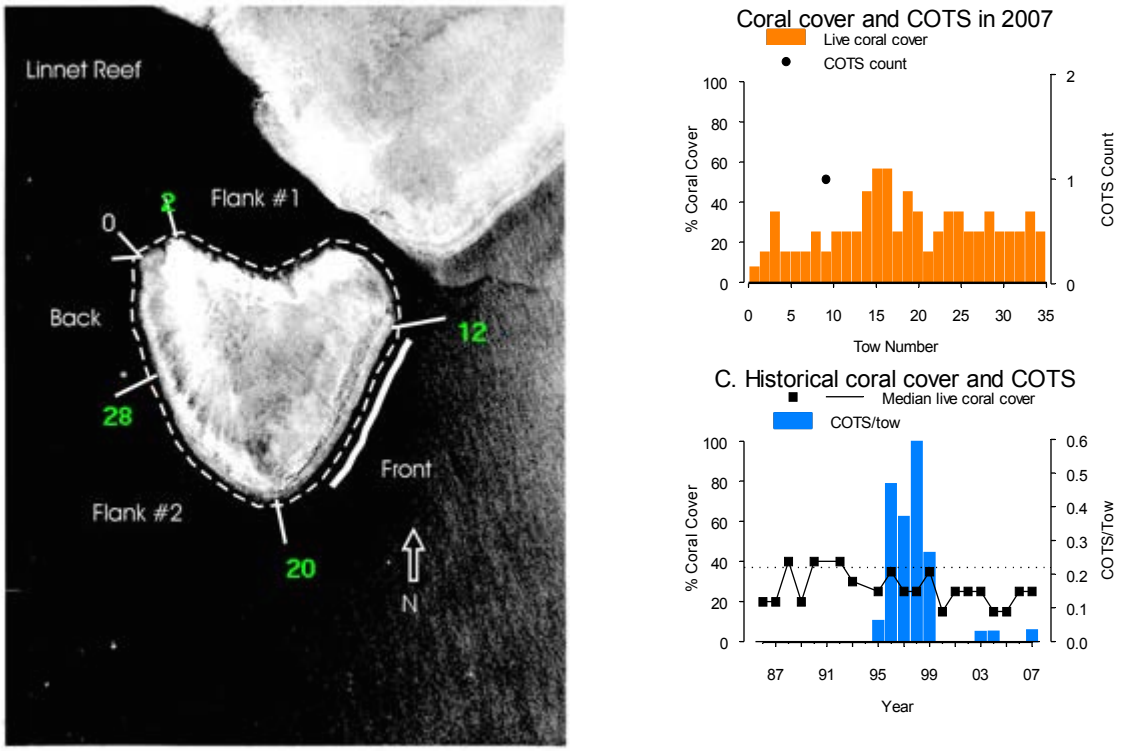
Linnet Reef has been surveyed regularly using manta tow since 1986. COTS have been recorded at Linnet Reef on numerous occasions since 1995. Linnet Reef had an Incipient Outbreak status in 1996 and COTS numbers remained at this level until 2000, when the reef was reclassified as No Outbreak. Median reef-wide live coral cover declined between 1999 and 2000, presumably as a result of COTS feeding activity, but then stabilised. Low numbers of COTS were observed in 2003 and 2004. Similarly low numbers of COTS were observed during surveys in 2007, but in all cases at a level considered too low to impact on reef-wide live coral cover that has been moderate (11-30%) in recent years. Linnet Reef remained classified as No Outbreak. No bleaching or signs of black band disease were recorded in 2007. Signs of white syndrome disease were restricted to a few scattered coral colonies on the southern flank.

Coral cover on the intensive survey sites increased over the survey period reaching 53% in 2004. Hard coral cover in 2005 and 2007 surveys remained high at 48%. Cover of algae showed a corresponding decline to 40% in 2003, where it remained in 2007. Since surveys commenced in 1993, the increase in cover of hard corals was largely due to small increases within the family Acroporidae, particularly branching and bottlebrush growth forms. The density of the corallivore, *Drupella* spp., was observed at 33/ha in 2007. A sharp increase in the occurrence of white syndrome was recorded in 2003. White syndrome was rare in 2004 and recorded at low levels in 2005 and 2007.

The majority of large, mobile reef fish species displayed no consistent trends in abundance over the 15 years of survey. However, numbers of Siganidae have steadily increased since 2004 and reached their highest abundance since surveys began in 2007. In 2005 species from family Lutjanidae showed a marked increase in abundance from the previous year's survey, and this was driven by large increases in three species, *Lutjanus vitta*, *L. carponotatus* and *L. lutjanus*. However, in 2007 Lutjanid abundance had returned to 2004 levels. While most damselfishes remained stable throughout the study period, three genera, *Pomacentrus*, *Acanthochromis* and *Amblyglyphidodon*, have been highly variable throughout the study,. These genera all increased in abundance in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

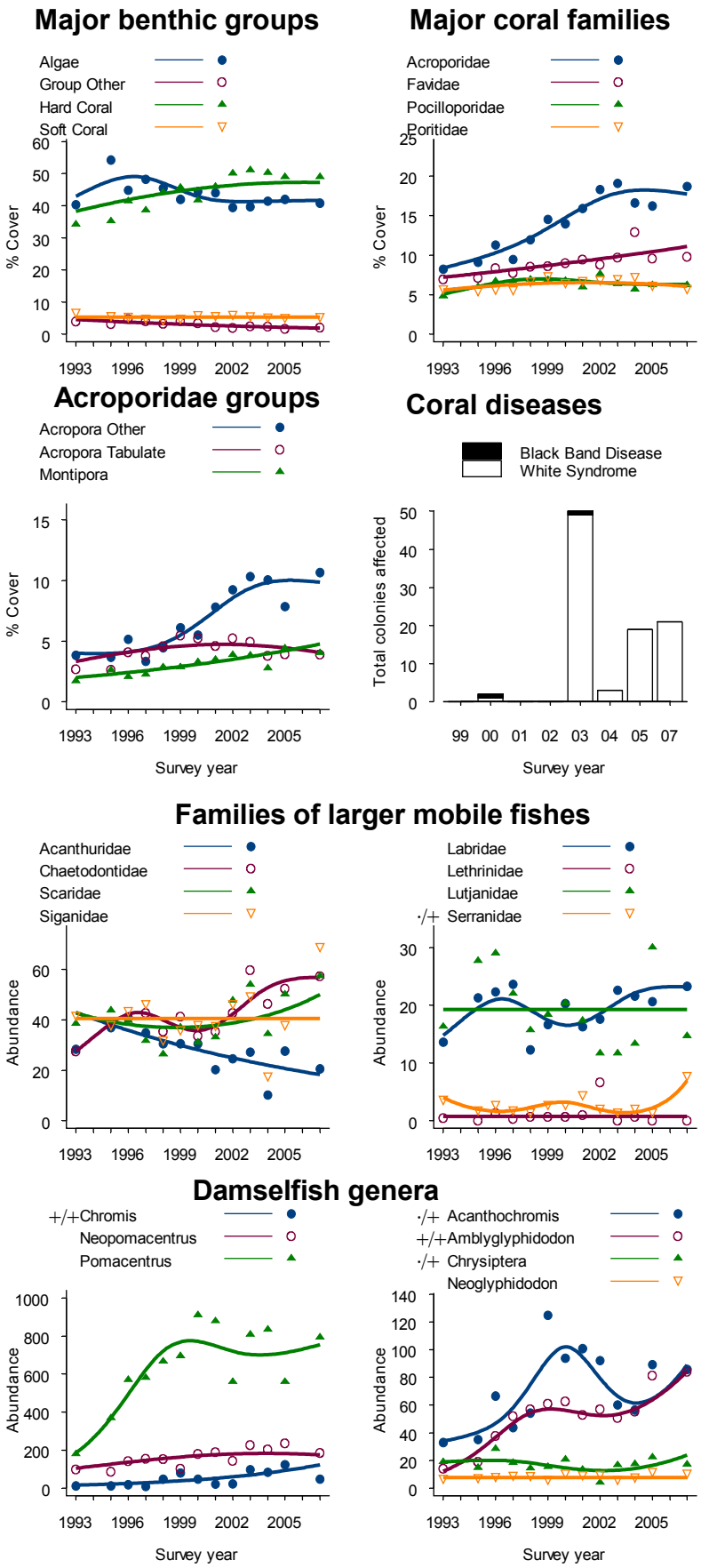
Figure 5.13



Linnet (No. 14-126) is an inshore planar reef with an area of 3.5 sq.km.

Figure 5.13 (cont.)

Linnet was last surveyed in October 2006.



LIZARD IS

Lizard Island Reef has been surveyed regularly using manta tow since 1986, when it was considered to be Recovering from previous COTS activity. From 1996 until 1998 the reef was classified as Active Outbreak. Since 1998 median reef-wide live coral has remained low (1-10%) on Lizard Island Reef, which was reclassified as Recovering in 1999, even though small numbers of COTS have persisted since this time. Surveys in 2007 indicated little recovery with median reef-wide live coral cover at a low level (1-5%), similar to that of 2004. Small numbers of COTS were observed in 2007, but at a level below that expected to impact reef-wide live coral cover and Lizard Island Reef remained classified as Recovering. No bleaching or signs of black band disease were recorded during manta tow surveys in 2007. Signs of white syndrome disease were restricted to a few scattered coral colonies on the southern flank.

Cover of hard coral on the intensive study sites has remained at moderate levels averaging around 13% since 1994. Hard coral marginally increased from 14% in 2001 to 21% in 2007. Algae persisted as the dominant benthic group with 55% average cover in 2007. Soft coral cover has been moderate over the entire survey period but declined from 19% in 2005 to 14% in 2007. The increasing trend in Poritidae and Faviidae throughout the survey period may be the result of avoidance of these corals by COTS. There has been a very low incidence of coral disease recorded on SCUBA searches in eight years of surveys. White syndrome was low in 2005, but in 2007 numbers of observed colonies with white syndrome were rare. Black band disease was observed for the first time at the intensive survey sites in 2007. One COTS was observed during the 2007 SCUBA searches. The occurence of *Drupella* spp. was recorded at 26/ha in 2007.

The majority of large mobile fish species displayed no consistent trends. There was high variability in the abundance of most Scaridae species, although numbers of a few species had increased since 2004 to peak levels in 2007. Numbers of the most abundant Acanthuridae genus, *Ctenochaetus* spp. declined after 2002, however, 2007 surveys indicated an increase in abundance. Numbers of the commercially important coral trout species, *Plectropomus leopardus*, steadily increased after 2002 and were at a survey maximum in 2007. Among damselfishes there were few consistent trends, although numbers of *Pomacentrus moluccensis* and *P. brachialis* increased in 2005 after declining from a peak in 2003. Numbers subsequently declined in the 2007 surveys. *Chrysiptera talboti* and *C. flavipinnis* declined in 2007 after they had remained stable up until 2005.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.14

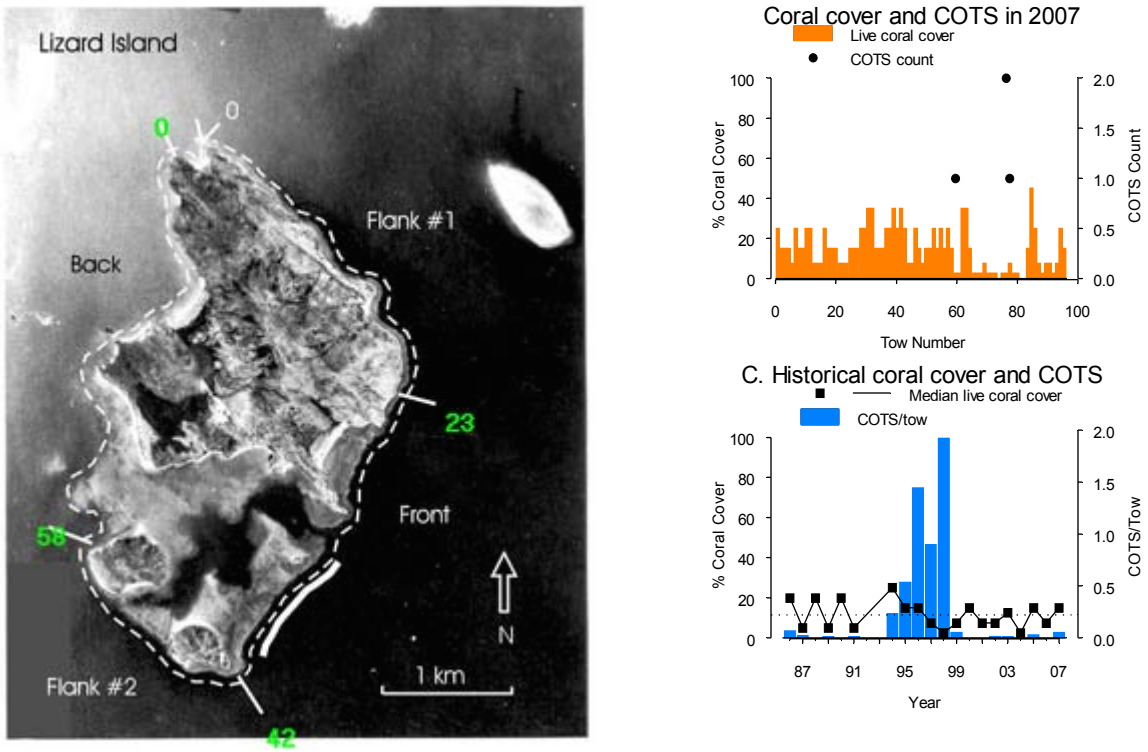
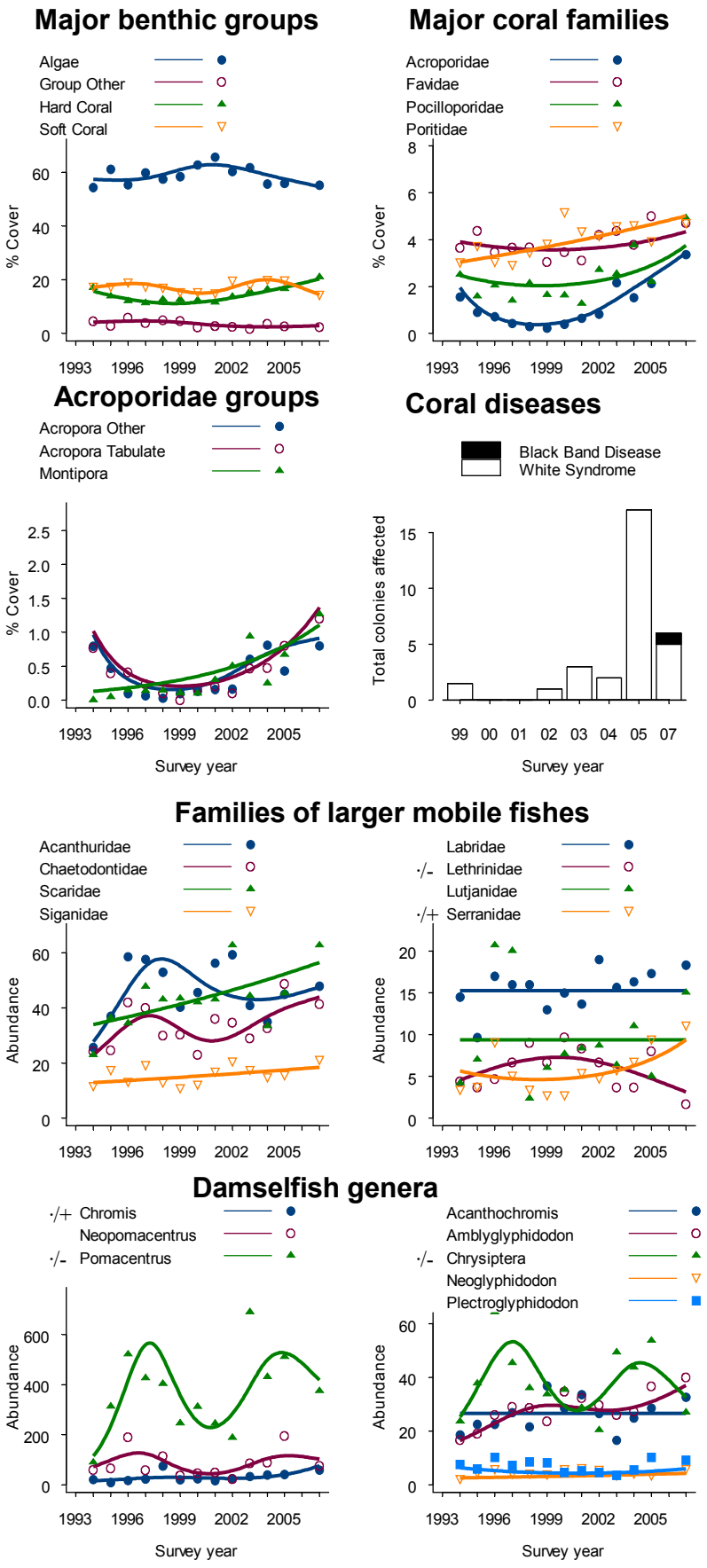


Figure 5.14 (cont.)

Lizard Is Reef was last surveyed in October 2006.



MACGILLIVRAY

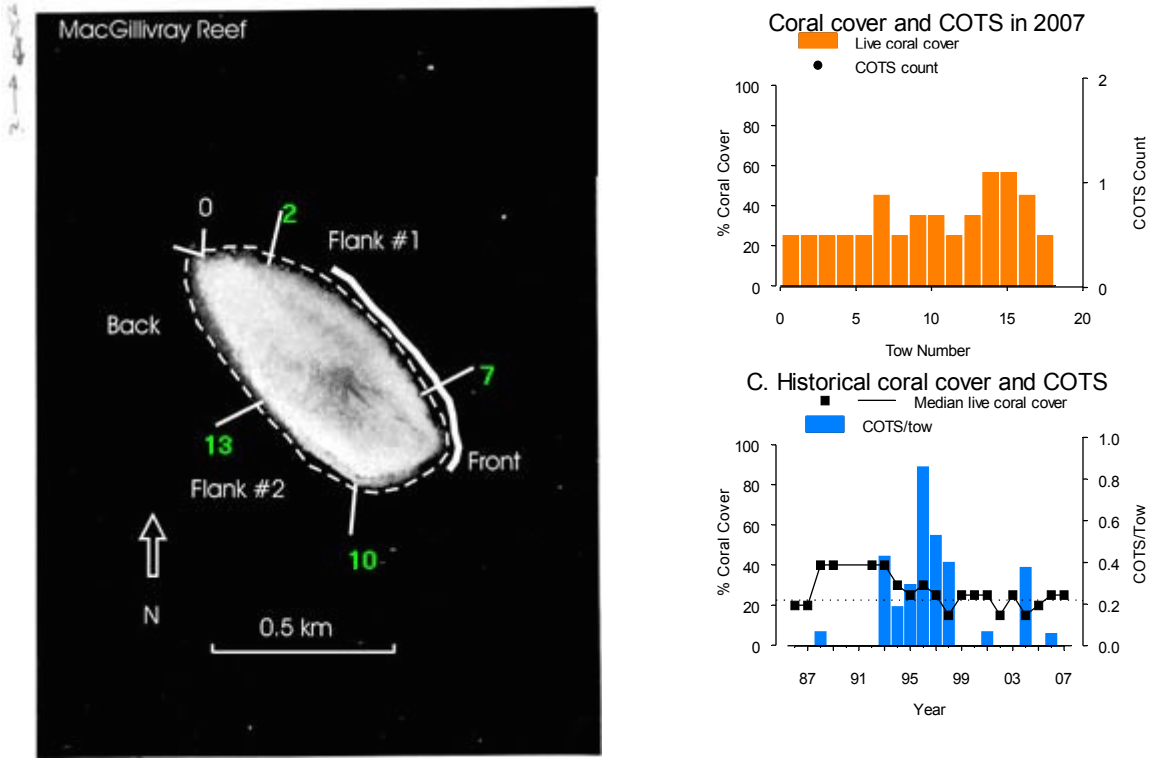
MacGillivray Reef has been surveyed regularly using manta tow since 1986, when it was classified as Recovering from a previous COTS outbreak. Median reef-wide live coral cover remained high until 1994. In 1993 elevated COTS populations were recorded and MacGillivray Reef was reclassified as Incipient Outbreak. COTS remained at or around Incipient Outbreak levels until 1998. There was a corresponding gradual decline in reef-wide live coral cover to moderate (11-30%) levels by 1998. Since then, coral cover has remained moderate (11-30%). By 2004 COTS numbers had once again risen to outbreak levels further reducing coral cover. Surveys in 2005 did not record any COTS and the reef was reclassified as Recovering. Only very low numbers of COTS were recorded in 2006. No COTS were recorded during surveys in 2007 and MacGillivray Reef remained classified as Recovering. Reef-wide live coral cover remained moderate (21-30%) in 2007. No bleaching or signs of coral disease were recorded during 2007 manta tow surveys.

At the intensive survey sites hard coral cover was moderate, averaging 26% in 2007. The coral community has been dominated by massive *Porites* since surveys began in 1993. The cover of *Porites* spp. had changed relatively little prior to 2005. This reflects the avoidance of this genus by COTS when they were present at MacGillivray Reef in the mid 1990s. From 2005 to 2007 there was a small increase in average cover of massive *Porites* spp. from 10% to 14%. Cover of soft coral remained stable throughout the survey period averaging 5% in 2007. Algal cover had remained stable around 51% until 2005, after which it decreased to 44% in 2007. It is also worth noting that the percent cover of sand at the fixed transects at MacGillivray Reef is relatively high (~20%) compared to other survey reefs. In 2007, one COTS was recorded and very low numbers of colonies with coral diseases, such as white syndrome, were noted during SCUBA searches. *Drupella* spp. were recorded at a density of 26/ha in 2007.

Species of large, mobile fish families were either stable or increasing in abundance between 2005 and 2007. Numbers of family Scaridae continued to increase at a slow rate in 2007. All species of Acanthuridae decreased in abundance in 2007, except *Zebrasoma veliferum*, which increased slightly. Numbers of Chaetodontidae continued to increase after reaching a low in 2001. The only damselfish to show any real increase in abundance in 2007 was the monophyletic genus, *Acanthochromis*. All other genera remained stable.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

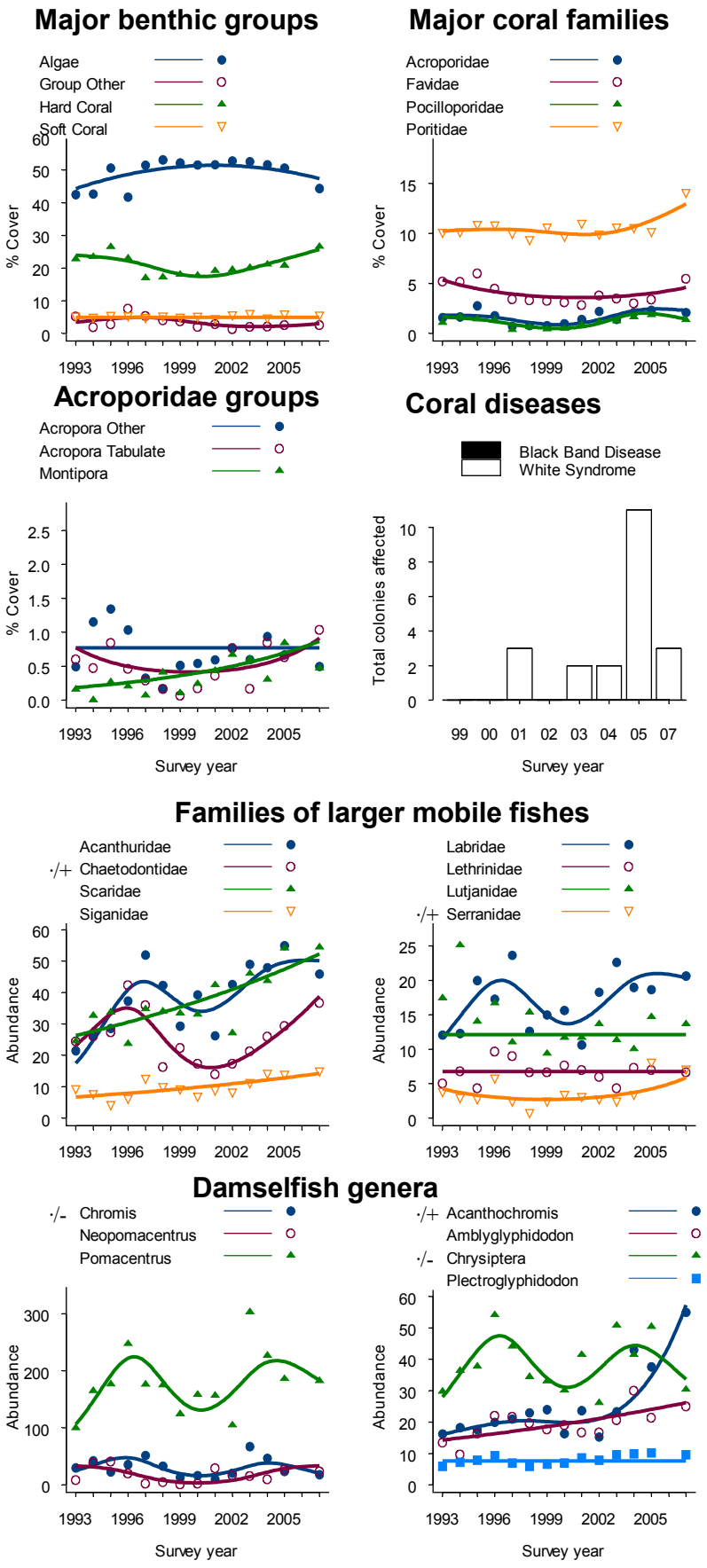
Figure 5.15



MacGillivray Reef (No. 14-114) is a mid-shelf planar reef with an area of 0.5 sq.km.

Figure 5.15 (cont.)

MacGillivray Reef was last surveyed in October 2006.



MARTIN

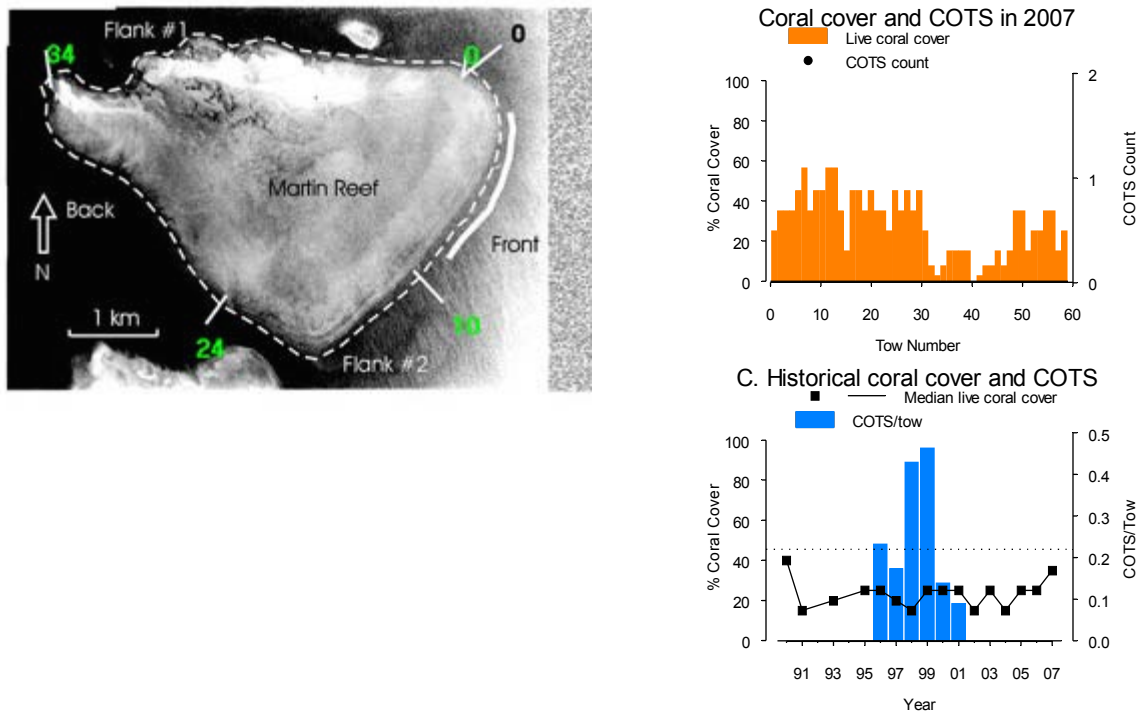
Martin Reef has been surveyed regularly using manta tow since 1990. Median reef-wide live coral cover has shown an increase in the most recent surveys and in 2007 was at a high (31-40%) level. This has been the first major increase since outbreaks levels of COTS affected Martin Reef between 1998 and 1999. No COTS have been seen in recent years and Martin Reef remained classified as No Outbreak in 2007. No bleaching was observed during manta tow surveys in 2007, nor were signs of white syndrome disease or signs of black band disease.

Hard coral cover on the intensive survey sites varied little until 2004, averaging 23%. After 2003 hard coral cover increased, reaching high cover at 31% in 2007. There was a corresponding decrease in algal cover from 55% to 42% in these years respectively. Cover of soft coral remained stable at 5% throughout the survey period. The slight increase in the cover of the family Acroporidae from 2003 to 2007 was due to increases in cover of the branching and tabulate growth forms of *Acropora* spp. The incidence of coral disease remained low in 2007. There were no *Drupella* spp. or COTS recorded at the survey sites in 2007.

Many large fish families have shown overall trends of slightly increasing abundance over the length of the study. However, there has been a lot of year to year variability, with some groups rising dramatically one year, and then falling the next. The best examples of this were the Scaridae, Labridae and Lutjanidae. The remaining families have shown no real trends. Trends in the damselfish community were largely driven by changes in a few abundant species. Numbers of *Pomacentrus moluccensis* declined after 2000 and have driven the observed trends in the genus *Pomacentrus*. Numbers of *Amblyglyphidodon curacao* had been declining up to 2004 but increased markedly in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

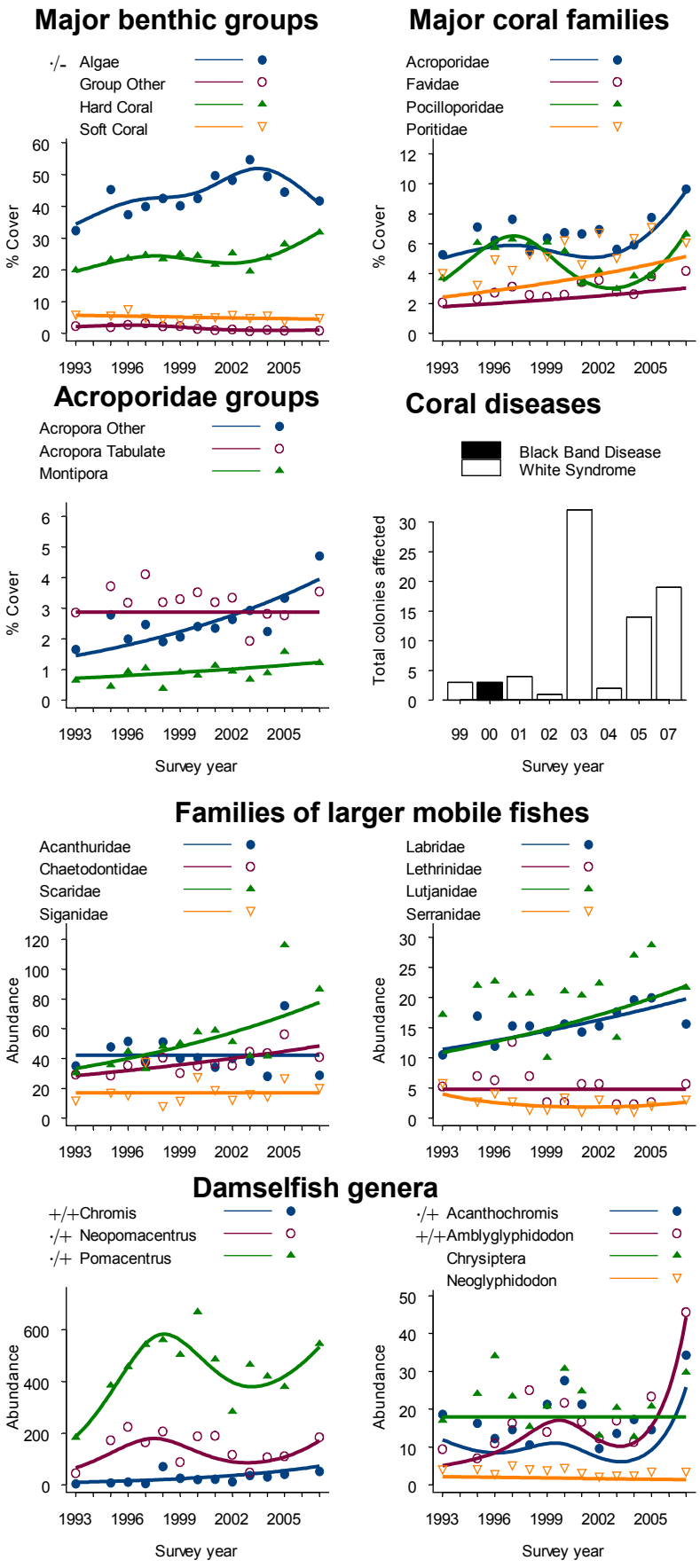
Figure 5.16



Martin Reef (No. 14-123) is an inshore planar reef with an area of 10.1 sq.km.

Figure 5.16 (cont.)

Martin Reef was last surveyed in October 2006.



NO NAME

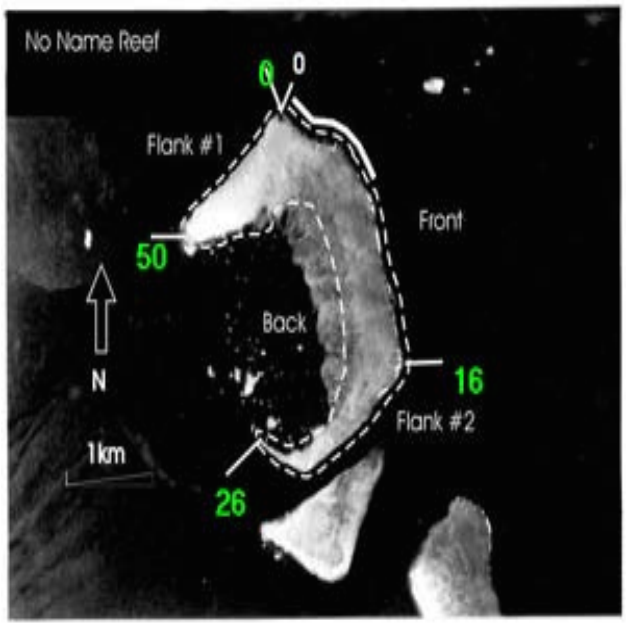
No Name Reef has been surveyed regularly using manta tow since 1986. No Name Reef was originally classified as Recovering from a COTS outbreak prior to the beginning of surveys, which probably caused the low initial coral cover. Cyclone Ivor also passed by the region in 1990 and caused significant physical damage. Median reef-wide live coral cover increased to a high level (31-50%) in subsequent years and No Name Reef was reclassified as No Outbreak in 2001. Surveys in 2007 showed that median reef-wide live coral cover had continued to decline on this reef and was at a low (5-10%) level. Cyclone damage (though not as extensive as that observed on Carter and Hilder Reef nearby) was observed during surveys and Cyclone Ingrid, a category 4 cyclone that passed to the north of the reef in March 2005, was considered responsible. It is also thought that ongoing low level disease (white syndrome) may have also contributed to the observed decline. No COTS have been observed on No Name Reef during surveys and it remained classified as No Outbreak in 2007. No bleaching or signs of black band disease were recorded during manta tow surveys in 2007. Signs of white syndrome disease were present around the reef perimeter and were particularly common (affecting more than 10 coral colonies per two-minute manta tow) on the front of this reef where coral cover was the highest.

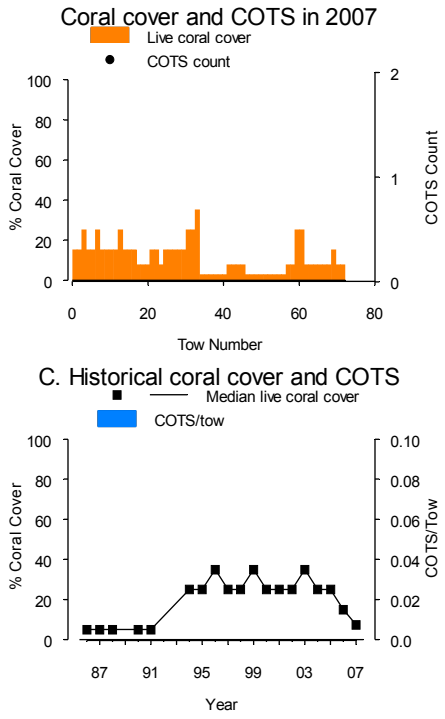
Cover of hard coral on the intensive survey sites increased from 21% in 1994 to a peak of 59% in 1999. This was primarily due to increases in the cover of fast growing tabulate *Acropora* spp. from approximately 5% in 1994 to 30% in 1999. Hard coral cover decreased after surveys in 1999, falling to 24% in 2007. Before 2005, high levels of coral disease may have contributed to the decline in hard coral cover. A dramatic increase in coral colonies with white syndrome disease was recorded in 2002. Incidence of coral disease had fallen in 2004 and remained at low levels up until 2007. The notable decrease in hard coral cover between 2005 and 2007 can be attributed to the decrease in tabulate *Acropora* spp. as a result of damage from Cyclone Ingrid in March 2005. Cover of algae correspondingly rose from 52% in 2005 to 64% in 2007. Soft coral cover decreased slightly from 11% in 1994 through to 6% in 2007. *Drupella* spp. were recorded at a density of 50/ha in 2007. It should be noted that only 2 of the 3 survey sites at No Name Reef were surveyed in 2007.

Numbers of the majority of large fish species had stabilised by 2005 and in many cases increased slightly by 2007. Members of the family Acanthuridae had initially decreased in abundance as coral cover increased, but since 1997, as coral cover began to plateau, most species from this family have shown little change in abundance. Families Chaetodontidae, Scaridae and Siganidae all showed little change in abundance from 2005 to 2007. Trends in the family Lutjanidae were driven mainly by the numerically abundant *Lutjanus gibbus*, which continued to decrease in abundance in 2007. In the damselfish community, increases in *Chromis* spp. in previous surveys had been reversed in 2007, and the changes were largely defined by numerically dominant species such as *C. ternatensis*. Most other damselfish genera have shown a general increase in numbers in 2007, however, some species declined in numbers (e.g. *Plectroglyphidodon* spp.).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.17

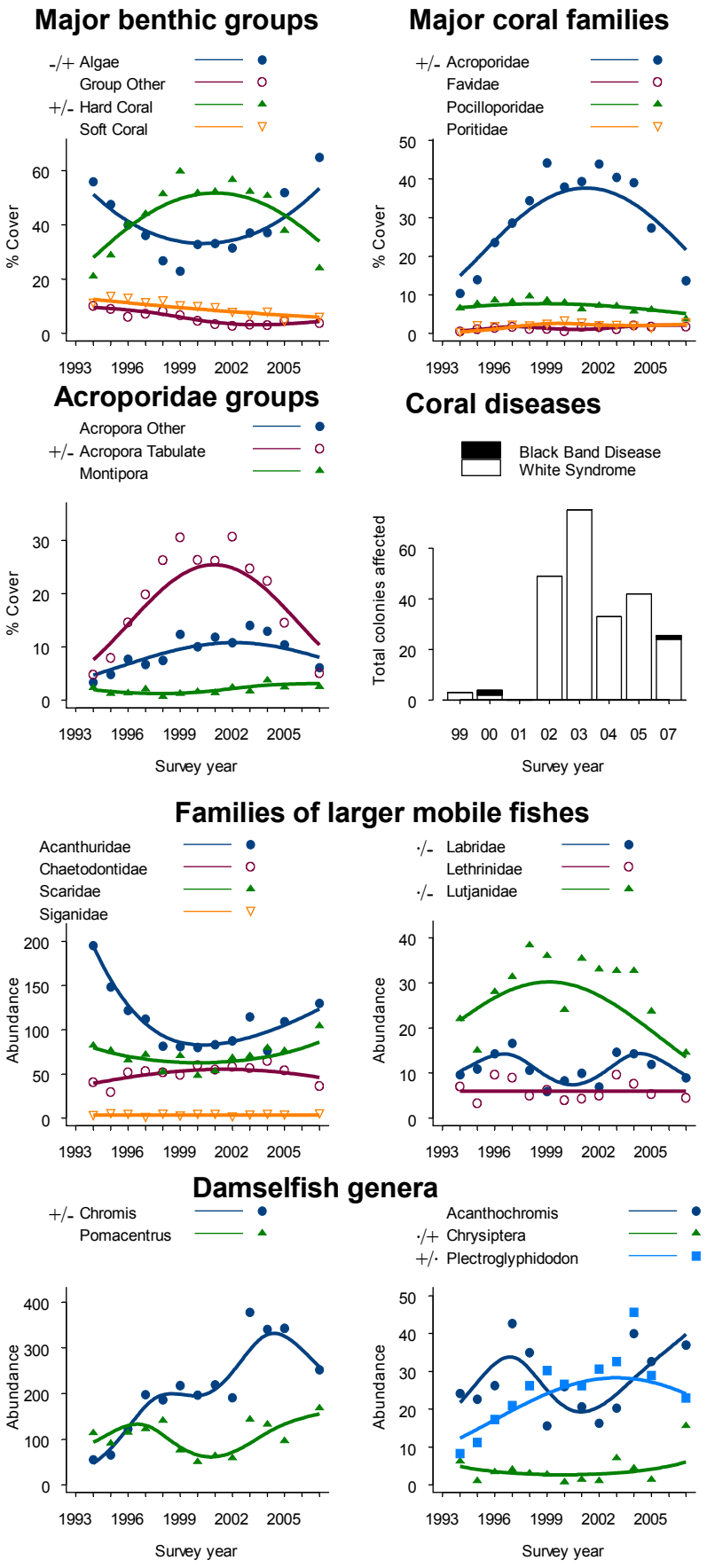




No Name Reef (No. 14-139) is an outer shelf ribbon reef with an area of 7 sq.km.

Figure 5.17 (cont.)

No Name Reef was last surveyed in October 2006.



NORTH DIRECTION IS

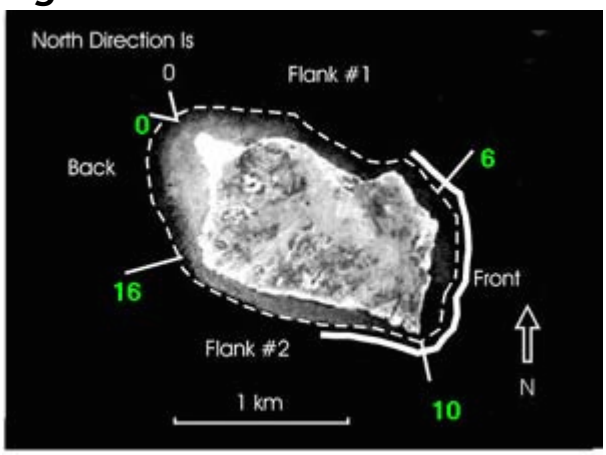
North Direction Is Reef was initially surveyed using manta tow in 1989 and has been surveyed annually since 1994. Median reef-wide live coral cover increased between 1989 and 1994 before declining through to 1998. COTS activity is the most likely cause of the decline, with North Direction Is Reef classified as Incipient Outbreak from 1995 to 1996. Small numbers of COTS below levels expected to impact on reef-wide live coral cover have been observed in recent years, including 2007. Coral cover has also increased in recent years reaching a high (31-40%) level by 2005 where it remained in 2007. No coral bleaching or signs of coral disease were recorded in 2007. North Direction Is Reef remained classified as No Outbreak in 2007.

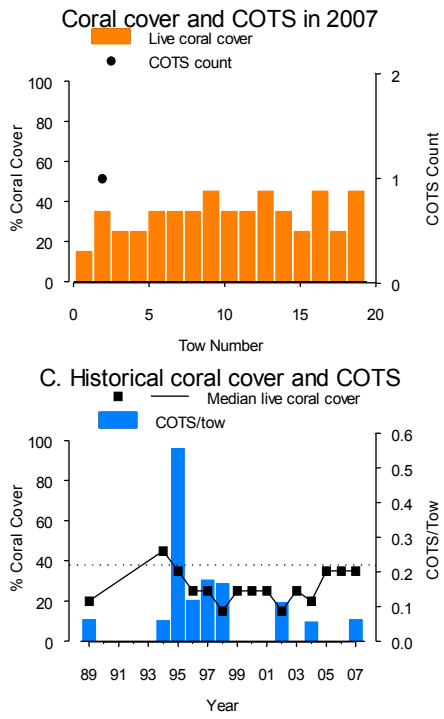
Hard coral cover on the intensive survey sites was 28% in 2007. Soft coral cover remained low averaging 3% in 2007. Algae, the dominant benthic group throughout the survey period, decreased in cover from 60% in 2005 to 53% in 2007. The cover of both Acroporidae and Pocilloporidae had been increasing gradually since the late 1990s. The average cover of the Poritidae family has varied over the course of the surveys, with a consistent, but small decrease observed since 2003. The four major families were represented relatively evenly in the community in 2007. Low numbers of diseased coral colonies (16 in total) were recorded during 2007, with white syndrome, black band disease and skeletal eroding band all represented. The occurrence of *Drupella* spp. recorded in 2007 was 646/ha. This is a standard observation at North Direction Is Reef, with similar concentrations of *Drupella* spp. recorded in all surveys since 1994.

All families of large mobile fishes increased in abundance in 2007, with the exception of Chaetodontidae and Labridae, which decreased slightly. However, none of these changes have affected the long term trend of increasing abundance. The damselfishes have remained stable or increased in 2007, particularly *Amblyglyphidodon curacoa* and *A. leucogaster*. The abundance of the genus *Pomacentrus* has been variable from year to year, due largely to variability in the two most abundant species, *Pomacentrus moluccensis* and *P. lepidogenys*. Similarly, the genus *Chrysiptera* has shown a large amount of temporal variability, due to the two most abundant species, *Chrysiptera talboti* and *C. rollandi*. Despite decreases in both species in 2007, the long term trend for this genera continued to increase.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.18

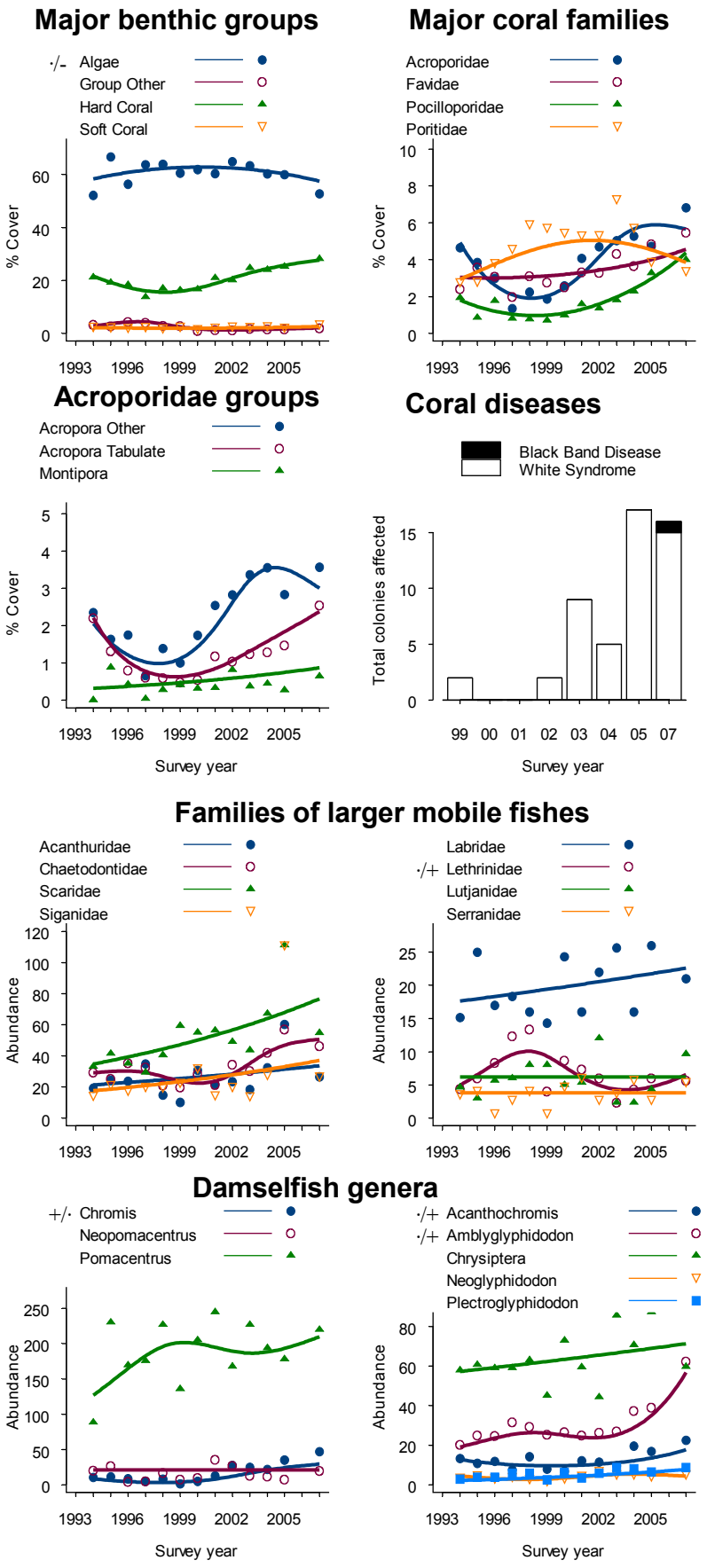




North Direction Is Reef (No. 14-143) is a mid-shelf fringing reef with an area of 0.9 sq.km.

Figure 5.18 (cont.)

North Direction Is Reef was last surveyed in October 2006.



YONGE

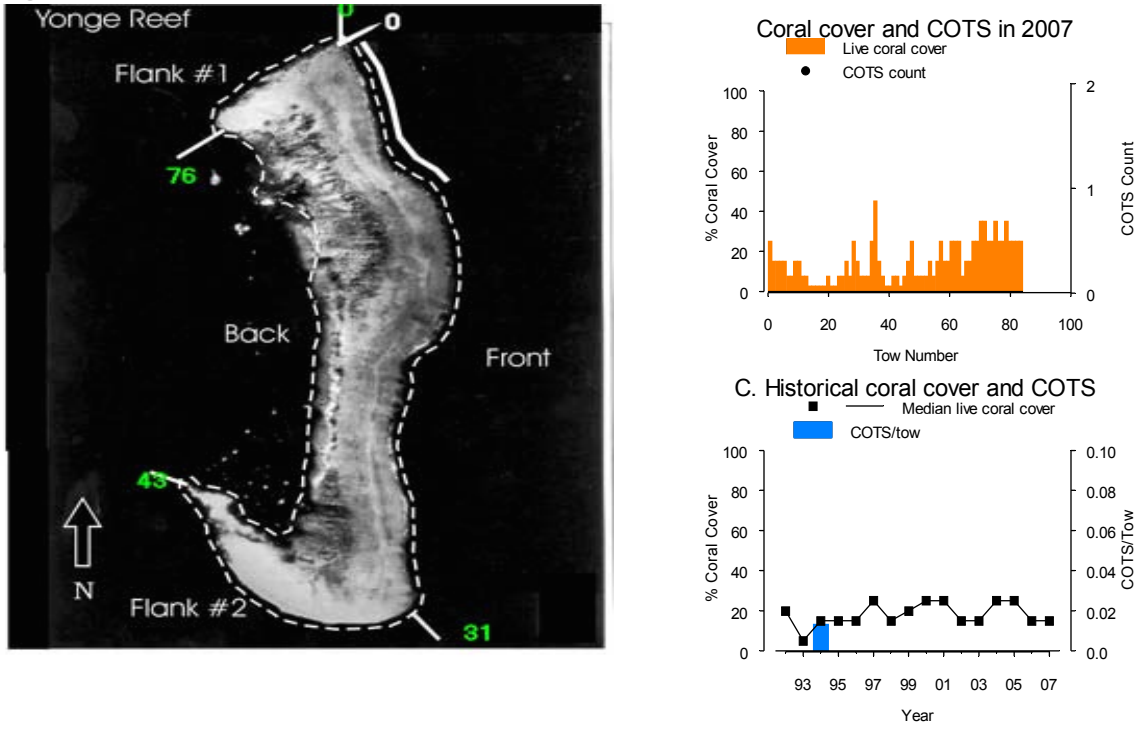
Yonge Reef has been surveyed annually using manta tow since 1992. COTS have only been observed on one occasion (1994) at extremely low density. However, Yonge Reef was considered to be recovering from COTS activity before surveys began, as well as from the effects of Cyclone Ivor (which passed through the area in 1990). Yonge Reef was first classified as No Outbreak in 2001. Median reef-wide live coral cover increased to moderate levels (11-30%) by 2000. There was a slight decline in 2002 and 2003 before bouncing back to moderate levels in 2004 and 2005. Surveys in 2006 indicated a decline in reef-wide live coral cover to a moderate level (11-20%). Cyclone damage (though not as extensive as that observed on Carter and Hilder Reef nearby) was observed during surveys and Cyclone Ingrid, a category 4 cyclone that passed to the north of the reef in March 2005, is considered responsible. It is also thought that disease (white syndrome) may have also contributed to the observed decline. Surveys in 2007 showed that coral cover remained moderate on this reef. No COTS have been observed on Yonge Reef during surveys and it remained classified as No Outbreak in 2007. No bleaching or signs of black band disease were recorded during manta tow surveys in 2007. Signs of white syndrome disease were present around the reef perimeter and and were particularly common (affecting more than 10 coral colonies per two-minute manta tow) on the back and front of the reef.

The cover of hard coral at the survey sites on Yonge Reef increased from 10% in 1993 to 61% in 2002. Hard coral cover varied little in following years until 2005, when it dropped to an average of 48%. This decline may be attributable to a low to moderate incidence of coral disease (mostly white syndrome) between 2002 and 2005. A dramatic drop in hard coral cover to an average of 24% was observed between 2005 and 2007. This reflects the damage caused to tabulate *Acropora* spp. by Cyclone Ingrid in March 2005. Tabulate *Acropora* spp., the dominant hard coral group, suffered a decline in average cover from 26% in 2005 to 6% in 2007 as a result of the cyclone damage. Algae cover varied inversely to the cover of hard coral over the survey period. Algal cover in 2007 was high at 70%. Soft coral cover has been consistent at 2% since 1993. Coral disease levels remained low in 2007. *Drupella* spp. were recorded at a density of 60/ha. in 2007.

Three families of large mobile fishes have shown long term trends of increasing abundance, despite two, Lutjanidae and Scaridae, having declined slightly in 2007. The third family, Acanthuridae, continued to increase in 2007, due to increases in *Ctenochaetus* spp. and *Acanthurus nigrofuscus*. The butterflyfishes (Chaetodontidae) decreased in abundance for the first time since surveys began. This was due largely to a decrease in abundance of the numerically dominant species, *Chaetodon trifascialis*. All genera of damselfishes, except *Chromis* spp., showed increasing or stable long term trends. Numbers of *Chromis* spp. continuously dropped between 2003 and 2007. This was largely driven by a large decline in a single species, *Chromis ternatensis*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

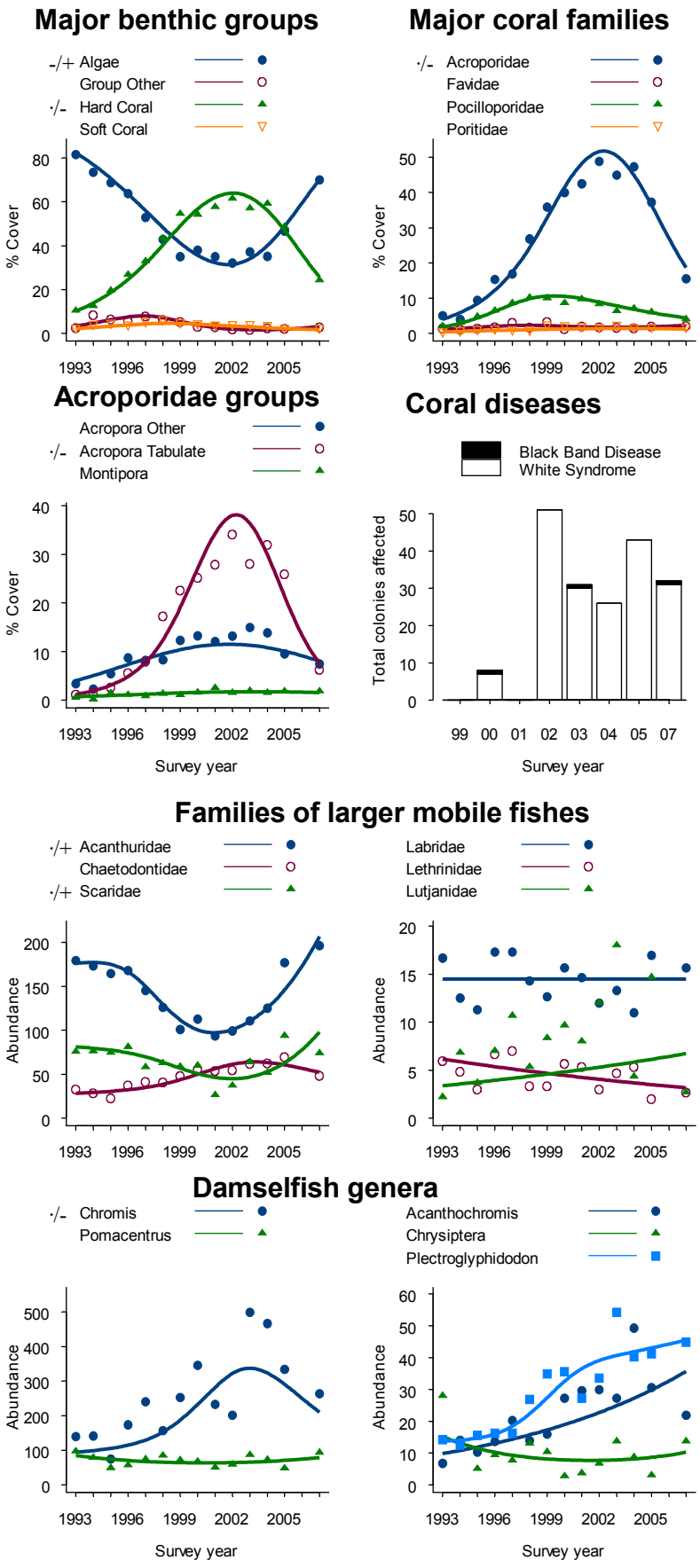
Figure 5.19



Yonge Reef (No. 14-138) is an outer shelf ribbon reef with an area of 11.1 sq.km.

Figure 5.19 (cont.)

Yonge Reef was last surveyed in October 2006.

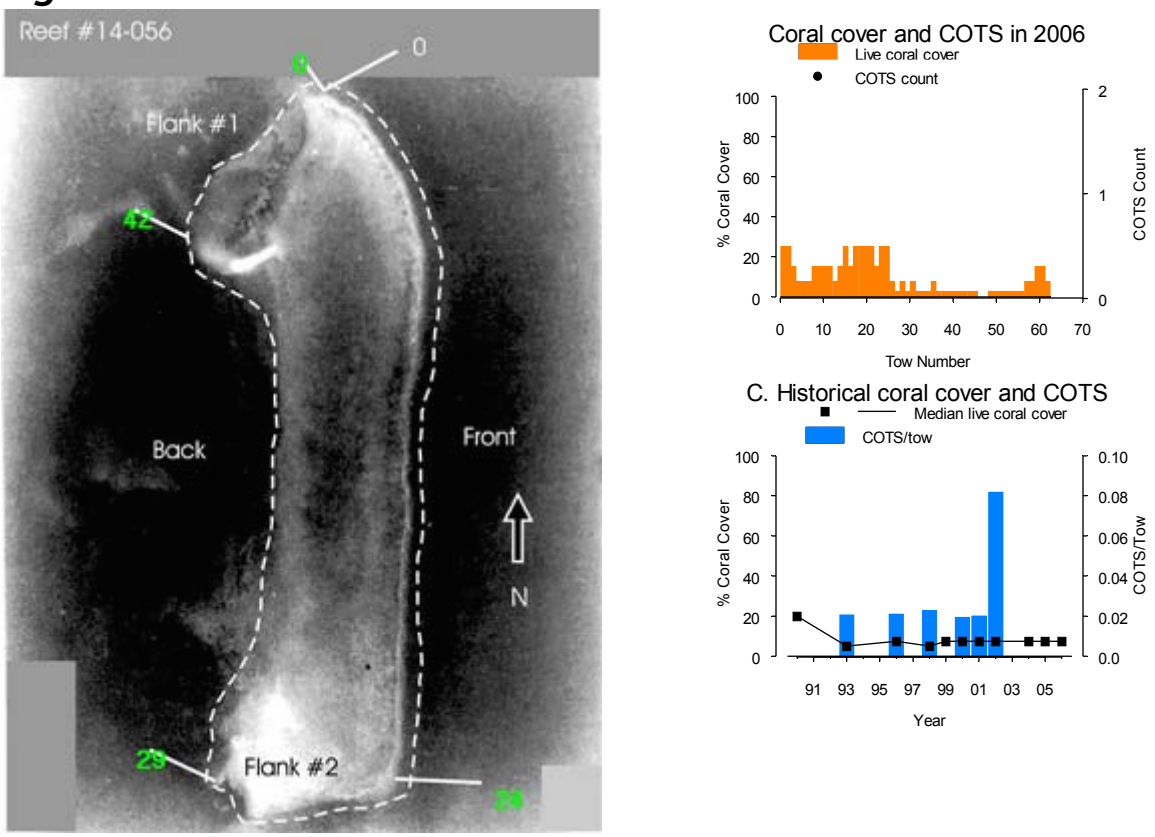


14-056

Reef 14-056 has been surveyed 11 times using manta tow since 1990. Initially median reef-wide live coral cover was moderate (11-30%), before declining to a low (1-10%) level in 1993, where it remained through to 2006. COTS have been observed in most survey years, though generally in numbers considered too low to cause significant reef-wide live coral mortality. However, it is likely that COTS have played a role in maintaining the continued low coral cover observed. No COTS were observed during manta tow surveys in 2006 and Reef 14-056 remained classified as No Outbreak. No bleaching or signs of black band disease were recorded. White syndrome disease was present in 2006 but was restricted to a few scattered coral colonies on the front and southern flank of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.20



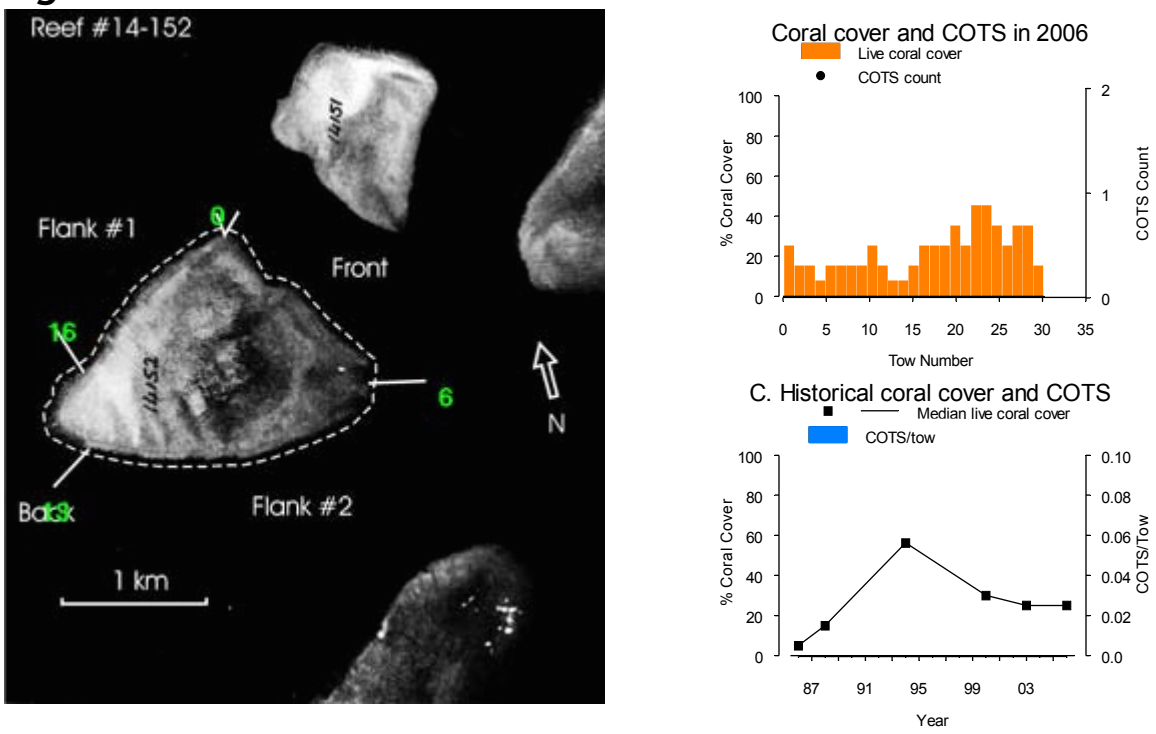
Reef 14-056 (No. 14-056) is a mid-shelf crescentic reef with an area of 7.8 sq.km.

14-152

Reef 14-152 has been surveyed six times using manta tow since 1986. Initially, median reef-wide live coral cover was low (1-10%) and the reef was considered to be Recovering from a COTS outbreak. Reef-wide live coral cover subsequently increased to a very high level (51-75%) by 1994 and the reef was reclassified as No Outbreak. Surveys in 2003 revealed that reef-wide live coral cover had declined to a moderate level (11-30%). COTS have not been recorded on this reef and the reason for this decline is unknown. Surveys in 2006 indicated that reef-wide coral cover remained moderate on this reef. Reef 14-152 remained classified as No Outbreak in 2006 . No COTS, coral bleaching or signs of black band disease were observed during surveys in 2006. Low levels of white syndrome disease (restricted to small numbers of scattered coral colonies) were observed on the back reef during manta tow surveys.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.21



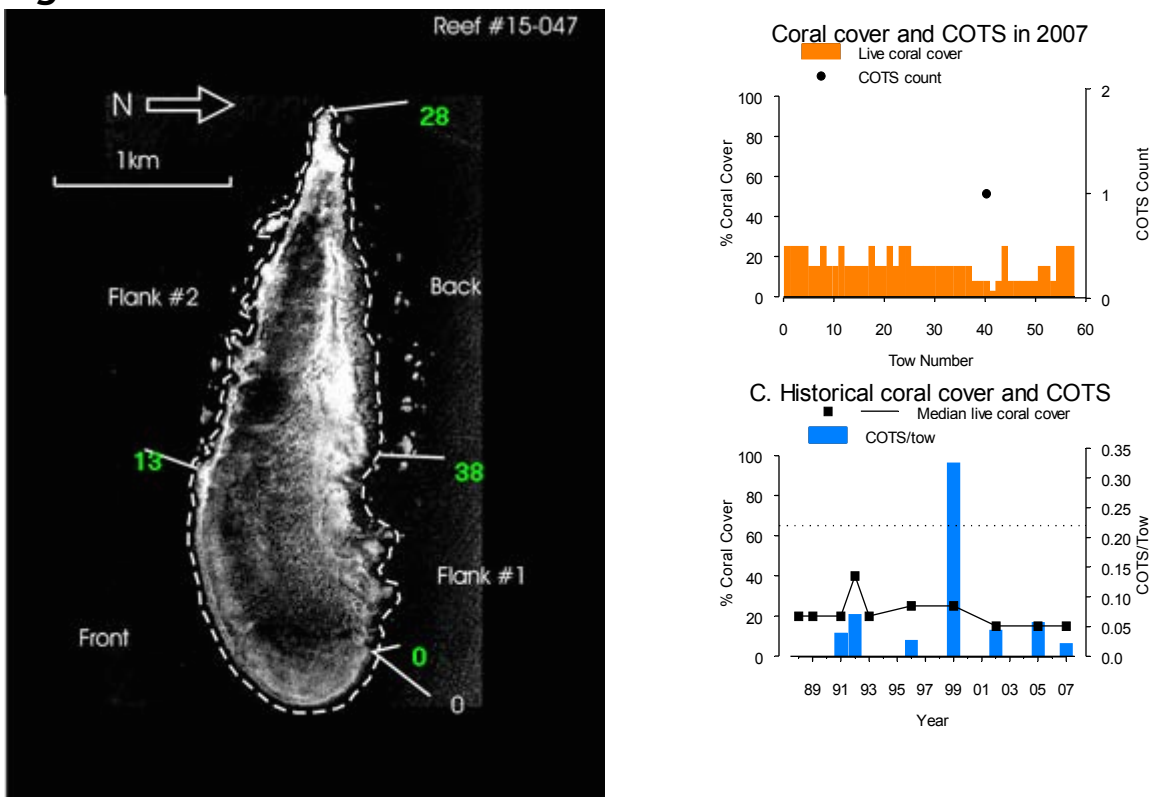
Reef 14-152 (No. 14-152) is an outer shelf planar reef with an area of 1.5 sq.km.

15-047

Reef 15-047 has been surveyed ten times using manta tow since 1988, when median reef-wide live coral cover was moderate (11-30%). Low numbers of COTS were recorded in several years following the initial survey. In 1999 COTS abundance had reached Incipient Outbreak levels. While COTS remained active in the years that followed, their numbers had declined to below outbreak level. The small decline in reef-wide live coral cover that occurred between 1999 and 2002 was most likely due to COTS feeding activity. Reef 15-047 was classified as No Outbreak in 2003. Surveys in 2007 showed that coral cover remained moderate on this reef. Although small numbers of COTS were observed in 2007 they occurred in numbers considered too low to impact on reef-wide live coral cover. No bleaching was observed and signs of white syndrome disease were restricted to a small number of scattered coral colonies on the back and flanks of the reef. No signs of black band disease were recorded during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.22



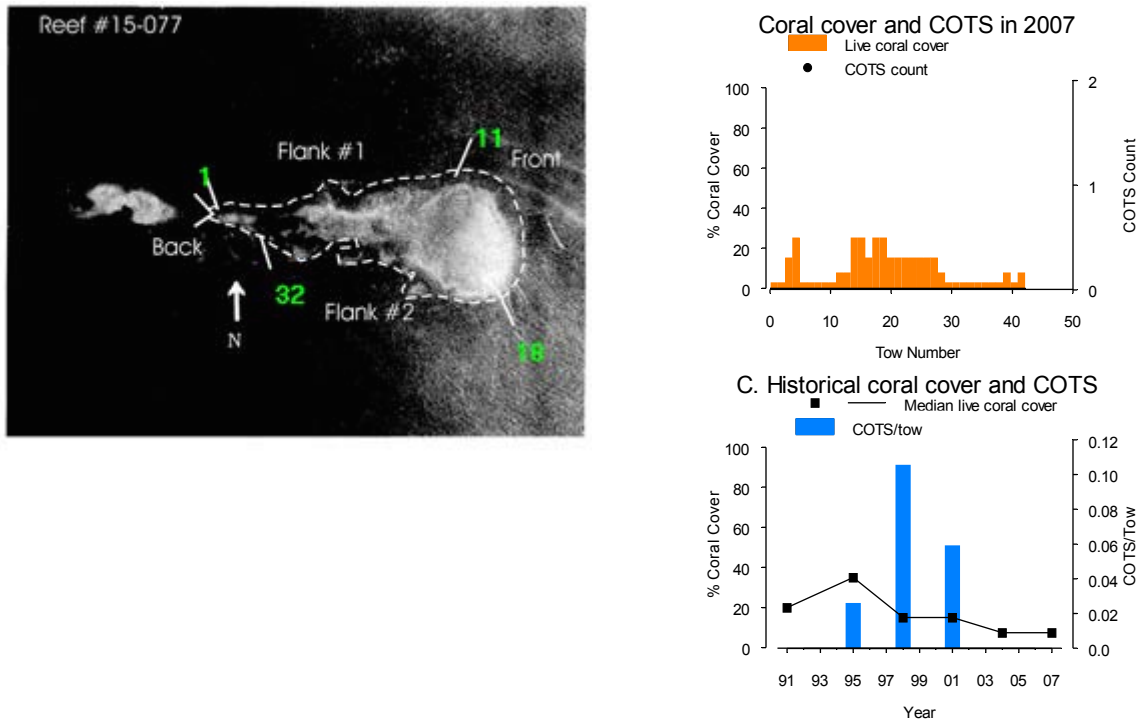
Reef 15-047 (No. 15-047) is a mid-shelf crescentic reef with an area of 4.89 sq.km.

15-077

Reef 15-077 has been surveyed six times using manta tow since 1991. Median reef-wide live coral cover peaked during surveys in 1995 before declining in later surveys. The decline coincided with increased COTS activity between 1995 and 2001. While COTS numbers over this time were generally considered too low to impact significantly on reef-wide live coral cover, it is expected that that they played a significant role in the observed decline in coral cover. No COTS have been observed since 2001 and the reef remained classified as No Outbreak in 2007. Surveys in 2007 showed that coral cover remained low (5-10%) on Reef 15-077. No bleaching was observed and signs of white syndrome disease were restricted to a small number of scattered coral colonies on the back and flanks of the reef. No signs of black band disease were recorded during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.23



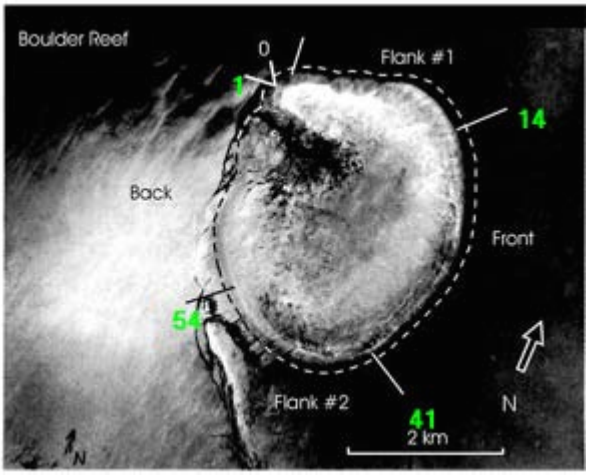
Reef 15-077 (No. 15-077) is a mid-shelf planar reef with an area of 6 sq.km.

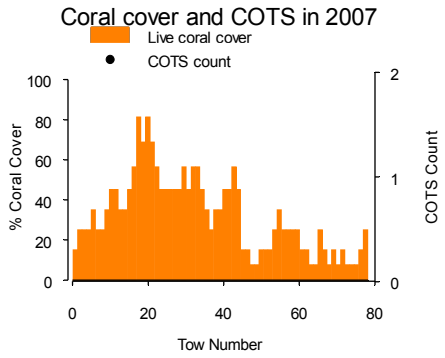
BOULDER

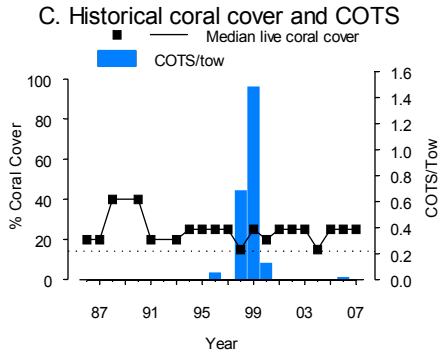
Boulder Reef has been surveyed regularly using manta tow since 1986. Early surveys found that median reef-wide live coral cover increased, peaking around 1990. This was followed by a decline to moderate levels (11-30%) that continued through to 2003. COTS were first recorded in 1996 and reached Incipient Outbreak levels in 1998. Surveys in 1999 revealed further increases in COTS and Boulder Reef was reclassified as an Active Outbreak. However, elevated COTS numbers were relatively short lived and no COTS have been observed on Boulder Reef since 2000. Live coral cover was only slightly affected during the outbreak and the reason for the decline in COTS numbers is uncertain. Boulder Reef was classified as No Outbreak in 2002 and had maintained this classification through to 2007. Coral cover remained moderate (11-30%) in 2007. Manta tow surveys in 2007 recorded no signs of bleaching or black band disease. Signs of white syndrome were observed on small numbers of scattered coral colonies on the front reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.24







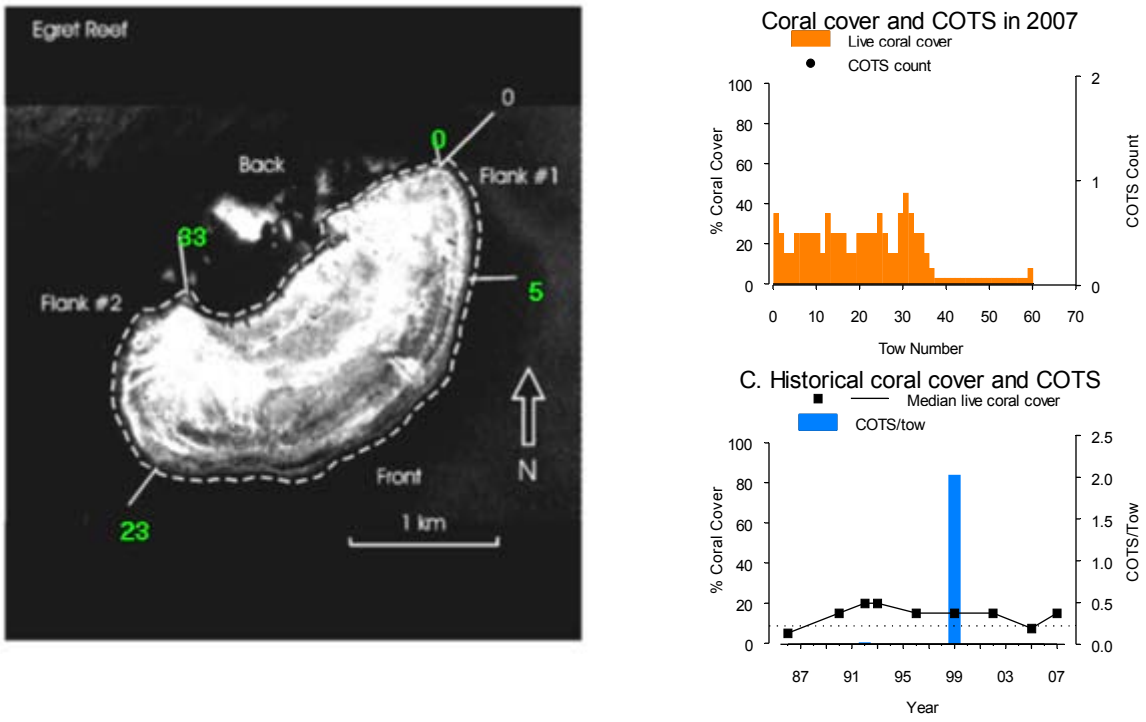
Boulder Reef (No. 15-012) is an inshore crescentic reef with an area of 12.6 sq.km.

EGRET

Egret Reef has been surveyed nine times using manta tow since 1986. Median reef-wide live coral cover initially increased and then remained stable at moderate levels (11-30%) through to 2002. COTS were first recorded on this reef in 1992 and had reached Active Outbreak levels by 1999. No COTS have been observed since 1999 and Egret Reef was classified as Recovering in 2000. Surveys in 2007 showed that median reef-wide live coral cover was at a moderate level (11-20%). No signs of coral bleaching or black band disease were observed during manta tow surveys in 2007. Signs of white syndrome were observed on small numbers of scattered coral colonies on the front reef. Egret Reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.25



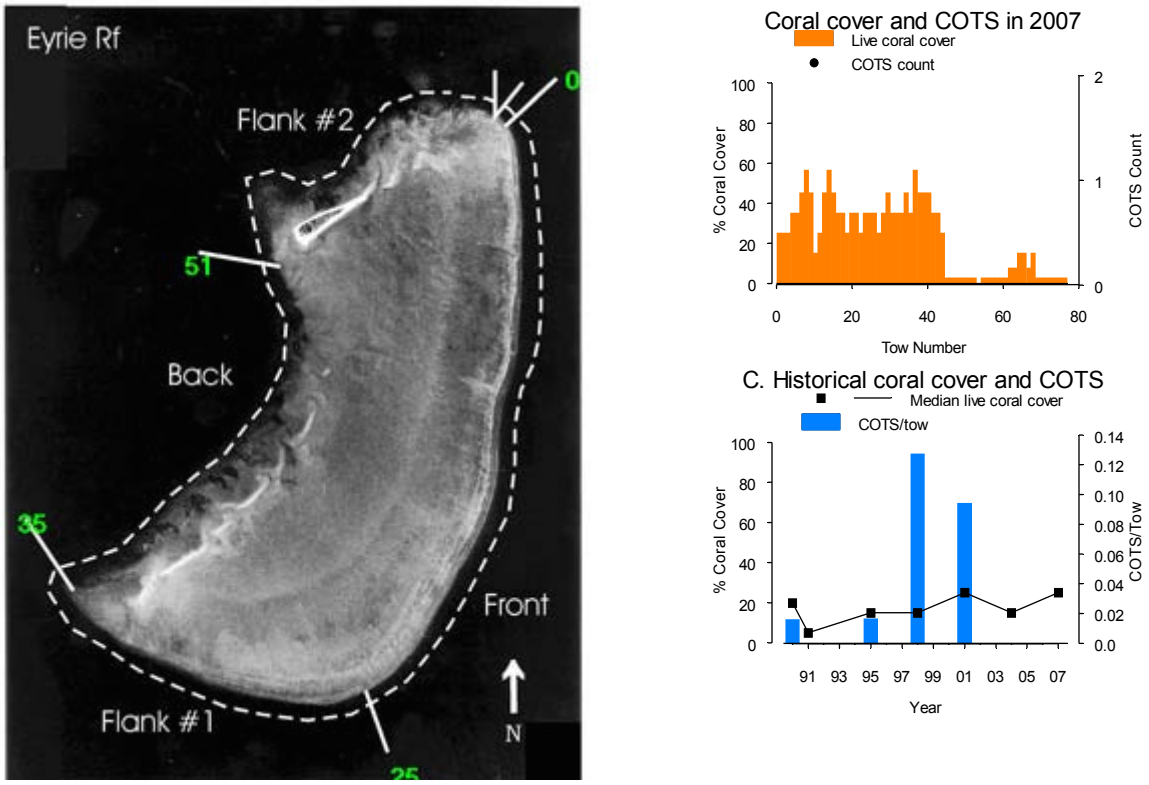
Egret Reef (No. 15-013) is an inshore crescentic reef with an area of 9.7 sq.km.

EYRIE

Eyrie Reef has been surveyed seven times using manta tow since 1990. Small numbers of COTS have been observed on this reef during most surveys. The initial decline in median reef-wide live coral cover (1990-1991) is unexplained. Although COTS were recorded at the time, they were in numbers normally considered too low to affect reef-wide live coral cover. Coral cover gradually increased until 2001, when it was moderate (11-30%). Small numbers of COTS have been recorded, at below outbreak levels, during most surveys, though not since 2001. No COTS were observed during surveys in 2007 and coral cover was moderate (21-30%). Eyrie Reef remained classified as No Outbreak in 2007. No bleaching or signs of coral disease were recorded during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.26



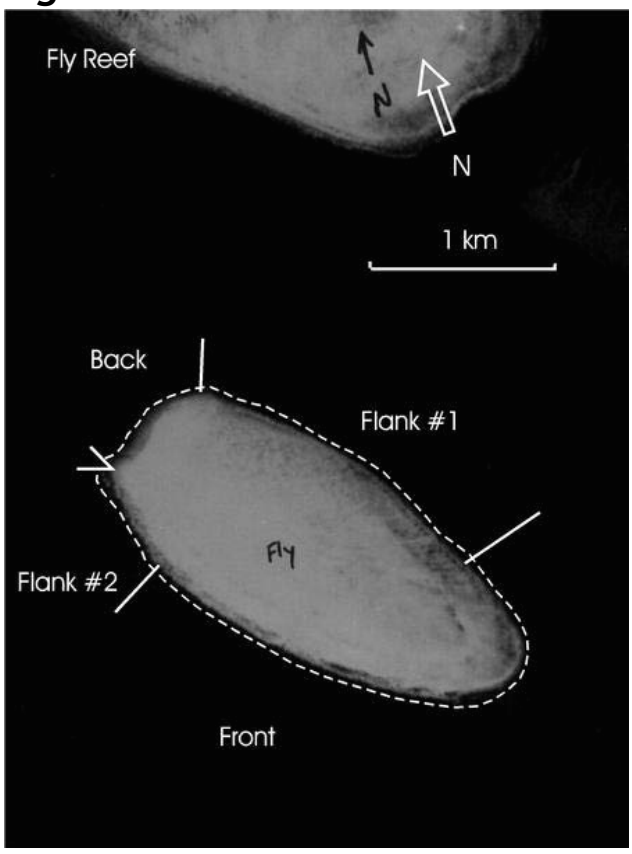
Eyrie Reef (No. 14-118) is a mid-shelf planar reef with an area of 12 sq.km.

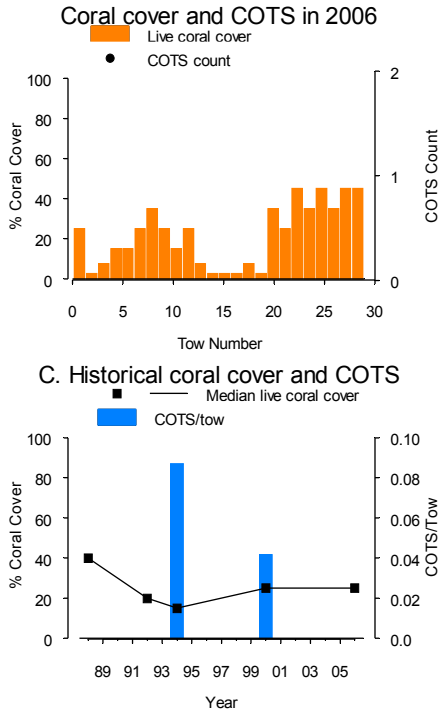
FLY

Fly Reef has been surveyed five times using manta tow since 1988. While COTS were observed in 1994 and 2000, they were in numbers that would be considered too low to cause significant reef-wide coral mortality. The cause of the decline in reef-wide live coral cover observed during the initial years of survey is unknown. Reef-wide live coral cover was moderate (21-30%) in 2006 and at a similar level to that recorded in 2000. The reef remained classified as No Outbreak in 2006. Low levels of bleaching were observed on a few scattered individual coral colonies on the front reef. No signs of black band disease were recorded, while signs of white syndrome disease were restricted to small numbers of scattered coral colonies around the reef perimeter, except for the back reef in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.27





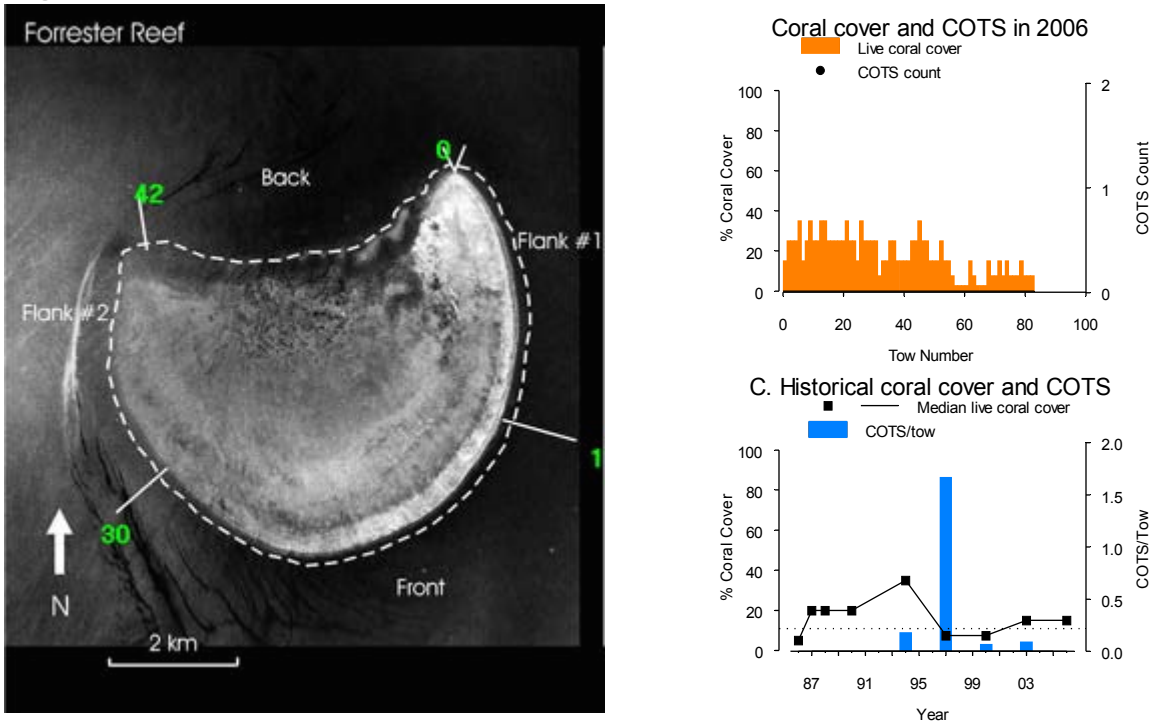
Fly Reef (No. 14-109) is a mid-shelf planar reef with an area of 1.3 sq.km.

FORRESTER

Forrester Reef has been surveyed regularly using manta tow since 1986. When first surveyed the reef was classified as Recovering from previous COTS activity. In the absence of COTS median reef-wide live coral cover increased to a high level (31-50%) by 1994. Surveys in 1997 found substantial COTS activity and a marked decline in reef-wide live coral cover to less than 10%. The reef was then reclassified as an Active Outbreak. Surveys in 2000 indicated that COTS were present in low numbers and the reef was reclassified as Recovering. By 2003 COTS numbers had declined and reef-wide live coral cover was beginning to increase reaching a moderate level (11-30%). Surveys in 2006 indicated that reef-wide live coral cover remained moderate. Forrester Reef remained classified as Recovering in 2006. Low levels of bleaching were observed on a few scattered individual coral colonies on the front of the reef. No signs of black band disease were recorded. Signs of white syndrome disease were restricted to small numbers of scattered coral colonies around the reef perimeter (apart from the back reef) in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.28



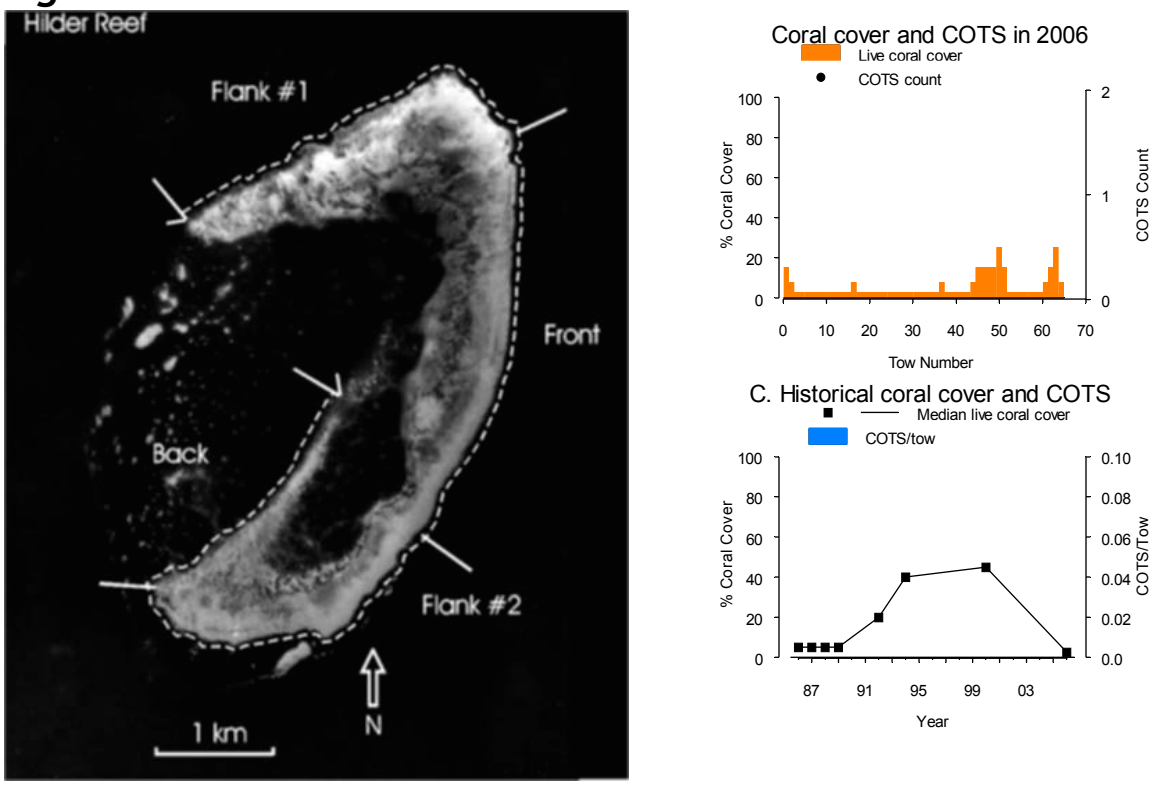
Forrester Reef (No. 15-009) is a mid-shelf planar reef with an area of 13.2 sq.km.

HILDER

Hilder Reef was sampled regularly using manta tow between 1986 and 1994 and intermittently since then. Initial surveys indicated median reef-wide live coral cover on Hilder reef was low (5-10%) as a result of COTS feeding activity (prior to the commencement of surveys) and the reef was classified as Recovering. Coral cover subsequently increased, particularly in the early 1990s, reaching a high level (41-50%) by 2000. Surveys in 2006 showed a marked decline in reef-wide live coral cover to a low level (5-10%). Cyclone damage was observed during surveys and Cyclone Ingrid, a category 4 cyclone that passed to the north of the reef in March 2005, is considered responsible. It is also considered that low level disease (white syndrome) may have also contributed to the observed decline. Very low cover on the sandy back reef also reduces the reef-wide average. No COTS have been observed on Hilder Reef during surveys and it remained classified as Recovering in 2006. No bleaching or signs of black band disease were recorded during manta tow surveys in 2006. Signs of white syndrome disease were common (affecting more than 10 coral colonies per two-minute manta tow) on the back reef area but were not observed on other parts of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.29



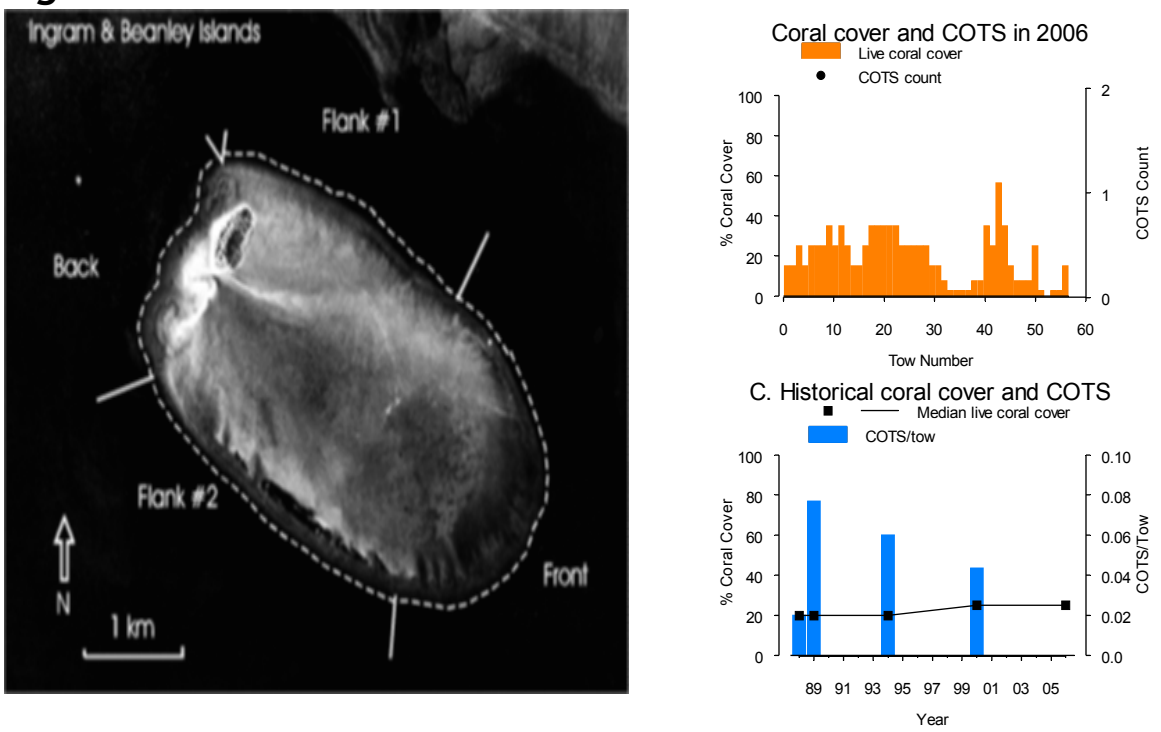
Hilder Reef (No. 14-085) is an outer shelf crescentic reef with an area of 12.9 sq.km.

INGRAM AND BEANLEY IS

Ingram and Beanley Islands Reef has been surveyed five times using manta tow since 1988. Median reef-wide live coral cover has remained at a moderate level (11-30%) over this time. COTS have been observed on this reef on the majority of surveys but at levels considered too low to cause significant coral mortality. No COTS, coral bleaching or signs of black band disease were recorded during surveys in 2006. Signs of white syndrome disease were observed on small numbers of scattered individual coral colonies on the back and southern flank of the reef. Ingram and Beanley Is Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.30



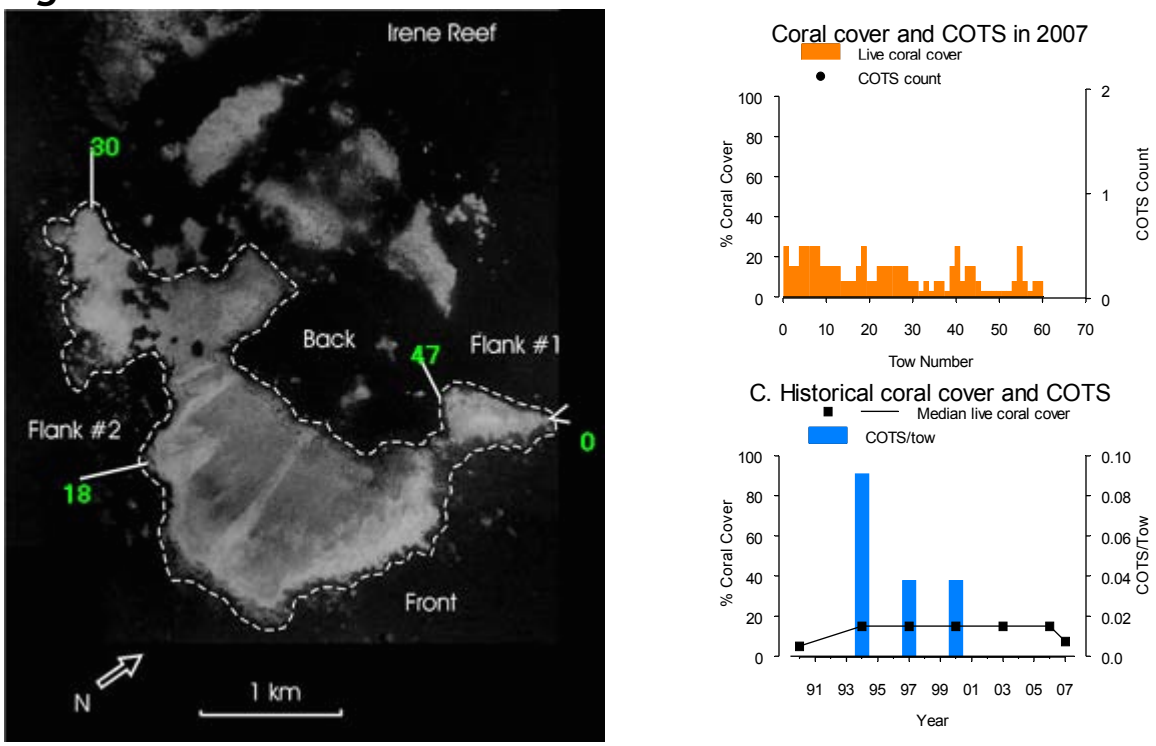
Ingram and Beanley Is Reef (No. 14-064) is a mid-shelf planar reef with an area of 6.7 sq.km.

IRENE

Irene Reef has been surveyed seven times using manta tow since 1990. Over this time median reef-wide live coral cover has remained at moderate levels (11-30%). Although COTS were observed on this reef during the three surveys prior to 2003, they were present in numbers considered too low to cause significant reef-wide live coral mortality. In 2007, Irene Reef remained classified as No Outbreak. Manta tow surveys in 2007 recorded a small dip in median reef-wide live coral cover to a low (5-10%) level, though this is not a substantial change from the previous moderate levels recorded from this reef. No coral bleaching or signs of black band disease bleaching were observed while signs of white syndrome disease were restricted to small numbers of individual coral colonies on the front reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.31



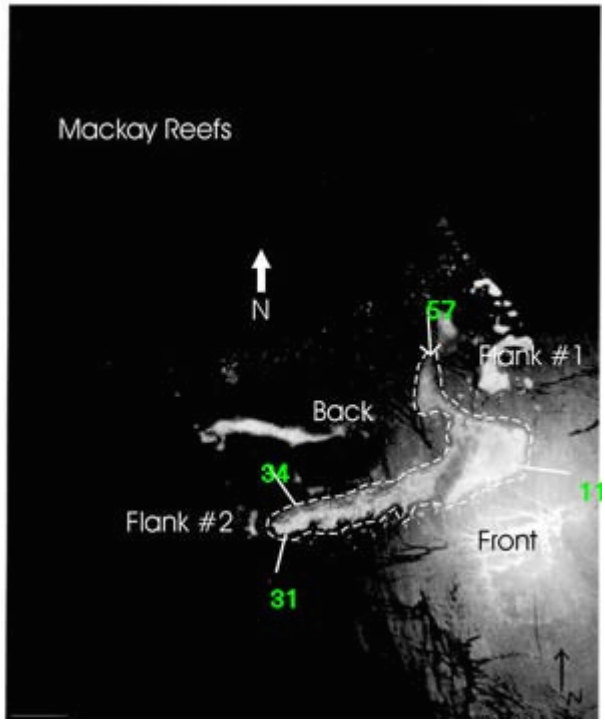
Irene Reef (No. 15-084) is a mid-shelf patch reef with an area of 13 sq.km.

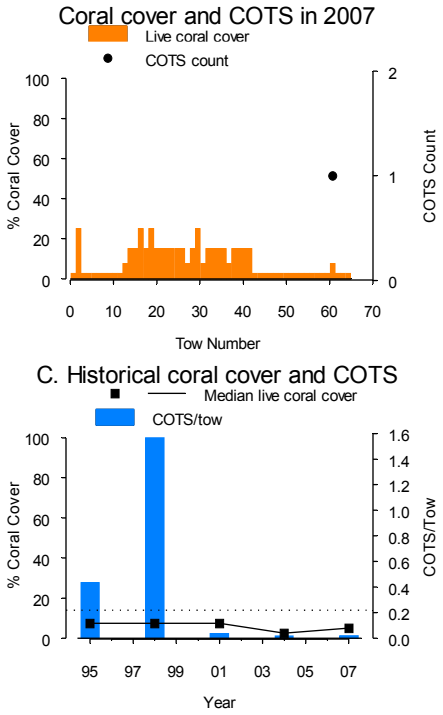
MACKAY REEFS

The Mackay Reefs have been surveyed five times using manta tow since 1995. COTS have been recorded in all surveys and the reef was declared an Active Outbreak in 1998. A single COTS was seen in 2007. Median reef-wide live coral cover remained low (6-10%), but showed a slight improvement from the previous survey in 2004, when it was at the lowest level recorded throughout the survey period. The low value for coral cover was almost certainly due to outbreak levels of COTS during the initial years of survey and the persistent low level COTS populations since that time. There was no coral bleaching in 2007. White syndrome was present, but restricted to a few scattered coral colonies on the back reef and second flank. No signs of black band disease were recorded. The reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.32





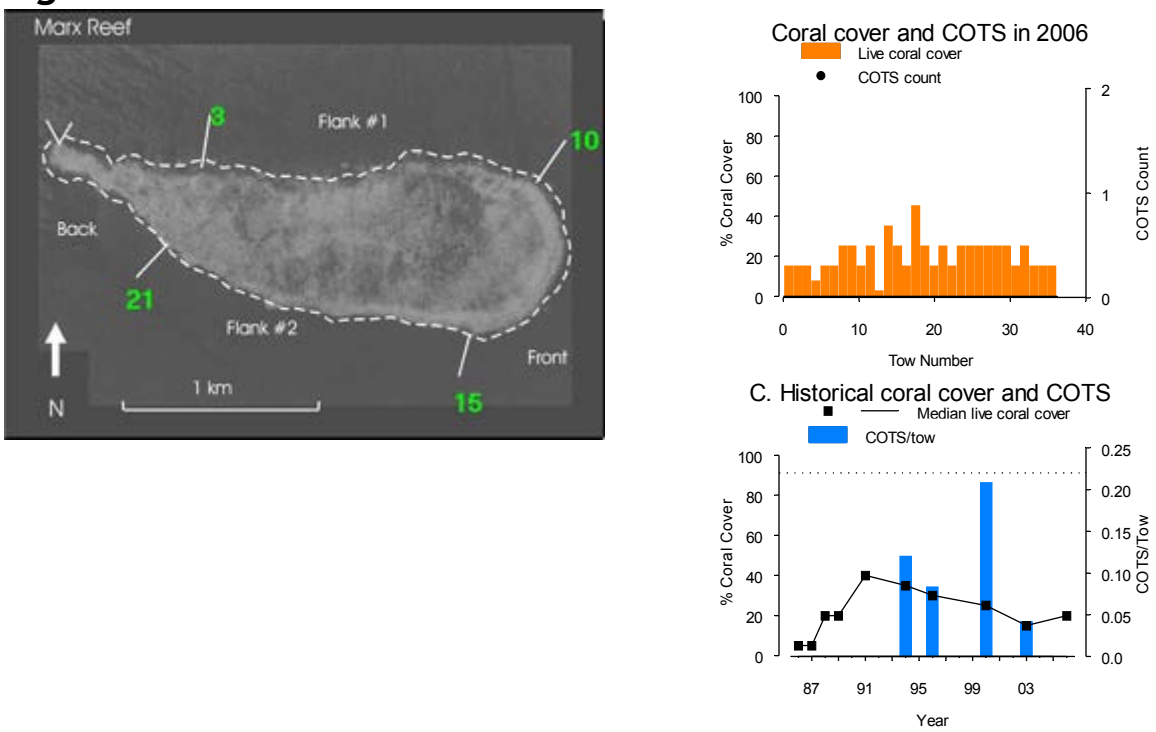
Mackay Reefs (No. 15-024) is a mid-shelf patch reef with an area of 25.9 sq.km.

MARX

Marx Reef has been surveyed regularly using manta tow since 1986. Initially, median reef-wide live coral cover was low (1-10%) increasing steadily to a high level (31-50%) by 1991. COTS were first observed on this reef in 1994 and reached just below Incipient Outbreak densities in 2000. In line with increased COTS activity, there was a decline in reef-wide live coral cover to moderate levels (11-30%) by 2003. Small numbers of COTS were again observed in 2003, but at levels considered too low to cause significant reef-wide coral mortality and the reef remained classified as No Outbreak. No COTS, coral bleaching or signs of black band disease were observed during surveys in 2006. Low levels of white syndrome (restricted to small numbers of scattered coral colonies) were observed on the northern flank during manta tow surveys in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.33



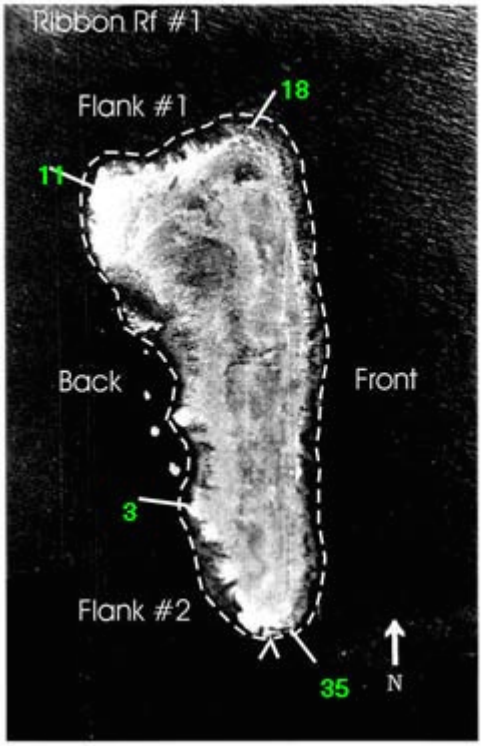
Marx (Reef No. 15-027) is a mid-shelf planar reef with an area of 1.9 sq.km.

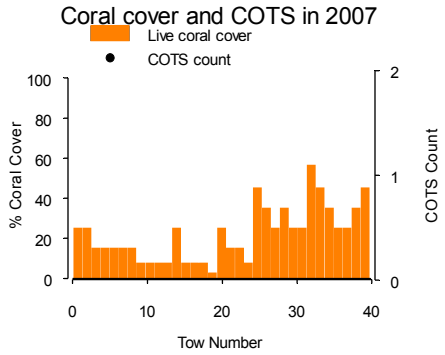
RIBBON NO.1

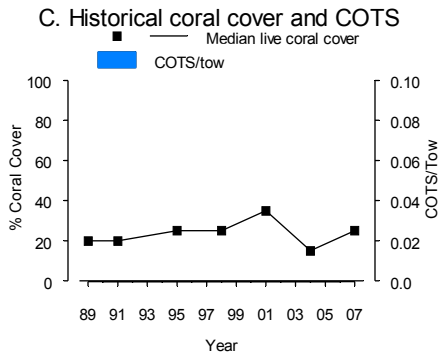
Ribbon Reef No. 1 has been surveyed seven times using manta tow since 1989. Median reef-wide live coral cover increased between 1989 and 2001, but then fell from a high level (31-40%) in 2001 to a moderate (11-20%) level in 2004. The reason for this decline remains enigmatic. No COTS have been recorded from this reef and it was classified as No Outbreak in 2004. Surveys in 2007 found coral cover remained moderate on this reef. No coral bleaching or signs of black band disease were observed. Signs of white syndrome were present, but restricted to small numbers of scattered coral colonies around the reef perimeter.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.34







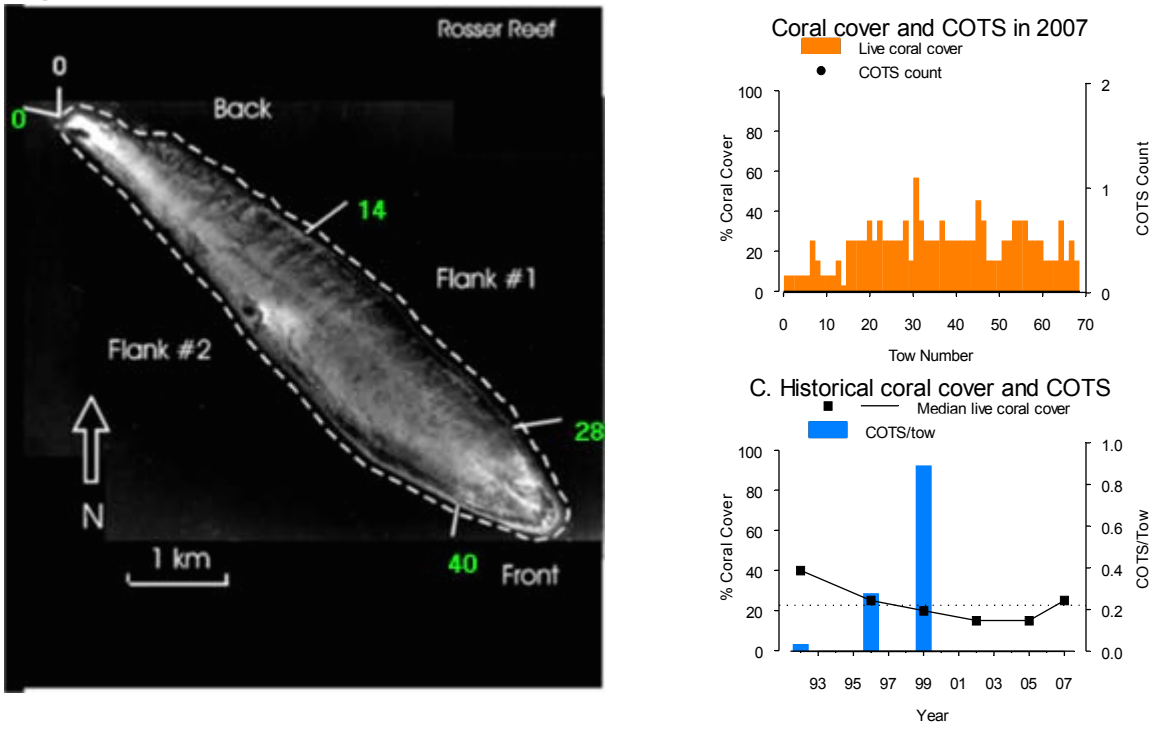
Ribbon Reef No.1 (No. 15-080) is an outer shelf ribbon reef with an area of 3.3 sq.km.

ROSSER

Rosser Reef has been surveyed six times using manta tow since 1992, when it was classified as No Outbreak. Initial surveys showed median reef-wide live coral cover to be high (31-50%), but during surveys in 1996 and 1999 Incipient Outbreak densities of COTS were recorded. Increased COTS activity was matched by a corresponding decline in reef-wide live coral cover to moderate levels (11-30%). COTS were no longer present in 2002 and median reef-wide live coral cover was moderate. Rosser Reef was reclassified as Recovering at this time. Surveys in 2007 indicate coral cover was beginning to increase on this reef though it still remained at a moderate level. There was no coral bleaching in 2007. White syndrome disease was present, but restricted to a few scattered coral colonies on the first flank. No signs of black band disease were recorded. The reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.35



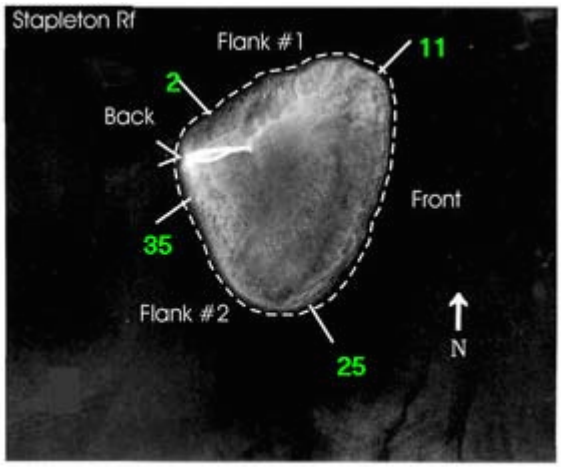
Rosser Reef (No. 15-081) is a mid-shelf planar reef with an area of 7.2 sq.km.

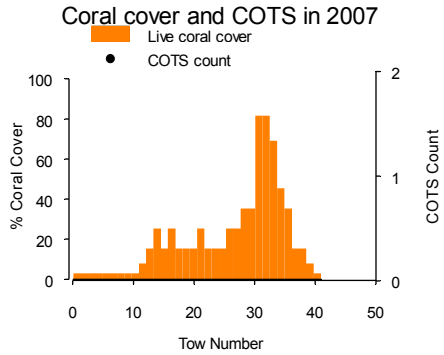
STAPLETON IT

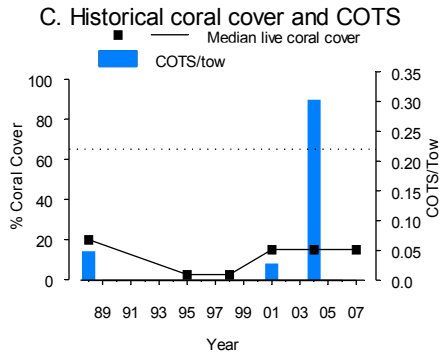
Stapleton Islet Reef has been surveyed six times using manta tow since 1988. After an initial decline between 1988 and 1995, median reef-wide live coral cover remained low (6-10%). COTS were present in early surveys and are probably responsible for the decline in coral cover. Reef-wide live coral cover was beginning to recover by 2001, when it was recorded at a moderate level (21-30%). This recovery stalled in 2004 when COTS were recorded at outbreak densities and the reef was reclassified as an Incipient Outbreak. No COTS were recorded during surveys in 2007 and the reef was reclassified as No Outbreak. Median reef-wide live coral cover remained at a moderate level. There was no coral bleaching in 2007 and white syndrome disease was present but restricted to a few scattered coral colonies on the back reef. No signs of black band disease were recorded during manta tow surveys.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.36







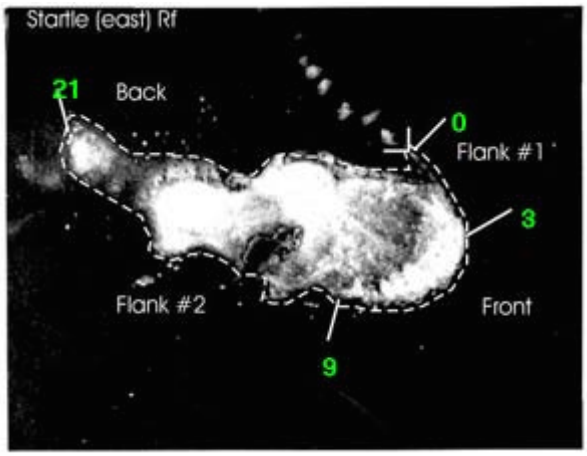
Stapleton It Reef (No. 14-054) is a mid-shelf planar reef with an area of 4.8 sq.km.

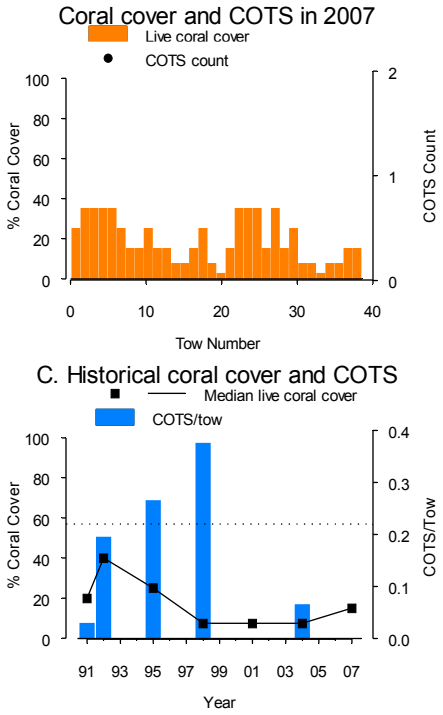
STARTLE (EAST)

Startle (East) Reef has been surveyed seven times using manta tow since 1991. Median reef-wide live coral cover declined from a high level (31-40%) in 1992 to a low level (5-10%) by 1998, where it remained until 2004. Outbreaks of COTS were recorded in 1995 and 1998 and these are the most likely cause of the decline in coral cover. The reef was classified as Recovering in 2004. No COTS were recorded during surveys in 2007 and there were signs that coral cover, which was observed at a moderate (11-20%) level, was beginning to recover. No bleaching or signs of black band disease were recorded during manta tow surveys in 2007. Signs of white syndrome disease were common (affecting more than 10 coral colonies per two-minute manta tow) on the first flank and front of this reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.37



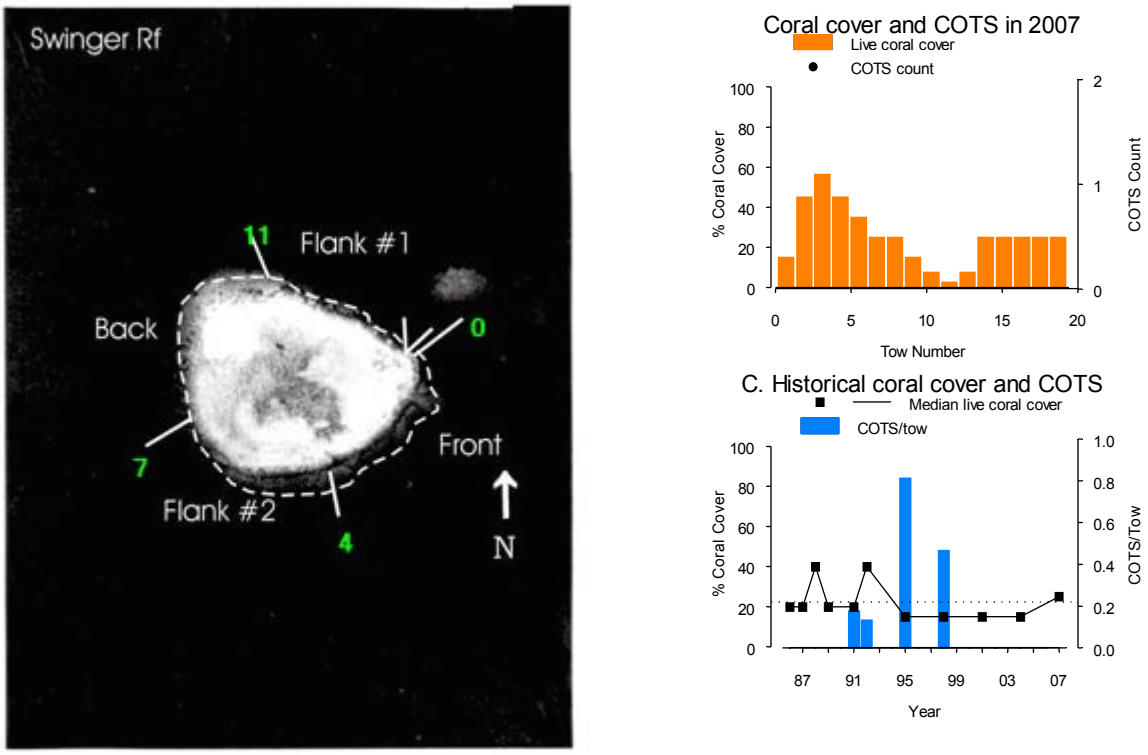


SWINGER

Swinger Reef has been surveyed 11 times using manta tow since 1986. Median reef-wide live coral cover was high (21-40%) until 1992 but declined to moderate levels (11-20%) in 1995, where it has remained. This is a reflection of COTS activity. COTS were present in 1991 and their numbers subsequently increased, reaching Outbreak levels between 1995 and 1998. No COTS have been observed since 1998 and the reef was classified as Recovering in 1999. Surveys in 2007 indicated that coral cover was beginning to increase on this reef, though it remained at a moderate (21-30%) level. No bleaching or signs of disease were recorded. The reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.38



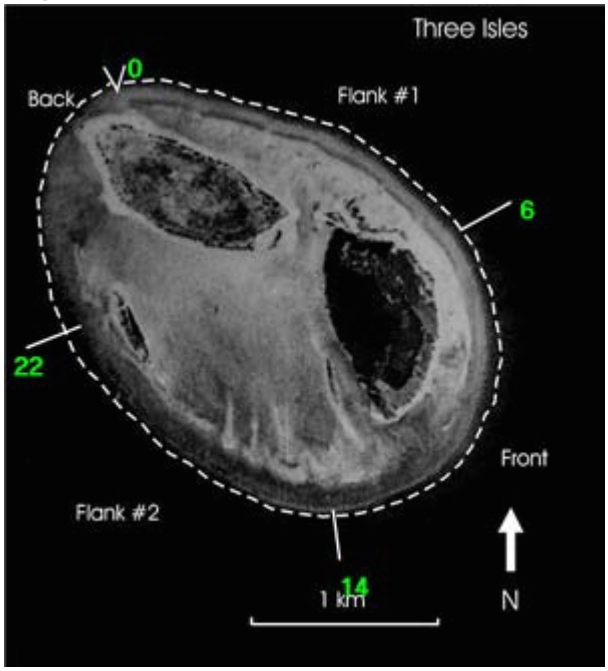
Swinger Reef (No. 15-030) is a mid-shelf planar reef with an area of 2.5 sq.km.

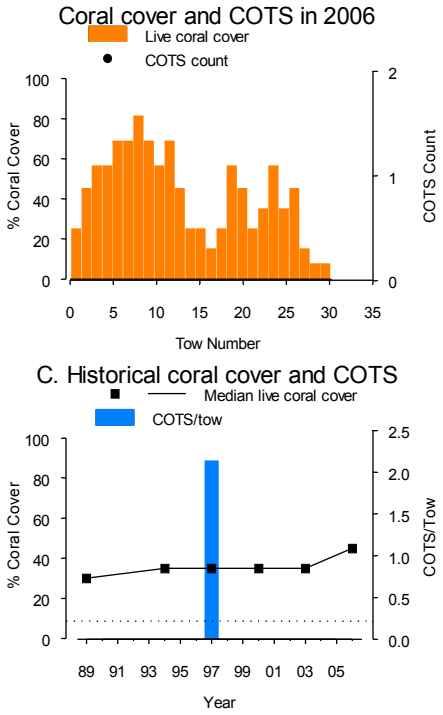
THREE ISLES

Three Isles Reef has been surveyed six times using manta tow since 1989. Median reef-wide live coral cover has remained high (31-50%). COTS were observed in substantial numbers on this reef in 1997 and the reef was reclassified as an Active Outbreak. During the 2000 survey no COTS were recorded and the reef was reclassified as Recovering. Surveys in 2003 showed little change and the reef was still classified as Recovering. Surveys in 2006 showed coral cover had increased to a high (41-50%) level since 2003. No COTS were observed and the reef was reclassified as No Outbreak. No bleaching or disease was recorded during manta-tow surveys in 2006.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.39





Three Isles Reef (No. 15-005) is an inshore planar reef with an area of 1.6 sq.km.

Cairns

Reef Pages

AGINCOURT NO.1

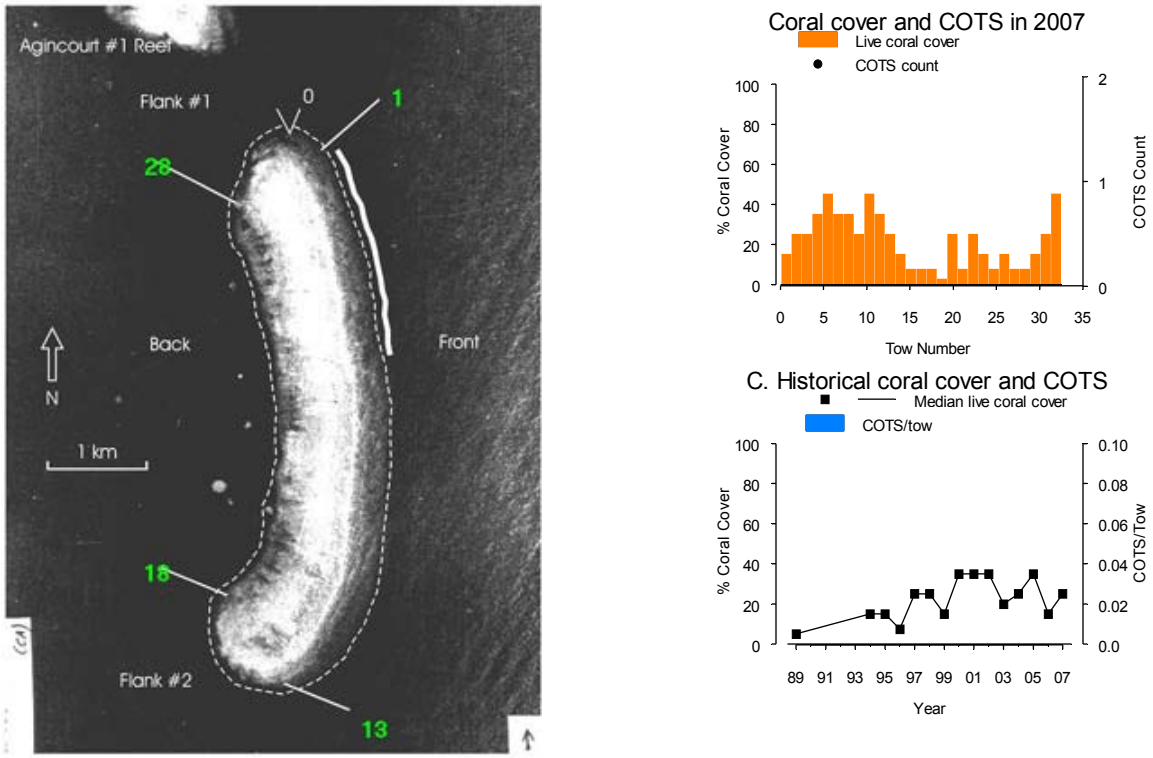
Agincourt Reef No.1 was first surveyed using manta tow in 1989 and has been surveyed annually since 1994. Median reef-wide live coral cover has shown a general, though fluctuating, increase since this time. No COTS have been recorded in any survey year and coral cover had increased to high levels (31-50%) by 2005. Surveys in 2006 showed coral cover had declined on this reef, with no apparent physical disturbance occurring between surveys. Observations in 2006 indicated an elevated incidence of the coral disease, white syndrome, that may have been implicated in this apparent decline. Surveys in 2007 showed reef-wide live coral cover was no longer declining and was at a moderate (21-30%) level. No COTS were recorded in 2007 and Agincourt Reef No.1 remained classified as No Outbreak. No bleaching was observed in 2006. Signs of white syndrome disease and black band disease were recorded from a small number of scattered coral colonies on the first flank of this reef during surveys in 2007.

At the intensive survey sites there had been an increase in hard coral cover over the first 10 years of surveys, with a peak of 39% recorded in 2002. This was largely due to increases in tabulate and branching *Acropora* spp. Hard coral cover subsequently showed little fluctuation until 2005. In 2006 a notable decrease in all growth forms of *Acropora* spp. caused a decline in hard coral cover to 29% and then to 25% in 2007. Algal cover increased correspondingly and reached 49% in 2007. Soft coral cover was moderate in 2007 at 22%, fluctuating minimally throughout the survey period. Cover of the families Faviidae, and Poritidae has remained relatively steady since 1994. The density of corallivorous snails, *Drupella* spp., has remained low throughout the survey period with a density of 33/ha recorded in 2007. White syndrome disease has been present at rare to low levels since 2001.

Numbers of fishes from the families Acanthuridae and Scaridae increased from 2005 to 2007, continuing the general trend that started in 2003. All other families remained relatively stable, except some species of Pomacentridae and the Labridae, which have shown an increasing trend since 2004. Increases in two genera of coral associated damselfishes, *Plectroglyphidodon* spp. and *Chromis* spp., drove the overall pattern for this family. This occurred despite a continuing decline in hard coral cover. It can be expected that declines in coral-associated groups of reef fishes will occur in future, after a lag period of coral decline.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

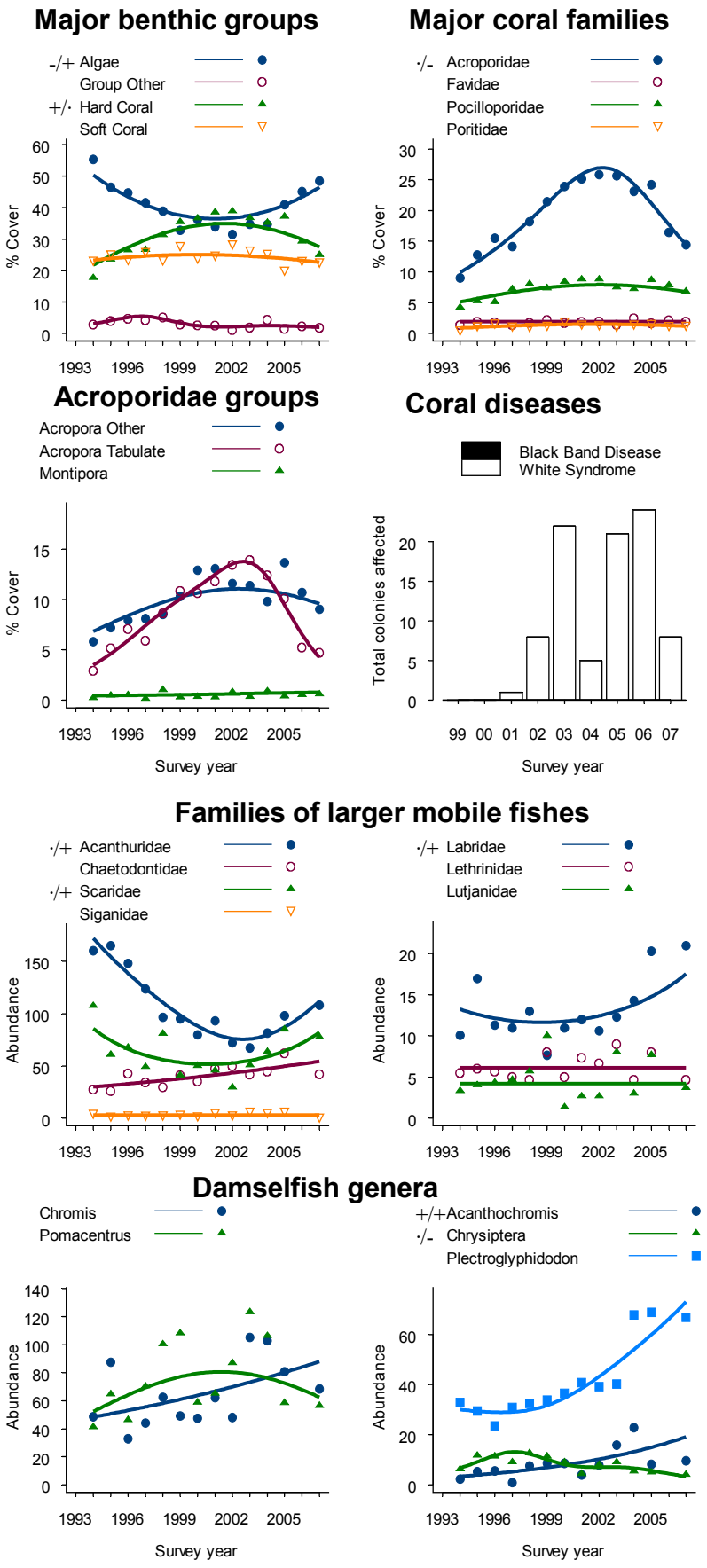
Figure 5.40



Agincourt No.1 Reef (No. 15-099) is an outer shelf ribbon reef with an area of 5.1 sq.km.

Figure 5.40 (cont.)

Agincourt No.1 Reef was last surveyed in January 2007.



ARLINGTON

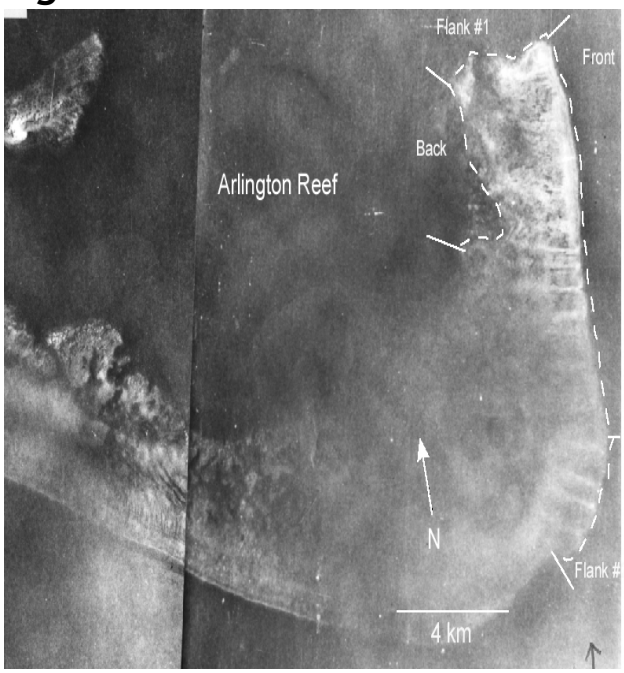
Arlington Reef has not been surveyed using manta tow since 1990. The large size of this reef means that only part of the reef was surveyed in 2006 and historically. Arlington Reef has a huge sandy back reef area that tends to drive down overall estimates of median reef-wide live coral cover. Coral cover on Arlington reef was low (6-10%) when surveyed in 2006 and comparable to levels recorded in previous surveys in 1990 and 1987. No bleaching or signs of coral disease were recorded from this reef during manta tow surveys in 2006. COTS have never been observed during manta tow surveys on Arlington Reef.

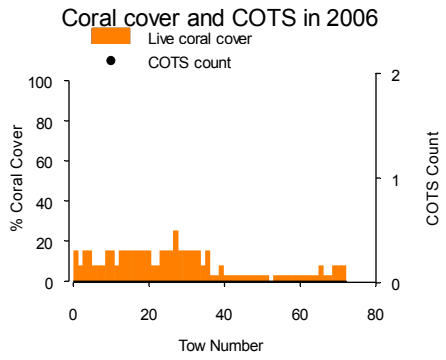
Survey sites at Arlington Reef were established in 2006. The percent cover of hard coral (18%) and soft corals (20%) was similar in 2006. Acroporidae was the most abundant hard coral family (6%), with Faviidae and Pocilloporidae following with 4% cover each. The soft coral community in 2006 had a mixed composition with Alcyoniidae the most abundant. Algal cover was composed of turf (44%) and coralline algae (11%). The number of colonies with coral diseases was low. *Drupella* spp. were present at the survey sites at a density of 13/ha.

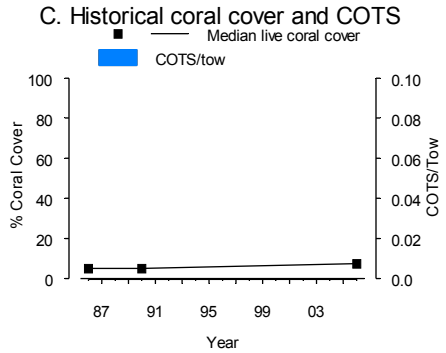
The large mobile fish community consisted of a high proportion of herbivorous fishes, such as parrotfishes (Scaridae & Acanthuridae), as would be expected from a reef where algae dominated hard coral in the benthic community. The low cover of hard coral meant coral affiliated fish species, such as butterflyfishes (Chaetodontidae) and some damselfishes (*Chromis* spp.) were present only in low numbers, most likely due to competitive exclusion and lack of available resources. The genus *Plectroglyphidodon* was composed mainly of a single algae affiliated species *P. lacrymatus*, whilst the coral affiliated con-generics, such as *P. dickii*, were present only in very low numbers.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.41

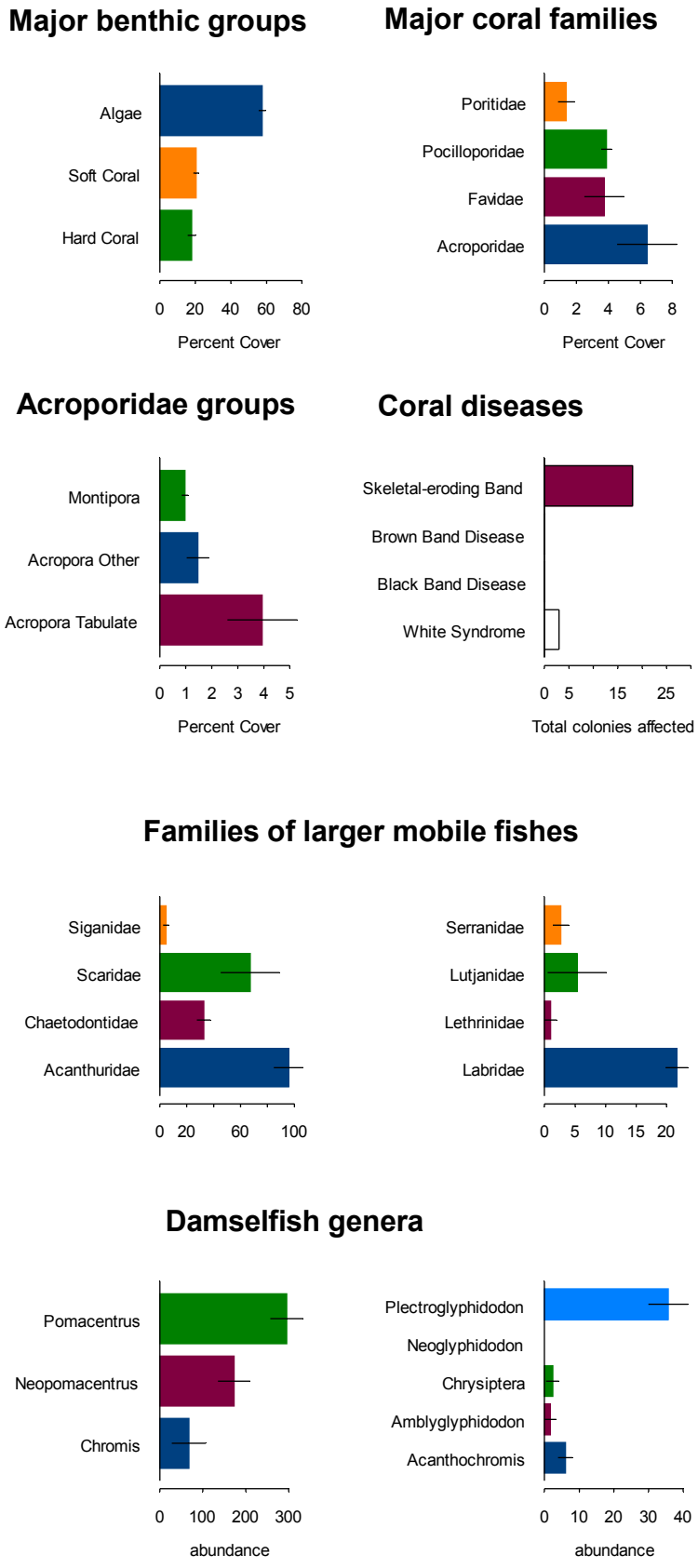






Arlington Reef (No. 16-064) is a mid-shelf crescentic reef with an area of 99.5 sq.km.

Figure 5.41 (cont.)
Arlington Reef was last surveyed in October 2005.



FITZROY IS

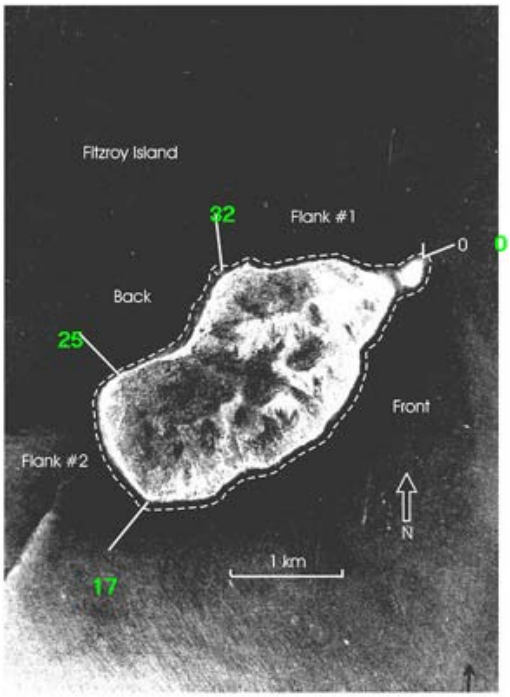
Fitzroy Island Reef has been surveyed 16 times using manta tow since 1986. Median reef-wide live coral cover was initially moderate (11-30%) before falling to a low level (1-10%) between 1989 and 1990, probably as a result of the 1989 flood on the northern GBR. Coral cover increased between 1995 and 1998 and then declined in 1999. A large proportion of corals were bleached at the time of survey in 1998. Small numbers of COTS were also observed during manta tows at this time. Surveys in 1999 recorded many dead standing coral colonies, particularly tabulate *Acropora* spp. that died approximately twelve months previously (based on the minimal erosion observed). This time frame for mortality coincides with the 1998 bleaching event. Reef-wide live coral cover remained very low (<5%) through to 2002. No manta tow surveys were conducted in 2003 or 2004 due to poor visibility. Surveys in 2005 indicated reef-wide live coral cover was beginning to recover and was at a moderate (11-20%) level. Surveys in 2007 indicated reef-wide live coral cover remained at levels similar to that seen in 2005 and that the reef remained in the early stages of recovery from the impacts inflicted in 1998. This is despite the passage of Cyclone Larry just south of this reef in 2006. No COTS have been recorded in the most recent surveys and Fitzroy Island Reef was last classified as No Outbreak in 2007. No bleaching or black band disease was recorded during manta tow surveys in 2007. White syndrome was recorded from small numbers of scattered colonies on the front and second flank of the reef

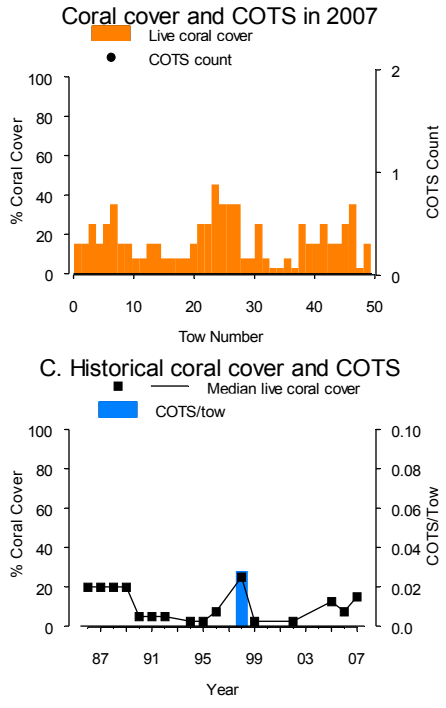
At the intensive survey sites bleaching was observed in February of 1999. Hard coral cover declined significantly following this bleaching from 32% in 1999 to less than 10% in 2000 and had slowly increased to a moderate level of 18% by 2007. The pattern of algae cover adjusted accordingly, increasing from 34% in 1999 to 65% in 2000, and then generally decreasing to 41% in 2007. Branching *Acropora* spp., foliose *Montipora* spp., and sub-massive *Porites* spp. were affected most by bleaching in 1999. The family Poritidae has since shown signs of recovery, increasing from 3% cover in 2000 to 10% in 2007. The other major hard coral families have remained below 2% average cover since 2000. The cover of soft corals has hovered around 20% throughout the survey period. Disease has not been found at the survey sites on Fitzroy Island Reef since recording began in 1999. No *Drupella* spp. were recorded in 2007.

Numbers of the majority of reef fish families remained relatively stable in 2007. Two families, Chaetodontidae and Siganidae, reversed their previous trends of decline showing slight increases in numbers since the previous surveys in 2005. Similarly, two genera of damselfish also showed slight increases after several years of declining numbers. These trends can probably best be explained by the recovery of the hard coral community, which was decimated by disturbance in the late 1990s.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.42

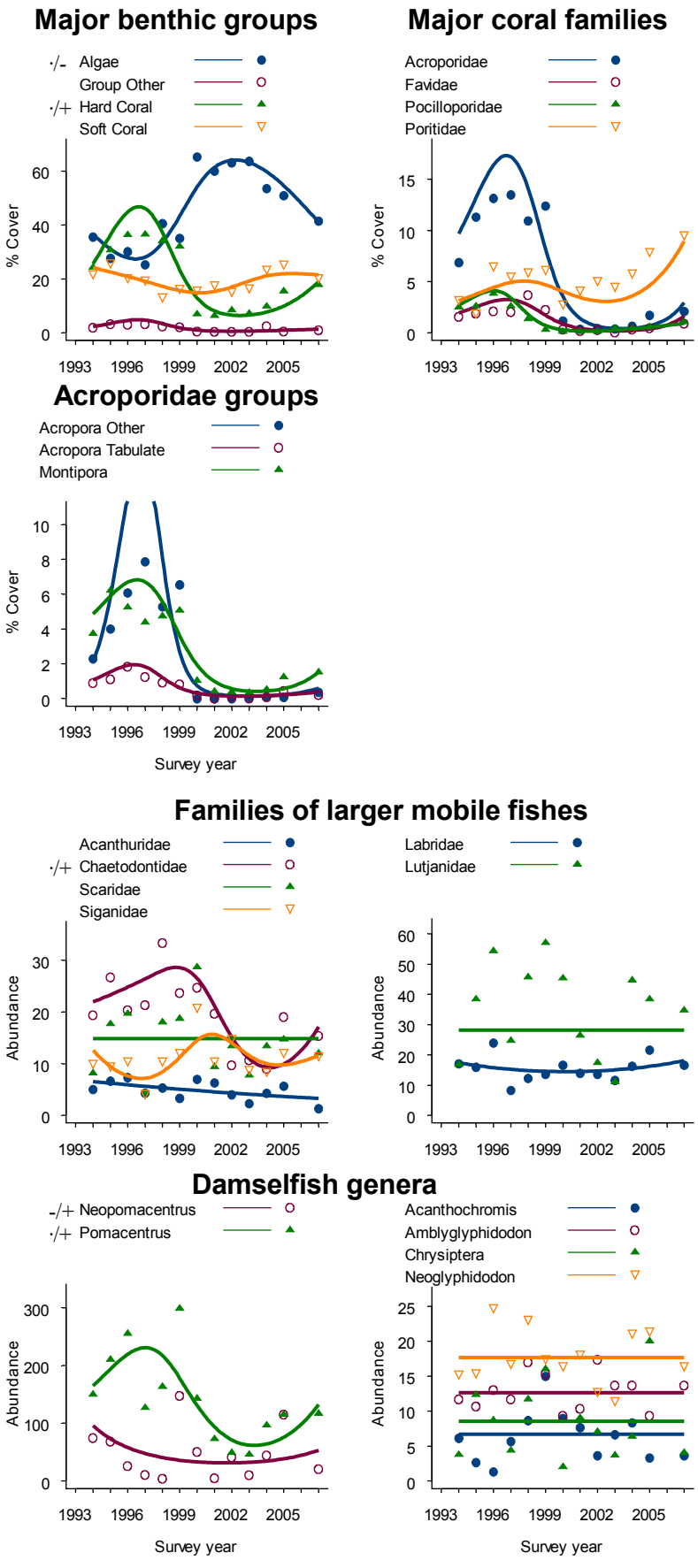




Fitzroy Is Reef (No. 16-054) is an inshore fringing reef with an area of 0.2 sq.km.

Figure 5.42 (cont.)

Fitzroy Is Reef (No. 16-054) was last surveyed in January 2007.



GREEN IS

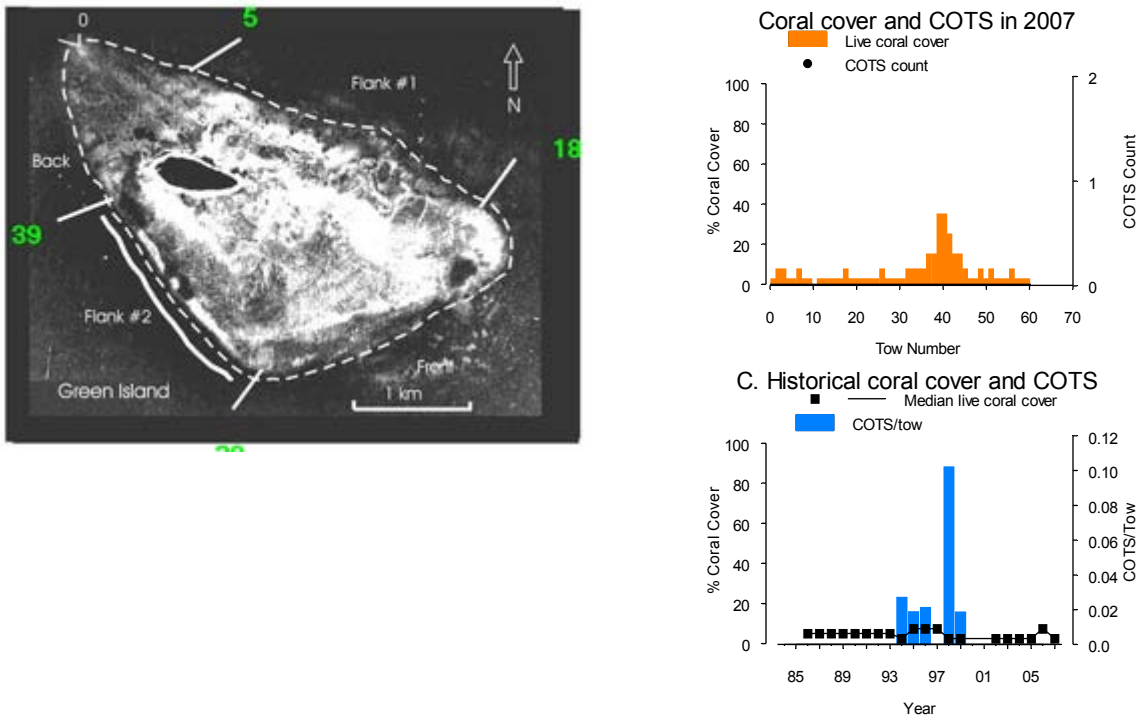
Green Island Reef has been surveyed regularly using manta tow since 1986, when it was classified as Recovering from a previous COTS outbreak. Since then, median reef-wide live coral cover has shown little change. An apparent small recovery in reef-wide live coral cover in 1995 subsequently stalled in 1998 as COTS numbers on this reef rose again. COTS have not been observed during manta tow surveys since 1999. Green Is Reef was reclassified as No Oubreak in 2004 to mark more than 20 years since the last COTS outbreak on this reef. However, over this time there has been little sign of recovery in coral cover on this reef where it has remained persistently low. Surveys in 2007 indicate reef-wide coral cover continues to be low (1-10%). Green Island Reef remained classified as No Outbreak in 2007. An apparent small recovery in reef-wide live coral cover recorded in 2006 has not persisted. No bleaching or signs of disease were observed during surveys in 2007.

Surveys of intensive survey sites showed that hard coral cover on Green Island Reef ranged between a low cover of 4% and moderate cover of 15% since surveys began in 1993. In 2007 hard coral cover was moderate at an average of 13%. Soft coral cover has remained stable at around 7% since surveys began. Algae cover has varied inversely to hard coral. There was a notable drop in algal cover from 69% in 2005 to 58% in 2007. The small fluctuations in hard coral cover reflect patterns observed in the abundance of the various forms of *Acropora* spp. Most of the major hard coral families have recorded less than 4% cover throughout the survey period. During 2007 surveys a low prevalence of white syndrome was recorded. *Drupella* spp. were observed at a density of 60/ha.

The abundances of many fish taxa have been variable with no consistent trends. This has been true of a number of families including the Chaetodontidae, Acanthuridae, Siganidae, Lutjanidae and Labridae. The only groups to have shown any real trend have been the parrotfishes (Scaridae), which have increased in numbers since 2002-03, and one genus of damselfishes, *Pomacentrus*. More specifically, the coral dependent species *Pomacentrus moluccensis* has increased in abundance since a large decline between 1999 and 2002.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

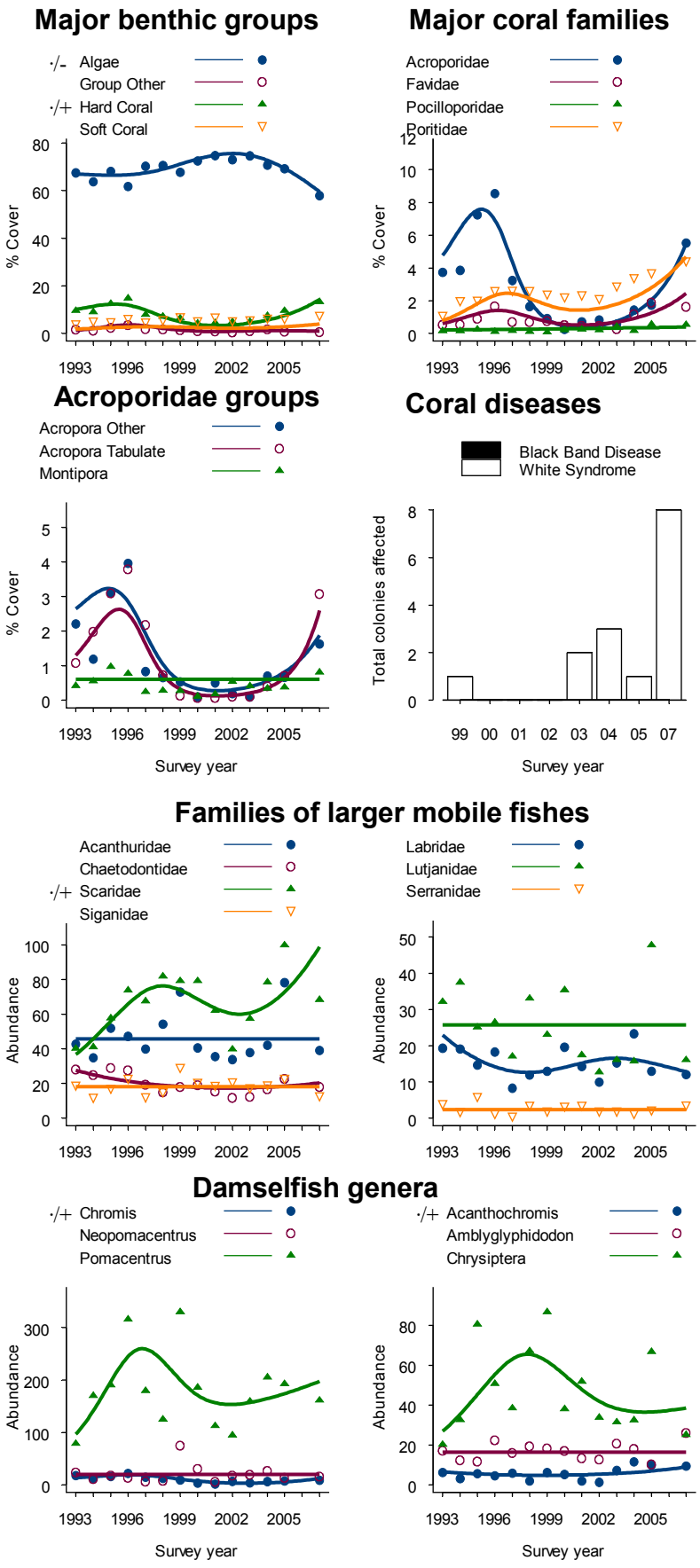
Figure 5.43



Green Is Reef (No. 16-049) is an inshore planar reef with an area of 7.1 sq.km.

Figure 5.43 (cont.)

Green Is Reef was last surveyed in January 2007.



HASTINGS

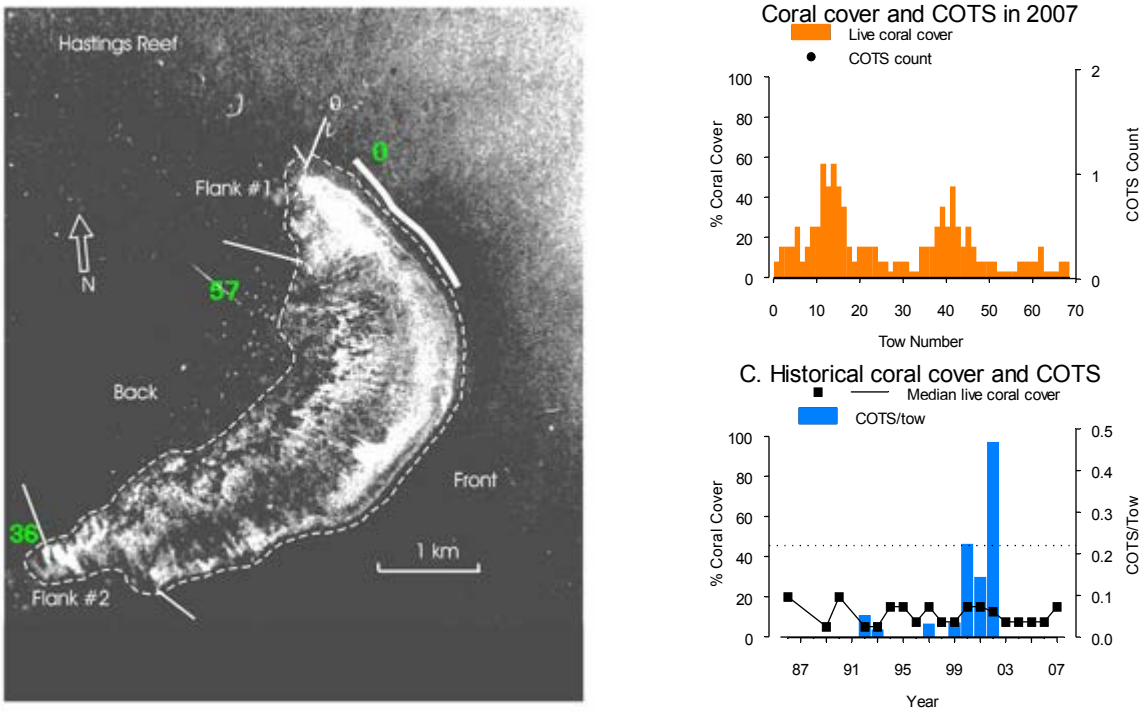
Hastings Reef has been surveyed regularly using manta tow since 1986. Over the period of survey median reef-wide live coral cover has generally remained at moderate levels (11-30%). COTS numbers increased in 2000 and Hastings Reef was then reclassified as Incipient Outbreak. COTS numbers peaked in 2002 with a corresponding decline in coral cover. Surveys in 2003 and 2004 failed to detect any COTS and Hastings Reef was reclassified as Recovering. Surveys in 2007 indicated the first appreciable change in reef-wide live coral cover since 2002, with coral cover reaching moderate (11-20%) levels. No bleaching or signs of coral disease were observed during surveys in 2007. The reef remained classified as Recovering.

Hard coral cover on the intensive survey sites has shown little change since 1993, ranging between 20% and 31%. Hard coral cover reached its highest level (31%) in 1999 and was 25% in 2007. Acroporidae has been the dominant coral group, with an average cover that has fluctuated between 12% (2007) and 16% (1999) since 1996. Other major families have displayed little change in average cover over the 14 years of surveys. A moderate level (116 colonies) of disease, primarily white syndrome, observed in 2003 is likely to have contributed to the notable drop in average tabulate *Acropora* spp. cover between 2004 and 2005 from 10% to 5% respectively. Rare to low levels of disease were observed in each of the following years. Tabulate *Acropora* spp. cover remained at this level in 2007. *Drupella* spp. were observed during 2007 SCUBA searches at a density of 90/ha.

There were few strong trends in the fish community since 2005, with the exception of the Labridae, which increased in abundance, and a genus of damselfishes, *Plectroglyphidodon*, which also increased in abundance. Much of the increase in the latter genus was attributable to a single species , *P. lacrymatus*, which defends algal territories on dead coral skeletons. Another damselfish, *Acanthochromis polyacanthus* increased in similar numbers. Chaetodontids continued to increase slightly in abundance, following the trend since the beginning of surveys in 1993.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

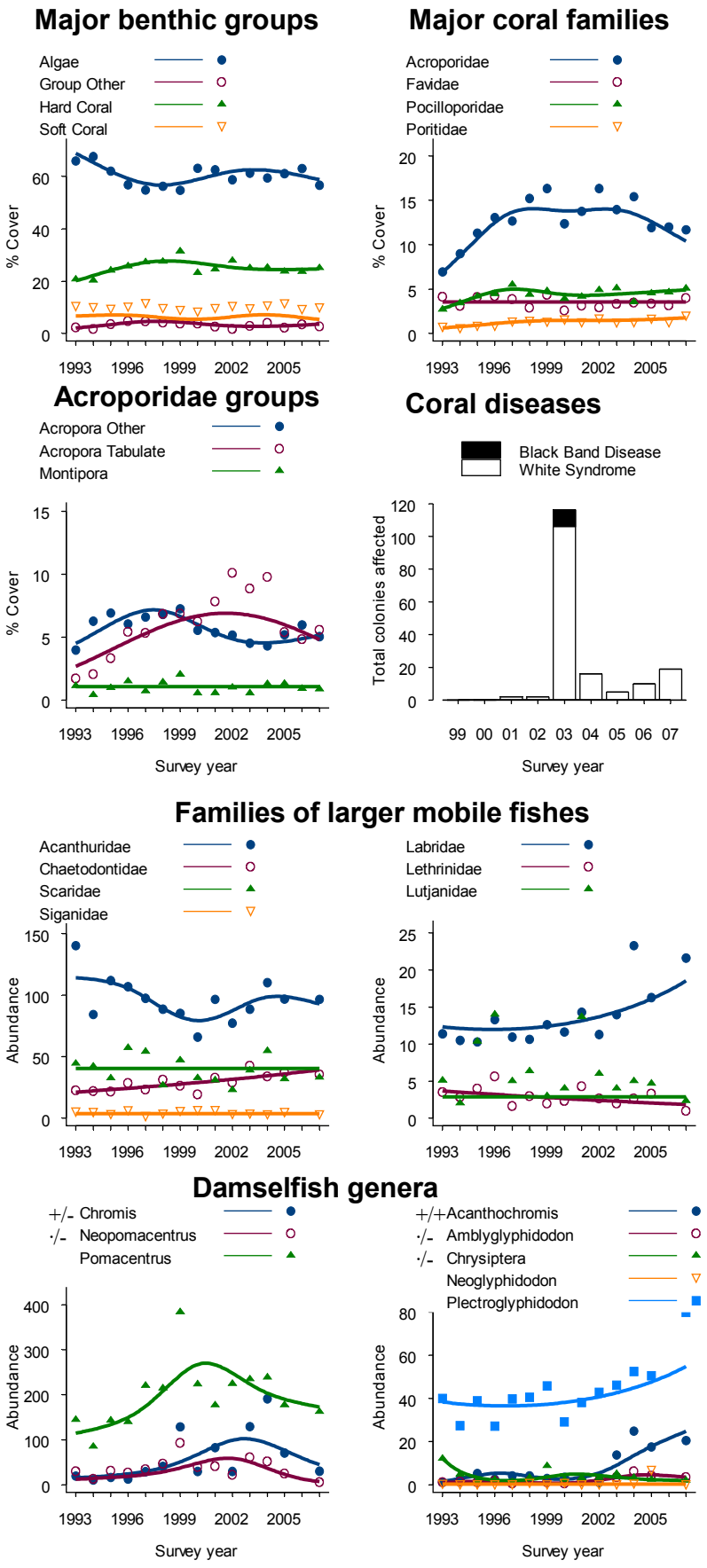
Figure 5.44



Hastings Reef (No. 16-057) is a mid-shelf crescentic reef with an area of 10.2 sq.km.

Figure 5.44 (cont.)

Hastings Reef was last surveyed in January 2007.



LOW ISLETS

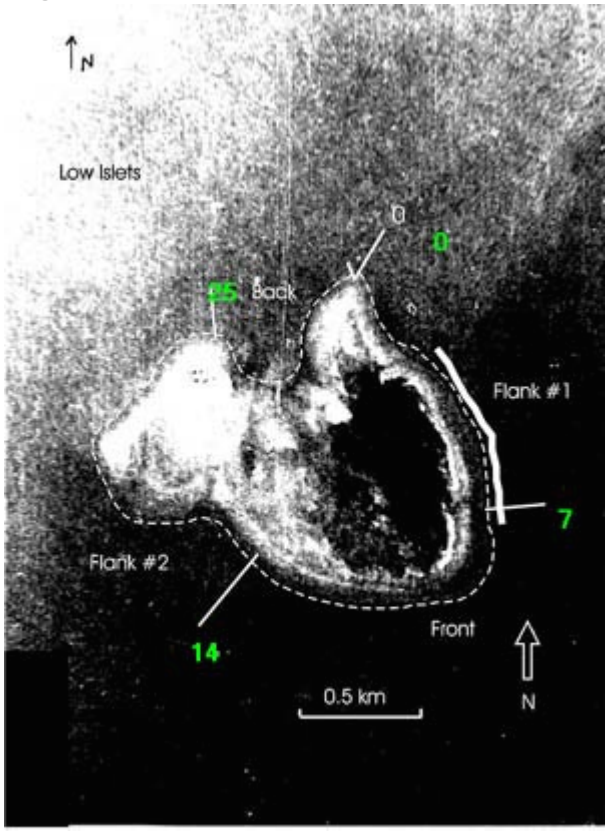
Low Islets Reef has been surveyed 15 times using manta tow since 1986. COTS were recorded in 1998 for the first time since the beginning of surveys. In 1999 there was a marked decline in median reef-wide live coral cover from a high (31-40%) level in 1998 to a low level of 5-10%. This decline was due to the combined effects of increasing COTS activity, coral bleaching and Cyclone Rona. In more recent surveys reef-wide coral cover had begun to show signs of recovery. No reef-wide surveys were conducted in 2005 due to poor visibility. Surveys in 2006 showed that coral cover had increased to a moderate (21-30%) level, where it remained in 2007. No COTS were observed in 2007 and the reef remained classified as No Outbreak. No coral bleaching or signs of disease were recorded at this reef during manta tow surveys in 2007.

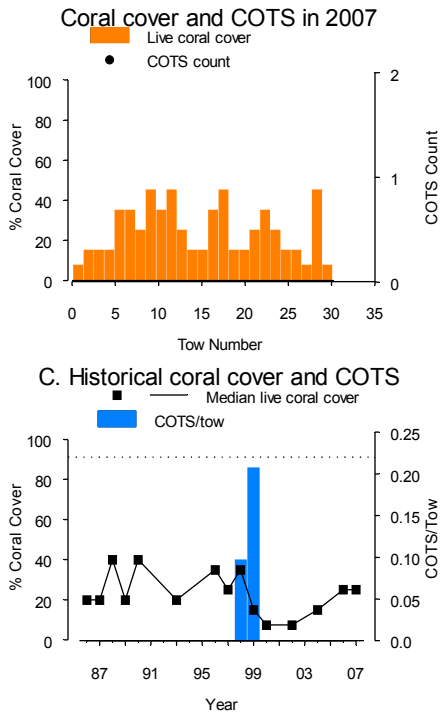
The coral community on the intensive survey sites has been affected by multiple impacts since surveys began in 1993. In 1996 hard coral cover peaked at an average of 40%. It then dropped each following year until 2000, when it became stable at approximately 10%. The significant decrease in cover of the family Acroporidae from 1997 to 1998 may in part be attributable to Cyclone Justin, which passed the area in March 1997. Cyclone Rona appeared to impact mostly on branching *Porites* spp. when it passed in February 1999. COTS activity in 1998 to 1999 and bleaching recorded in January 2000 also contributed to the decline in hard coral cover observed up until 2000. Increases in the cover of the family Poritidae since 2001 from 4% cover to 10% in 2007 caused hard coral cover to rise to 18% by 2007. All other major coral families have recorded a cover of less than 2% since 2000. Low Islets Reef experienced high water temperatures in the summer of 2002, which may have inhibited coral recovery from the various disturbances. Soft coral cover has been gradually declining since 1995 (17%) with 8% recorded in 2007. In 2007 white syndrome was observed for the first time since intensive surveys began, although its occurrence was rare. *Drupella* spp. were not found during the 2007 surveys.

Many of the observed changes in the fish community may be related to the effects of Cyclone Rona in 1999. Two families, Siganidae and Chaetodontidae, showed significant declines in abundance in the years following the storm. However, these families have since increased in numbers to abundance levels comparable to pre-disturbance levels. The increase in Chaetodontidae was driven largely by a single species, *Chaetodon aureofasciatus*. Conversely, two families of herbivores, Acanthuridae and Siganidae, increased in abundance in the years following the storm, however, their numbers have declined in the last two survey years. The decline in Siganidae was driven largely by a single species, *Siganus doliatus*, whilst the decline in Acanthuridae was a result of a general decline across a number of species. Lutjanidae numbers dropped after several years of increasing, due mainly to decreases in two species, *Lutjanus vitta* and *L. fulviflamma*. Numbers of Pomacentridae generally increased, particularly for the coral-associated species *Pomacentrus moluccensis*, mirroring the increase in hard coral cover.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.45

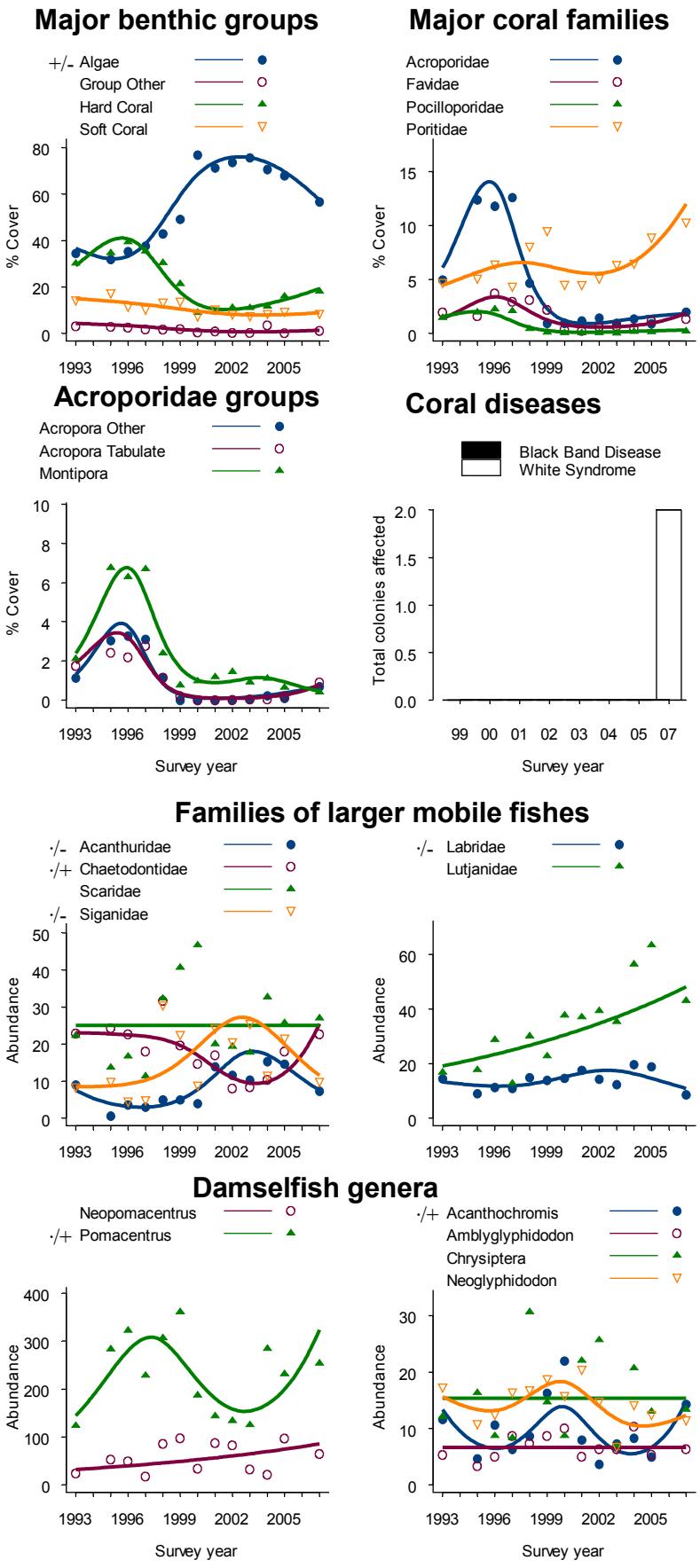




Low Islets Reef (No. 16-028) is an inshore planar reef with an area of 2.3 sq.km.

Figure 5.45 (cont.)

Low Islets Reef was last surveyed in January 2007.



MACKAY

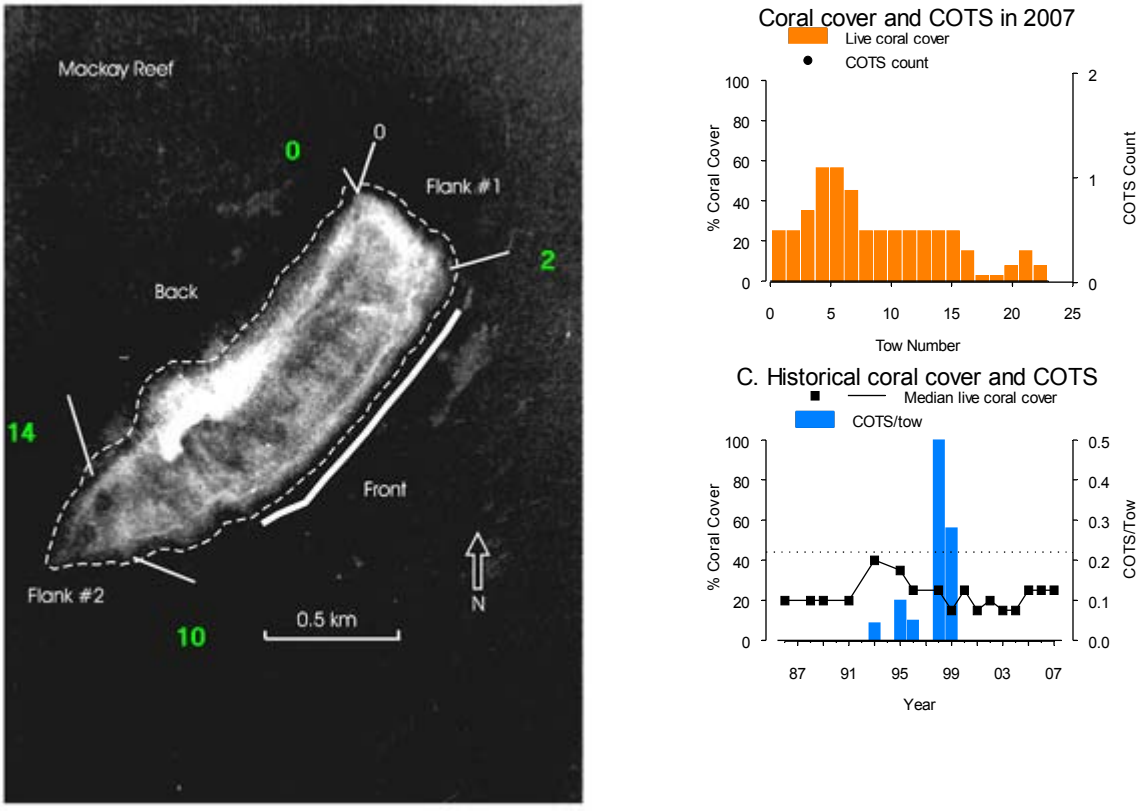
Mackay Reef has been surveyed 17 times using manta tow since 1986, when it was classified as Recovering from prior COTS activity. Median reef-wide live coral cover rose to a high level (31-50%) in 1993, when COTS were recorded in low numbers. COTS numbers built up and peaked in 1998 when Mackay Reef was classified as an Incipient Outbreak. Increased COTS activity coincided with a gradual decline in reef-wide live coral cover to moderate levels (11-30%). Mackay Reef was also affected by Cyclone Rona, which crossed the area in 1999. Since this time there has been little change in reef-wide live coral cover that has remained at moderate levels, though there has been some indication of increasing cover in more recent surveys. In 2007 reef-wide coral cover was moderate (21-30%). No coral bleaching was recorded and white syndrome disease was restricted to a few individual colonies on the first flank. The reef remained classified as Recovering in 2007.

Hard coral cover on the intensive survey sites has been fairly stable over the survey period and in 2007 was 25%. Algae has exhibited an inverse relationship to hard coral reaching a maximum cover of 65% in 2004. Faviidae has been the dominant coral family since 2000, with 6% average cover observed in 2007. The pattern observed for Faviidae abundance is largely driven by fluctuations in the abundance of *Echinopora* spp. Black band disease and white syndrome have been recorded in scuba searches since 2001, although the occurrence of both has been rare in all surveys. *Drupella* spp. were observed at a density of 140/ha in 2007.

The majority of reef families remained stable, with neither significant increases or declines in numbers. This reflects the stable benthic community, which has shown little change in community structure or hard coral cover. Some genera of Pomacentridae increased slightly, however, these changes would probably be attributable to sampling variation rather than a response to any change in the benthos.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

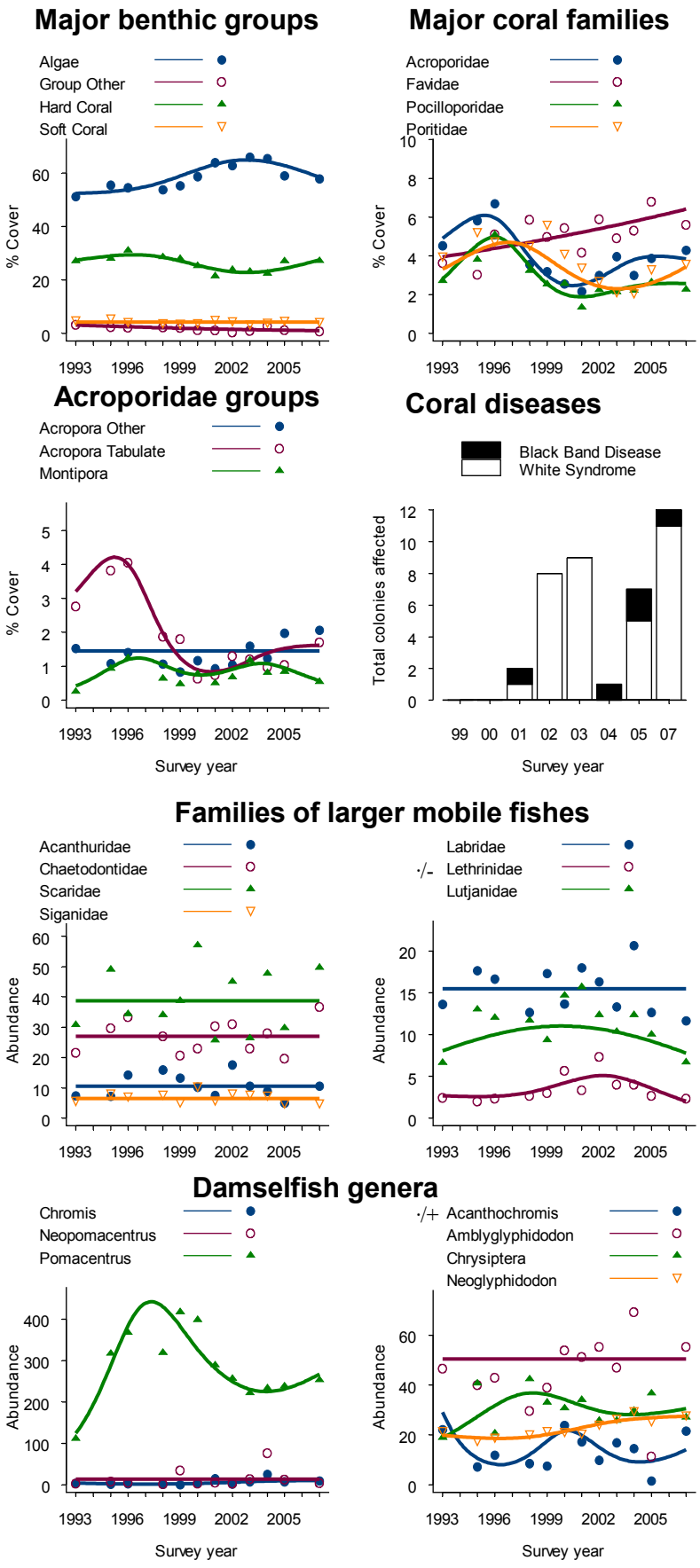
Figure 5.46



Mackay Reef (No. 16-015) is a mid-shelf planar reef with an area of 4.2 sq.km.

Figure 5.46 (cont.)

Mackay Reef was last surveyed in January 2007.



MICHAELMAS

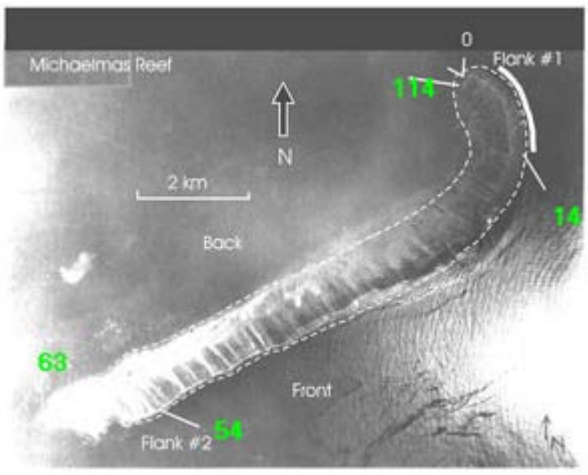
Michaelmas Reef has been surveyed regularly using manta tow since 1986. Median reef-wide live coral cover dropped from moderate to low levels in the initial survey years and remained generally low (1-10%) through to 2004. COTS populations have been a common feature since 1993. 2003 was the first year since 1992 that COTS had not been recorded. Overall COTS numbers have been below outbreaking levels. However, they have had localised impacts on coral communities in small sections of this very large reef. There has been a small increase in reef-wide live coral cover in recent years with moderate levels (11-20%) recorded in 2007. This figure must be seen in the context that Michaelmas Reef has a huge sandy back reef area which tends to drive overall estimates of coral cover on this reef down. Michaelmas Reef remained classified as No Outbreak in 2007. No bleaching was observed during surveys in 2007. Signs of black band disease were observed on a small number of individual coral colonies on the back reef while signs of white syndrome were restricted to small numbers of individual colonies on the back and flanks of the reef in 2007.

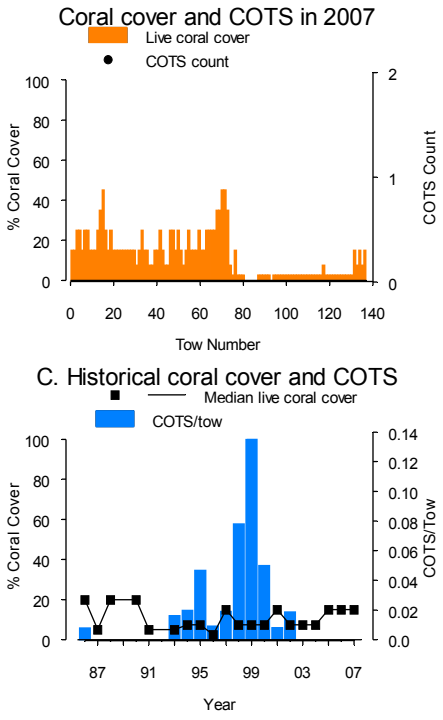
The cover of hard coral on the intensive survey sites increased from <15% in 1993 to a maximum of 26% in 1999. Hard coral cover has varied little since reaching 20% in 1996 with 21% recorded in 2007. Tabulate *Acropora* spp., the dominant hard coral in the community, had an increasing trend over the survey period until 2002, when it reached a maximum of 10%. In 2007 tabulate *Acropora* spp. cover was 6%. Soft coral cover has been greater than that of hard coral throughout the survey period with surveys in 2007 recording a moderate cover of 28%. A moderate level of white syndrome (92 colonies) was observed in 2003 but appeared to have little influence on community structure in the following years. The occurrence of white syndrome in 2007 was rare. No *Drupella* spp. were recorded during SCUBA searches in 2007.

A number of reef fish families have shown slight increases in abundance since the last surveys, including Acanthuridae, Labridae, Lutjanidae and Chaetodontidae. This is despite relatively little change to the benthic community, which has been stable for the last eight years. Among the Pomacentridae, a single genus, *Plectroglyphidodon*, continued the increasing trend of the last four surveys, due mainly to a large increase in an algal affiliated species *P. lacrymatus*. The genus *Chromis* has shown a decline in abundance in the two most recent surveys, due mainly to a large decline in a single species *Chromis atripectoralis*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.47

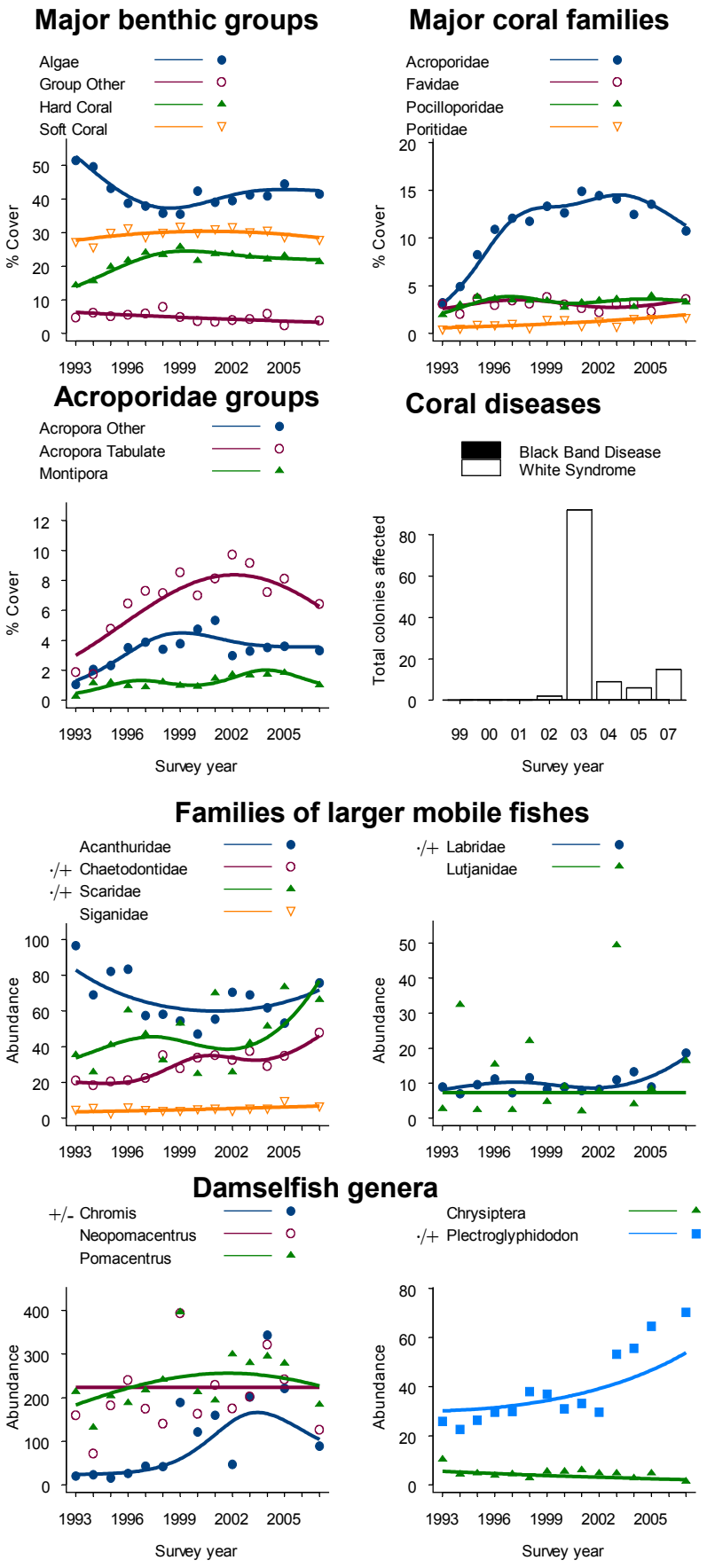




Michaelmas Reef (No. 16-060) is a mid-shelf crescentic reef with an area of 30 sq.km.

Figure 5.47 (cont.)

Michaelmas Reef was last surveyed in January 2007.



OPAL (2)

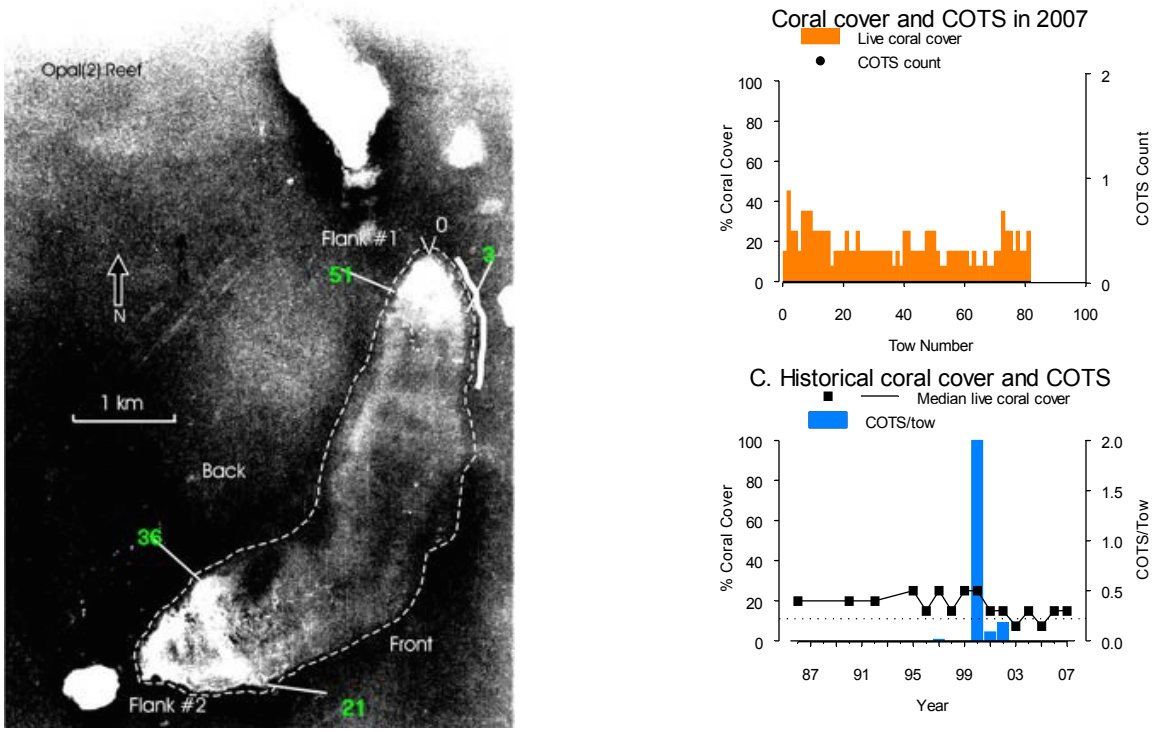
Opal (2) Reef has been surveyed using manta tow 16 times since 1986. Until 2000 median reef-wide live coral cover remained at moderate levels (11-30%). There were high COTS densities (2 COTS per tow) in 2000 and Opal (2) Reef was classified as Active Outbreak. COTS numbers declined rapidly and in the following year had dropped below outbreak levels and Opal (No. 2) Reef was reclassified as Recovering. Residual COTS populations persisted up until 2002. As a result of the COTS feeding, median reef-wide live coral cover declined to a low level (1-10%) by 2003. No COTS have been observed since this time and surveys in 2007 indicated some sign of continued recovery. Coral cover in 2007 was moderate (11-20%). No bleaching or signs of black band disease were recorded. Small numbers of scattered individual coral colonies with signs of white syndrome disease were observed around the reef perimeter. Opal (2) Reef remained classified as Recovering in 2007.

Hard coral cover has declined slightly on the intensive survey sites over the survey period from 24% in 1995 to 19% in 2007. Soft coral, the dominant coral group, has generally decreased over the survey period from a high cover of 43% in 1995 to 34% in 2007. A 10% decline in Xeniidae soft corals in 1999 was probably due to bleaching mortality. The algal community, primarily composed of filamentous and coralline algae, has fluctuated in abundance inversely with the abundance of soft coral. Acroporidae has been the dominant hard coral family due to a relatively high cover of encrusting *Acropora* spp. throughout the survey period. Encrusting *Isopora* spp. had an average cover of 7% in 2007. Black band disease and white syndrome were observed on a small number of coral colonies in 2007. There were no *Drupella* spp. found on the survey sites in 2007.

The majority of large mobile fish families were stable or had increased slightly over the study period, especially the Scaridae, Chaetodontidae, Lethrinidae and Lutjanidae, although the latter family have shown significant temporal variability throughout the study period. The surgeonfishes (Acanthuridae) have shown a large increase in numbers between 2004 and 2007. This increase was due to increases in three groups *Acanthurus blochii*, *A. auranticavus* and *Ctenochaetus* spp. Among the damselfishes (Pomacentridae) the majority of genera remained stable with the exception of *Chromis*, which have declined substantially since 2004, and *Plectroglyphidodon*, which continually increased from 2002 to 2007 . The trend in *Chromis* spp. was mainly due to decreases in two species, *Chromis atripectoralis* and *C. weberi*, whilst the increase in *Plectroglyphidodon* was due wholly to a large increase in the coral affiliated species, *P. lacrymatus*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

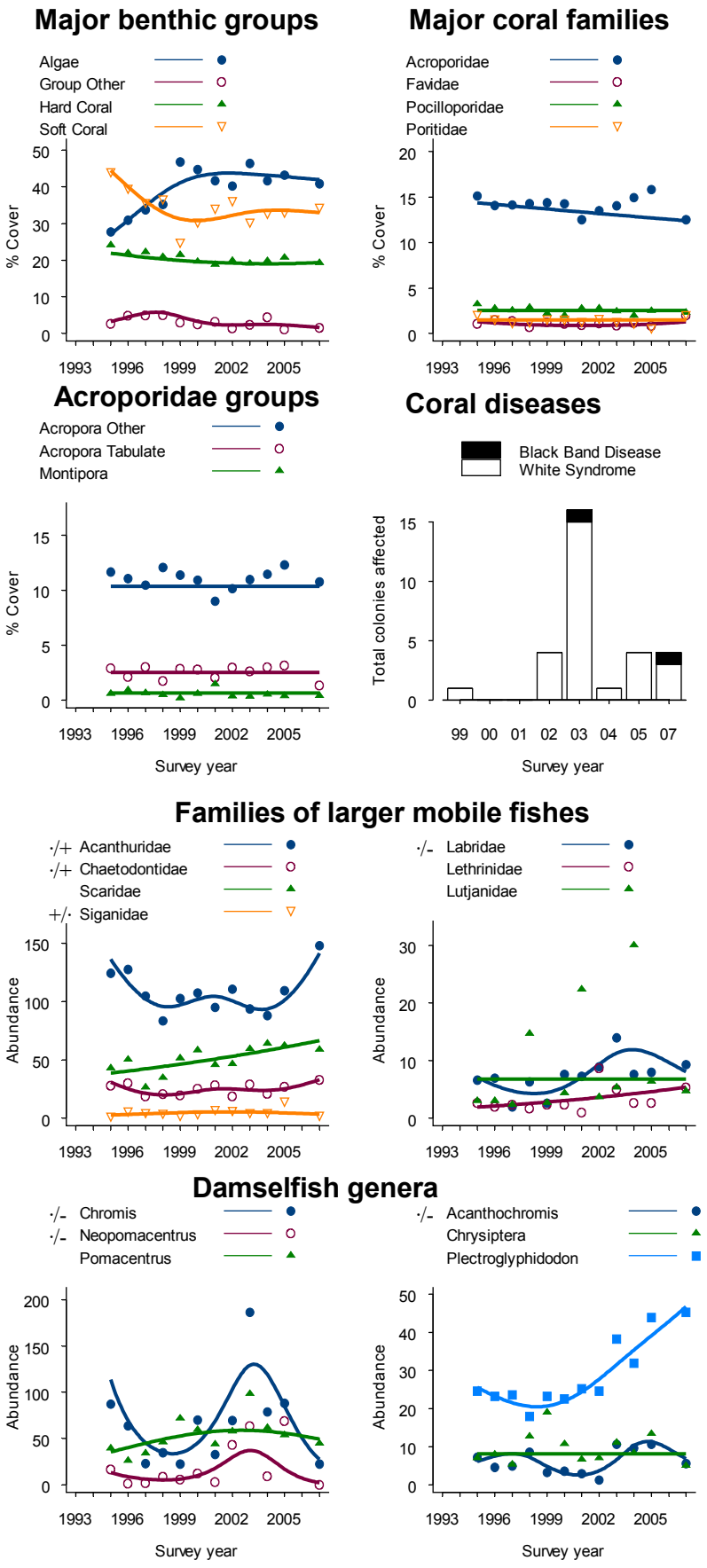
Figure 5.48



Opal (2) Reef (No. 16-025) is an outer shelf crescentic reef with an area of 24.7 sq.km.

Figure 5.48 (cont.)

Opal (2) Reef was last surveyed in January 2007.



ST. CRISPIN

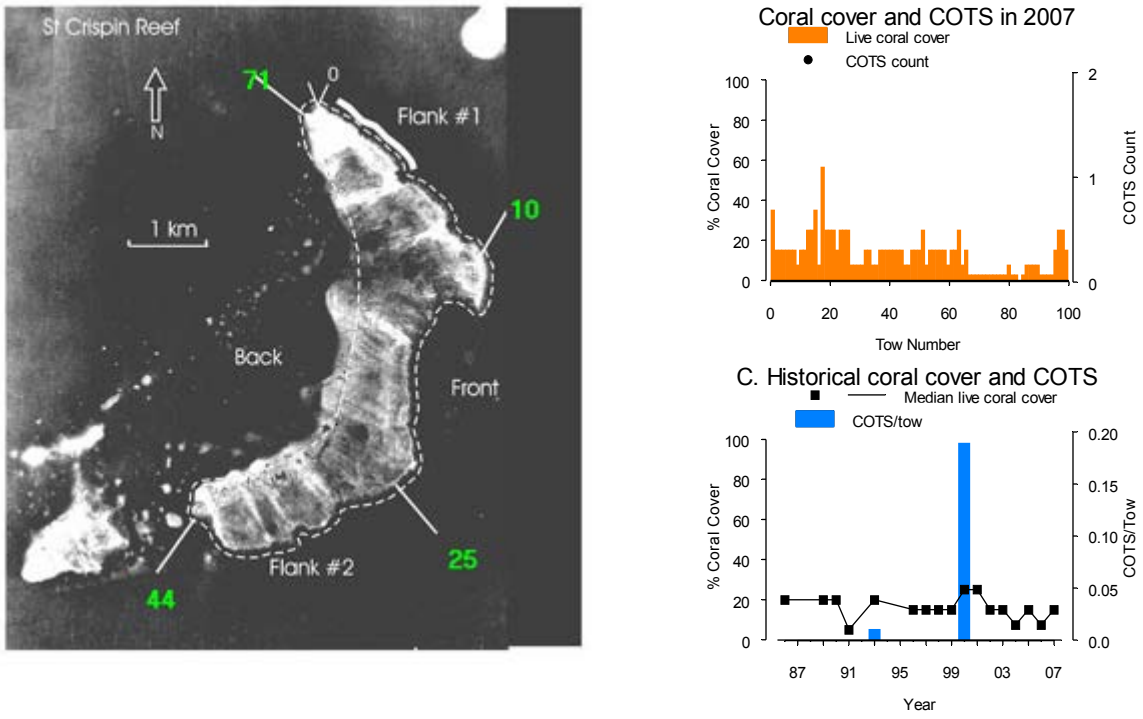
St. Crispin Reef has been surveyed regularly using manta tow since 1986. Over this time median reef-wide live coral cover remained at moderate levels (11-30%) despite low numbers of COTS being present in 1993. Coral cover increased slightly in 2000 and 2001. Numbers of COTS just below Incipient Outbreak levels were recorded in 2000 and may have been responsible for the small decline in reef-wide live coral cover observed in 2002. The factors responsible for the continued decline exhibited up to 2004 are unknown. Reef-wide live coral cover was moderate (11-30%) in 2006 and remained at similar levels in 2007. St. Crispin Reef remained classified as No Outbreak in 2007. No bleaching or signs of black band disease were recorded, while signs of white syndrome were observed on a few scattered coral colonies on the front reef during surveys in 2007.

Hard coral cover at the intensive survey sites has been steadily increasing since 2000. In 2007 it reached 28%, the highest level recorded since surveys began in 1993. Much of this increase was due to increases in cover of branching and tabulate *Acropora* spp. The consistent increase in tabulate *Acropora* spp. cover stalled after 2005 while branching *Acropora* spp. continued to increase in abundance up until the latest survey in 2007. Until 2005, soft coral had generally been the dominant benthic group, with an average cover exceeding that of algae. In 2007 the cover of soft coral and of algae was equal, with 32% and 33% recorded for each group respectively. Low levels of white syndrome were observed at the survey sites in 2003 and 2006. In 2007 the occurrence of white syndrome was rare. The density of corallivorous snails *Drupella* spp. was 20/ha in 2007.

The abundance of the majority of large, mobile reef fish species has been variable with few consistent trends since surveys began in 1993.The butterflyfishes (Chaetodontidae) differ in that numbers had steadily increased in abundance over the survey period. This trend was common to a number of *Chaetodon* species. The parrotfishes (Scaridae) showed a large increase in abundance in 2007, due wholly to a large increase in a single species, *Scarus psittacus*. Of the damselfishes (Pomacentridae), only one genus, *Plectroglyphidodon* spp., showed an increase in abundance, driven exclusively by a single species *P. lacrymatus*. All other damselfish genera were stable or exhibited a slight decline (e.g. *Chromis* spp. and *Acanthochromis* spp.).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

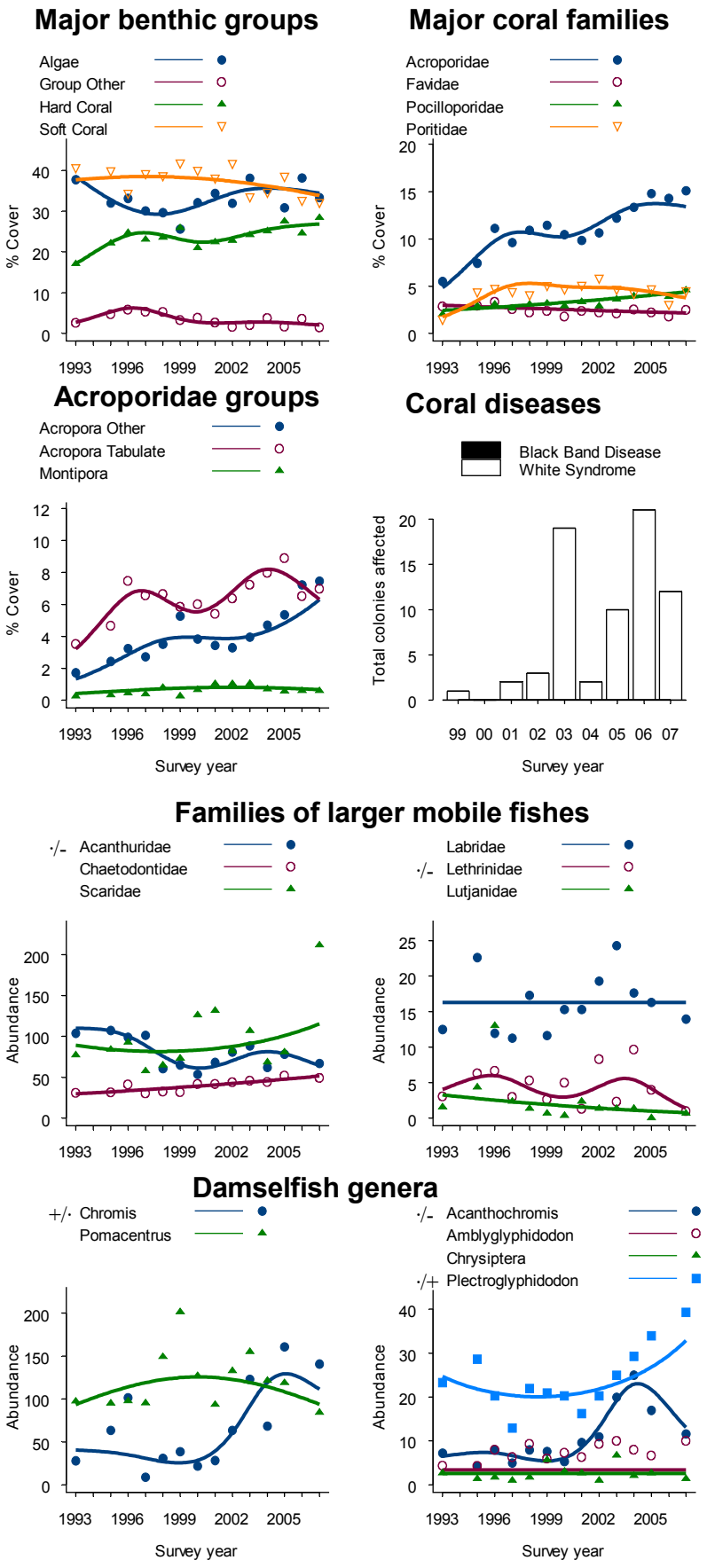
Figure 5.49



St. Crispin Reef (No. 16-019) is an outer shelf crescentic reef with an area of 38.19 sq.km.

Figure 5.49 (cont.)

St. Crispin Reef was last surveyed in January 2007.



THETFORD

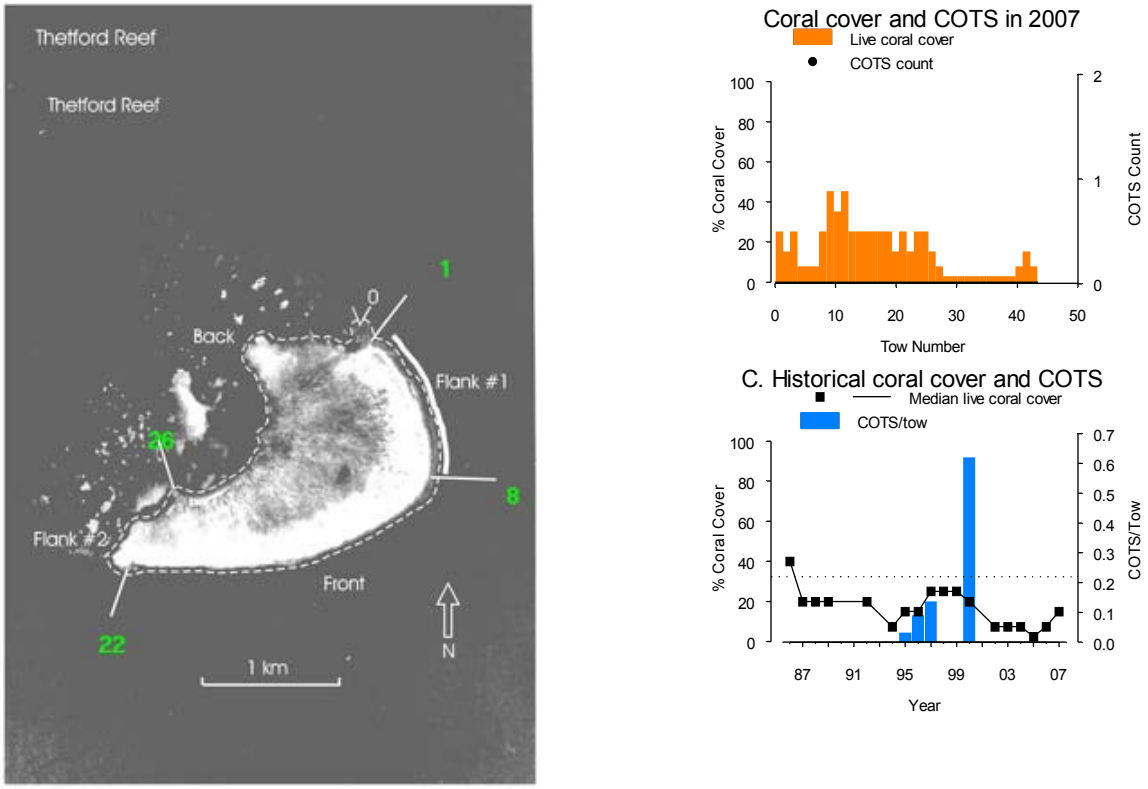
Thetford Reef has been surveyed using manta tow 18 times since 1986. Median reef-wide live coral cover showed a declining trend until 1994. There was then a gradual increase to a moderate level (11-30%) by 1999. Surveys in 2000 indicated COTS numbers had increased and the reef was classified as Incipient Outbreak. Following this survey reef-wide live coral cover declined to a low level (1-5%) over a period until 2004, most likely as a result of COTS feeding activity. COTS have not been observed during reef-wide surveys on this reef since 2000. Thetford Reef was reclassified as Recovering in 2002. Surveys in 2007 showed reef-wide live coral cover continued to increase since 2004, reaching a moderate (11 -20%) level. No bleaching or signs of black band disease were observed in 2007 while signs of white syndrome disease were restricted to a few scattered coral colonies on the back reef and reef flanks. The reef remained classified as Recovering in 2007.

At the intensive survey sites hard coral cover increased between 1994 and 1999, when it reached its highest cover of 36%. Significant reductions in hard coral cover recorded in 2000 and 2002 were primarily caused by COTS feeding on tabulate *Acropora* spp., the dominant coral group. Hard coral cover reached its lowest point of 4% in 2003. The largest taxa decline was in *Acropora* spp. although Faviidae and Pocilloporidae also showed declining trends. There was a rapid increase in tabulate *Acropora* spp. cover from 1% in 2005 to 7% in 2007. Hard coral cover correspondingly rose from 8% in 2005 to 16% in 2007. Algae cover varied inversely to the pattern observed in hard coral cover. Algal cover reached an extremely high level of 80% in 2003. By 2007 algal cover had decreased to 58%. Soft coral cover has been stable over the survey period with an average of 17% in 2007. A moderate level of white syndrome recorded in 2003 appeared to have little influence on the community structure. A small number of colonies with white syndrome have been reported in each survey beyond 2003. There were no *Drupella* spp. found during SCUBA search surveys in 2007.

The majority of reef fish families have shown no obvious long term trends. Family Scaridae has been variable through time. Recently, however, number have been increasing since 2002, driven largely by a single species *Scarus altipinnis*, which, in 2007, reached the highest levels of abundance since surveys began. Despite year to year variability, the wrasses (Labridae) have been showing an increasing trend since 1998. Among the damselfishes (Pomacentridae), only the genus *Plectroglyphidodon* spp. has shown any significant long term trend, with an increase in abundance since 2000. This is due solely to a single species, *P. lacrymatus*, which has undergone large increases in abundance on not only this reef, but on a sector wide basis.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

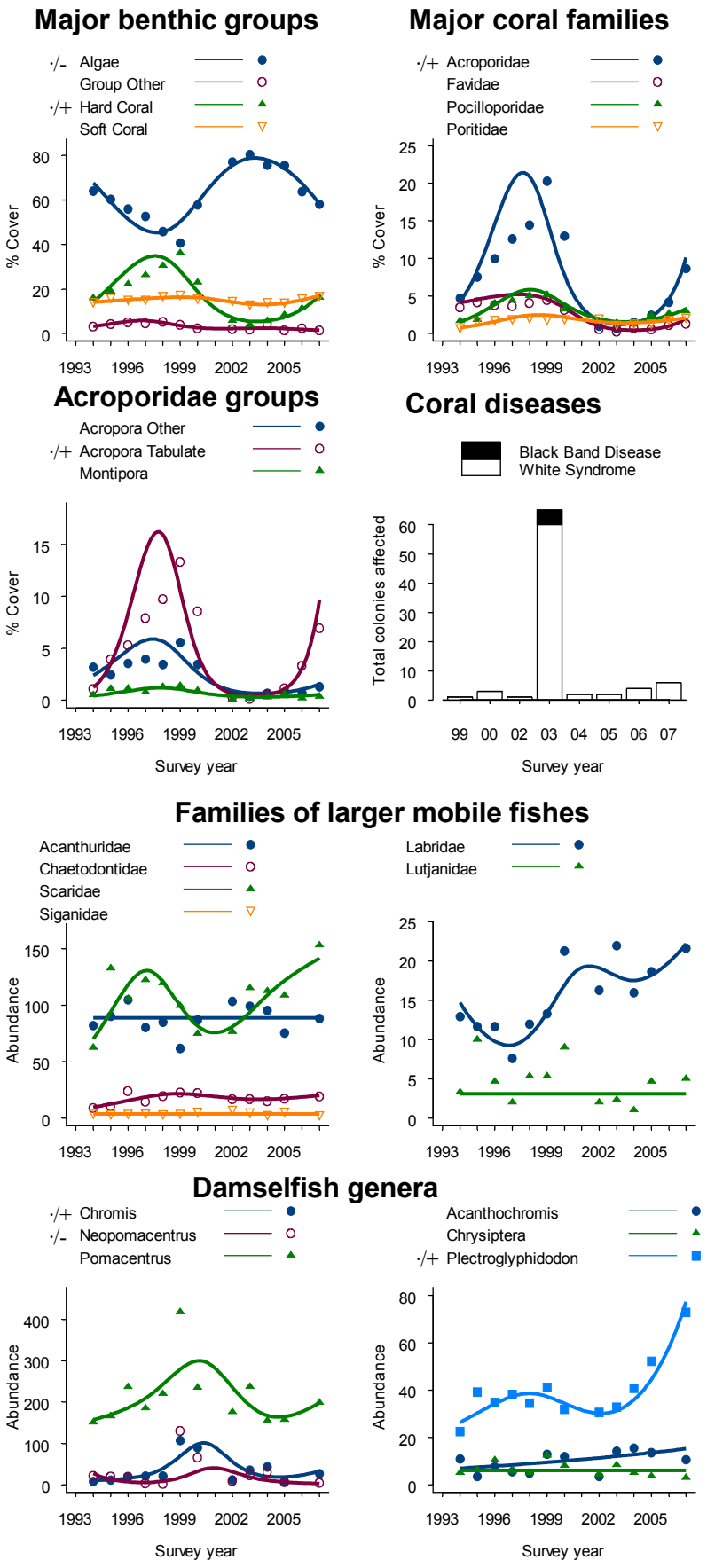
Figure 5.50



Thetford Reef (No. 16-068) is a mid-shelf crescentic reef with an area of 7.9 sq.km.

Figure 5.50 (cont.)

Thetford Reef was last surveyed in January 2007.

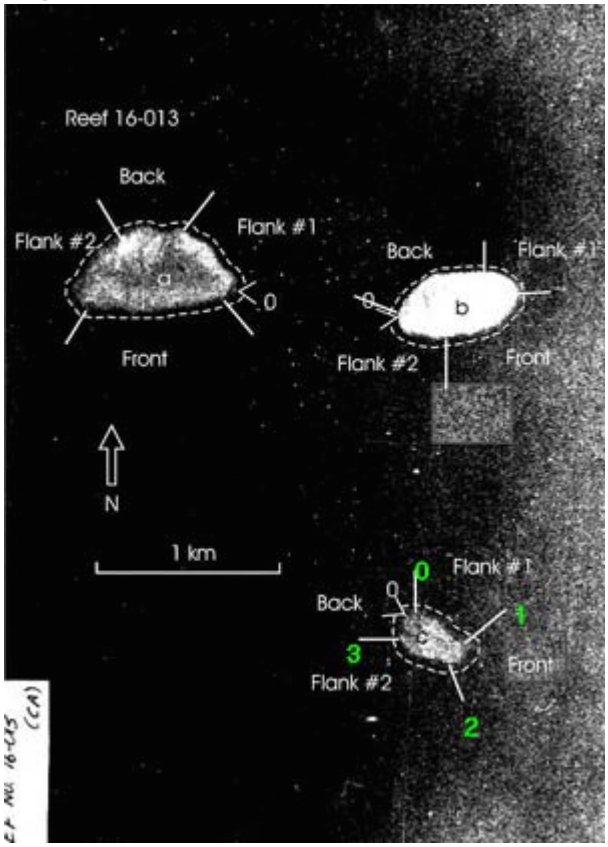


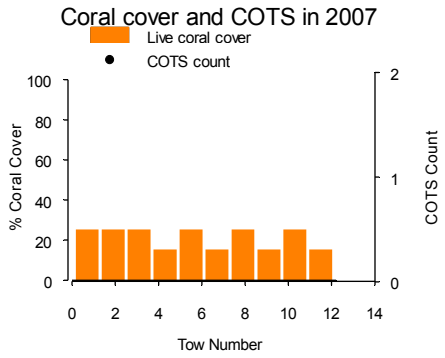
16-013 (A)

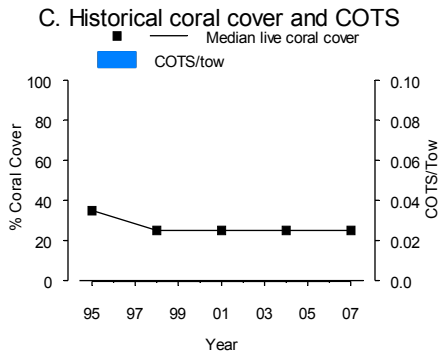
Reef 16-013(A) has been surveyed using manta tow five times since 1995. Over the survey period there has been little appreciable change in median reef-wide live coral cover, which remained at moderate levels (21-30%) in 2007. No COTS have been observed on this reef during surveys. No bleaching was recorded in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.51







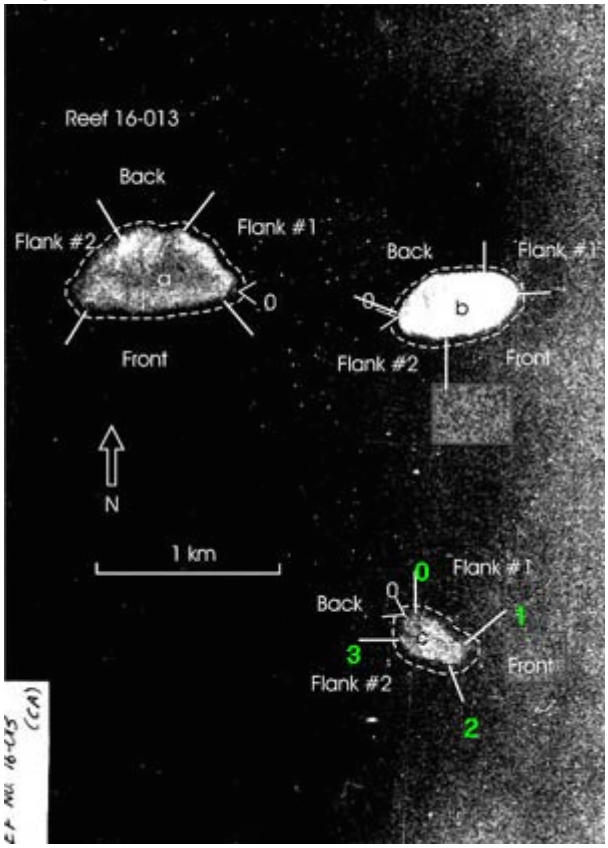
Reef 16-013 (A) (No. 16-013) is a mid-shelf patch reef with an area of 0.4 sq.km.

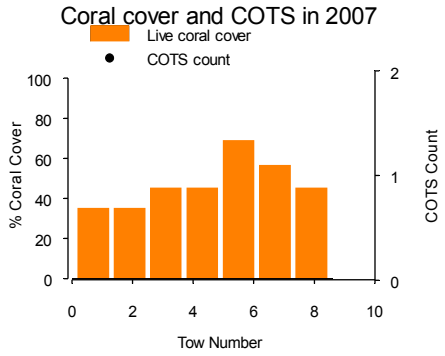
16-013 (B)

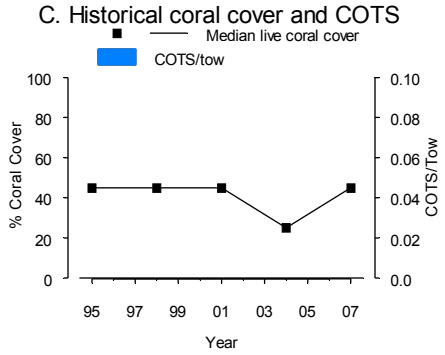
Reef 16013 (B) has been surveyed using manta tow five times since 1995. Median reef-wide live coral cover was high (41-50%) in the first three surveys. In 2004 coral cover declined to a moderate level (21-30%). No COTS have been observed on Reef 16-013(B) and the reason for the decline remains enigmatic. Surveys in 2007 indicated coral cover was high on this reef. No bleaching or disease was recorded in 2007. The reef remained classified as No Outbreak following the 2007 survey.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.52







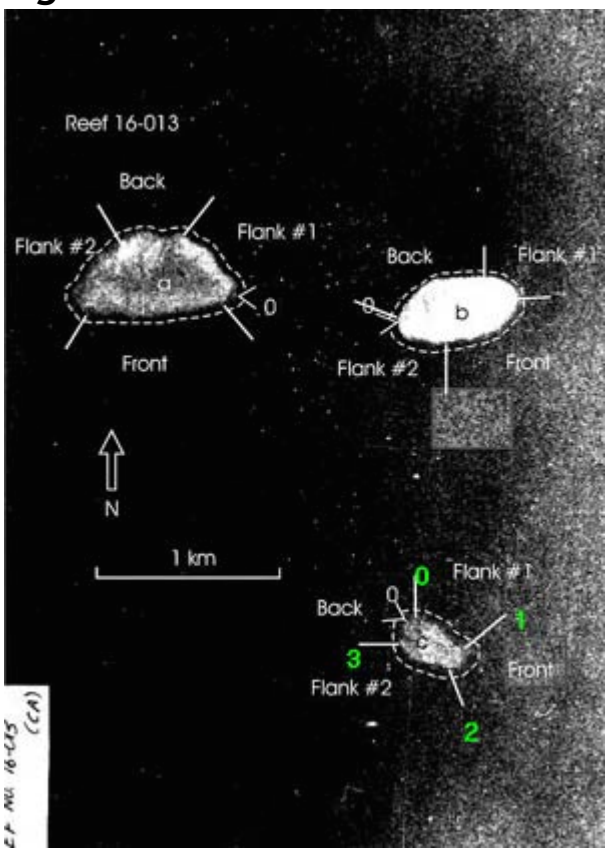
Reef 16-013 (B) (No. 16-013) is a mid-shelf patch reef with an area of 0.2 sq.km.

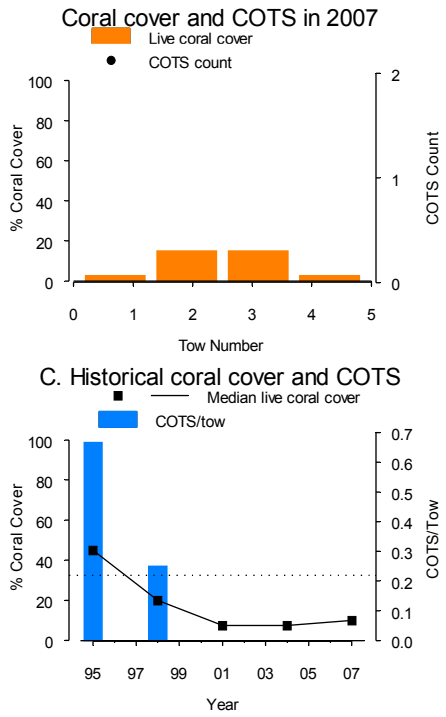
16-013 (C)

Reef 16-013 (C) has been surveyed using manta tow five times since 1995. Initial surveys revealed a high COTS population on this reef and it was classified as Incipient Outbreak. COTS remained active up until surveys in 2001 when no COTS were sighted. COTS feeding activity had resulted in a decline in median reef-wide live coral cover to a low (6-10%) level by 1998. Since this time median reef-wide live coral cover has remained low. The 2007 survey indicated some signs of recovery with moderate (11-20%) levels of coral cover recorded. No bleaching or disease was recorded in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.53





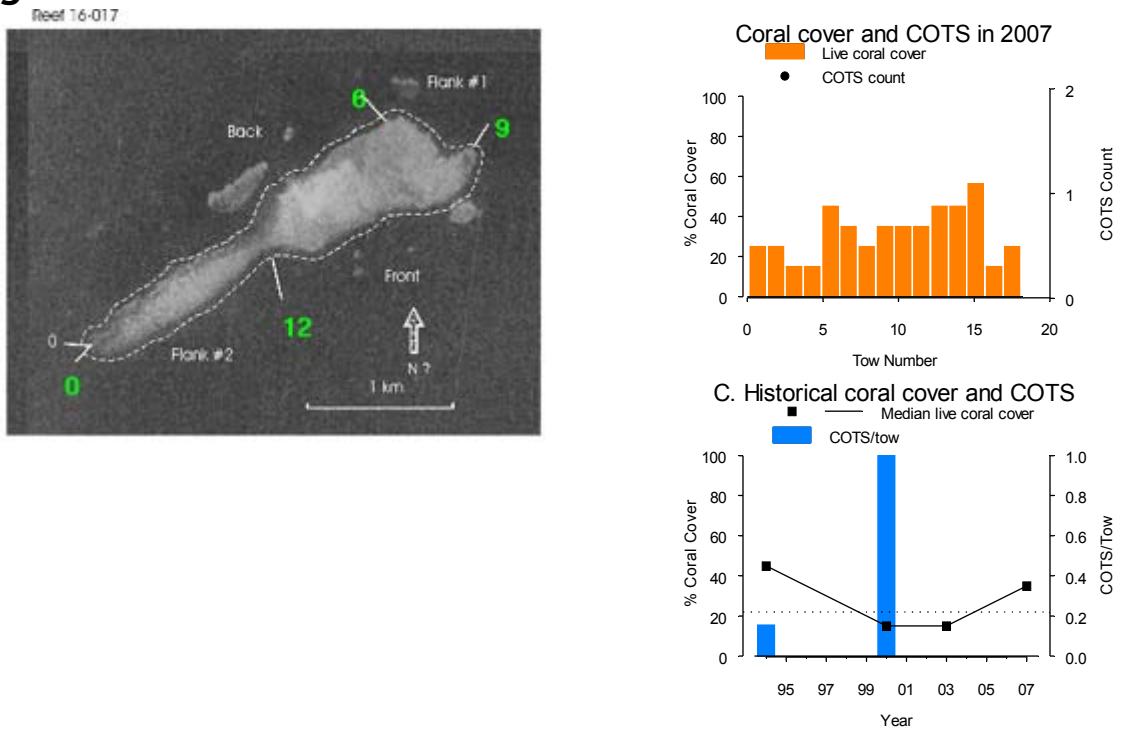
Reef 16-013 (C) (No. 16-013) is a mid-shelf patch reef with an area of 0.2 sq.km.

16-017

Reef 16-017 has been surveyed using manta tow four times since 1994, when median reef-wide live coral cover was high (31-50%) and the reef was classified Incipient Outbreak with respect to the COTS population. Manta tow surveys in 2000 detected an increase in COTS activity and the reef was reclassified as an Active Outbreak. Reef-wide live hard coral cover had also declined to moderate levels (11-20%) in 2000, where it remained until 2003 when the reef was reclassified as Recovering. Surveys in 2007 showed that coral cover was increasing on Reef 16-017 with a high (31-50%) level recorded. Because coral cover on this reef in 2007 was at a level equivalent to that recorded prior to the last COTS outbreak, the reef was reclassified as No Outbreak. No bleaching or signs of black band disease were observed in 2007. Signs of white syndrome disease were observed on small numbers of scattered colonies on the front and first flank of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.54



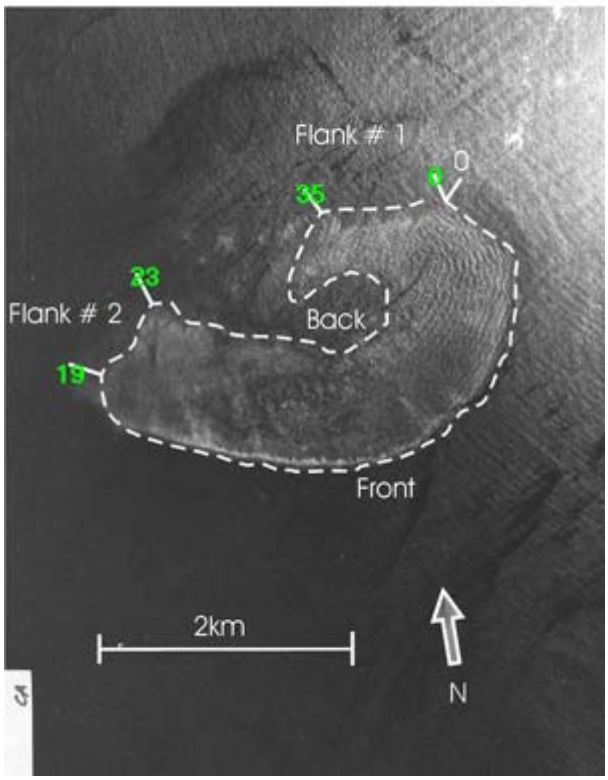
Reef 16-017 (No. 16-017) is a mid-shelf planar reef with an area of 2 sq.km.

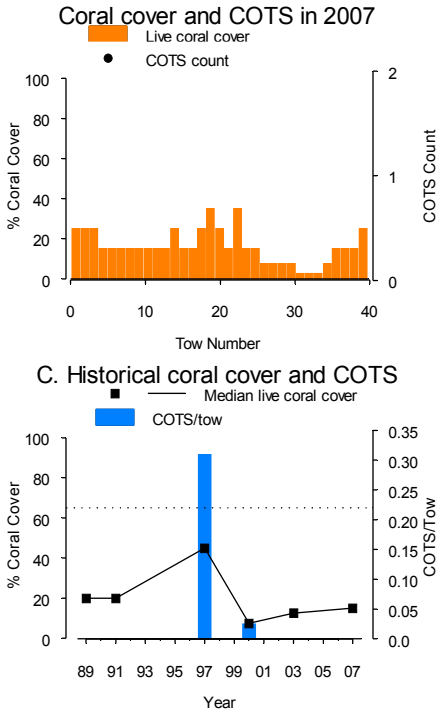
16-024

Reef 16-024 (Chinamen Reef) has been surveyed using manta tow six times since 1989. Median reef-wide live coral cover had increased to a high (41-50%) level by 1997, but outbreak levels of COTS populations at this time lead to a subsequent drop in coral cover to a low level (5-10%) by 2000. No COTS have been observed on this reef since 2000 and coral cover has subsequently shown a general increasing trend. Surveys in 2007 indicated that coral cover has continued to increase to a moderate (11-20%) level. Reef 16-024 remained classified as Recovering in 2007. No bleaching or signs of black band disease were observed during manta tow surveys in 2007. Signs of white syndrome disease were restricted to small numbers of scattered coral colonies on the front and the back of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.55
Reef 16024





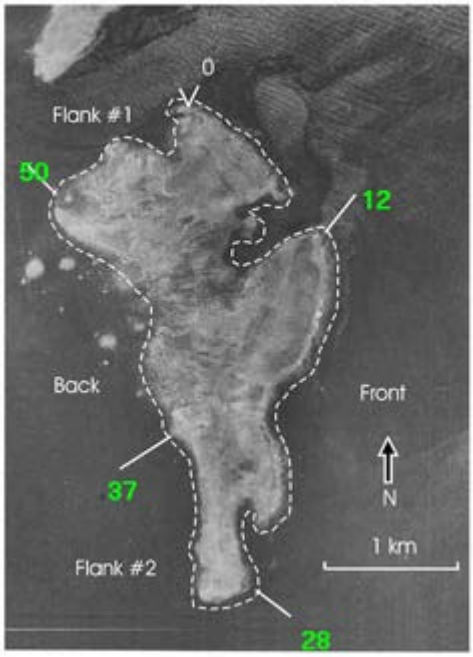
Reef 16-024 (No. 16-024) is a mid-shelf crescentic reef with an area of 5.6 sq.km.

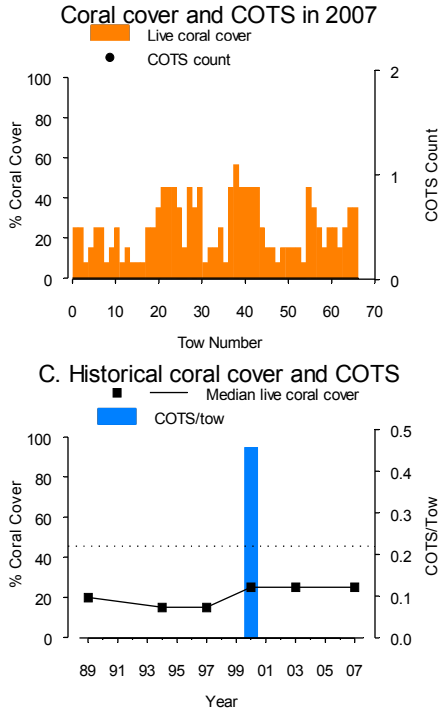
AGINCOURT NO.3

Agincourt Reef No. 3 has been surveyed using manta tow six times since 1989 when it was classified as No Outbreak. Median reef-wide live coral cover remained at moderate levels (11-30%) up to 2003. Recovery of reef-wide live coral cover was hampered by an Incipient Outbreak of COTS in 2000. No COTS were recorded in 2003 and the reef was reclassified as No Outbreak. Surveys in 2007 showed no signs of black band disease or bleaching on this reef and coral cover remained moderate. Signs of white syndrome disease were restricted to small numbers of dispersed coral colonies on the front and second flank.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.56





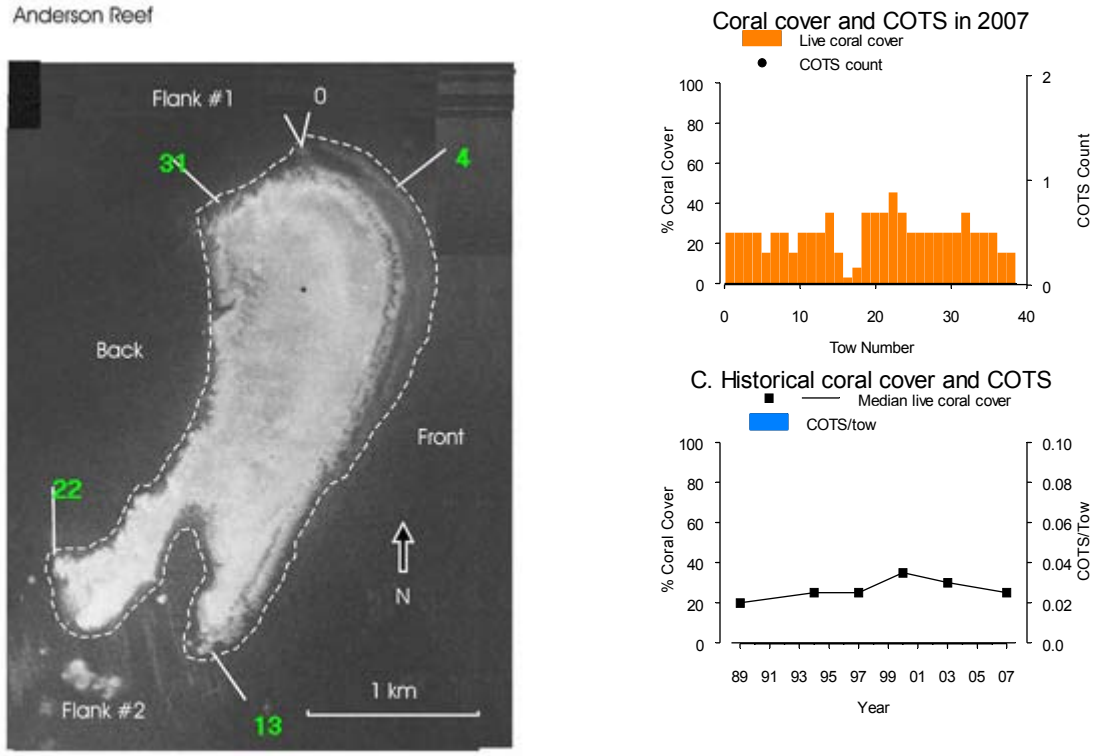
Agincourt Reef No.3 (No. 15-099) is an outer shelf ribbon reef with an area of 12.5 sq.km.

ANDERSEN

Andersen Reef has been surveyed using manta tow six times since 1989. Median reef-wide live coral cover showed a slow and steady increase from the moderate (11-30%) levels recorded in 1989 to a high level (31-50%) in 2000. Coral cover declined in subsequent years and was moderate (21-30%) in 2007. No COTS have been observed on Anderson Reef in any survey and it remained classified as No Outbreak in 2007. No bleaching or black band disease was observed during manta tow surveys in 2007. Signs of white syndrome disease were apparent on a small number of dispersed coral colonies on the front and back of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.57



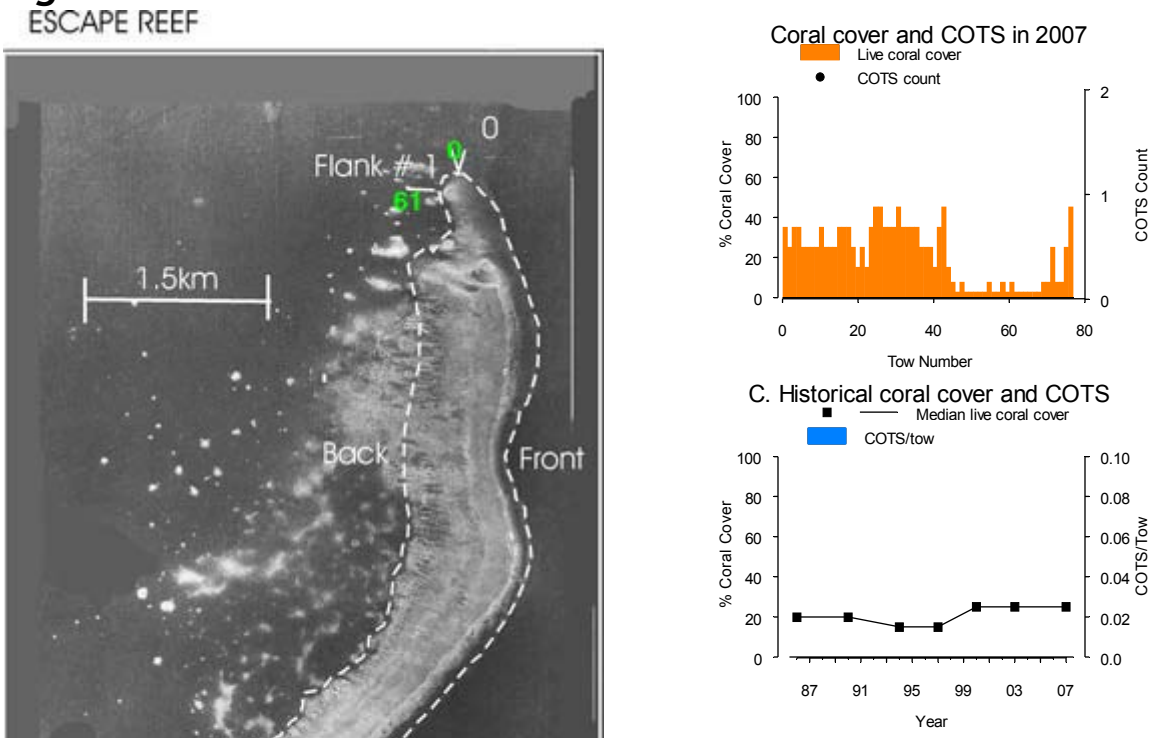
Andersen Reef (No. 15-090) is an outer shelf ribbon reef with an area of 3.1 sq.km.

ESCAPE (NO.1)

Escape (No. 1) Reef has been surveyed using manta tow 7 times since 1986. Median reef-wide live hard coral cover had remained relatively stable at a moderate level (11-30)% up until 2007. No COTS have been observed on this reef in any survey year and it remained classified as No Outbreak in 2007. No bleaching or signs of black band disease were observed while white syndrome disease occurred on small numbers of dispersed coral colonies on the front reef in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.58



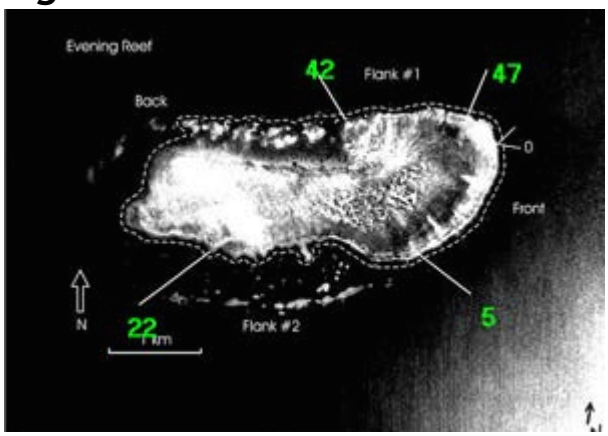
Escape Reef (No. 1) (No. 15-094) is an outer shelf ribbon reef with an area of 21 sq.km.

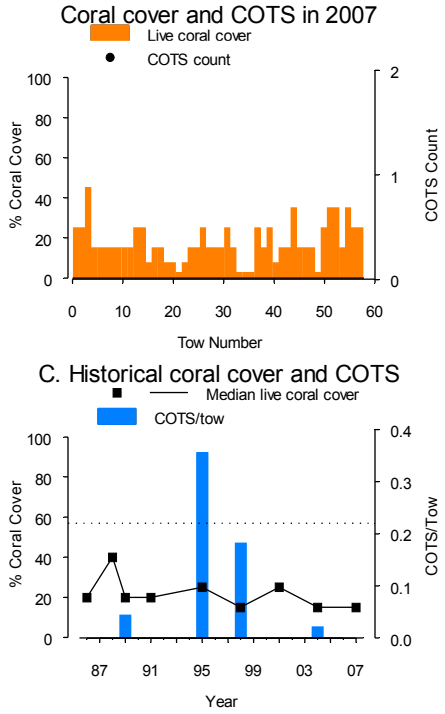
EVENING

Evening Reef has been surveyed using manta tow 9 times since 1986. Over this time reef-wide live coral cover remained at moderate (21-30%) levels. The reef was classified as Recovering from COTS activity prior to the commencement of surveys in 1986. Large numbers of COTS were observed in 1995 and it was reclassified as an Incipient Outbreak. A decline in COTS in 1998 saw the reef reclassified as Recovering. Small numbers of COTS below outbreak densities were also observed in 2004. No COTS were observed during surveys in 2007 and median reef-wide live coral cover remained moderate.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.59





Evening Reef (No. 15-095) is a mid-shelf planar reef with an area of 8.79 sq.km.

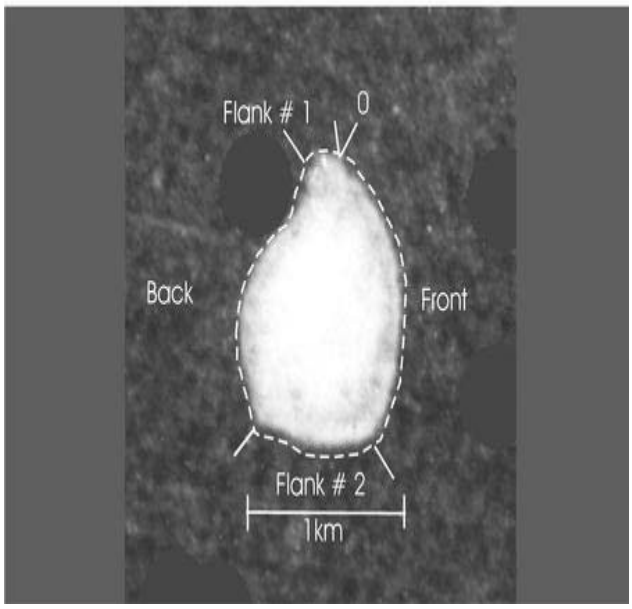
HOPE

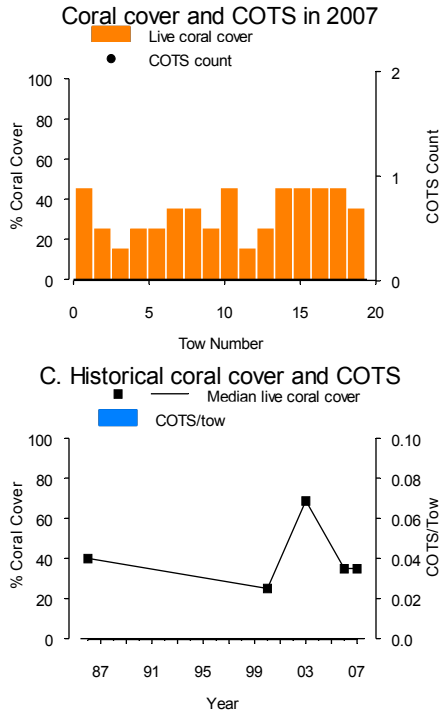
Hope Reef has been surveyed using manta tow 5 times since 1986. There was an initial decline in median reef-wide live coral cover from a high level of 31-50% in 1996 to a moderate level of 11-30% in 2000. Reef-wide live coral cover had increased to a very high level (51-75%) by 2003 and observers remarked that coral cover was quite spectacular. Surveys in 2006 indicated a decline in reef-wide live coral cover to a high level (31-50%) recorded in 2007. It should be noted that this is a submerged reef which is difficult to survey and variation in towpath may explain to some extent observed variability in estimates of reef-wide live coral cover. No COTS, bleaching or signs of black band disease were observed in 2007. Signs of white syndrome were common (on average more than ten colonies per two minute manta tow) on the back and flanks of this reef where tabulate *Acropora* spp. corals were abundant.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.60

Hope Reef





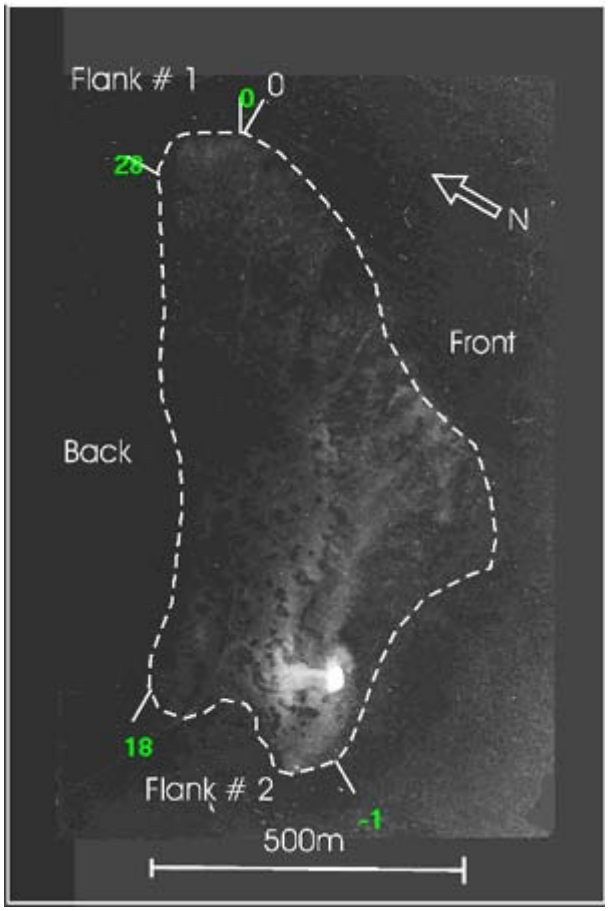
Hope Reef(No. 16-058) is an outer shelf submerged reef with an area of 0.2 sq.km.

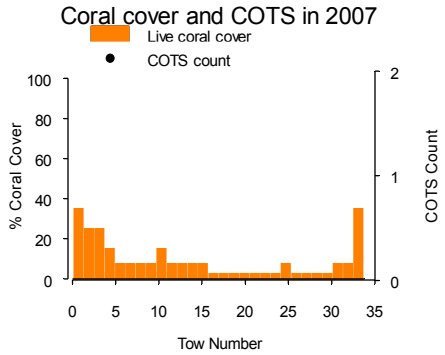
MIDDLE CAY (B)

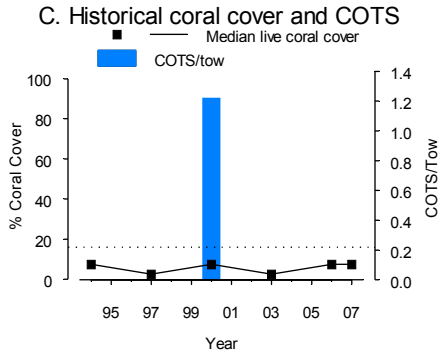
Middle Cay (B) Reef was initially classified as No Outbreak in 1994 and has been surveyed using manta tow six times. Median reef-wide live coral cover has remained at low levels (1-10%) over the entire survey period. In 2000, despite the low coral cover, a large COTS population was observed and the reef was classified as Active Outbreak. Surveys in 2003 showed a reduction in reef-wide live coral cover (as a result of the COTS outbreak). However, no COTS were observed and consequently the reef was reclassified as Recovering. Surveys in 2006 and 2007 indicated some recovery in reef-wide live coral cover, though it remained low (5-10%). No bleaching or signs of disease were observed. Middle Cay (B) Reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.61
Middle Cay B







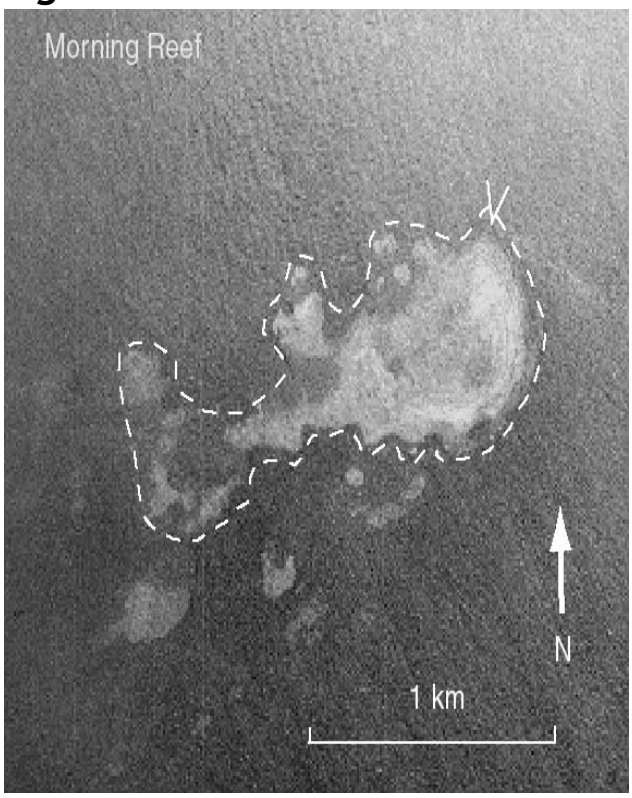
Middle Cay (B) Reef (No. 16-044) is a mid-shelf planar reef with an area of 6.25 sq.km.

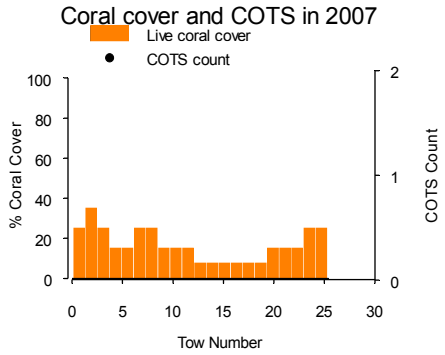
MORNING

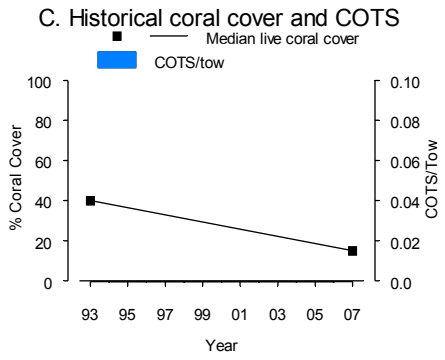
2007 was the first time Morning Reef had been surveyed using manta tow since 1993. During this time median reef-wide live coral cover dropped from a high (31-40%) to a moderate (11-20%) level. The long period between surveys means little can be inferred about the causes of this apparent decline. No COTS were observed on this reef during surveys in 2007 and it remained classified as No Outbreak. Similarly no signs of bleaching or black band disease were observed. However a low level of white syndrome disease affecting small numbers of scattered coral colonies around the reef perimeter was observed during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.62







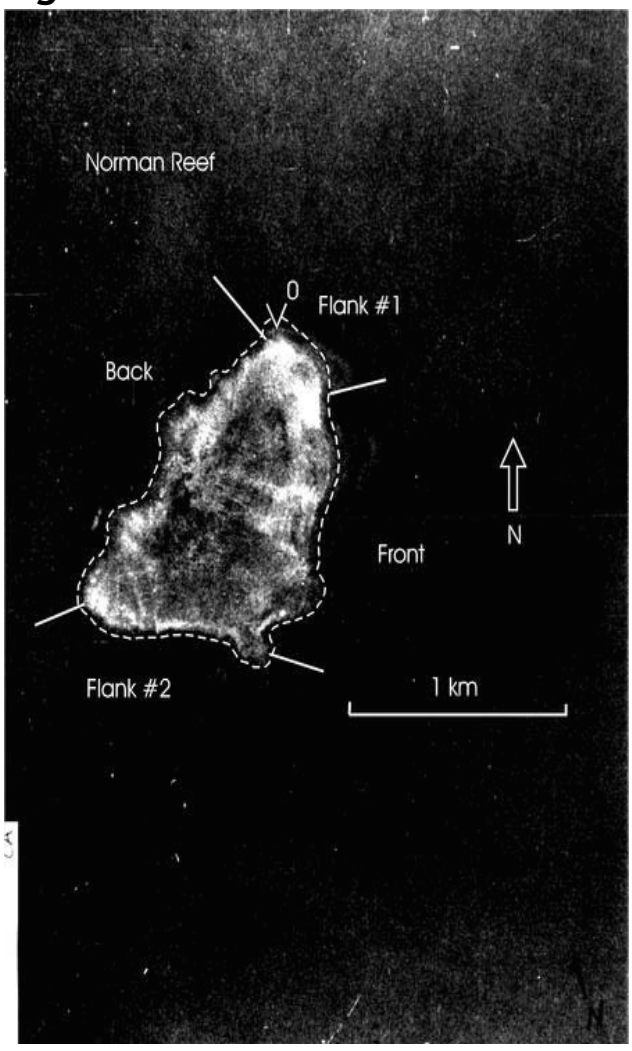
Morning Reef (No. 15-098) is a mid-shelf patch reef with an area of 14.8 sq.km.

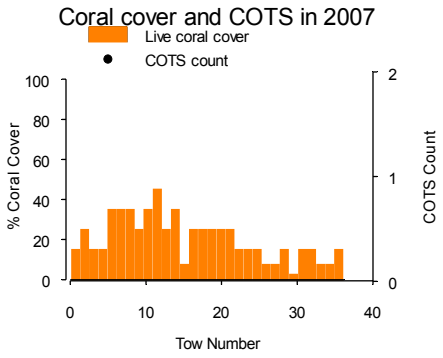
NORMAN

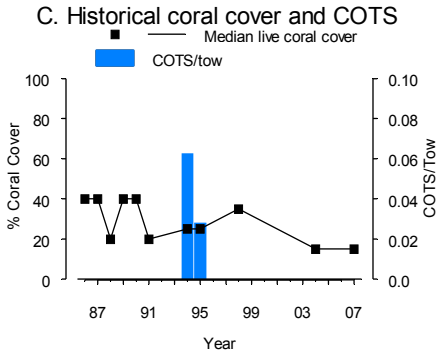
Norman Reef has been surveyed 11 times using manta tow since 1986. Median reef-wide live coral cover was generally high (31-40%) in the initial surveys, then dropped to moderate levels (11-30%) in 1991. No COTS had been recorded and the reason for this decline is unknown, though Cyclone Joy did impact reefs in the area just prior to the 1991 survey. From 1991 to 1998 coral cover recovered to a high level despite the presence of small numbers of COTS on the reef. Surveys in 2004 showed that coral cover had again declined on Norman Reef. The long period between surveys makes it difficult to ascribe reasons for this decline. Norman reef was classified as No Outbreak in 2004. Surveys in 2007 indicated that coral cover remained moderate on Norman Reef. No bleaching or signs of black band disease were recorded. Signs of white syndrome disease were restricted to small numbers of individual coral colonies scattered around the reef perimeter. Norman Reef remains classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.63







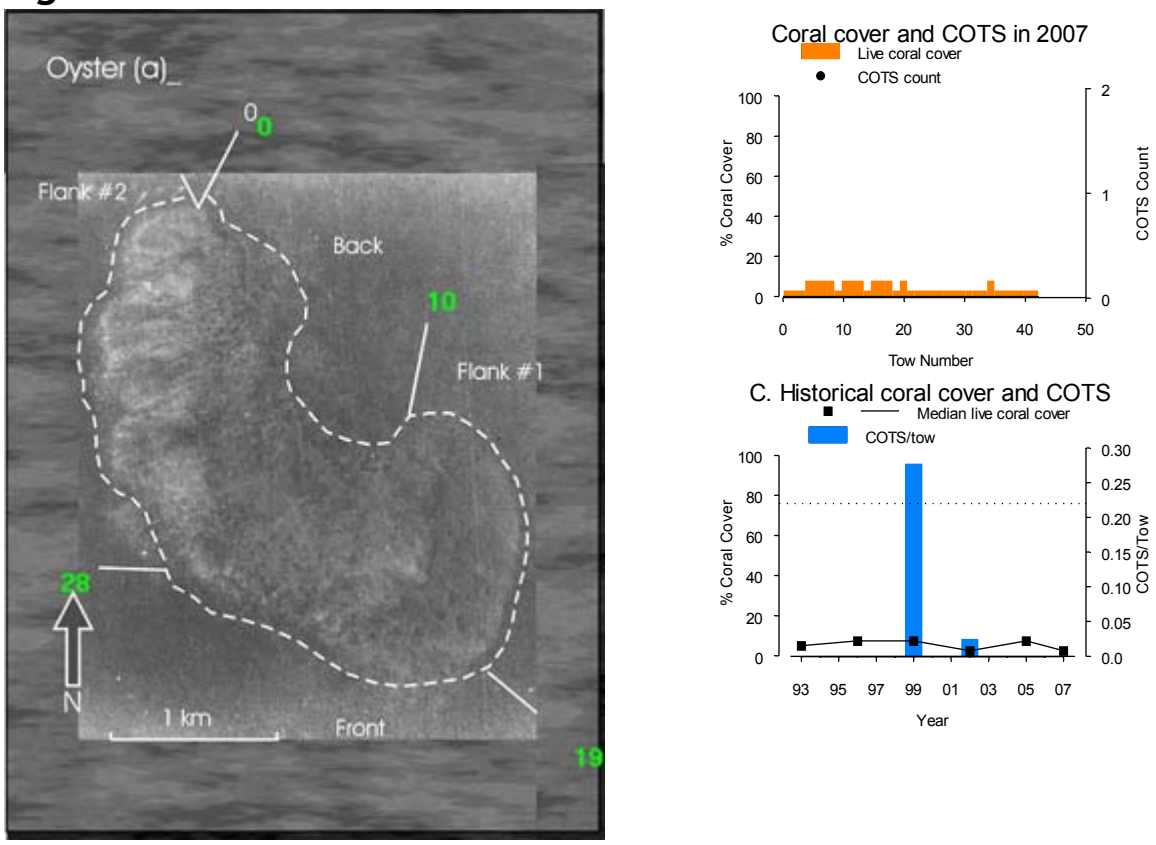
Norman Reef (No. 16-030) is an outer shelf planar reef with an area of 4.3 sq.km.

OYSTER (A)

Oyster (A) Reef has only been surveyed using manta tow 6 times since 1993. There has been little change in median reef-wide live coral cover, which has remained low (1-10%) over the entire survey period. COTS at Incipient Outbreak levels were recorded at this reef in 1999. Manta tow surveys in 2002 indicated that COTS populations had declined and reef-wide live coral cover was low. Oyster (A) Reef was reclassified as No Outbreak. No COTS were observed during surveys in 2007 and the reef remained classified as No Outbreak. Coral cover in 2007 also remained low. No bleaching or signs of disease were recorded at this reef in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.64



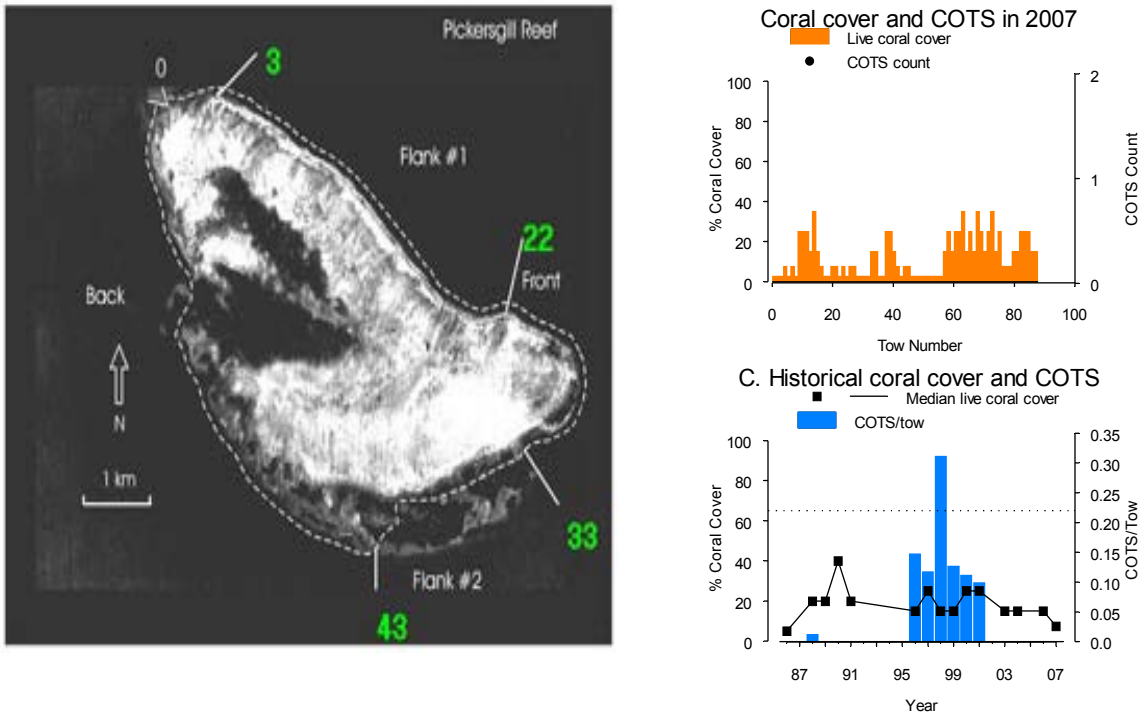
Oyster (A) Reef (No. 16-043) is a mid-shelf planar reef with an area of 14.5 sq.km.

PICKERSGILL

Pickersgill Reef has been surveyed 15 times using manta tow since 1986. Originally classified as Recovering from COTS activity prior to the first surveys, median reef-wide live coral cover increased until 1990. Coral cover dropped appreciably in 1991. The reasons for this are uncertain; there were no large COTS populations but Cyclone Joy passed near the area in December 1990. After 1991 there was little change in coral cover although COTS numbers continued to grow up until 1998 and the reef was reclassified as an Incipient Outbreak. Persistent COTS populations at or below outbreak levels have hampered recovery on this reef and reef-wide live coral cover was moderate (11-20%) in 2004. Surveys in 2007 showed no sign of a subsequent recovery in reef-wide live coral cover, with a low (1-10%) level recorded. No COTS were observed and the reef remained classified as Recovering in 2007. No bleaching was recorded and signs of white syndrome were restricted to small numbers of individual coral colonies scattered around the reef perimeter. No signs of black band disease were recorded.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.65



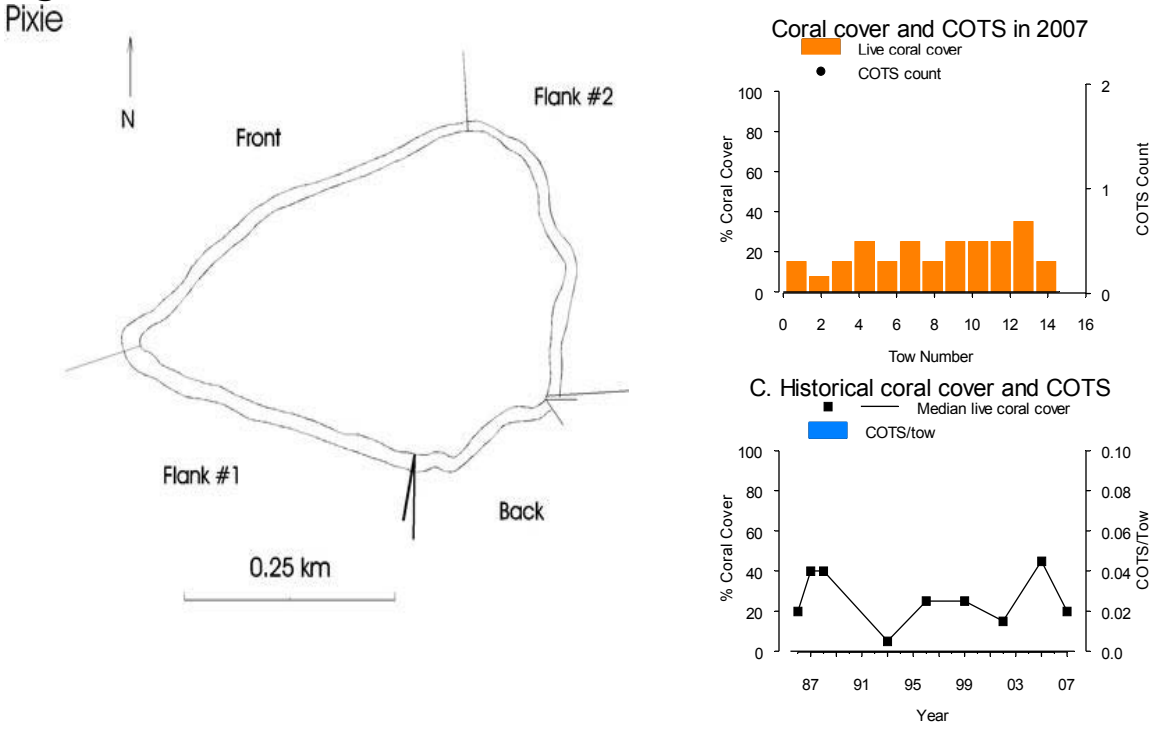
Pickersgill Reef (No. 15-093) is a mid-shelf lagoonal reef with an area of 17 sq.km.

PIXIE

Pixie Reef has been surveyed using manta tow 9 times since 1986. Median reef-wide live coral cover was high (31-50%) during the late 1980s before a significant drop occurred in 1993. Given the interval between surveys and that no COTS had been seen, the cause of the drop in coral cover remains unknown. From 1993 reef-wide live coral cover recovered to some extent and was moderate (11-30%) in 2002. In 2005 Pixie Reef was classified as No Outbreak, with reef-wide coral cover returning to high levels (31-50%). In 2007 coral cover had dropped to moderate (11-30%) levels. No COTS were observed during 2007 surveys and Pixie Reef remained classified as No Outbreak. No coral bleaching was recorded in 2007. White syndrome disease affected only a few scattered colonies around the reef perimeter.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.66



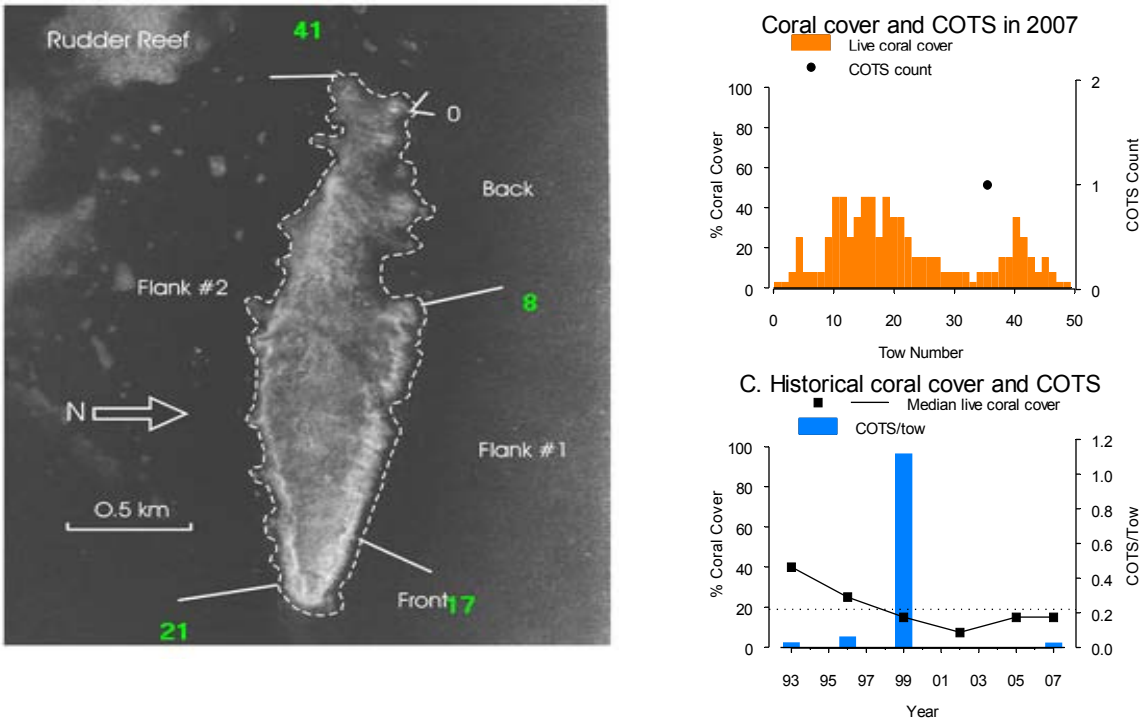
Pixie Reef (No. 16-040) is a mid-shelf planar reef with an area of 0.7 sq.km.

RUDDER

Rudder Reef has been surveyed using manta tow 6 times since 1993. Median reef-wide live coral cover was initially high (31-50%), but COTS were recorded at each visit between 1993 and 1999, reaching Active Outbreak levels by 1999. Increased COTS feeding activity resulted in a subsequent decline in reef-wide live coral cover to a low level (1-10%) in 2002 and when Rudder Reef was reclassified as Recovering. In 2005 reef-wide coral cover had increased to moderate levels (11-20%) where it remained in 2007. COTS were observed during 2007 surveys but in numbers well below those expected to impact on reef-wide live coral cover. No evidence of bleaching was seen and white syndrome disease only affected a few scattered coral colonies.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.67



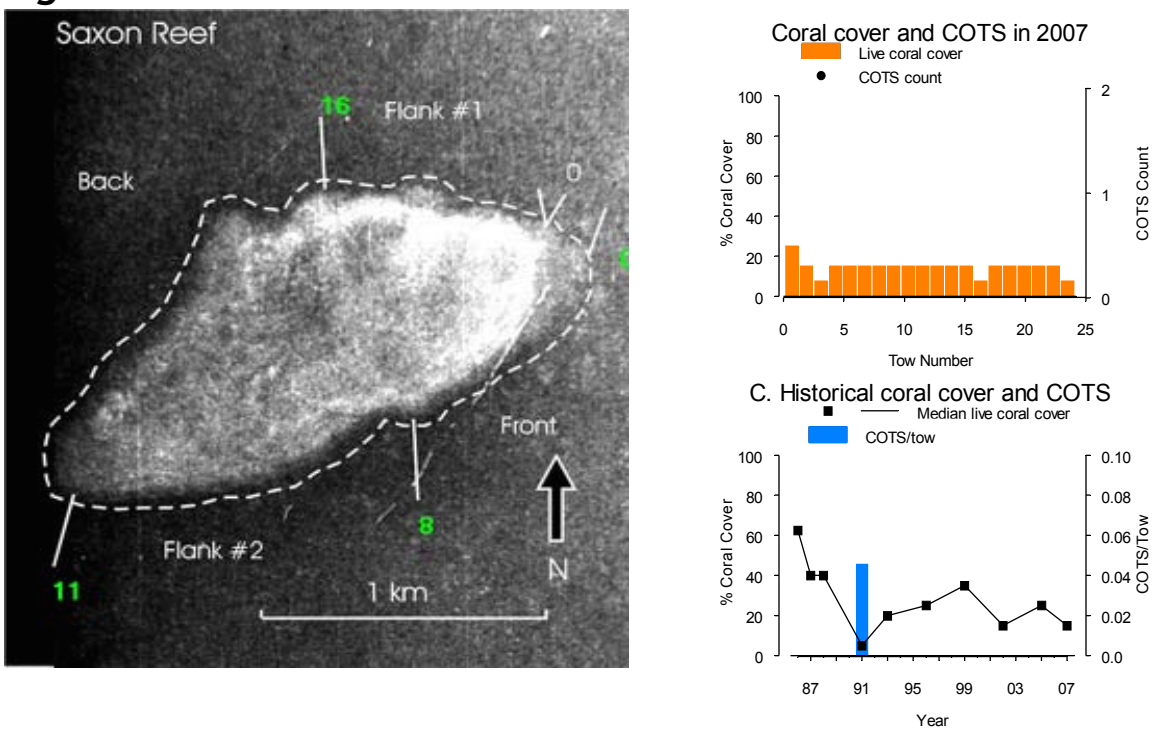
Rudder Reef (No. 16-023) is a mid-shelf patch reef.

SAXON

Saxon Reef has been surveyed using manta tow 10 times since 1986. Median reef-wide live coral cover was initially very high (51-75%) through the late 1980s, but declined in the early 1990s for unknown reasons, but possibly due to a low numbers of COTS. From 1991 to 1999 reef-wide live coral cover recovered to a high level (31-50%) before declining to a moderate level (11-30%) in 2002. The reason for this decline is also unknown. No COTS were recorded from Saxon Reef during recent surveys and it was classified as No Outbreak in 2005. Coral cover remained moderate (11-20%) on this reef in 2007. No bleaching was observed and signs of black band disease only affected a few scattered coral colonies on the back reef. Signs of white syndrome were more widespread, around the entire reef perimeter, but again at a low level only affecting small numbers of scattered coral colonies

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.68



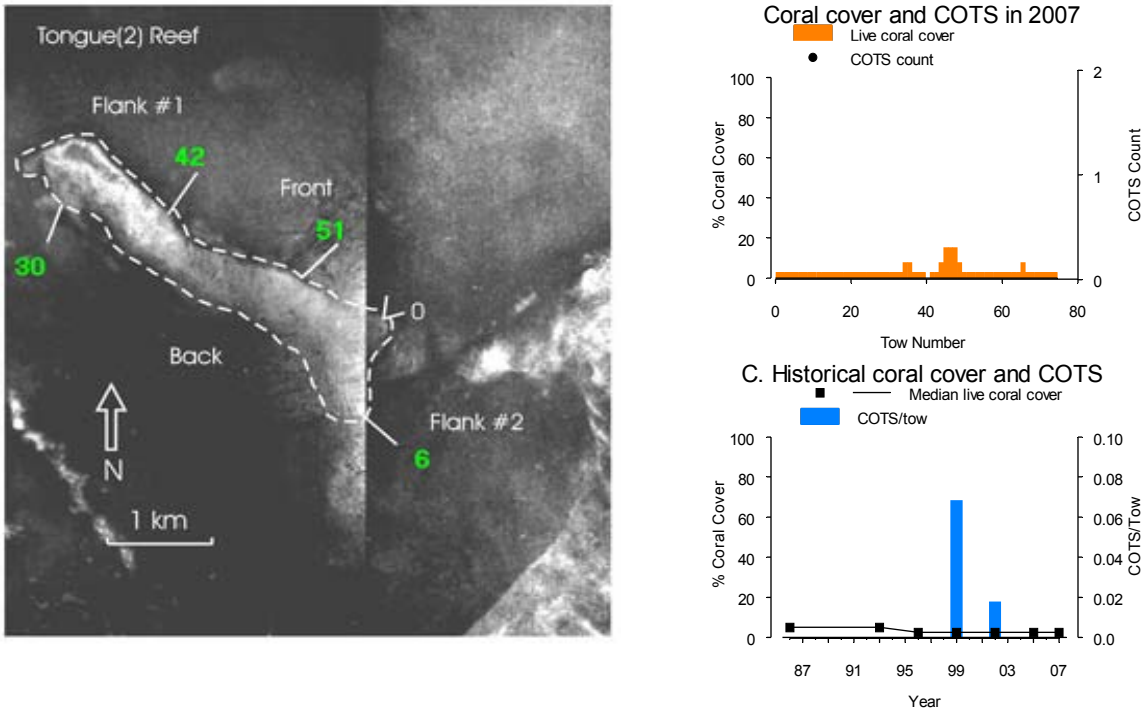
Saxon Reef (No. 16-032) is a mid-shelf planar reef with an area of 1.9 sq.km.

TONGUE (2)

Tongue (2) Reef has been surveyed using manta tow 7 times since 1986. There has been little change in median reef-wide live coral cover, which remained low (1-10%) in 2007. Although COTS were recorded from this reef in 1999, their numbers were considered too low to affect reef-wide live coral cover. The reef was classified as No Outbreak in 2002. No bleaching or signs of black band disease were observed in 2007. Signs of white syndrome disease were observed on a few scattered coral colonies on the second flank in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.69



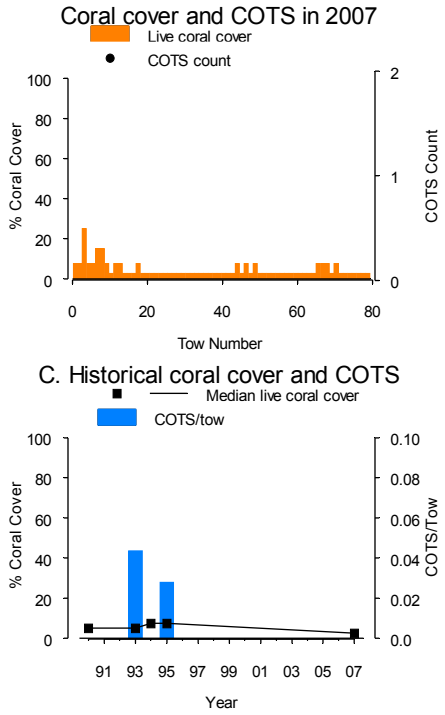
Tongue (2) Reef (No. 16-026) is a mid-shelf crescentic reef with an area of 213.3 sq.km.

UNDINE (A)

Undine (A) Reef has been surveyed using manta tow 5 times since 1990. However, 2007 was the first time that this reef had been surveyed since 1995. The long period between surveys makes it difficult to discuss trends in median reef-wide live coral cover for this reef although it has stayed very low (1-5%) over the survey period. Low numbers of COTS (below outbreak levels) were observed in the early 1990s and that may have had some influence on coral cover around that time. No COTS were observed during surveys in 2007. Similarly, no bleaching or signs of black band disease were recorded. Signs of white syndrome disease were restricted to small numbers of scattered colonies on the front and first flank in 2007. Undine (A) Reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.70



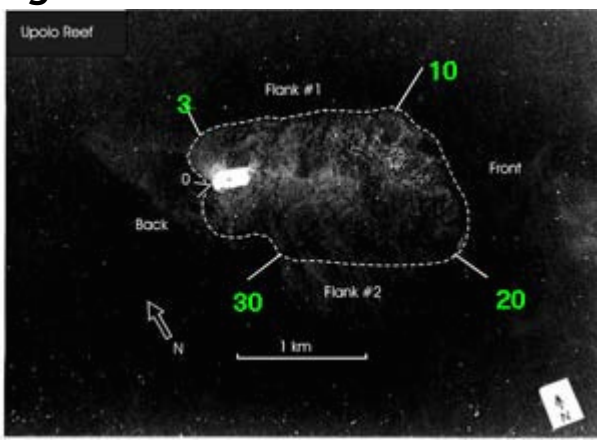
Undine (A) Reef (No. 16-020) is a mid-shelf patch reef with an area of 30.5 sq.km.

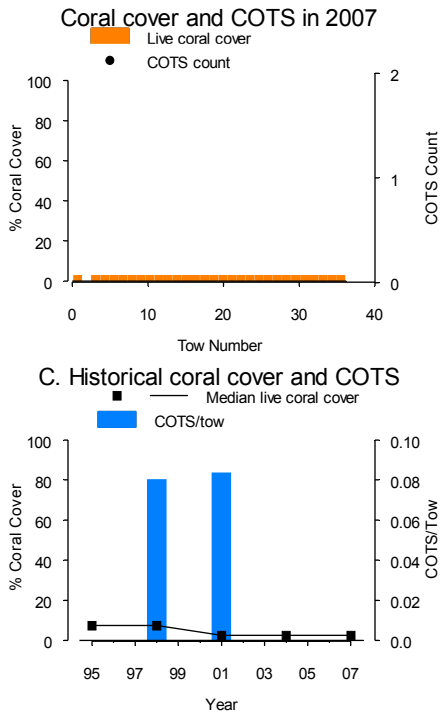
UPOLU CAY

Upolu Cay Reef has been surveyed using manta tow 5 times since 1995. Over this time there was a reduction in median reef-wide live coral cover from low (6-10%) to very low (<5%) levels between 1997 and 2001. This corresponded to a time when small numbers of COTS were observed on this reef. Although their abundance was below outbreak levels, COTS were most likely responsible for the observed decline. Upolu Cay Reef was classified as No Outbreak in 2007 and coral cover remained low. No bleaching or signs of disease were observed during surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.71





Upolu Cay Reef (No. 16-046) is a mid-shelf planar reef with an area of 12.1 sq.km.

Innisfail

Reef Pages

FARQUHARSON (A)

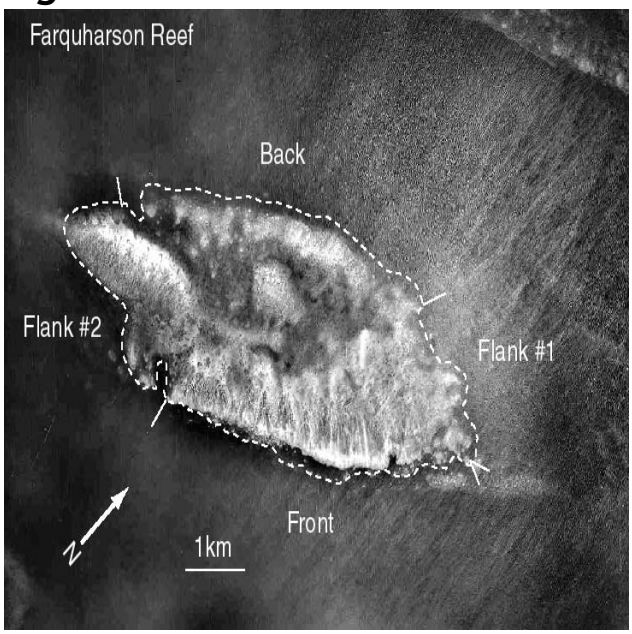
2006 was the first time that Farquharson (A) Reef had been surveyed using manta tow. Initial surveys indicated that median reef-wide live coral cover was very low (1-5%). Since Farquharson (A) Reef is surrounded by reefs that have experienced COTS outbreaks in recent years it is almost certain that such low coral cover is a result of a recent COTS outbreak. Therefore Farquharson (A) Reef was classified as Recovering. No COTS, coral bleaching or signs of black band disease were observed during surveys in 2006. Signs of white syndrome were observed on a few scattered coral colonies on the back and southern flank of the reef.

Intensive survey sites at Farquharson (A) Reef were established in 2006. Hard coral cover was very low (6%) in 2006. Survey results indicate that reefs in the Innisfail area had the lowest coral cover on the GBR around 2000 due to COTS outbreaks. Other disturbances since then, including cyclones and bleaching, have inhibited recovery on some reefs. Algal cover on Farquarson Reef in 2006 was 79% and consisted mostly of turf species. Macroalgae was 20%, mostly composed of *Halimeda* spp. Poritidae was the most abundant hard coral family (<2%). In 2006 soft coral abundance was low. Coral diseases were recorded on 3 colonies. *Drupella* spp. were not present along the fixed transects in 2006.

The fish community at Farquharson Reef reflected the state of the benthic community, which was dominated by algae with very little live hard coral cover. Therefore, it was not surprising that the numerically dominant species were those from herbivorous feeding guilds, e.g. families Scaridae and Acanthuridae. Most other large mobile fish families, with the exception of the wrasses (Labridae) were present only in low numbers. Similarly the damselfish community also reflected the lack of hard coral at this reef, with coral affiliated species from the genera *Chromis*, *Pomacentrus* and *Plectroglyphidodon* completely absent or present only in low numbers.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.72



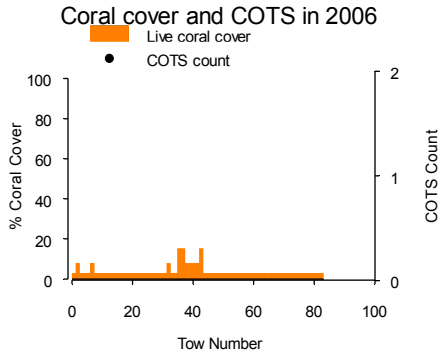
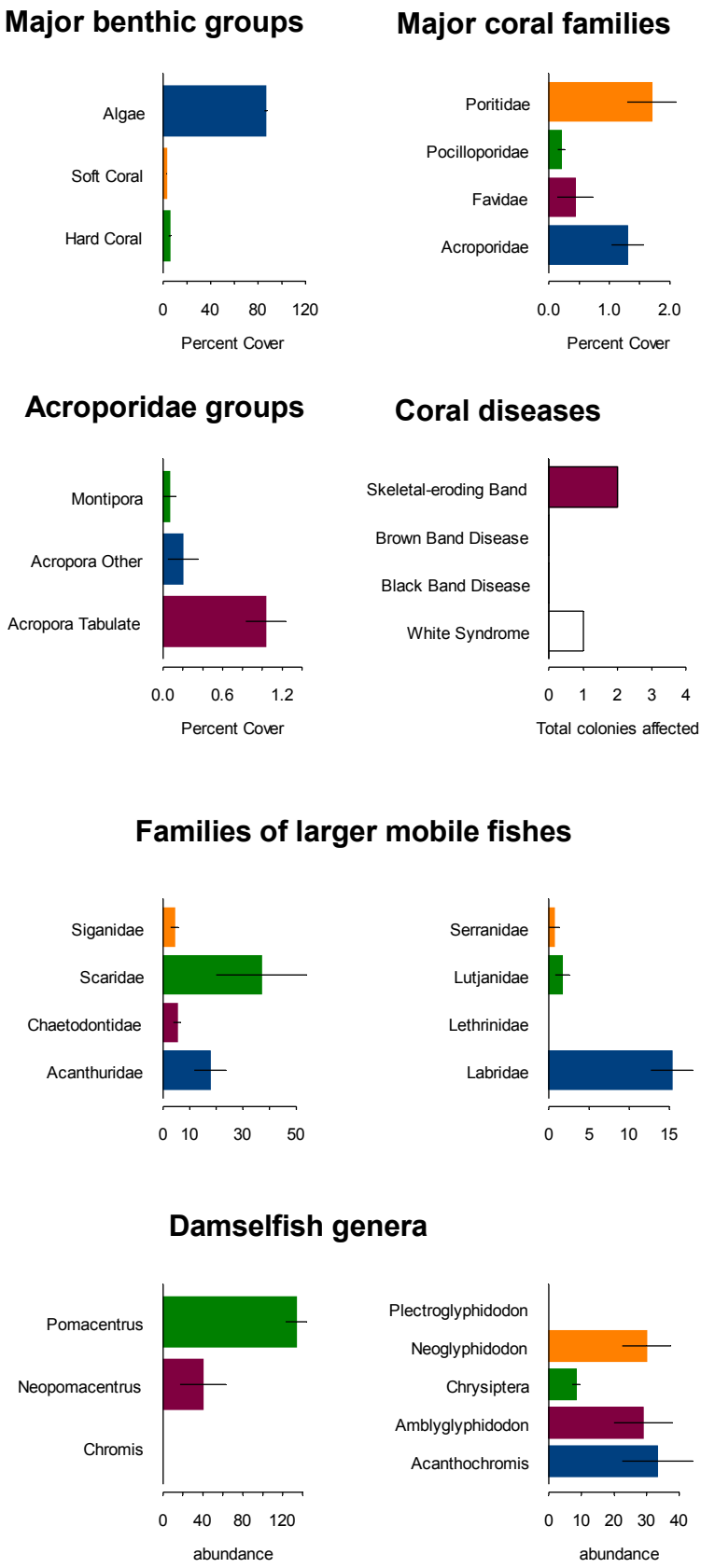


Figure 5.72 (cont.)
Farqhuarson (A) Reef was last surveyed in December 2005.



FEATHER

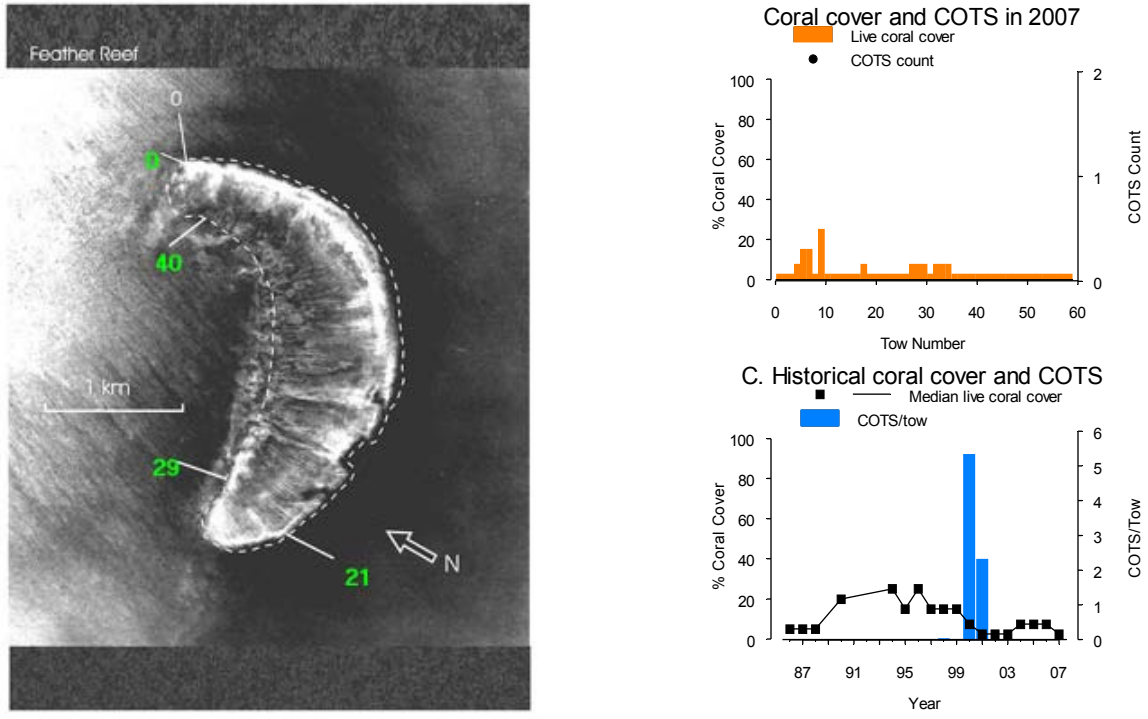
Feather Reef has been surveyed regularly using manta tow since 1986. It was initially classified as Recovering from previous COTS activity. There was a gradual increase in median reef-wide live coral cover to a moderate level (11-30%) during the late 1980s and early 1990s. The recovery of coral cover stalled in the mid 1990s, possibly due to the effects of cyclones (Cyclones Gillian, Ita and Justin were active in the area) and remained at moderate levels through the late 1990s. In 2000 Feather Reef experienced a COTS outbreak and there was a corresponding decline in median reef-wide live coral cover to a low level (1-10%) by 2001. By 2002 COTS numbers had declined and the reef was reclassified as Recovering. Reef-wide live coral cover remained low in 2007. Feather Reef remained classified as Recovering in 2007. No COTS, bleaching or signs of disease were observed during manta tow surveys in 2007.

Intensive survey sites on Feather Reef were established in 2006. In 2006, hard coral cover was moderate (21%) with Acroporidae the most abundant family at 9%, suggesting that recovery from a COTS outbreak around 2000 was occurring. Soft coral cover was 15% in 2006 with Alcyoniidae being the most abundant family. Algae cover in 2006 was 60% and was composed mostly of turf species. Coral diseases were recorded on 4 colonies. The corallivorous snail *Drupella* spp. was recorded at a density of 13/ha during SCUBA search surveys.

The large fish community was dominated by three families, the parrotfishes (Scaridae), wrasses (Labridae) and the snappers (Lutjanidae). However, the abundance of these families was largely driven by one or two species within the family, indicating that the large fish community was not particularly diverse. The damselfish community was dominated by a few highly abundant species, including *Pomacentrus lepidogenys*, *Neopomacentrus azysron*, *Amblyglyphidodon curacoa* and *Acanthochromis polyacanthus*. None of these species have close affiliations with hard coral cover, and the fish community generally was a reflection of the state of the benthic community, which had low hard coral cover. Thus, coral affiliated species such as many butterflyfishes (Chaetodontidae) and the damselfish genera *Plectroglyphidodon* and *Chromis* are absent or present only in low numbers.

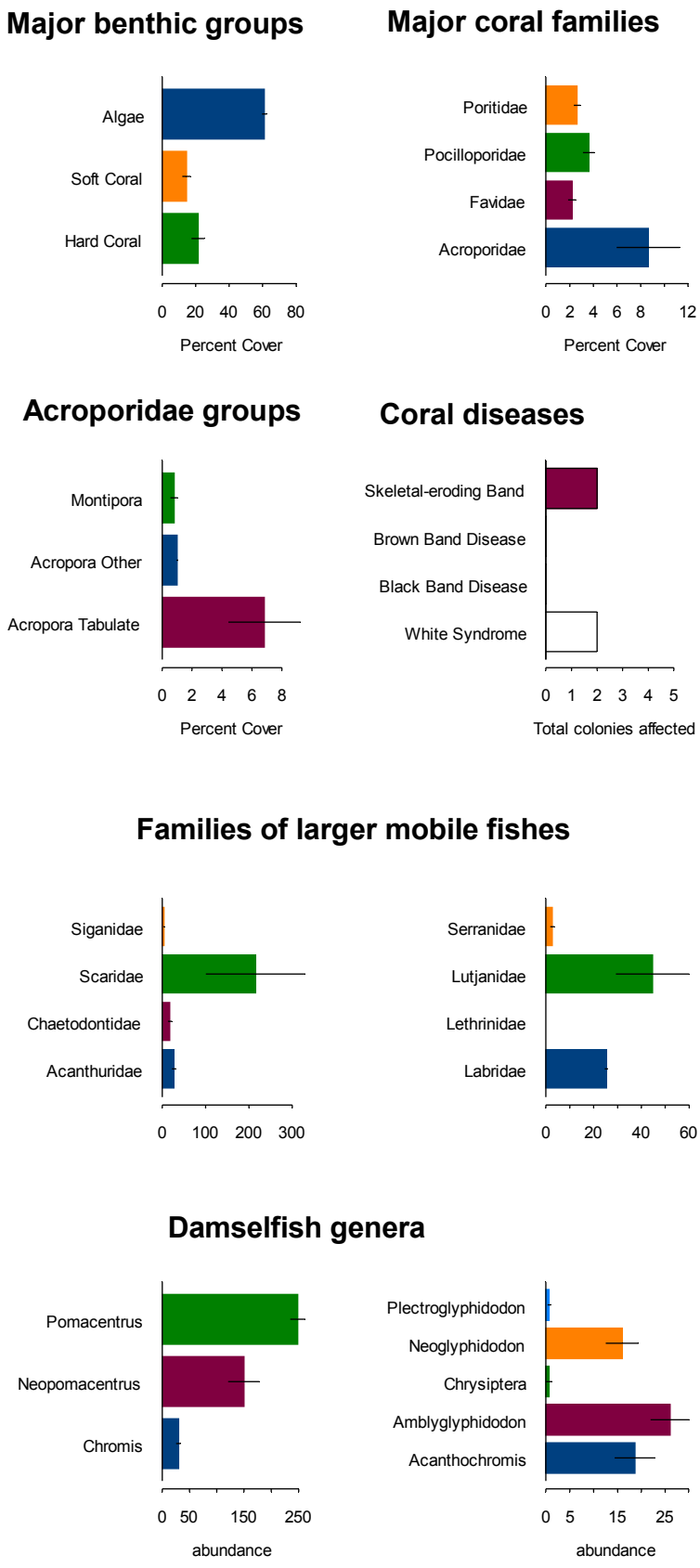
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.73



Feather (No. 17-034) is a mid-shelf crescentic reef with an area of 14.1 sq.km.

Figure 5.73 (cont.)
Feather was last surveyed in December 2005.



HEDLEY

Hedley Reef has been surveyed using manta tow six times since 1986, when it was initially classified as Recovering from COTS activity. Median reef-wide live coral cover had shown little change between surveys up until 1997, when signs of increasing coral cover stalled due to an outbreak level of COTS. Surveys in 2000 showed that reef-wide coral cover had subsequently declined to a low level (5-10%). Surveys in 2006 indicated that reef-wide coral cover was in the early stages of recovery, with a moderate (11-20%) level of coral cover recorded. Surveys in 2007 indicated that recovery had stalled to some extent most likely due to the effects of Cyclone Larry that passed through the region in 2006. No COTS or coral bleaching were observed in 2007. Hedley Reef remained classified as Recovering in 2007. Signs of white syndrome disease were observed on small numbers of scattered coral colonies on the back and first flank of the reef during surveys in 2007.

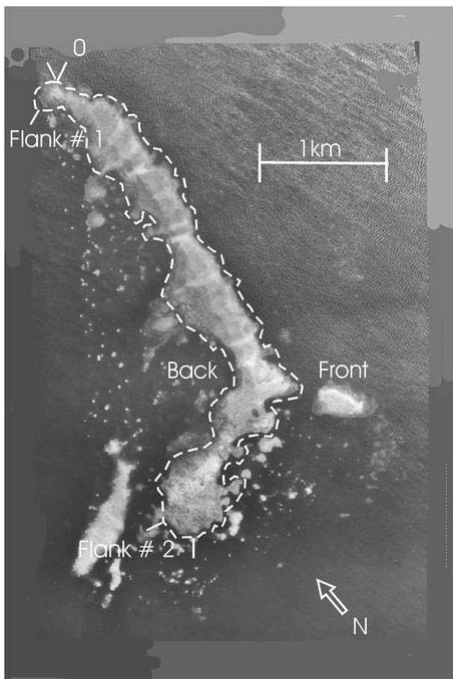
Intensive survey sites on Hedley Reef were established in 2006. In 2006, hard coral cover was showing signs of recovery (15%) following a COTS outbreak around 1997. Acroporidae was the most abundant hard coral family at 10%. Soft coral cover was 10% in 2006 with Xeniidae the most abundant family. Algae cover in 2006 was 68% and was composed mostly of turf species. The number of colonies with coral diseases was low. The density of the corallivorous snail *Drupella* spp. at the survey sites was 13/ha. No COTS were recorded during surveys in 2006.

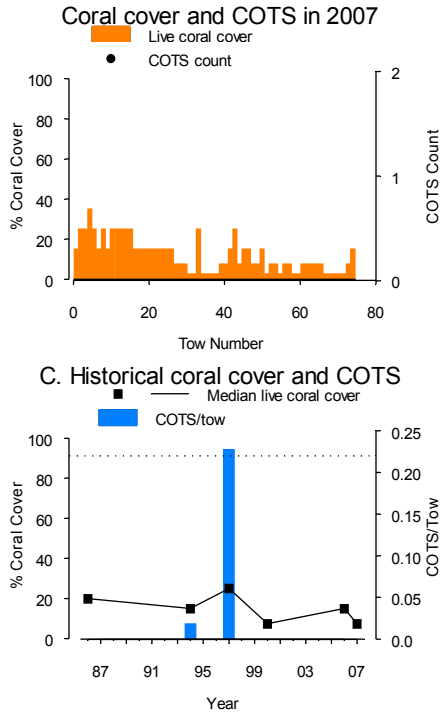
The large mobile fish community was dominated by surgeonfishes (Acanthuridae) and parrotfishes (Scaridae). Both families contain numerous herbivorous species, feeding on algae, which was found in high abundance on this reef. Numbers of butterflyfishes were moderate and were due largely to a single species *Chaetodon trifasciatus*. Similarly, there were moderate numbers of coral trout, which are the major target species for the hook and line fishery on the GBR. The damselfish community was comprised of large numbers of *Pomacentrus moluccensis*, *P. lepidogenys* and *Neoglyphidodon nigroris*. The presence of *P. moluccensis* in large numbers indicated that the hard coral community was recovering from a COTS outbreak in 1997, as this species recruits to live coral colonies as juveniles.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.74

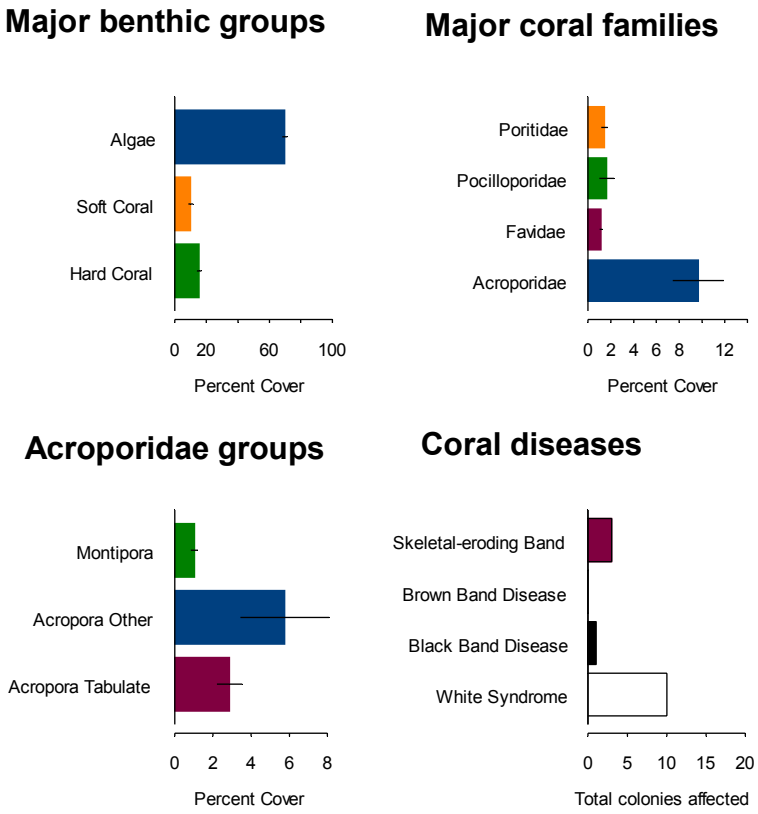
Hedley Reef





Hedley Reef (No. 17-014) is an outer shelf patch reef with an area of 22.6 sq.km.

Figure 5.74 (cont.)
Hedley Reef was last surveyed in November 2005.



MCCULLOCH

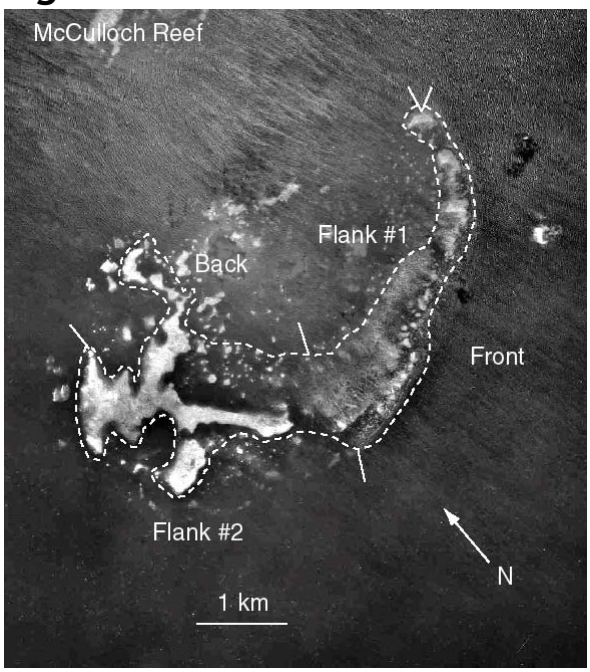
2006 was the first time that McCulloch Reef had been surveyed using manta tow. Median reef-wide live coral cover in 2006 was very low (1-5%). Since McCulloch Reef is surrounded by reefs that have experienced COTS outbreaks in recent years it is almost certain that the low coral cover reflects a recent COTS outbreak. Following 2006 survey results, the reef was classified as Recovering. No COTS, coral bleaching or signs of black band disease were observed during surveys in 2006. Signs of white syndrome were observed on a few scattered coral colonies on the northern flank of the reef.

Intensive survey sites on McCulloch Reef were established in 2006. While there is no survey history for this reef, COTS outbreaks have been recorded on reefs nearby since 2000. In 2006, hard coral cover was 17%, with Acroporidae the most abundant family with 8% cover, followed by Pocilloporidae (4%). Soft coral was the dominant coral group at 23% cover in 2006. Algae cover in 2006 was 56% and was composed mostly of turf species. The number of colonies with coral diseases was low. *Drupella* spp. occurred at a density of 6/ha at the survey sites.

The overall fish community generally reflected the state of the benthic community, which had low live coral cover and was dominated by turfing algae. The large mobile fish community was comprised of large numbers of surgeonfishes (Acanthuridae), parrotfishes (Scaridae) and wrasses (Labridae). Acanthuridae species such as *Acanthurus lineatus* and *Ctenochaetus* spp. were largely responsible for the observed patterns. The common coral trout was present at this reef in moderate numbers, whilst the coral affiliated butterflyfishes were also present in low to moderate numbers. The damselfish community was dominated by species that are considered herbivorous (e.g. *Plectroglyphidodon lacrymatus*) or generalist/planktivorous e.g. *Pomacentrus lepidogenys*, *Neopomacentrus azysron*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.75



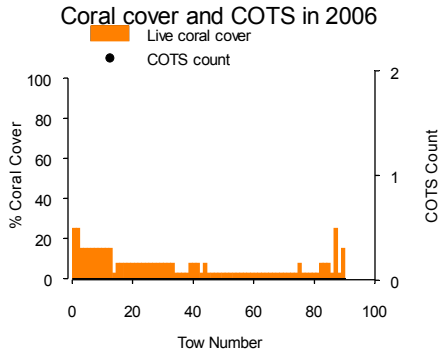
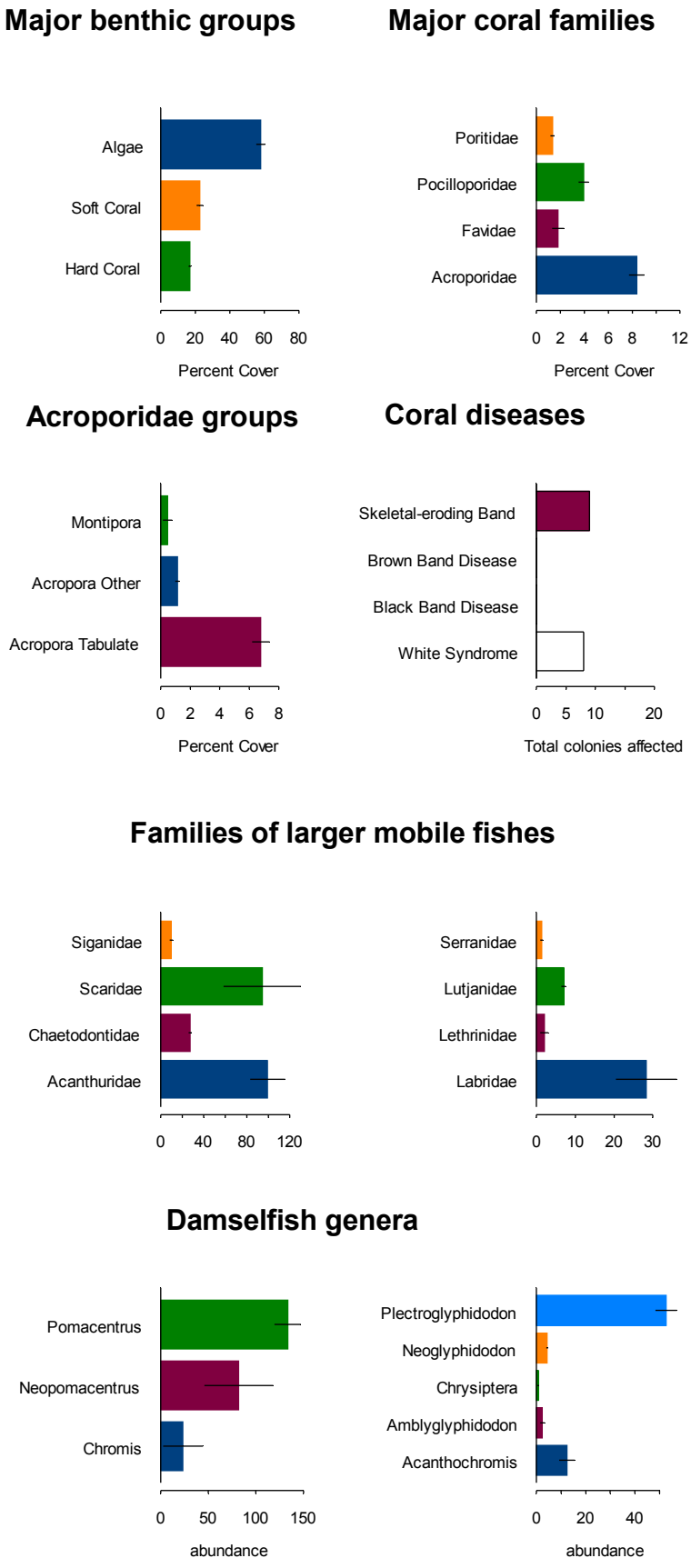


Figure 5.75 (cont.)
McCulloch Reef was last surveyed in December 2005.



MOORE

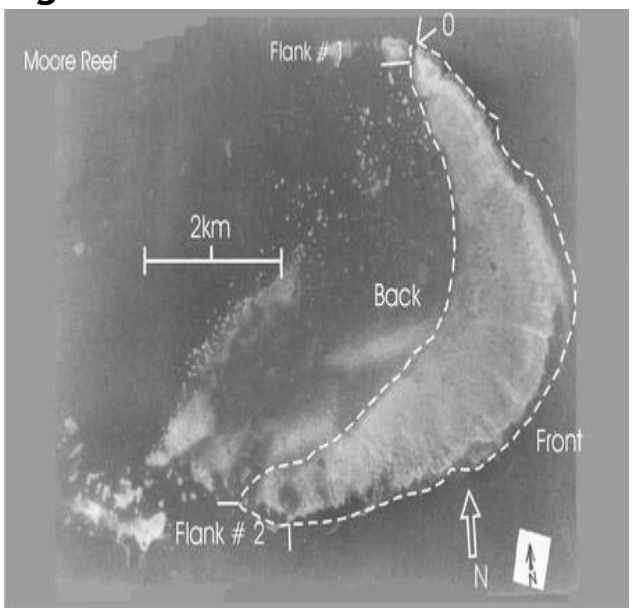
Moore Reef has been surveyed seven times using manta tow since 1989, when it was initially classified as Recovering from previous COTS activity. Median reef-wide live coral cover remained moderate (21-30%) on this reef before declining between 1989 and 1994, possibly due to the effects of Cyclones Felicity and Ivor that passed nearby in 1989 and 1990. Since this time coral recovered to a limited extent before declining again in 2000. Elevated COTS numbers (just below outbreak levels at the time of survey) contributed to the observed decline. Subsequent surveys have shown little change in coral cover since 2000 and coral cover remained low (6-10%) in 2007. The reef remained classified as Recovering in 2007. No COTS or incidence of bleaching were observed in 2007. Signs of black band disease were restricted to a small number of scattered coral colonies on the back reef and white syndrome was common (on average more than ten colonies per two minute manta tow) on the back reef.

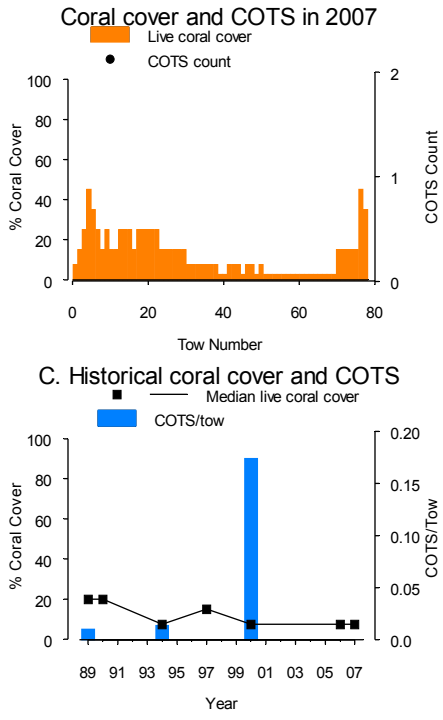
Intensive survey sites on Moore Reef were established in 2006. Hard coral cover during the initial survey was moderate at 29%, with Acroporidae the most abundant family at 16% followed by Faviidae (5%). The abundance of soft coral cover was moderate (23%). Algal cover in 2006 was 41% and the algal community was composed mostly of turf species. The number of colonies with coral diseases was low. *Drupella* spp. were not found at the survey sites in 2006.

Moore Reef had moderate coral cover and this was generally reflected by higher numbers of coral affiliated fish species compared to other reefs in this sector. The abundance and diversity of the butterflyfish family (Chaetodontidae) were relatively high, as they were for the majority of large fish families. Numbers of the commercially important coral trout species, *Plectropomus leopardus*, were low. In the damselfish community, there were large numbers of coral associated planktivores from the genera *Chromis* and *Neopomacentrus*. Numbers of the genus *Pomacentrus*, were driven by one highly abundant generalist species, *P. lepidogenys*. Similarly, the high abundance of the genus *Plectroglyphidodon* was driven by an algal affiliated species, *P. lacrymatus*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

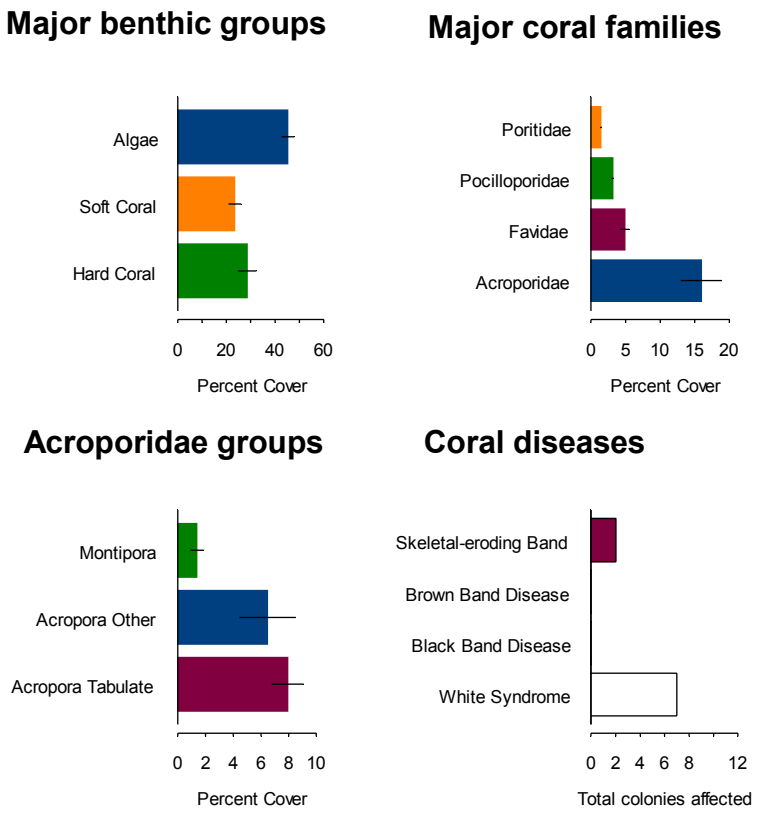
Figure 5.76





Moore Reef (No. 16-071) is a mid-shelf crescentic reef with an area of 26.5 sq.km.

Figure 5.76 (cont.)
Moore Reef was last surveyed in December 2005.



PEART

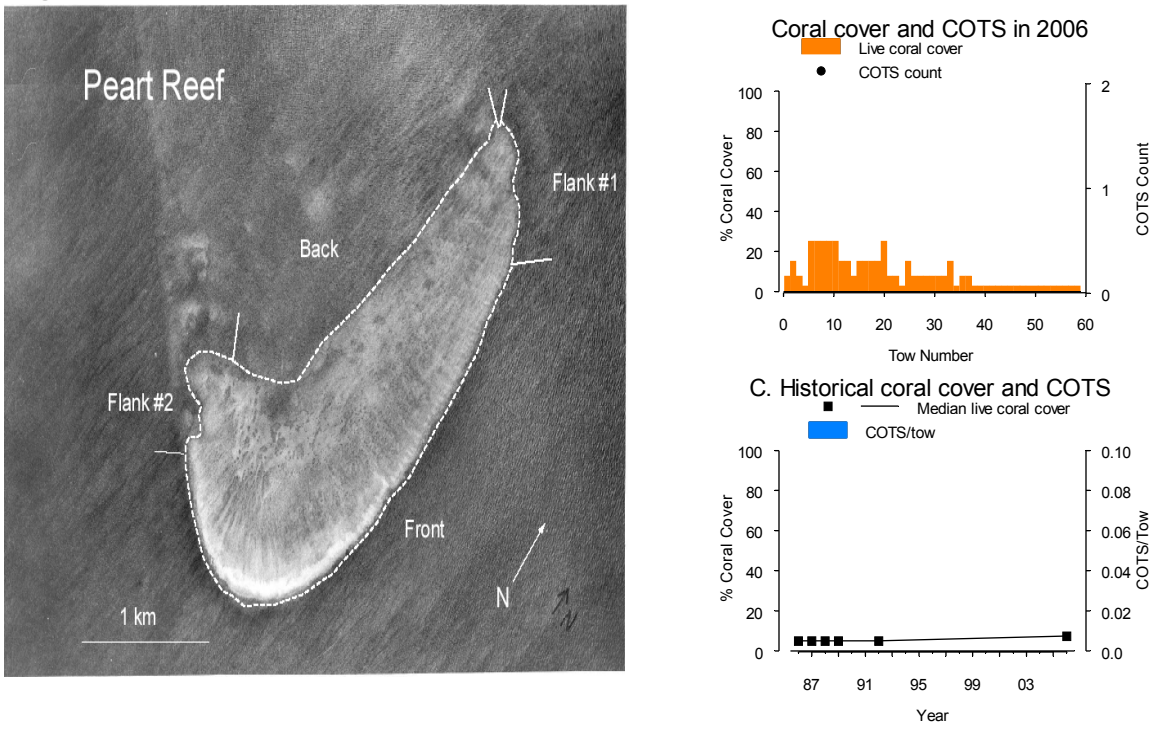
Peart Reef was first surveyed using manta tow in 1986, when it was classified as Recovering from prior COTS activity. It was then surveyed regularly up until 1992. Over this time there was little change in median reef-wide live coral cover. which was low. Surveys in 2006 indicated that coral cover remained low (6-10%). While little can be said about changes in coral cover in intervening years it is almost certain that, because Peart Reef is surrounded by reefs that have experienced COTS outbreaks in recent years, the low coral cover is a result of a recent COTS outbreak. No COTS, coral bleaching or signs of black band disease were observed during surveys in 2006. Signs of white syndrome were observed on a few scattered coral colonies on the front of the reef. Peart Reef remained classified as Recovering in 2006.

Intensive survey sites on Peart Reef were established in 2006. Hard coral cover was 13% with Acroporidae the most abundant family with 6% cover. Soft coral cover was 9% in 2006. Algae cover was 64% and was composed mostly of turf species with some *Halimeda* spp. and other macroalgae. Low coral cover is probably due to COTS predation during the last outbreaking period for the region (1997-2002). No coral diseases were recorded at the survey sites in 2006. *Drupella* spp. were not found during SCUBA search surveys.

The low coral cover at Peart Reef accounts for the low abundance of the butterflyfishes counted during the 2006 survey. Other large mobile fish families, such as the surgeonfishes (Acanthuridae), parrotfishes (Scaridae) and wrasses (Labridae), occurred in high abundances. Numbers of the commercially important species, the common coral trout, occurred in low numbers. Among the damselfishes, three genera, *Pomacentrus*, *Neopomacentrus* and *Amblyglyphidodon*, were highly abundant and constituted the majority of abundance for the family as a whole.

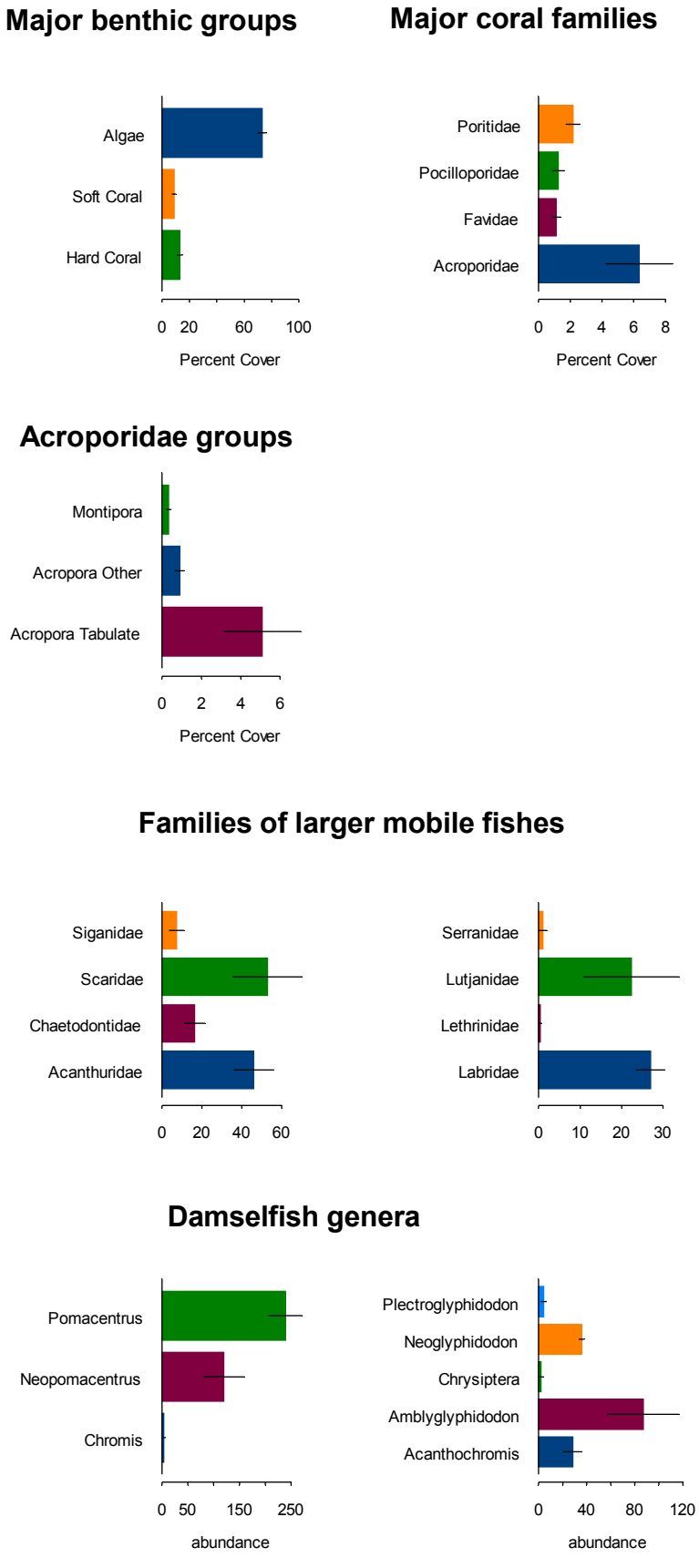
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.77



Peart Reef (No. 17-024) is a mid-shelf crescentic reef with an area of 16.2 sq.km.

Figure 5.77 (cont.)
Peart Reef was last surveyed in December 2005.



TAYLOR

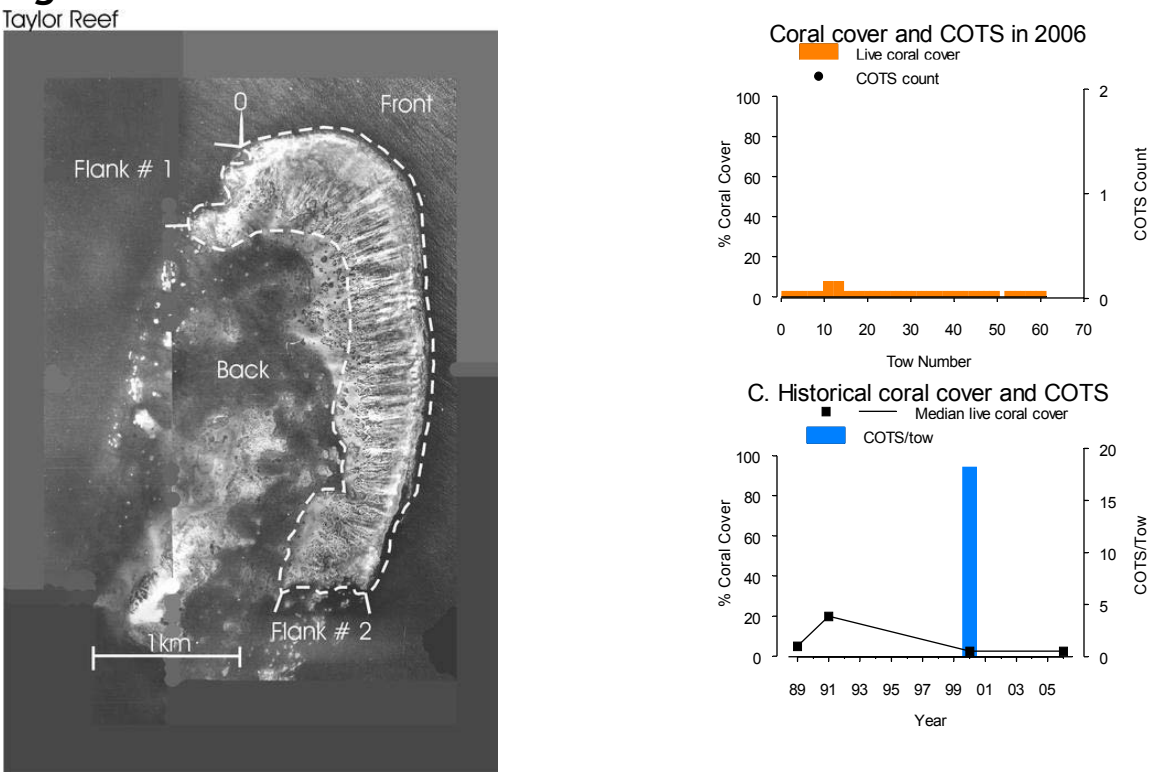
Taylor Reef has only been surveyed using manta tow four times since 1989, when it was initially classified as Recovering from previous COTS activity. While there were initial signs of coral recovery on Taylor Reef a lack of surveys make it difficult to determine the extent of this recovery. Surveys in 2000 indicated very large numbers of COTS and the reef was reclassified as an Active Outbreak. Surveys at that time showed a corresponding decline in reef wide coral cover from a moderate (21-30%) to a low (6-10%) level. Surveys in 2006 showed coral cover was very low (1-5%), though no COTS were observed and Taylor Reef was reclassified as Recovering. No bleaching or signs of coral disease were observed on this reef during surveys in 2006.

Intensive survey sites at Taylor Reef were established in 2006. Hard coral cover was very low (6%). LTMP surveys indicated that reefs in the Innisfail region had the lowest coral cover on GBR around 2000 due to COTS outbreaks. Other disturbances since then, including cyclones and bleaching, have inhibited recovery. Algal cover in 2006 was 72% and consisted mostly of turf species. Coralline algae contributed 12% to the benthic cover. Acroporidae was the most abundant hard coral family with 2% cover. In 2006 soft coral abundance was moderate (17%) with Xeniidae the most common family observed. White syndrome was found on one colony only and no other coral diseases were observed. There were no signs of *Drupella* spp. at the survey sites in 2006.

Four families of large mobile fishes, surgeonfishes (Acanthuridae), parrotfishes (Scaridae), wrasses (Labridae) and snappers (Lutjanidae) accounted for the majority of biomass recorded at Taylor Reef. The abundance of these families was generally attributed to high numbers of one or two dominant species, such as surgeonfishes of the genus *Ctenochaetus* spp and the parrotfishes *Scarus niger* and *Chlorurus sordidus*. Coral dependent species from the butterflyfish family (Chaetodontidae) were rare or absent and numbers of coral trout were also low. Of the damselfishes, the most prolific species were those generalist and planktivorous species not intimately associated with live coral, such as *Pomacentrus lepidogenys*, *P. wardi*, *Amblyglyphidodon* curacoa and *Neoglyphidodon nigroris*. Coral dependent species, such as many *Chromis* species and *Plectroglyphidodon dickii* were either recorded in very low numbers or were absent, reflecting the low levels of live coral cover on this reef.

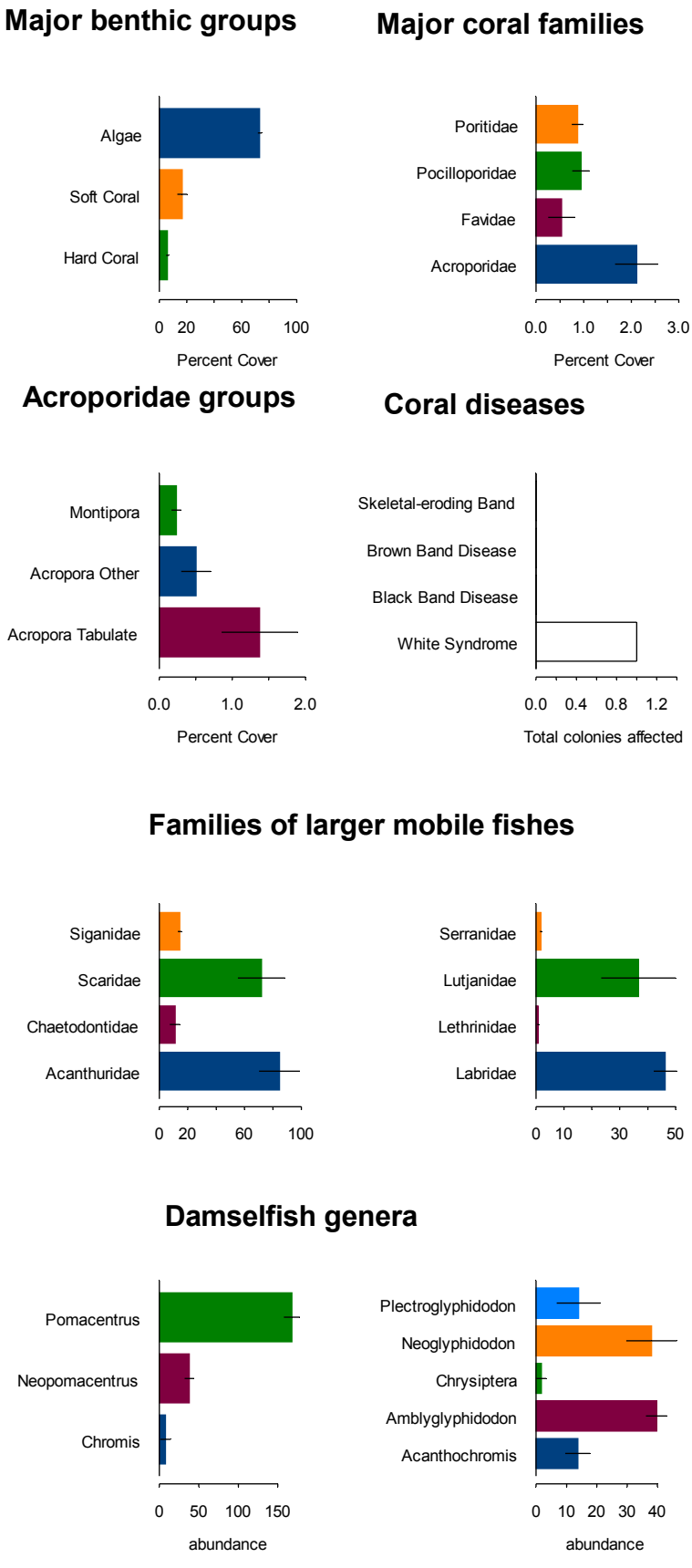
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.78



Taylor Reef (No. 17-064) is a mid-shelf crescentic reef with an area of 16.5 sq.km.

Figure 5.78 (cont.)
Taylor Reef was last surveyed in December 2005.

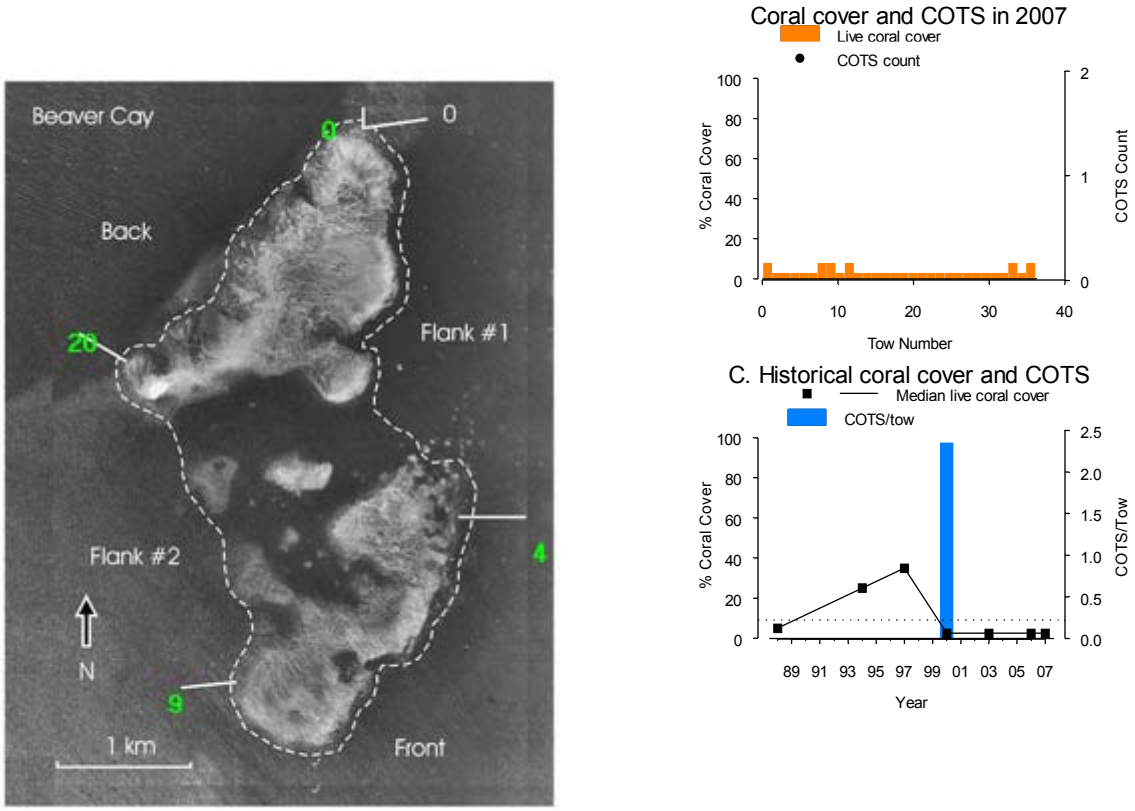


BEAVER

Beaver Cay Reef has been surveyed using manta tow seven times since 1988. When originally surveyed, median reef-wide live coral cover was low (1-10%) and the reef was classified as Recovering from previous COTS activity. Reef-wide live coral cover then increased to high levels (31-50%) by 1997. Surveys in 2000 indicated an Active Outbreak of COTS, with numbers well in excess of those expected to reduce coral cover. There was an associated marked decline in reef-wide live coral cover to a low (1-10%) level in 2000. In 2001 the reef was reclassified as Recovering. Surveys up to and including 2007 showed that coral cover persisted only at a very low (1-5%) level beyond 2000. No COTS were recorded and there were no signs of coral disease or bleaching in 2007. The reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.79



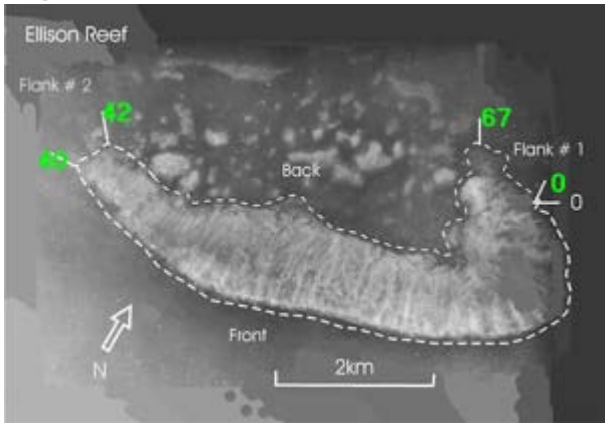
Beaver Cay Reef (No. 17-051) is a mid-shelf patch reef with an area of 12.6 sq.km.

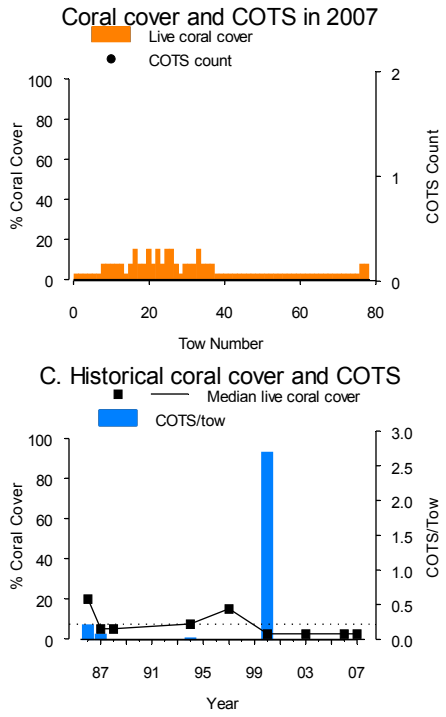
ELLISON

Ellison Reef has been surveyed using manta tow regularly since 1986. When first surveyed in 1986 median reef-wide live coral cover was moderate (11-30%) and small numbers of COTS were present. The reef was classified as Recovering from a prior COTS outbreak. Small numbers of COTS were seen again in 1987 and, although found in numbers below that expected to cause significant coral mortality, were considered responsible for a continued decline in reef-wide live coral cover to a low (1-10%) level. Reef-wide live coral cover increased beyond 1987, peaking in 1997 at moderate (11-30%) levels. Surveys in 2000 showed a dramatic increase in COTS activity and the reef was reclassified as an Active Outbreak. Reef-wide live coral cover declined again to a low level by 2003 due to COTS feeding activity and the reef was reclassified as Recovering. Surveys in 2007 showed that reef-wide coral cover remained very low (1-5%). Ellison Reed remained classified as Recovering in 2007. No bleaching or signs of black band disease were recorded. Signs of white syndrome disease were observed on small numbers of individual scattered colonies on the front and first flank of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.80





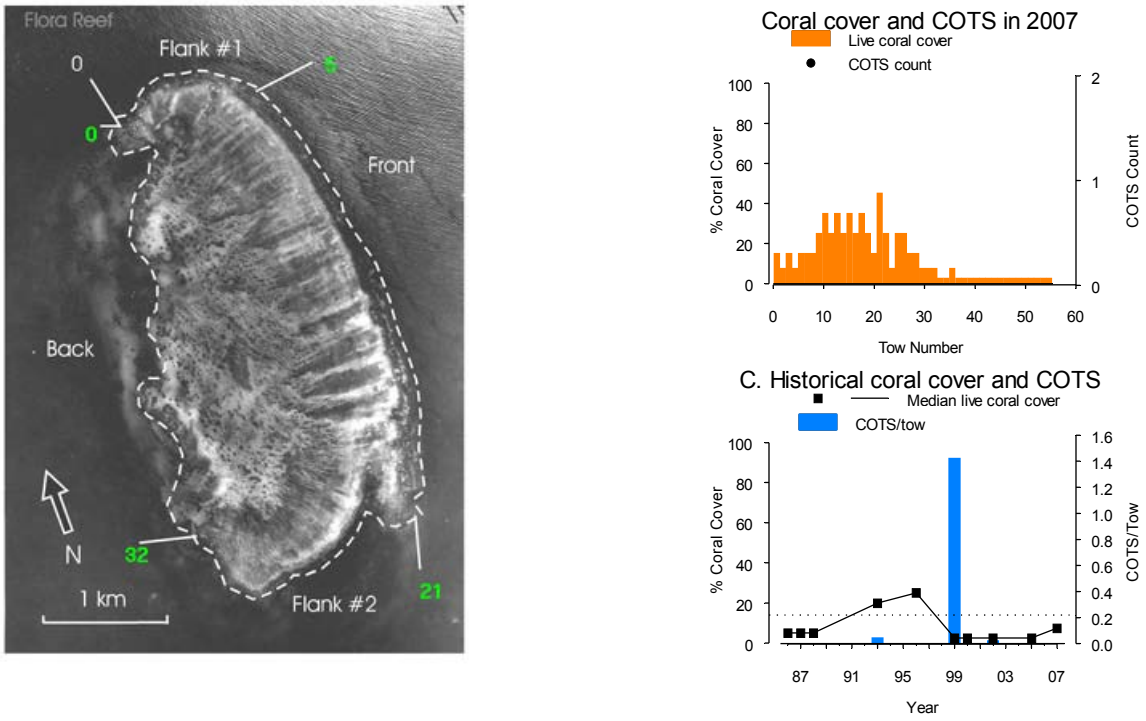
Ellison Reef (No. 17-044) is a mid-shelf crescentic reef with an area of 13.1 sq.km.

FLORA

Flora Reef has been surveyed using manta tow ten times since 1986, when it was classified as Recovering from prior COTS activity. Median reef-wide live coral cover was initially low (1-10%) and increased gradually to a moderate level (11-30%) by 1996. Surveys in 1999 found a decline in reef-wide live coral cover to a low level (1-10%). Large numbers of COTS were present at the time and Flora Reef was reclassified as an Active Outbreak. Although COTS certainly played an important role in the decline of live coral cover, bleaching, which was extensive on the GBR in 1998, may have also contributed. COTS in small numbers were last observed in 2002 when live coral cover was low and Flora Reef was classified as Recovering. No COTS were observed during surveys in 2007 and median reef-wide live coral cover remained low. No bleaching was observed and white syndrome disease was restricted to small numbers of scattered coral colonies on the back reef in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.81



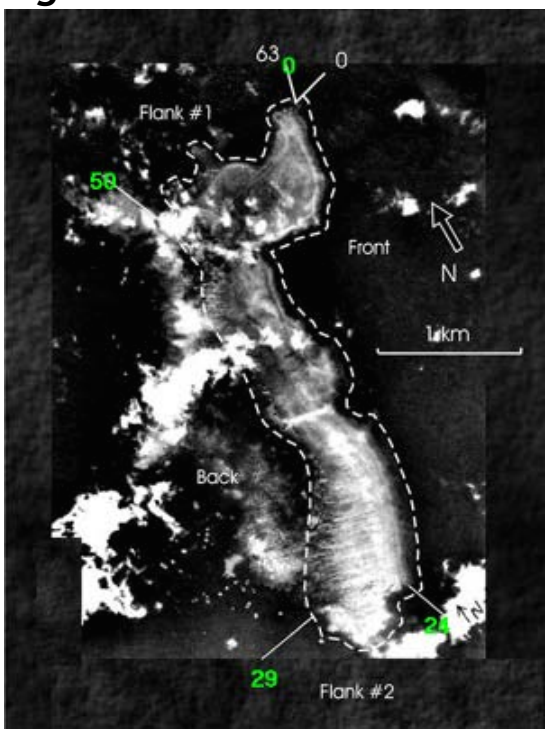
Flora Reef (No. 17-010) is a mid-shelf crescentic reef with an area of 8.79 sq.km.

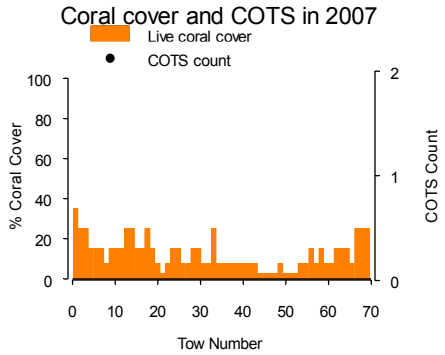
NOGGIN

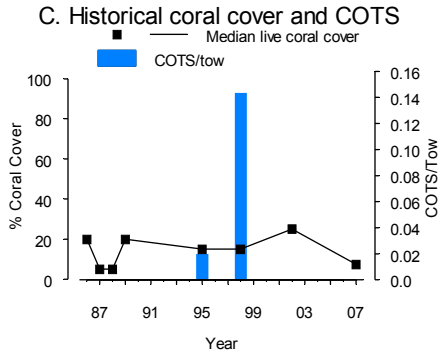
Noggin Reef has been surveyed using manta tow eight times since 1986. Median reef-wide live coral cover has generally remained moderate (11-30%) since 1989, except for a notable decrease to a low (6-10%) level between 2003 and 2007. COTS have been observed on this reef during two surveys (1995 and 1998). In both instances they were at low densities that should not have caused significant coral mortality. Reef-wide live coral cover declined to a low (1-10%) level between 2002 and 2007, possibly due to the effects of Cyclone Larry that passed through the region early in 2006. No bleaching or signs of black band disease were observed in 2007. Signs of white syndrome disease was restricted to a small number of scattered coral colonies on the front and back of the reef. Noggin Reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.82







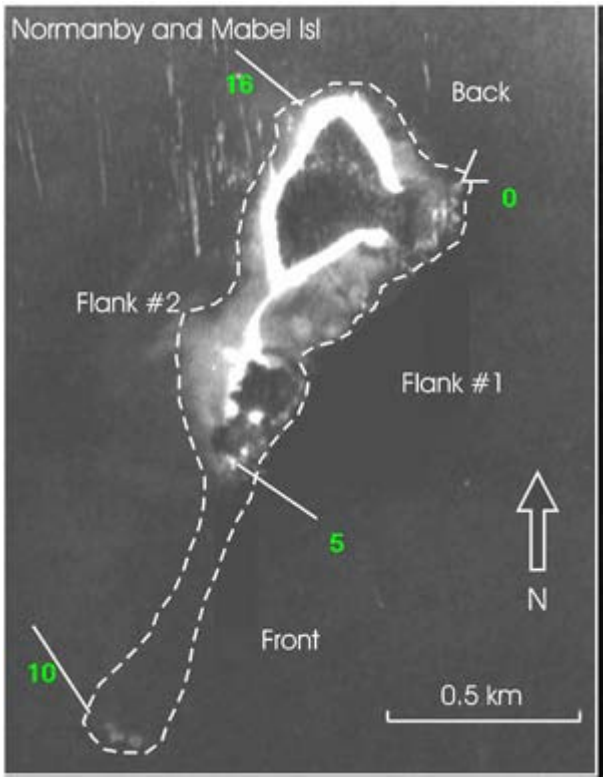
Noggin Reef (No. 17-008) is an outer shelf crescentic reef with an area of 9.2 sq.km.

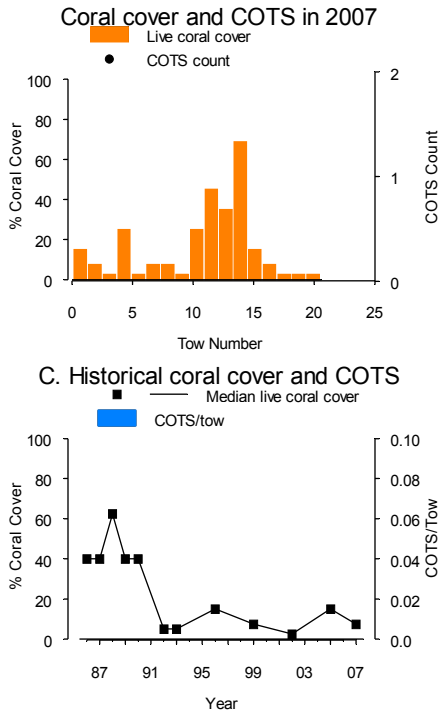
NORMANBY AND MABEL IS

Normanby and Mabel Is Reef has been surveyed using manta tow 12 times since 1986. No COTS have been recorded in any surveys. Median reef-wide live coral cover was initially high (31-50%) before a major decline between 1990 and 1992. The reasons for this drop in coral cover were uncertain but flooding and structural damage from Cyclone Ivor (March 1990) are likely factors. There was some recovery of reef-wide live coral cover up until 1996 before another period of decline, most likely driven by the 1998 coral bleaching event. Reef-wide live coral cover was low (1-10%) by 2002. Surveys in 2005 indicated that reef-wide live coral cover was at a moderate (11-20%) level and showing signs of recovery. Surveys in 2007 showed that the recovery in coral cover had stalled, most likely due to the effects of Cyclone Larry that passed through the region in 2006. Normanby and Mabel Is Reef remained classified as No Outbreak in 2007. No bleaching or disease was observed during surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.83





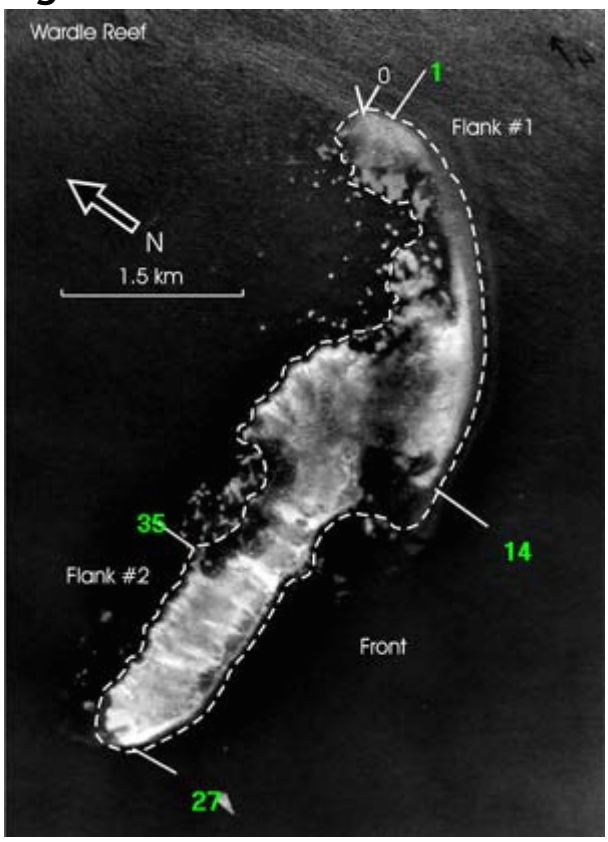
Normanby and Mabel Is Reef (No. 17-012) is an inshore submerged reef with an area of 0.4 sq.km.

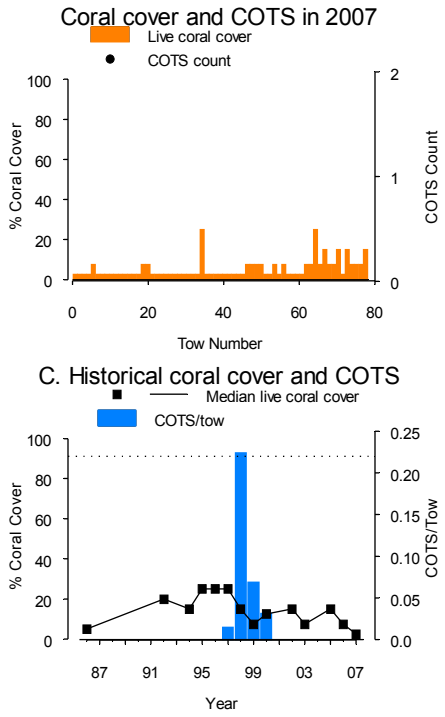
WARDLE

Wardle Reef has been surveyed using manta tow 14 times since 1986, when it was classified as Recovering from prior COTS activity. There was a gradual recovery of median reef-wide live coral cover to a moderate level (11-30%) by 1997. Incipient Outbreak levels of COTS were recorded in 1998, and by 1999 coral cover had declined to a low level (1-10%). COTS numbers had also declined and Wardle Reef was reclassified as Recovering. Reef-wide live coral cover had shown signs of recovery up until 2005, when it was at a moderate level. in recent years and was moderate by 2005. Surveys in 2007 indicated a decline in coral cover beyond 2005 to a low (1-10%) level, most likely due to the effects of Cyclone Larry that crossed the region in 2006. No COTS or coral bleaching were recorded in 2007. Wardle Reef remained classified as Recovering in 2007. Signs of white syndrome disease were restricted to small numbers of individual coral colonies on the back reef but were absent from other parts of the reef in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.84





Wardle Reef (No. 17-032) is an outer shelf crescentic reef with an area of 11.8 sq.km.

Townsville

Reef Pages

CENTIPEDE

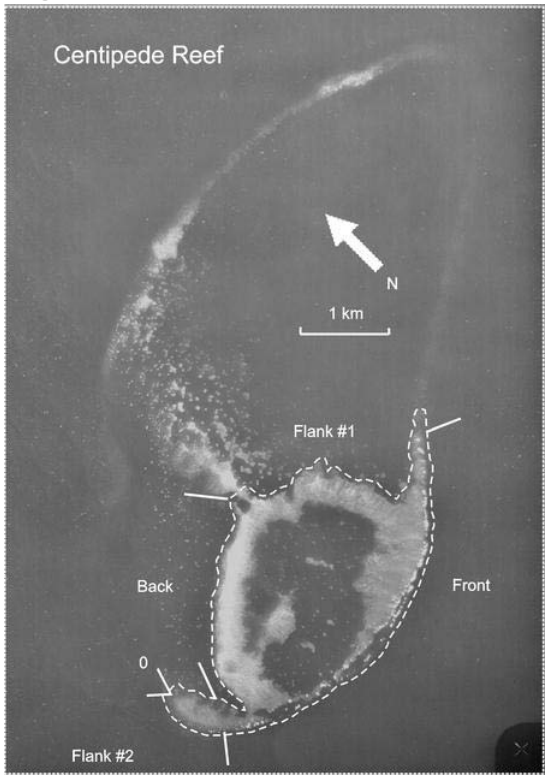
Centipede Reef has been surveyed using manta tow twelve times since 1986, when it was initially classified as No Outbreak. Incipient Outbreak levels of COTS were recorded on this reef in 1990. Elevated COTS activity was accompanied by a small drop in median reef-wide live coral cover from a moderate (11-30%) level in 1989 to a low (1-10%) level in 1990. Reef-wide live coral cover had returned to moderate levels by 1991 and the reef was reclassified as No Outbreak. The reef was surveyed again in 1992 and further surveys did not occur until 2002 and 2003. No COTS were detected during surveys between 1993 and 2003 and reef-wide live coral cover remained moderate (11-30%) in 2003. Surveys in 2006 showed an increase in COTS activity and the reef was classified as an Active Outbreak. Coral cover had declined on the reef to a very low (1-5%) level in 2006.

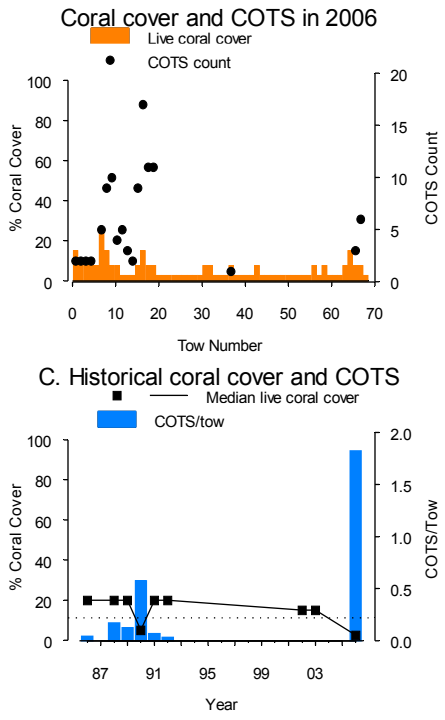
Intensive survey sites on Centipede Reef were first established in 2006. In the initial surveys, algae was the dominant benthic group, with 81% cover. Turf algae, *Halimeda* spp. and coralline algae were the primary constituents of the algal community with 59%, 12% and 6% cover respectively. Hard coral cover was recorded at a moderate level of 12%. Poritidae was the dominant hard coral family with an average cover of 4%. Acroporidae had the lowest cover of the four major coral families at 1%. This may reflect feeding activity by COTS, which typically favour the various forms of *Acropora* spp. While a SCUBA search survey, which includes a search for COTS, was carried out at Centipede Reef in 2006, manta tow data indicated that Centipede Reef had an active outbreak of COTS in 2006. Soft coral cover was very low at 2%.

Reefs with coral cover around 10% or less often house low numbers of certain fish taxa due to limitations in key habitat and/or food supplies. Therefore, the hard coral cover of 12% at this reef, probably accounts for the relatively low numbers of the often coral dependent Chaetodontidae and *Chromis* spp. Herbivorous fishes (Acanthuridae and Scaridae) dominated the large mobile fish community, possibly due to the dominance of a major food item (turf algae) in the benthic community. Abundances of *Pomacentrus* spp. and *Neopomacentrus* spp. were high and driven largely by *P. lepidogenys* and N. *azysron* respectively; two damselfish species that are often very abundant on mid-shelf reefs in the Townsville sector.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

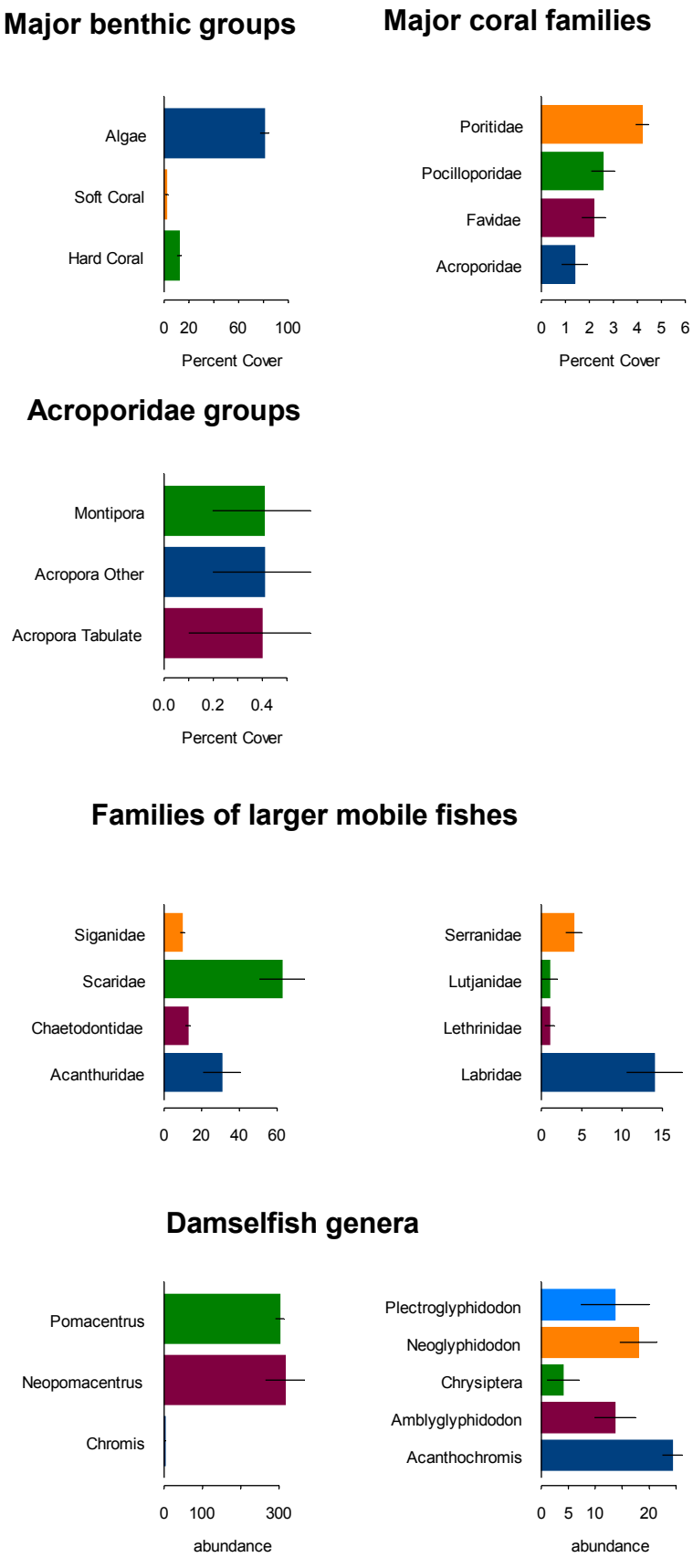
Figure 5.85





Centipede Reef (No. 18-088) is a mid-shelf crescentic reef with an area of 27.5 sq.km.

Figure 5.85 (cont.)
Centipede Reef was last surveyed in September 2006.



CHICKEN

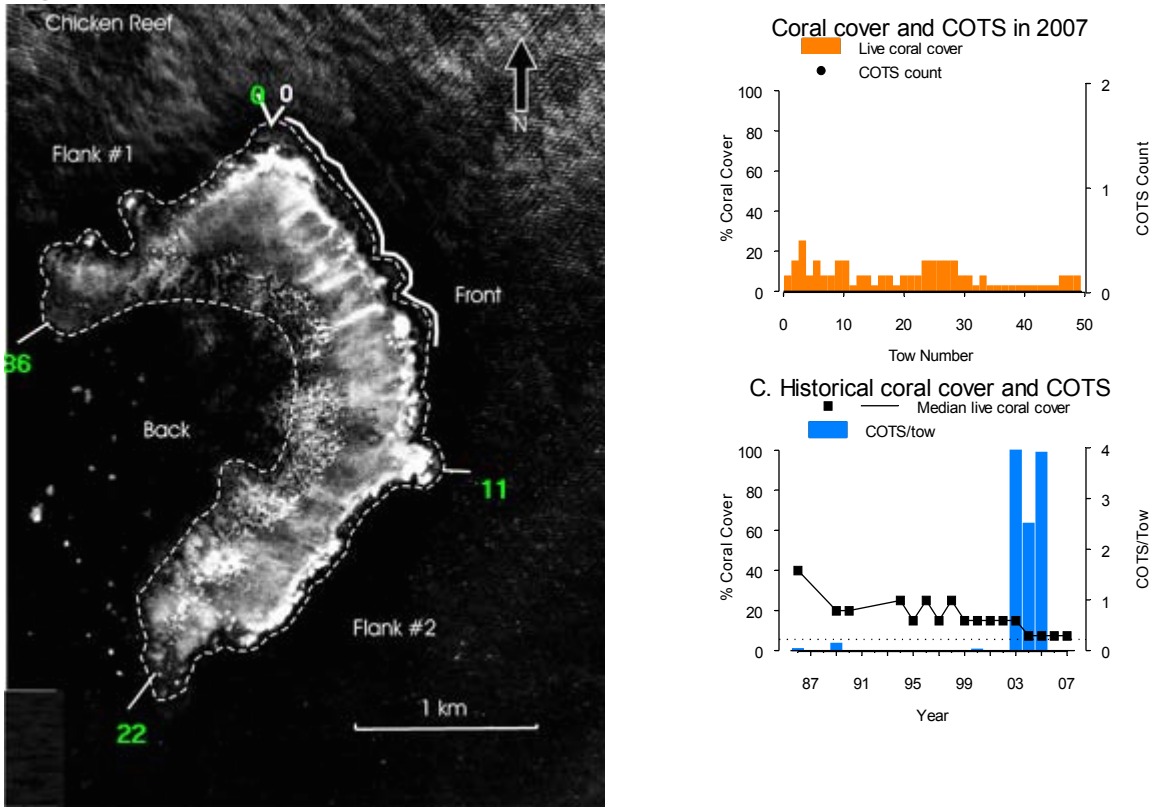
Chicken Reef has been surveyed using manta tow 16 times since 1986. Median reef-wide live coral cover was initially high (31-50%) but dropped to a moderate level in 1989, possibly due to COTS feeding activity. Reef-wide live coral cover remained stable at moderate levels (11-30%) between 1989 and 2003. COTS numbers increased sharply in 2003 when the reef was classified as an Active Outbreak. COTS numbers remained above outbreak levels through to 2005 and there was a corresponding decline in reef-wide live coral cover to a low level (6-10%). In 2006 Chicken Reef was reclassified as Recovering. No COTS, coral bleaching or signs of disease were observed during surveys in 2007. Reef-wide live coral cover was low and the reef remained classified as Recovering in 2007.

Hard coral cover increased from 30% in 1994 when intensive surveys began to 42% in 1999. Hard coral cover was reduced to 38% in 2000 (possibly due to Cyclone Tessi), and decreased further to 13% in 2004 as a result of feeding activity by COTS. Hard coral cover remained stable at 13% from 2004 through to 2007. The observed changes in hard coral cover until 2004 are mostly due to losses of *Acropora* spp. but are also evident in Faviidae and Pocilloporidae. Algae cover has changed inversely with coral cover throughout the survey period. In 1994 algae cover was 57%, then it declined to 41% in 1999, increased to 75% in 2004 and was 72% in 2007. The soft coral community has been stable over the survey period and was 12% in 2007. In 2003 adolescent COTS were recorded at a density of 220/ha and adult COTS at 387/ha. Juvenile COTS were seen at very low densities, with 6/ha recorded in 2006 and 20/ha recorded in 2007. *Drupella* spp. were recorded at 13/ha. in 2006 and 2007. White syndrome was rare in 2006 and 2007 surveys.

There have been few consistent trends in abundance of most reef fish taxa and inter-annual variability was often high. A number of species have contributed to increases in abundance of the herbivorous Scaridae since 2002 resulting in maximum numbers in 2007. These changes coincided with increases in cover of turf algae as coral cover declined. Abundances of *Chrysiptera* spp. (driven mostly by *C. rex*) had decreased up to 2005 but had begun to recover in 2007 despite coral cover remaining low.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

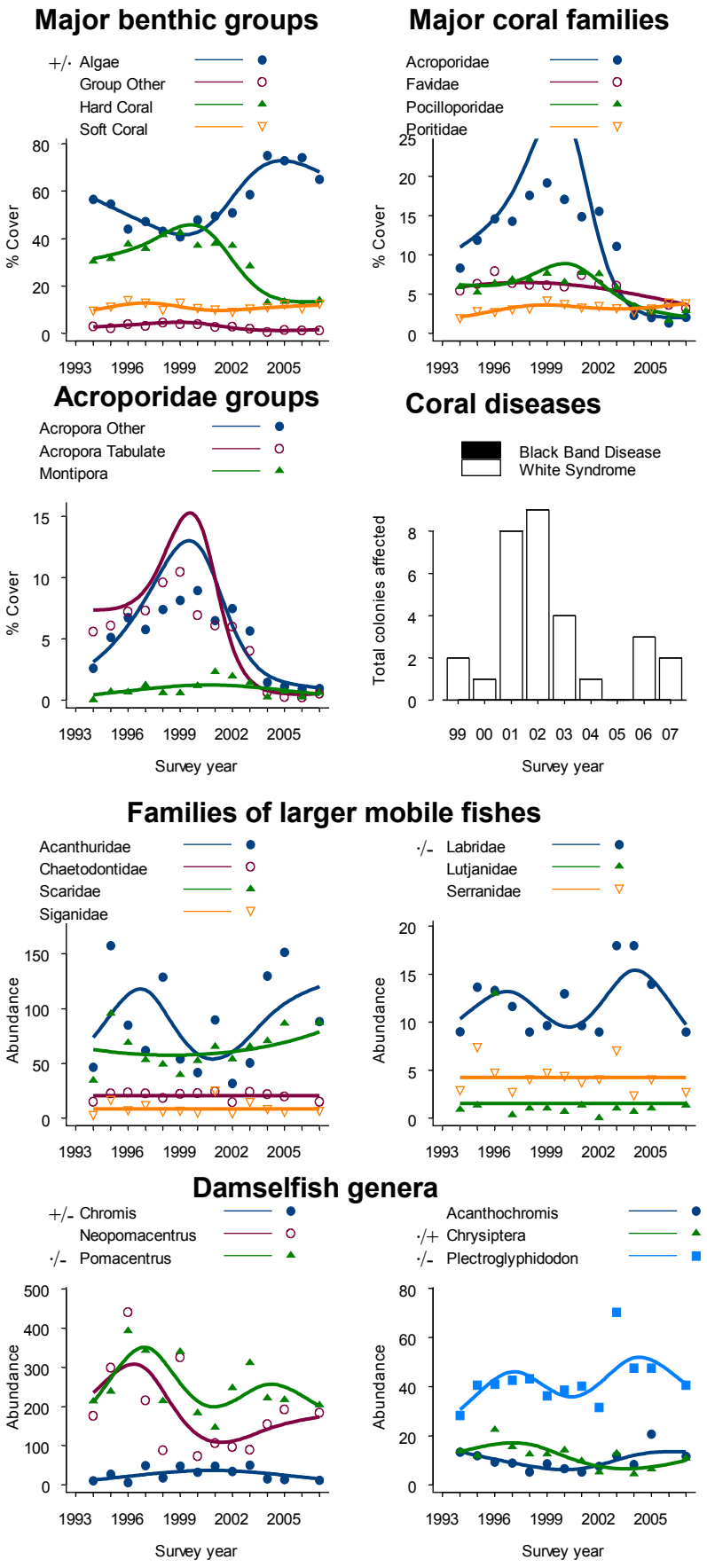
Figure 5.86



Chicken Reef (No. 18-086) is an outer shelf crescentic reef with an area of 3.8 sq.km.

Figure 5.86 (cont.)

Chicken Reef was last surveyed in May 2007.



DAVIES

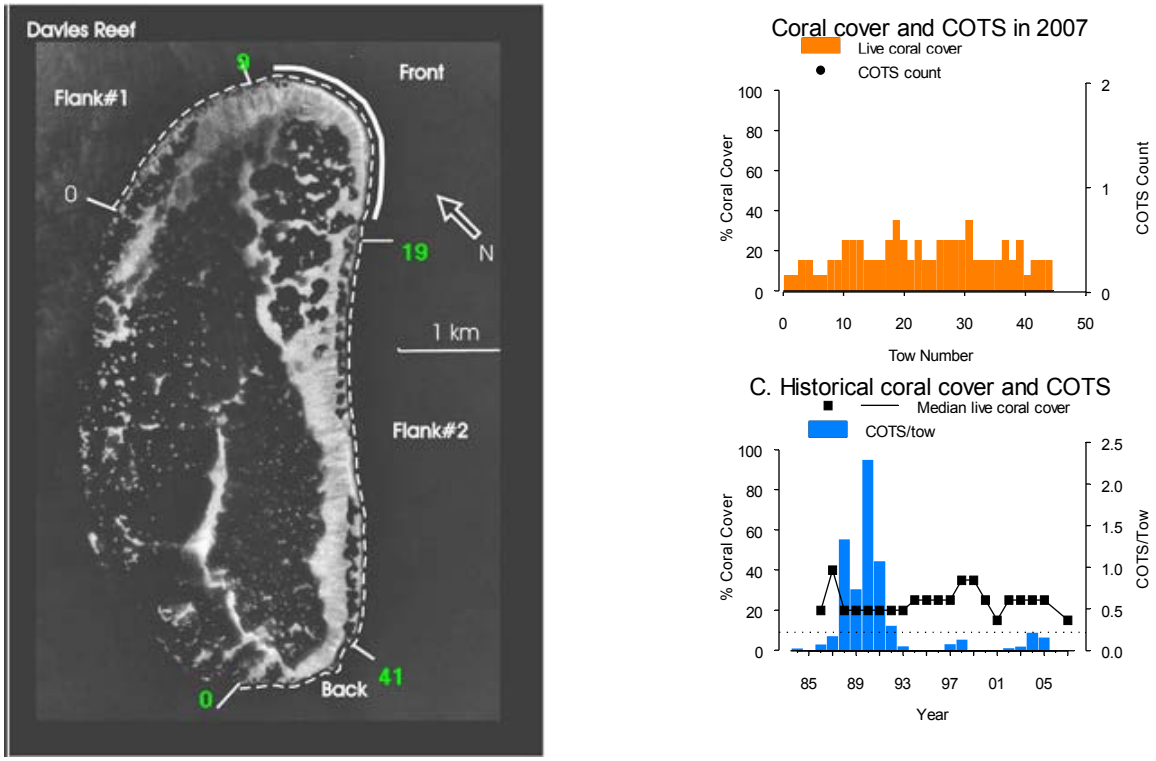
Davies Reef has been surveyed extensively using manta tow since 1986, when it was originally classified as No Outbreak. Median reef-wide live coral cover was high (41-50%) in 1987. In 1988 COTS numbers increased and the reef was classified as an Active Outbreak. Reef-wide coral cover correspondingly had dropped to a moderate (11-30%) level. COTS numbers subsequently peaked in 1990 and had declined by 1993 when the reef was reclassified as Recovering. Despite decreased numbers of COTS, median reef-wide live coral cover remained moderate and it was not until 1998 that there was a noticeable increase to a high level (31-50%). Small numbers of COTS were observed in 1997 and 1998 but well below levels that should affect reef-wide live coral cover. Coral cover declined between 1999 and 2001 to a moderate level (11-30%) that persisted through to 2004. There was an increase in COTS activity between 2002 and 2005, which contributed to the small decline in reef-wide live coral cover to a moderate (11-20%) level in 2007. No COTS or signs of coral disease were recorded during surveys in 2007. The reef remained classified as Recovering.

Intensive coral surveys since 1993 showed that coral cover increased from 24% in 1993 to 41% by 1999. Beyond 1999 coral cover consistently decreased reaching a moderate cover of 27% in 2007. The decline in hard coral is likely to be a result of multiple low level disturbances associated with COTS, bleaching and cyclones. Soft coral cover has not changed over the survey period and was below 2% in 2007. Algae cover was high in 2007 at 64%. The algal community was comprised of turf algae (32%), *Halimeda* spp. (13%), other macro-algae (12%) and coralline algae (7%). White syndrome disease was rare in 2007. *Drupella* spp. were recorded at a density of 33/ha.

Reef fish abundances over the survey period were often relatively stable or tended to increase from around 2002. Abundances of Scaridae, Serranidae, *Neopomacentrus* spp., *Chromis* spp., *Amblyglyphidodon* spp. and *Acanthochromis* spp. had increased to 15 year highs when surveyed in 2007. Key species driving these increases included *Scarus rivulatus*. *Plectropomus leopardus*, *Neopomacentrus azysron*, *Chromis atripectoralis*, *Amblyglyphidodon curacao* and *Acanthochromis polyacanthus*. Only one taxon, *Chrysiptera* spp., showed major declines in abundance. Abundances of both *C. rollandi* and *C. talboti* had decreased since 2005 to be at 16 year lows in 2007. The reason for decreases in these small reef associated damselfishes is unknown as most benthic variables had been stable between 2005 and 2007.

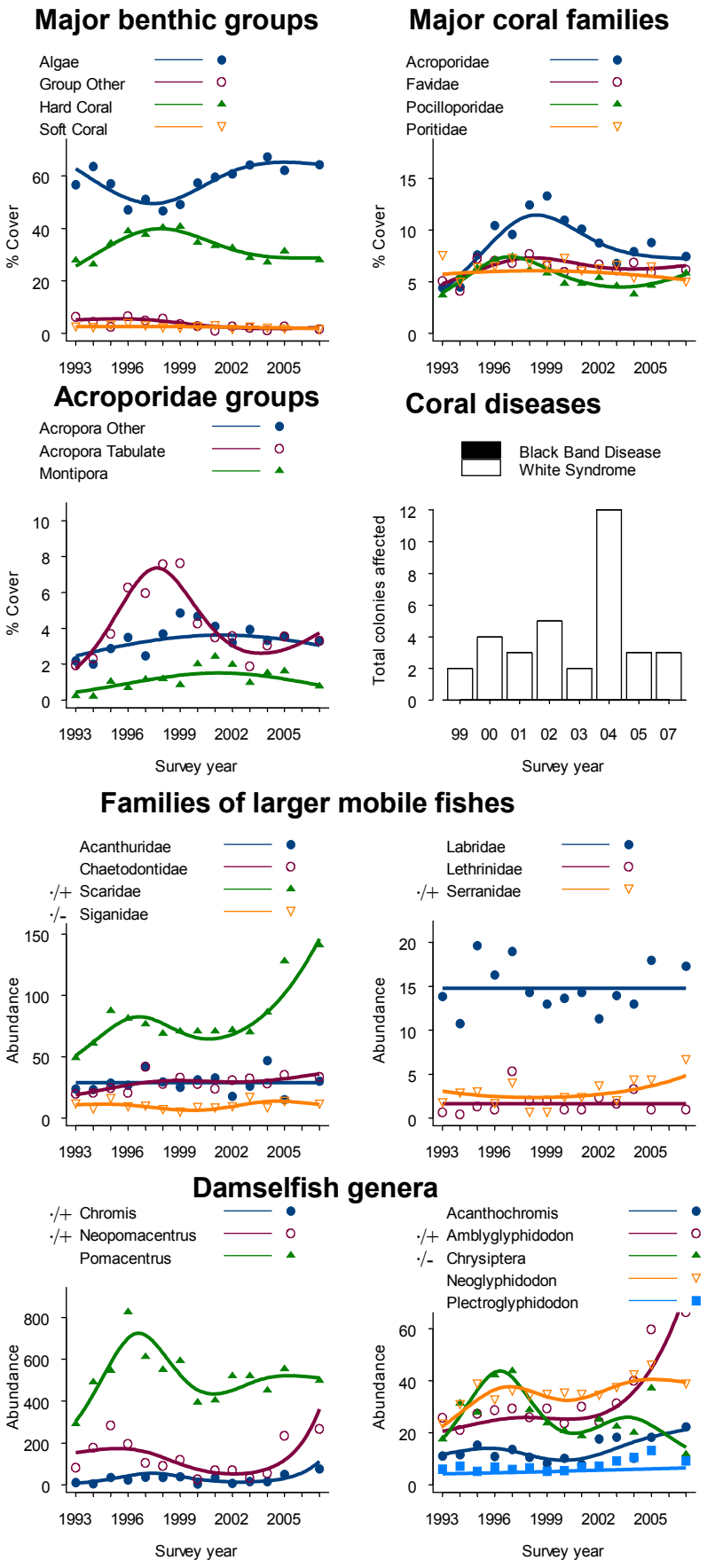
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.87



Davies Reef (No. 18-096) is a mid-shelf lagoonal reef with an area of 13.8 sq.km.

Figure 5.87 (cont.)
Davies Reef was last surveyed in May 2007.



DIP

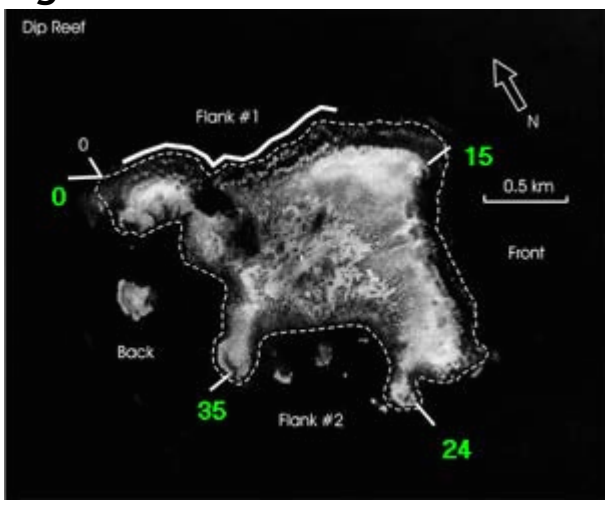
Dip Reef has been surveyed using manta tow regularly since 1984, when it was classified as No Outbreak. Subsequently, high COTS densities were seen in 1986 and the reef was reclassified as Active Outbreak. Dip Reef was reclassified as Recovering in 1988 following a decline in COTS numbers. Median reef-wide live coral cover was dramatically reduced from a high (31-50%) level to a low (1-10%) level as a result of COTS activity between 1986 and 1988. Beyond 1988 median reef-wide live coral cover increased reaching a moderate (11-30%) level by 1993 that persisted through to 2007. No COTS had been observed on this reef since 1986, however, Dip Reef remained classified as Recovering in 2007 because coral cover had not returned to those levels observed prior to the initial COTS outbreak in 1986. No signs of bleaching or black band disease were observed during surveys in 2007. Signs of white syndrome were restricted to a few scattered colonies on the front and southern flank of the reef.

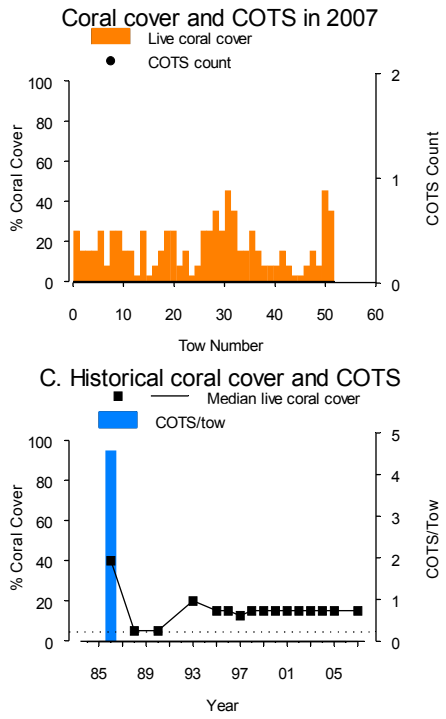
On the intensive survey sites the hard coral community was relatively stable, varying between 25% and 29% cover between 1993 and 2005. In 2007 hard coral cover decreased to 19%. The family Acroporidae included a relatively high cover of *Isopora* spp. The decrease in tabulate *Acropora* spp. in 1997, 2000 and 2007 is likely to be due to Cyclones Justin, Tessi and Larry respectively. The soft coral and algal communities were relatively stable over the survey period. No *Drupella* spp. were observed in 2007. Very low levels of white syndrome have been recorded during all surveys since 1999.

Abundances of large mobile fishes often fluctuated from year to year but with no temporal trend. Conversely, for three major damselfish genera, *Pomacentrus*, *Chromis* and *Neopomacentrus*, abundances had declined, reaching (or coming close to) 16 year lows when surveyed in 2007. These changes were most strongly driven by *Pomacentrus lepidogenys*, *Chromis margaritifer* and *Neopomacentrus azysron*. Reasons for these declines are unclear as major benthic variables did not change significantly over the same time period. Low recruitment is one possible explanation.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

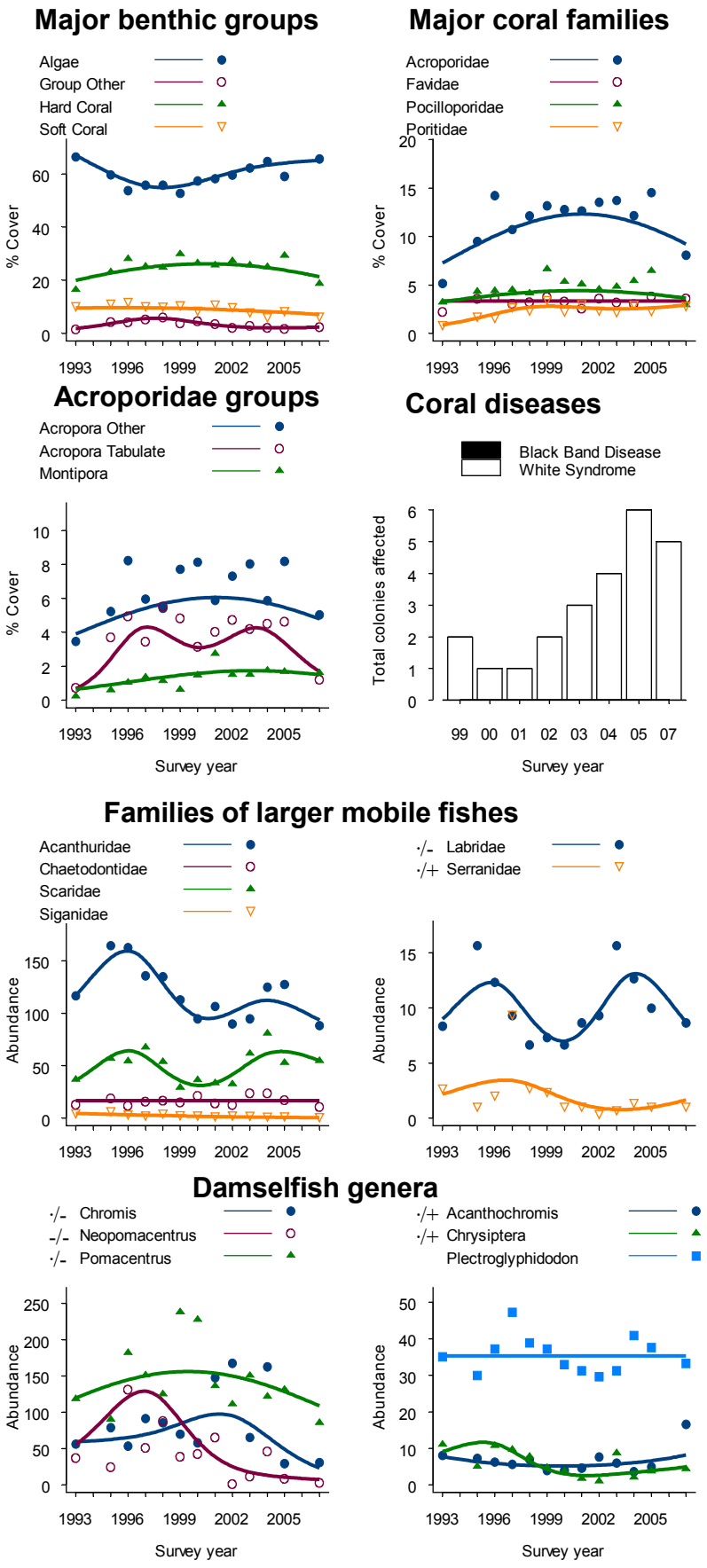
Figure 5.88





Dip Reef (No. 18-039) is an outer shelf crescentic reef with an area of 5.6 sq.km.

Figure 5.88 (cont.)
Dip Reef was last surveyed in May 2007.



FORE AND AFT

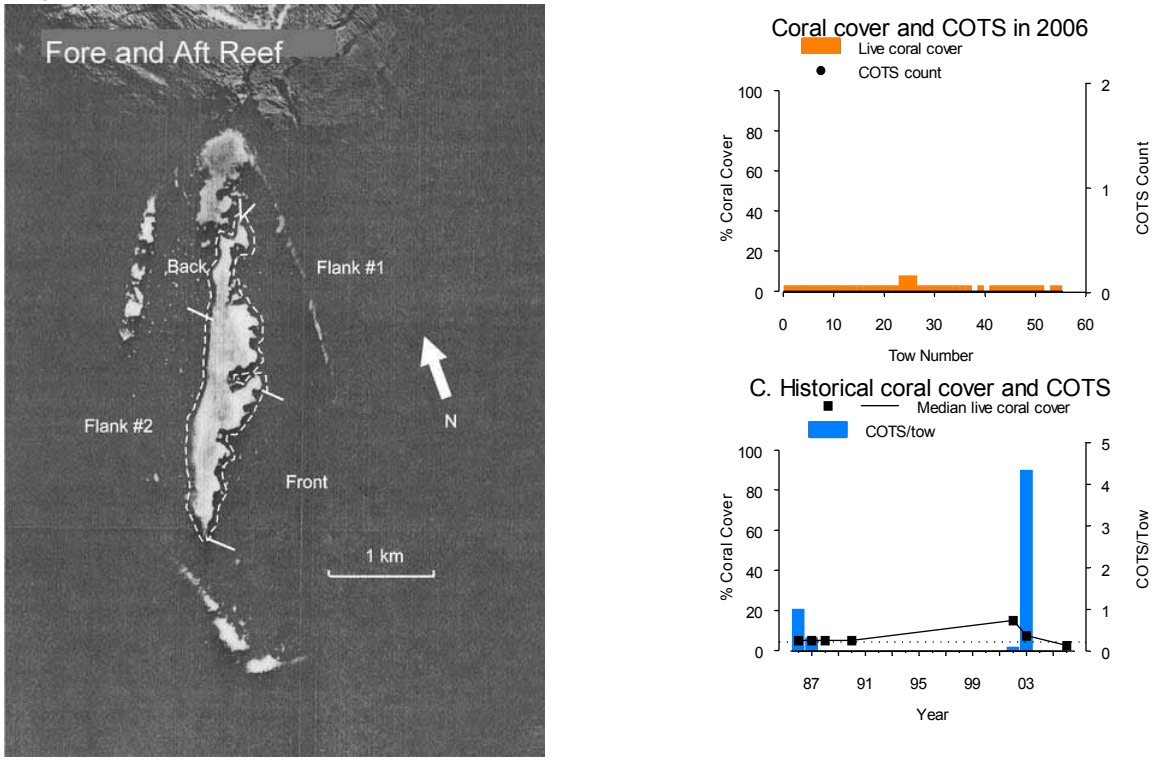
Fore and Aft Reef has been surveyed using manta tow seven times since 1986, with a large gap between the 1990 and 2002 surveys. Initial surveys revealed a large COTS population and the reef was classified as Active Outbreak. Median reef-wide live coral cover at this time was low (1-10%), presumably as a result of COTS feeding activity. No COTS were observed in 1988 and the reef was reclassified as Recovering. Subsequent surveys up to and including 2002 showed only a small recovery in median reef-wide live coral cover to a moderate (11-20%) level. Surveys in 2003 indicated a large increase in COTS numbers and the reef was reclassified as Active Outbreak. There was a corresponding decline in reef-wide live coral cover to a low level (1-10%). Surveys in 2006 indicated reef wide live coral cover on this reef was very low (1-5%). No COTS were observed in 2006 and the reef was reclassified as Recovering. No bleaching or signs of coral disease were recorded during surveys in 2006.

In 2006, the first year of intensive surveys, algae dominated the survey sites at Fore and Aft Reef with a cover of 78%. The dominant algae group was turf algae with 60% cover, followed by coralline algae and *Halimeda* spp., with 6% and 5% cover respectively. Sand constituted 10% of the benthic cover at the survey sites. Hard coral cover was a low 5% and soft coral cover was 3%. Poritidae was the dominant hard coral family with 2% cover. Pocilloporidae accounted for 1% of the benthic cover, while Faviidae and Acroporidae contributed less than 1% to the benthic cover. Sponges covered 2% of the benthos. No diseased colonies were recorded in 2007. There were no signs of bleaching at the survey sites. No *Drupella* spp. were found at the intensive survey sites, nor were any COTS.

In 2006, the benthic community was dominated by turfing algae, with hard coral cover very low. This is reflected in the abundance of large mobile fish families, with the herbivorous families Scaridae and Acanthuridae highly abundant. Three species of Acanthuridae, *Ctenochaetus* spp., *Acanthurus nigrofuscus* and *A. lineatus*, drove these patterns. Two species of Scaridae, *Scarus chameleon* and *Chlorurus sordidus*, accounted for the majority of the abundance. Numbers of the coral affiliated Chaetodontidae were generally low. Within this group the highest abundance was observed in two species of generalist coral feeders, *Chaetodon trifasciatus* and *C. rainfordi*. The only other large fish family of high abundance was the Labridae (wrasses), whose numbers were dominated by *Hemigymnus fasciatus*, a generalist invertebrate feeder. The damselfish community was dominated by two species, *Pomacentrus lepidogenys* and *P. wardi*, both of which are generalist feeders. All coral associated damselfishes, like *Plectroglyphidodon dickii*, *Pomacentrus moluccensis* and *Chromis* spp, were either absent from the surveys or were found in very low numbers.

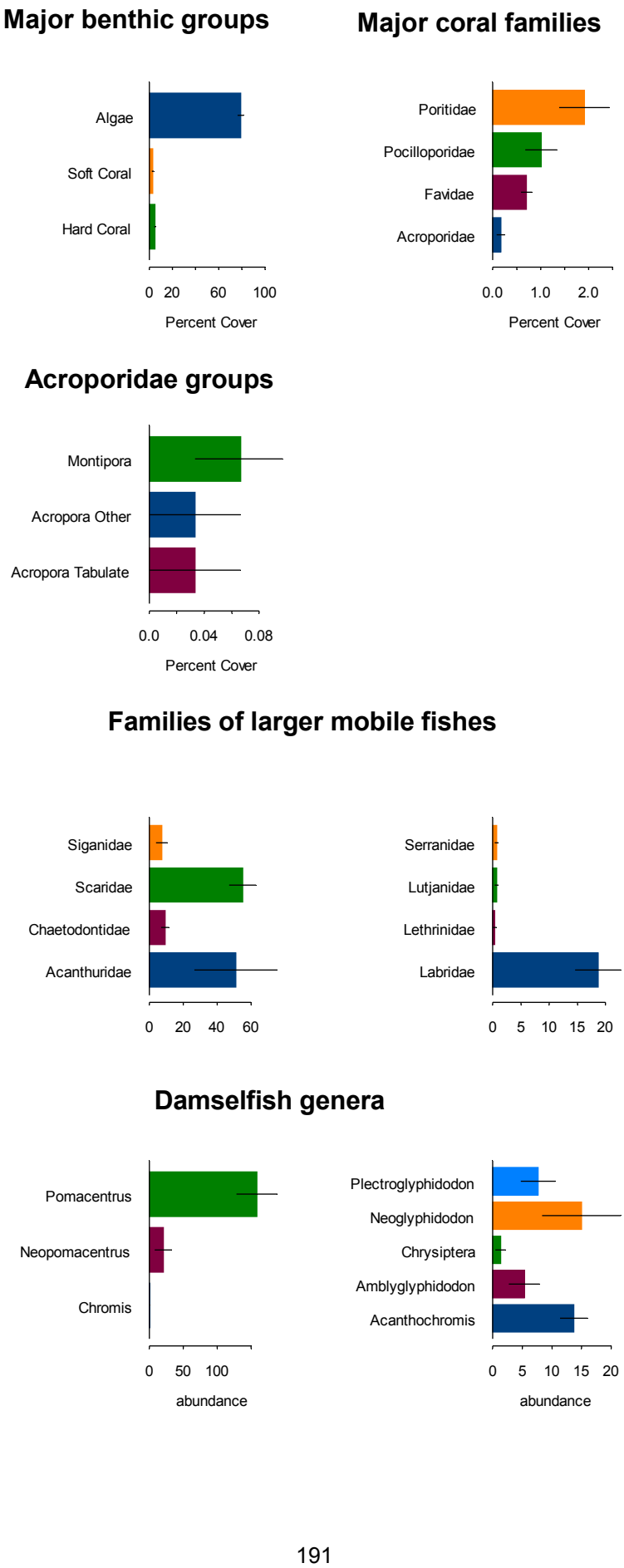
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.89



Fore and Aft Reef (No. 18-043) is a mid-shelf patch reef with an area of 19.4 sq.km.

Figure 5.89 (cont.)
Fore and Aft Reef was last surveyed in July 2006.



FORK

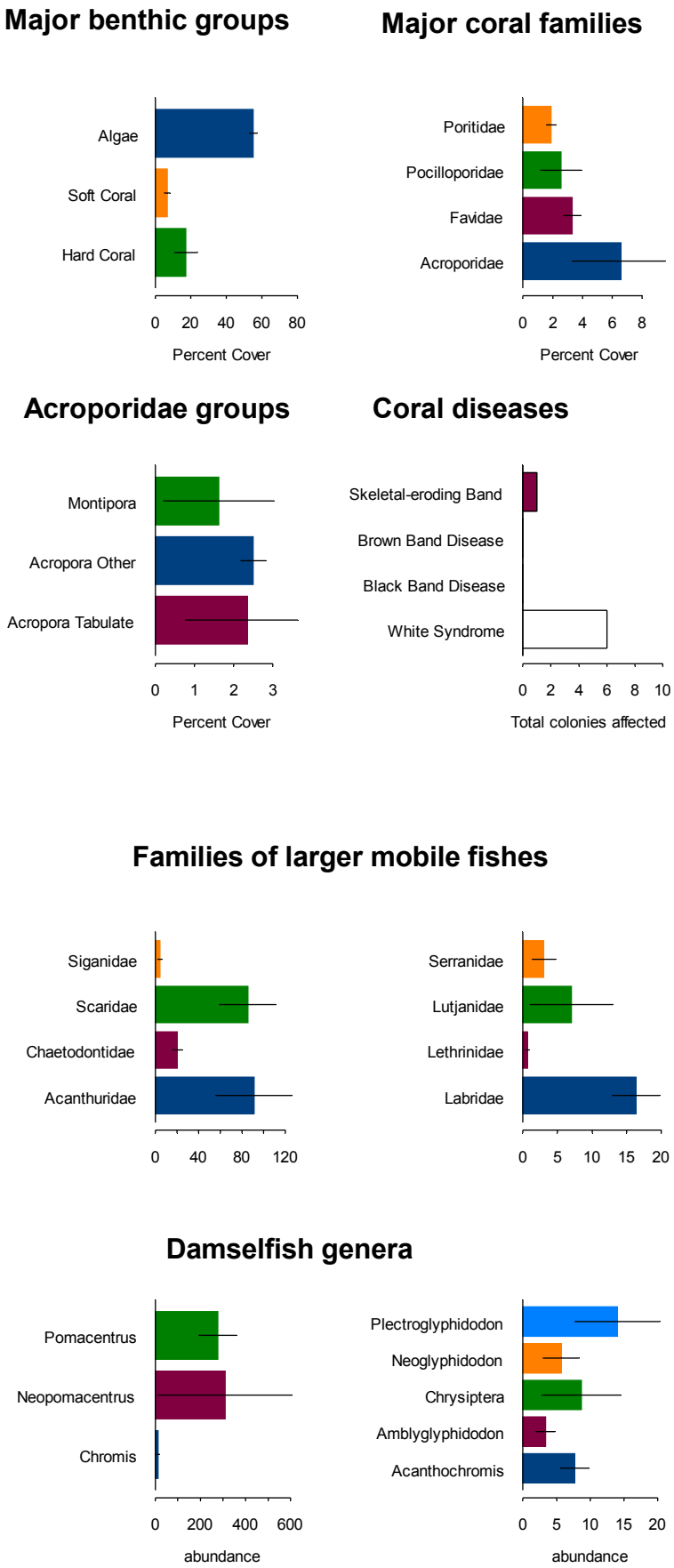
Fork Reef was surveyed using manta tow three times between 1987 and 1990. Coral cover was low (1-10%) over this time period. The small numbers of COTS recorded in 1987 were considered to be remnants of a much larger outbreaking population and the reef was classified as Recovering. Although the LTMP conducted SCUBA surveys at intensive survey sites on this reef in 2006, the reef could not be surveyed using manta tow due to strong winds and high seas.

2006 was the first year that intensive surveys were carried out at fixed sites on Fork Reef. Algae was the dominant benthic group with 54% cover. The algal community was primarily comprised of turf algae (43%) and coralline algae (8%). A large portion of the benthic cover at the survey sites was sand (20% cover) because two of the three survey sites were established on the more protected back reef area due to difficult working conditions on the north-east flank. Average hard coral cover was moderate at 16%, although it varied greatly among sites with relatively high cover on the north east flank site compared to the back reef sites. The hard coral community was dominated by the Acroporidae family with 6% cover. Soft coral cover was low at 6%. A small number of colonies affected by white syndrome were observed along with one colony affected by skeletal eroding band disease (SEB). The corallivorous snail *Drupella* spp. were found at a density of 40/ha during surveys in 2006.

The large mobile fish community was dominated by three families, Acanthuridae, Scaridae and Labridae. The first two are herbivorous/detritivorous families, and the Labridae are generalist benthic feeders. This reflects the generally low levels of hard coral cover recorded at this reef, and explains the low abundance of the coral affiliated Chaetodontidae. Of the damselfishes, two genera accounted for the majority of abundance within the family, *Pomacentrus* spp. and *Neopomacentrus* spp.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.90
Fork Reef was last surveyed in July 2006.



GRUB

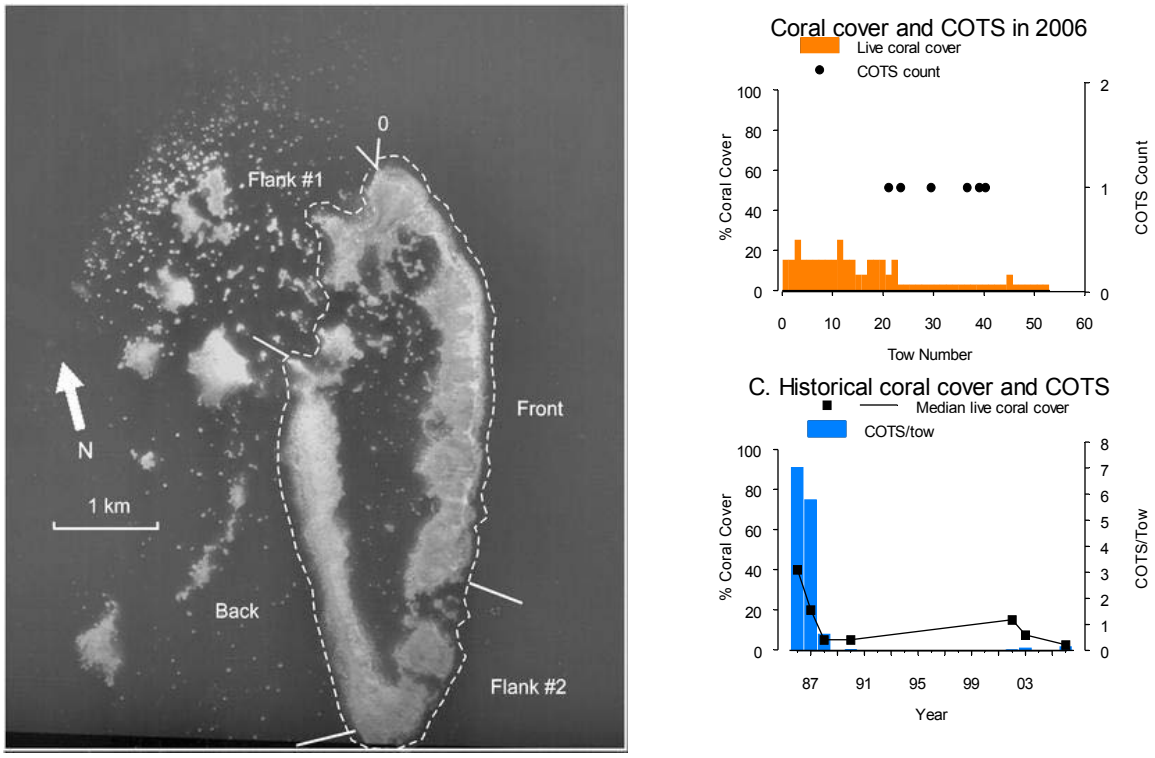
Grub Reef has been surveyed using manta tow eight times since 1986, when it was first classified as an Active Outbreak. COTS numbers remained at outbreak levels on this reef through to 1988. Elevated COTS populations were matched by a corresponding decline in median reef-wide live coral cover from a high (31-50%) level recorded in 1986 to a low level (1-10%) recorded in 1987. The reef was reclassified as Recovering in 1990. No surveys were conducted on this reef between 1990 and 2002. Surveys in 2002 indicated some recovery in median reef-wide live coral cover to a moderate (11-30%) level. Surveys in 2003 revealed small numbers of COTS on this reef but below outbreak levels and median reef-wide live coral cover was low (1-10%). Residual numbers of COTS were observed in 2006 and reef-wide live coral cover continued to decline to a very low (1-5%) level. COTS numbers recorded on this reef since 2003 have been well below numbers normally expected to influence reef-wide coral cover, however, given the already low coral cover on this reef, it is highly likely that COTS feeding activity has influenced the coral cover patterns observed. No bleaching or signs of coral disease were recorded during surveys in 2006. Grub Reef remained classified as Recovering in 2006.

Intensive surveys at fixed sites were carried out at Grub Reef for the first time in 2006. The surveys indicated that Grub Reef was dominated by algae (61% cover), particularly turf algae, which constituted 55% of the benthic cover. Sand, the next major contributing benthic group following algae, accounted for 18% of the benthic cover. Sites were set up in comparable locations to those of the paired reef (Fork Reef), with two sites situated on the more protected back reef area. One of these sites covered a relatively sandy area (42% cover), which dramatically influenced the benthic group cover estimates. On average hard coral cover was moderate at 16%. The dominant hard coral family was Faviidae, with a recorded cover of 6%. The Acroporidae and Poritidae families each contributed 3% to the benthic cover. Soft coral had a very low cover of 2%. No diseased colonies were observed at the intensive survey sites in 2006. *Drupella* spp. were recorded at a density of 6.67/ha at the survey sites. No COTS were observed during 2006 surveys.

Abundance of the majority of families of large mobile fishes was low at Grub Reef, with the exception of the parrotfishes (Scaridae) and the wrasses (Labridae). The damselfish community was comprised almost wholly of a number of generalist feeding *Pomacentrus* species, and fewer numbers of the remaining genera. However, the coral affiliated planktivores from the genera *Chromis* and *Neopomacentrus* were completely absent from these surveys.

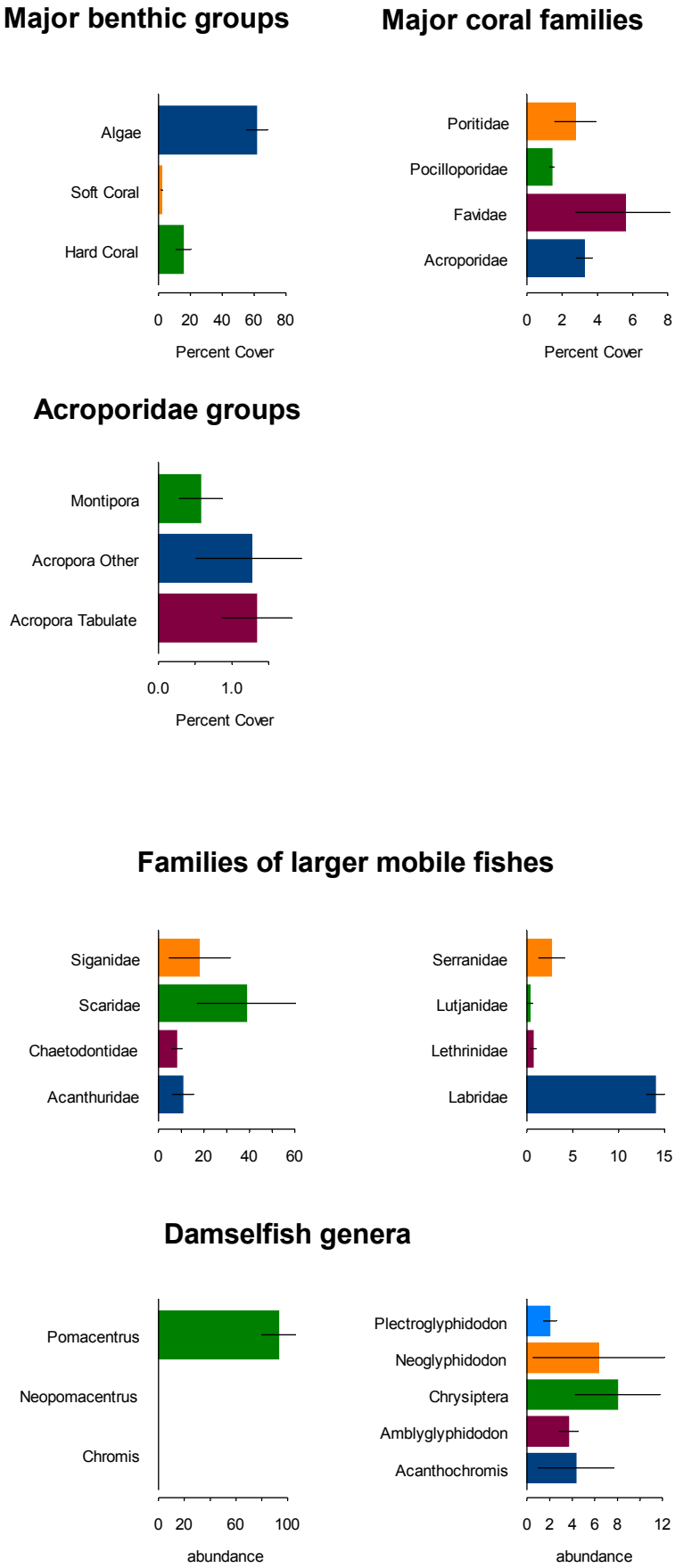
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.91



Grub Reef (No. 18-077) is a mid-shelf lagoonal reef with an area of 23.8 sq.km.

Figure 5.91 (cont.)
Grub Reef was last surveyed in July 2006.



HAVANNAH IS

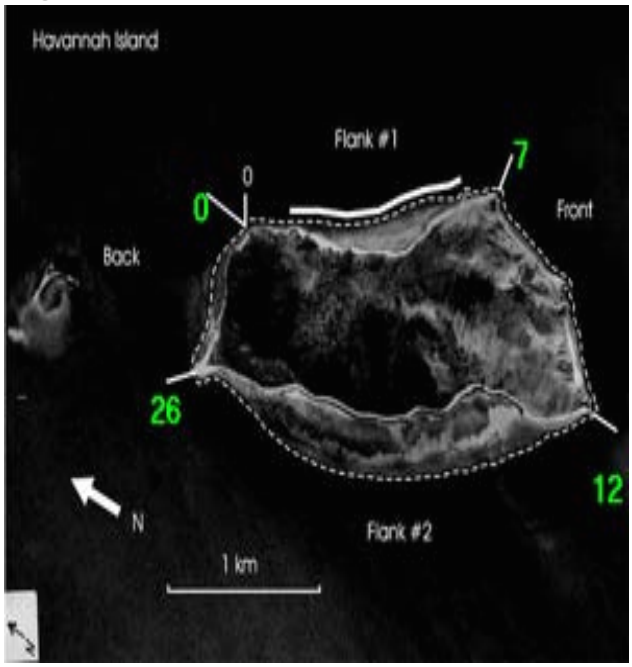
Havannah Island Reef has been surveyed using manta tow 13 times since 1987, with annual surveys since 1996. Median reef-wide live coral cover initially increased from moderate levels in 1987 (11-30%) to high (41-50%) levels by 1997. There was a sharp decrease in median reef-wide live coral cover due to extensive coral bleaching in 1998. Reef-wide live coral cover continued to decline through to 1999. Surveys in 2007 indicated median reef-wide live coral cover remained very low (1-5%) on Havannah Is Reef. No COTS have been recorded during any manta tow surveys and the reef remained classified as No Outbreak in 2007. No bleaching or signs of coral disease were observed during manta tow surveys in 2007.

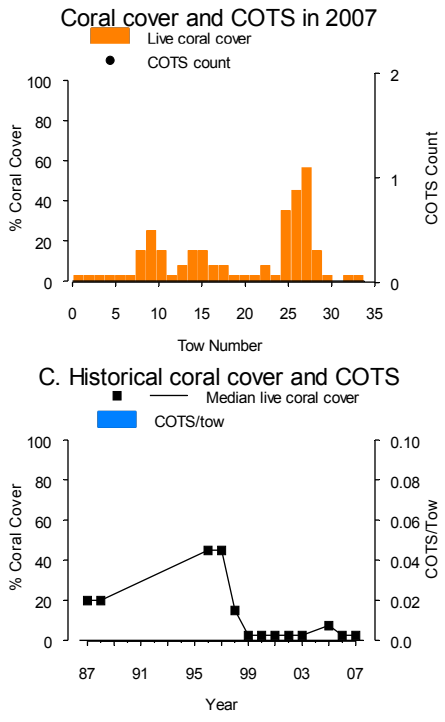
Intensive surveys at fixed sites on Havannah Island Reef commenced in 1997. Hard coral cover in 1997 was moderate at 36% and it was dominated by branching and bottlebrush coral colonies of the genus *Acropora*. By 1999, cover of *Acropora* spp. had declined to 16% as a result of bleaching mortality. Since 1999 other disturbances have contributed to the further decline in hard coral. In 2000 Cyclone Tessi passed close to the reef and in 2001 small COTS were found during intensivie SCUBA surveys. The cover of algae remained extremely high (80%) in 2007. Macroalgae (59%) increased by 7% and turfing algae (20%) decreased by 10% from the previous survey in 2005. In 2007 the hard coral and soft coral cover were low (each 7%). Bleaching mortality is a likely explanation for the decline in soft coral, with the dominance of brown algae from the genus *Lobophora* possibly impeding recovery. No diseased coral colonies or corallivorous snails (*Drupella* spp.) were recorded in 2007.

In response to substantial decreases in live coral cover between 1997 and 2001, abundances of many fish taxa had markedly declined. After this time, abundances of most taxa tended to stabilise at low levels. Scaridae abundances were highly variable throughout the study period. Abundances of Chaetodontidae (driven by a range of species but particularly *Chaetodon* <>*aureofasciatus*) remained very low in 2007, mirroring patterns in hard coral cover. Many Chaetodontidae are highly coral dependent and often decline in abundance as coral cover is lost. Declines in abundance of most damselfish genera were also not surprising as many species have life histories associated with live corals. Perhaps surprising, was the marked decrease in abundance of the large mobile Lutjanidae, driven by a range of species but particularly *Lutjanus carponotatus*. In 2007 both the abundance and diversity of the Lutjanidae were at an 11 year low. In 2007 only two Lutjanidae species were recorded, compared to the typical five species commonly encountered when coral cover was higher. The widespread reduction in fish numbers at Havannah Island Reef presumably reflected a general reduction in habitat suitability for reef fishes. This was brought about by the breakdown of dead coral skeletons into rubble and the insidious overgrowth of over 50% of the substrate by a prostrate macroalgae, (genus *Lobophora*). However, two taxa, Siganidae (driven by *Siganus doliatus*) and *Acanthochromis polyacanthus*, have defied the common trend and increased in abundance during the low coral cover period.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.92

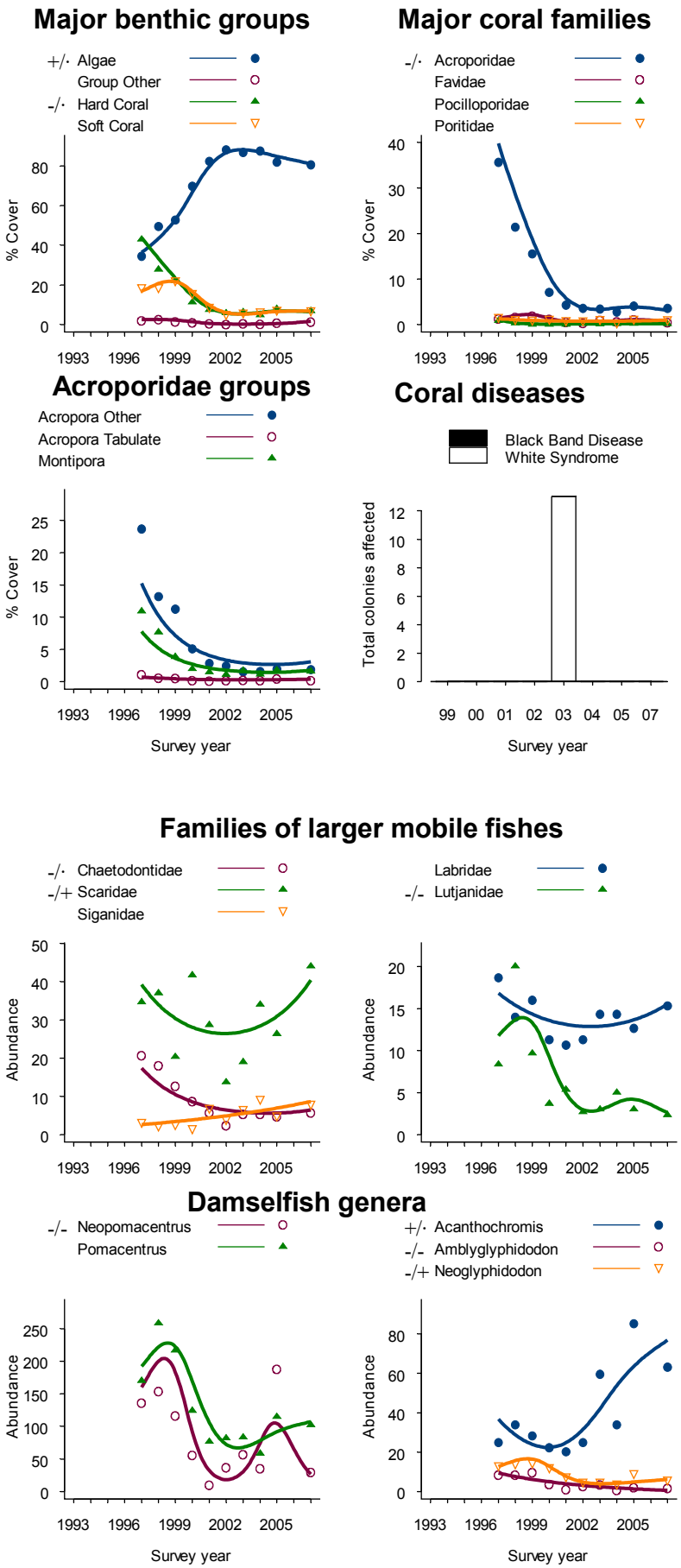




Havannah Is Reef (No. 18-065) is an inshore fringing reef with an area of 0.3 sq.km.

Figure 5.92 (cont.)

Havannah Is Reef was last surveyed in May 2007.



HELIX

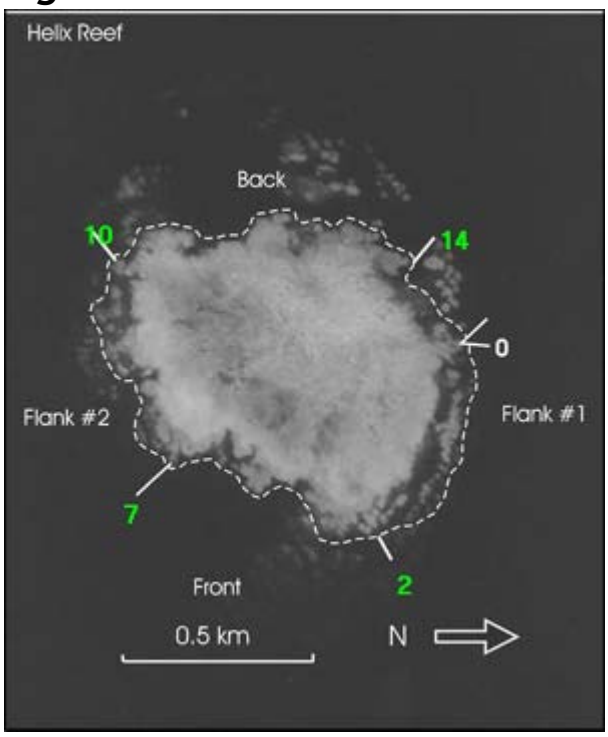
Helix Reef has been surveyed using manta tow 14 times since 1984, when it was classified as an Active Outbreak. Median reef-wide live coral cover was initially high (31-50%) before rapidly declining to an extremely low level (0%) in 1987 due to intense COTS feeding activity. Helix reef was reclassified as Recovering in 1988 and median reef-wide live coral cover gradually increased to a high level (31-50%) by 2003. Surveys in 2005 showed that COTS activity had increased and it was reclassified as Incipient Outbreak. Surveys in 2006 indicated that COTS numbers had continued to increase and there had been a corresponding decline in reef-wide live coral cover to a moderate (21-30%) level. Helix reef was reclassified as an Active Outbreak in 2006. No bleaching or signs of black band disease were observed during surveys in 2006. White syndrome disease was common (signs on more than ten colonies per two minute manta tow) on the front and southern flank but was not observed on other parts of the reef.

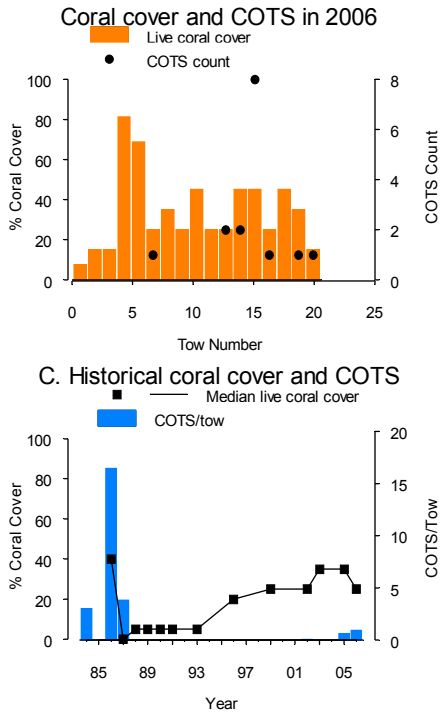
Helix Reef was intensively surveyed using SCUBA for the first time in 2006. Hard coral cover in 2006 at the intensive survey sites was moderate at 23%. The Acroporidae family (16%) was represented mostly by tabulate and branching *Acropora* spp., which accounted for 7% and 6% of the benthic cover respectively. Encrusting and submassive forms of non-*Acropora* genera accounted for 4% and 3%, of the benthos, respectively. Algae was the dominant benthic group recording 70% cover. The algal community was comprised of two major groups: turf algae (55% cover) and coralline algae (13% cover). Soft coral cover was very low at 3%. Brown band disease, white syndrome and skeletal eroding band were rare on the sites. 39 COTS were counted during SCUBA search surveys in 2006, most of which were adults. The corallivorous snail *Drupella* spp. were recorded at a density of 20/ha.

The highest abundance of large mobile fishes was accounted for by two families, Scaridae and Acanthuridae. The four species of parrotfish that accounted for almost all of the Scaridae abundance were *Scarus altipinnis*, *S. psittacus*, *S. niger* and *Chlorurus sordidus*. Of the surgeonfishes, *Ctenochaetus* spp. were the most abundant. The butterflyfishes included moderate numbers of two species, *Chaetodon rainfordi* and *C. trifasciatus*, as well as low numbers of a coral feeding specialist, *C. trifascialis*. Numbers of the commercially valuable Serranidae family were very low. The damselfish community was highly abundant, especially the genera *Chromis*, *Pomacentrus* and *Neopomacentrus*. The majority of these species are planktivores.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

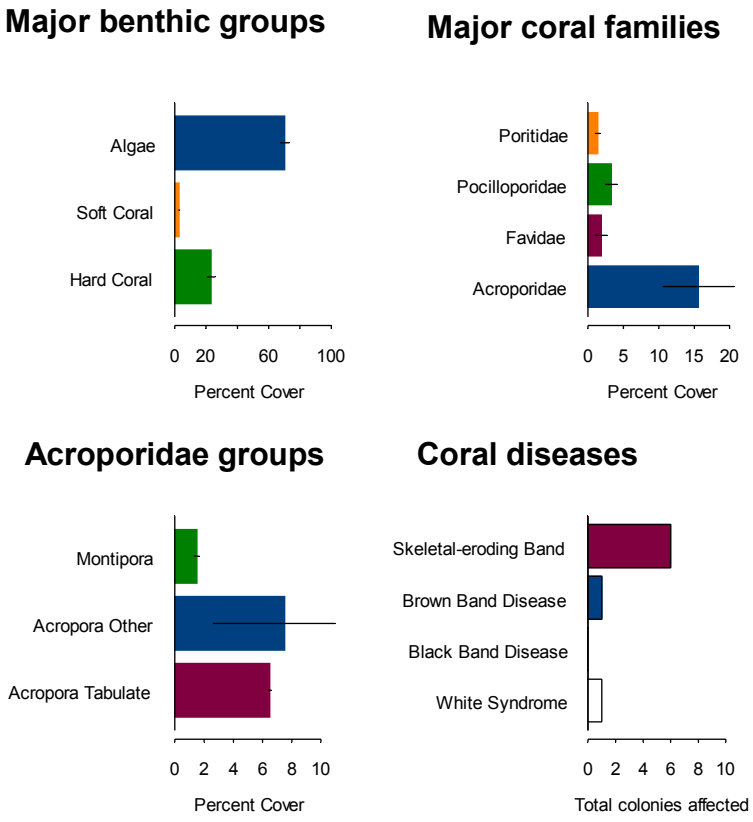
Figure 5.93





Helix Reef (No. 18-076) is a mid-shelf patch reef with an area of .6 sq.km.

Figure 5.93 (cont.)
Helix Reef was last surveyed in December 2005.



JOHN BREWER

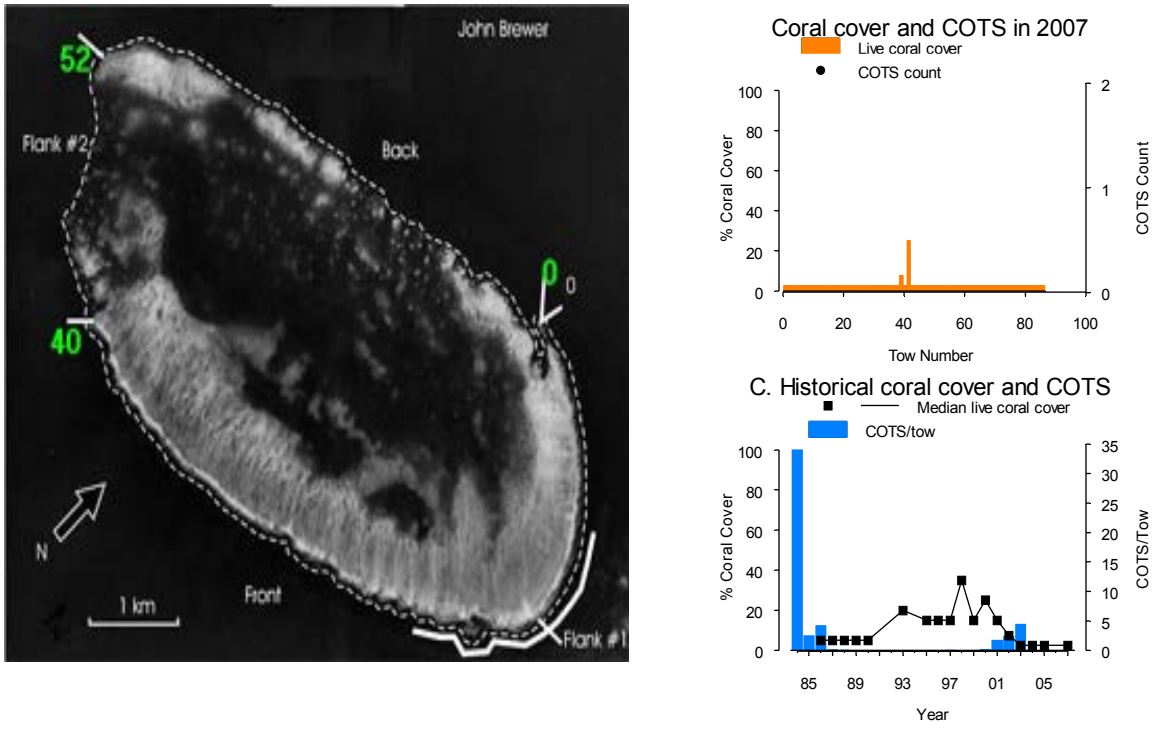
John Brewer Reef has been surveyed using manta tow regularly since 1984, when it had an extremely large COTS population and the reef was classified as Active Outbreak. The COTS population subsequently declined and in 1987 the reef was reclassified as Recovering. Median reef-wide live coral cover persisted only at a low (1-10%) level from 1986 through to 1990 before beginning to show signs of recovery. In 1993 reef-wide live coral cover increased to moderate (11-30%) levels and by 1998 reef-wide live coral cover was at high levels (31-50%). Surveys in 2001 recorded high COTS numbers and the reef was reclassified as Active Outbreak. COTS remained at outbreak levels through to 2003 and there was a corresponding drop in coral cover to a very low (1-5%) level. Coral cover persisted at this low level through to 2007. The reef was reclassified as Recovering in 2004 and remained so in 2007. No COTS, coral bleaching or signs of disease were observed during broadscale surveys in 2007.

Multiple disturbances have impacted the intensive survey sites at John Brewer Reef over the survey period. Hard coral cover reached a maximum of 31% in 1996. In 1997 a slight decline in hard coral was observed, which was attributed to the impact of Cyclone Justin on tabulate *Acropora* spp. A low level of coral bleaching was recorded in 1998 and 1999 on the transects but cover of hard corals did not decrease significantly over these years. By 2004 hard coral cover had declined dramatically to 0.6% as a result of COTS feeding activity and in 2007 John Brewer had the lowest coral cover (1%) of all the reefs surveyed that year. The cover of soft corals has been gradually declining since 1998 and in 2007 was 2%. At 88%, the algae cover at John Brewer Reef was the highest of the reefs surveyed in 2007 and was represented primarily by turf algae (64%). In 2003, 153 adult COTS were observed during at the intensive survey sites, giving an estimated density of 1020/ha. This is the highest density of COTS ever recorded during routine SCUBA surveys on any of the LTMP reefs. No COTS were observed at the intensive survey sites in 2004, 2005 or 2007. No white syndrome was observed in 2007. Coralline lethal orange disease and coralline lethal algal pinking were observed which may explain the very small decline in coralline algae cover.

The decline in coral cover since 1999 has generally not been reflected by changes in the fish community. Although inter-annual variation in abundance was often high, the abundances of many taxa have shown few consistent trends over the survey period. The abundance of both the coral-associated butterflyfishes (Chaetodontidae) and the damselfish genus *Chromis*, had decreased with coral cover to very low levels in 2007. While the overal abundance of the genus *Pomacentrus* varied little from 2005 to 2007, the relative species composition of the group changed. The coral-dependent species *Pomacentrus moluccensis* decreased in abundance while the algal farming species *P. wardi* increased in abundance. A large increase in abundance among the herbivorous Scaridae from 2004 to 2007 was driven by a range of species and presumably reflects increased resource availability in the form of algal turf. Numbers of *Acanthochromis polyacanthus* also increased in conjunction with a decline in hard coral cover.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

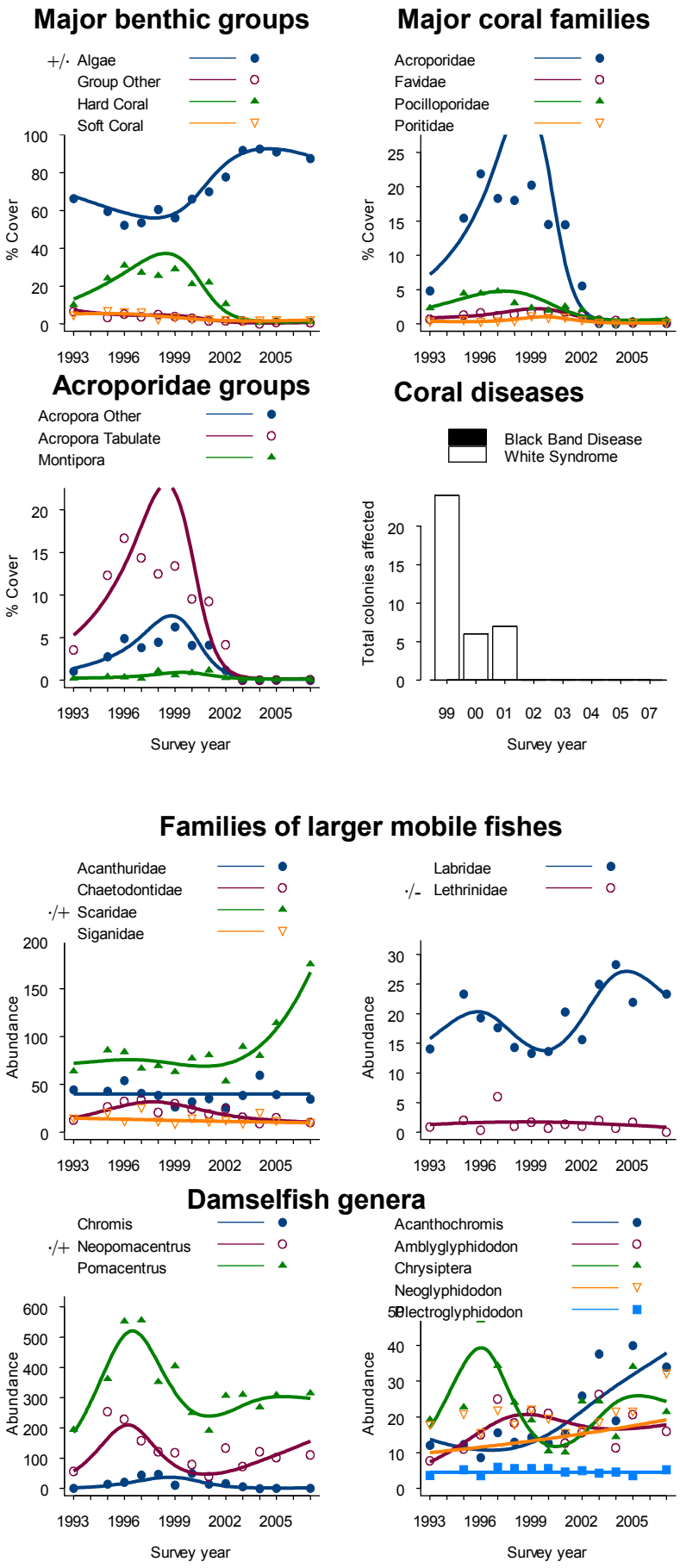
Figure 5.94



John Brewer Reef (No. 18-075) is a mid-shelf lagoonal reef with an area of 17.5 sq.km.

Figure 5.94 (cont.)

John Brewer Reef was last surveyed in May 2007.



KELSO

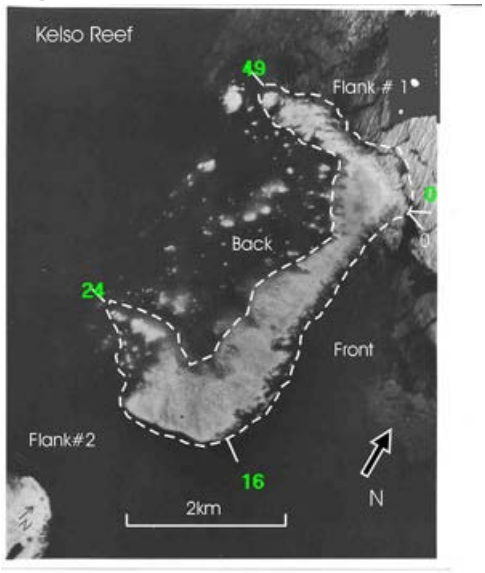
Although LTMP SCUBA surveys were carried out on Kelso Reef in 2006, manta tow survyes could not be conducted due to strong winds and high seas. Kelso Reef has been surveyed five times since 1986 using manta tow, with a considerable gap from 1990 to 2002. The most recent survey was in 2003. A large COTS population was present in the initial surveys and the reef was classified as Active Outbreak. Only one COTS was observed in 1989 and the reef was reclassified as Recovering. Median reef-wide live coral cover was low (1-10%), presumably as a result of COTS feeding activity. COTS were present again in high numbers in 2002 and the reef was reclassified as Active Outbreak. The density of COTS increased further in 2003. Reef-wide live coral cover was low in 2002 and 2003 but had probably reached at least moderate levels in the late 1990s, as was the case on several other reefs in the region (eg John Brewer, Rib, Wheeler) that were more frequently monitored. No bleaching or coral disease was recorded in 2003.

The intensive survey sites on Kelso Reef were established in 2006. The initial survey indicated that Kelso Reef was dominated by algae (75% cover), particularly turf algae (62% cover). Soft corals were the dominant coral group with 8% cover. Sponge cover was 6%, slightly higher than that of hard coral, which was low at 5%. The most abundant hard coral family was the Faviidae with 2% cover. The other major hard coral families contributed 1% or less to the benthic cover. Low cover of *Acropora* spp. is most likely due to high densities of COTS on Kelso Reef discovered during manta tow surveys in 2002 and 2003. No COTS were recorded during 2006 SCUBA surveys, nor were any diseased colonies. The density of the corallivorous snail *Drupella* spp. was recorded at 6.67/ha.

Four families of large mobile fishes accounted for the majority of the abundance of this group of fishes in 2006. In particular the families Scaridae, Acanthuridae, Chaetodontidae and Labridae were most abundant. Three species of Scaridae drove patterns within the family, *Scarus niger*, *Chlorurus sordidus* and *S. psittacus*, while two species of Acanthuridae accounted for the majority of the abundance recorded for this family. The abundance of these two herbivorous families reflects the high level of algae observed at this reef and the low coral cover. The damselfishes were dominated by a single genus, *Pomacentrus*, of which one species, *P. lepidogenys*, accounted for almost all of the abundance. Moderate numbers of the remaining damselfish genera were recorded during 2006 surveys.

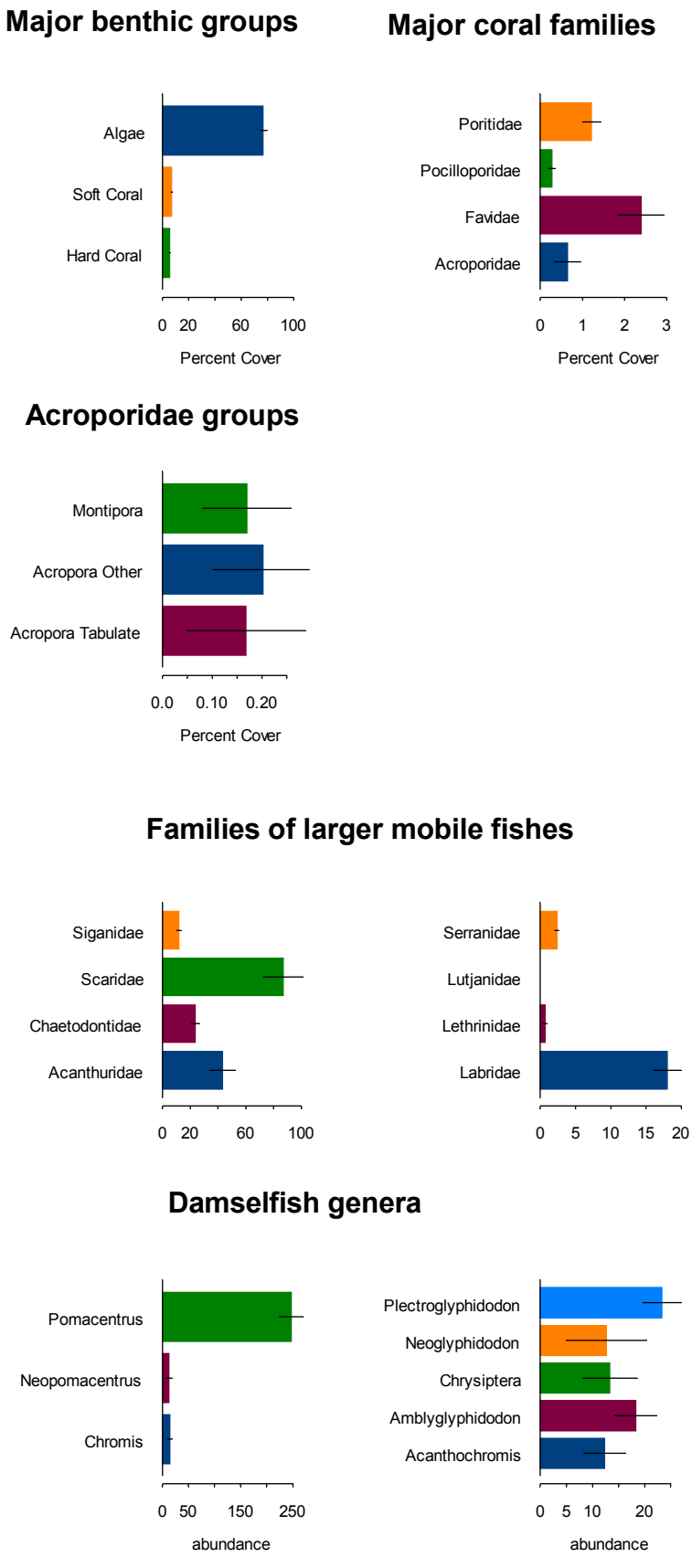
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.95



Kelso Reef (No. 18-030) is a mid-shelf crescentic reef with an area of 8.79 sq.km.

Figure 5.95 (cont.)
Kelso Reef was last surveyed in July 2006.



KNIFE

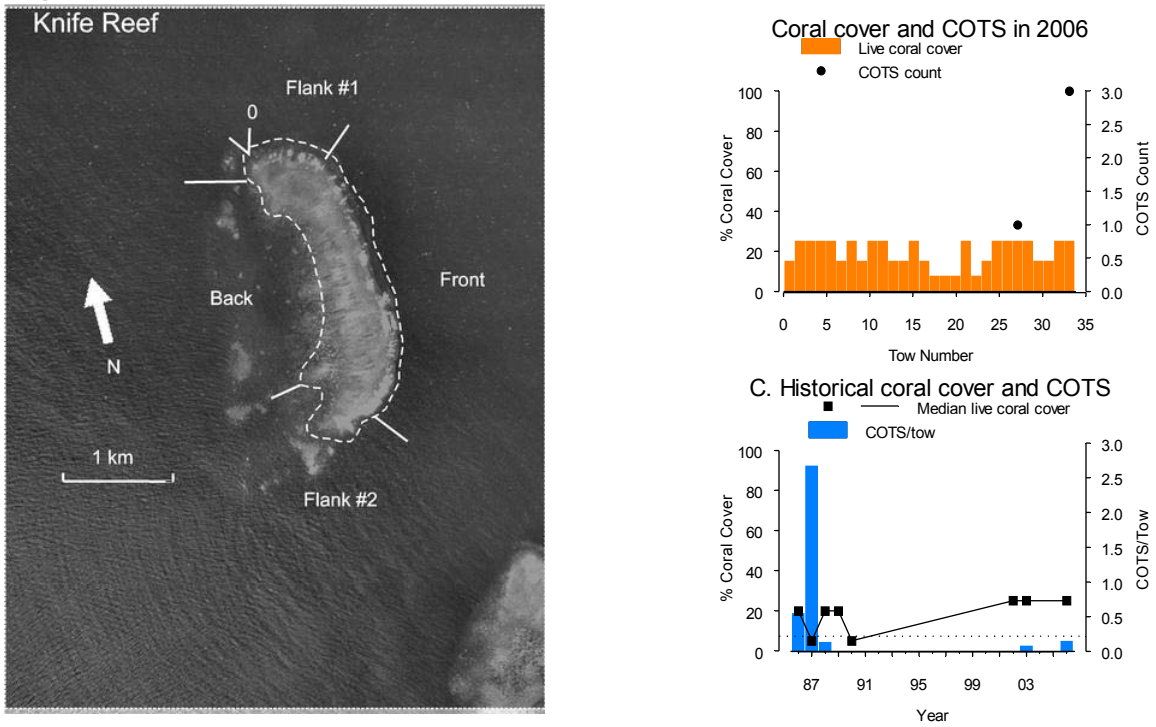
Knife Reef has been surveyed using manta tow eight times since 1986, with a large gap between 1990 and 2002. Initial surveys showed an elevated COTS population and the reef was classified as Incipient Outbreak. COTS numbers increased and the reef was reclassified as an Active Outbreak in 1987. COTS numbers had dramatically declined by 1988 and the reef was reclassified as Recovering. The increased COTS activity was matched by a corresponding decline in median reef-wide live coral cover from a moderate (11-30%) level in 1986 to a low level (1-10%) in 1988. Subsequent surveys through to 2003 showed only a small recovery in median reef-wide live coral cover to a moderate (11-30%) level. In 2006 small numbers of COTS were observed on Knife Reef but in numbers too low to affect median reef-wide live coral cover and the reef remained classified as Recovering. Coral cover remained moderate in 2006. No coral bleaching was observed, while white syndrome disease was recorded on a few scattered coral colonies around the reef perimeter. Black band disease was observed on a few scattered coral colonies on the back reef during surveys in 2006.

Intensive survey sites at Knife Reef were established in 2006. Hard coral cover in 2006 was moderate at 26%. The dominant hard coral family was Acroporidae (10% cover), represented largely by tabulate (4%) and digitate (2%) growth forms of the genus *Acropora*. The other major hard coral families each accounted for approximately 5% of the benthic cover. Turf algae was the benthic group with the highest cover (50%), followed by coralline algae (11%). Soft corals had a low abundance, contributing 8% to the benthic cover. Incidents of skeletal eroding band and white syndrome were rare. No COTS were found during 2006 surveys. *Drupella* spp. were recorded at a density of 33/ha.

Hard coral cover was moderate at this reef, whilst algae dominated the benthic community. This is reflected in the low abundance of coral affiliated fish species, both in the families with large mobile fishes and in the damselfish family (Pomacentridae). Most of the abundance of the Chaetodontidae is accounted for by a single species, *Chaetodon citrinellus*, which is a generalist feeder. The parrotfishes (Scaridae) exhibited a lot of variability from site to site, a reflection of the schooling nature of many of these species. However, Scaridae were the most abundant fishes encountered during the surveys. Their abundance was driven largely by three species, *Scarus globiceps*, *S. psittacus* and *Chlorurus sordidus*. Four genera accounted for almost all of the abundance of the Pomacentridae, including two planktivorous genera, *Chromis* and *Neopomacentrus*, as well as the more generalist *Pomacentrus* genus and the territorial algal feeder, *Plectroglyphidodon lacrymatus*.

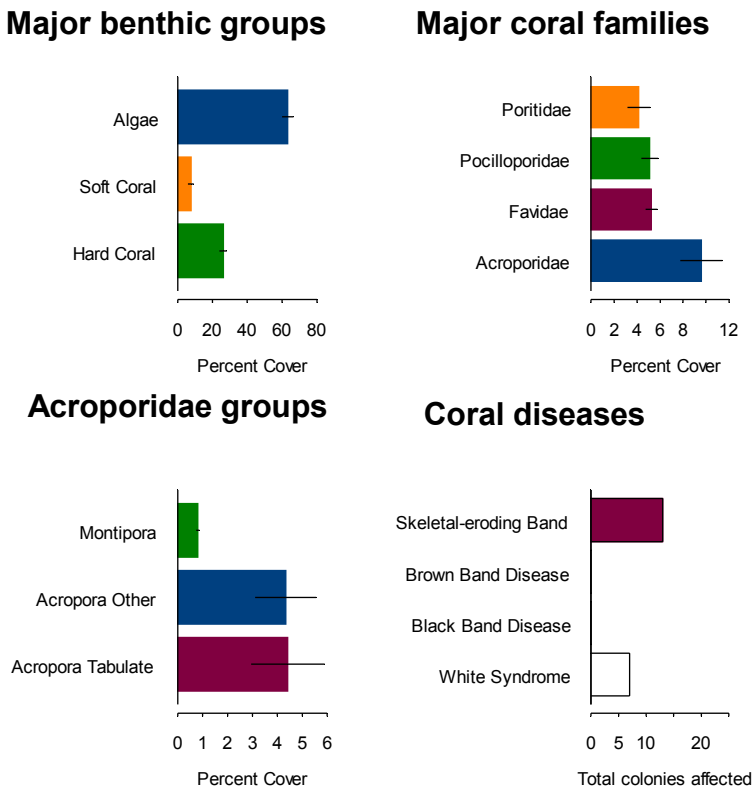
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

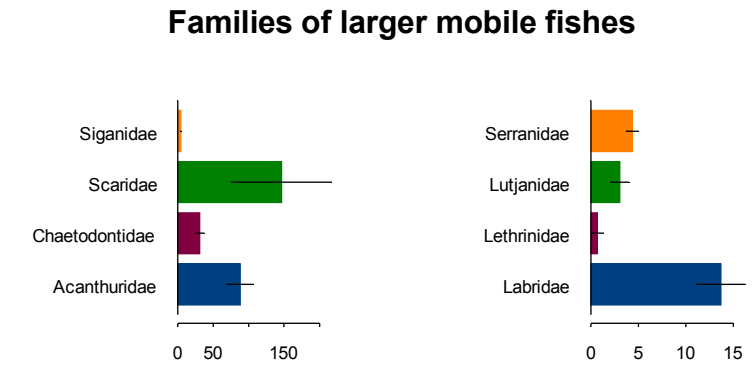
Figure 5.96

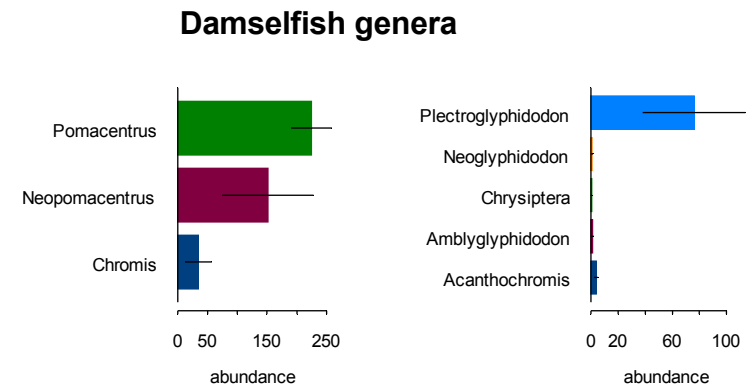


Knife Reef (No. 18-081) is an outer shelf crescentic reef with an area of 3.1 sq.km.

Figure 5.96 (cont.)
Knife Reef was last surveyed in September 2006.







LITTLE KELSO

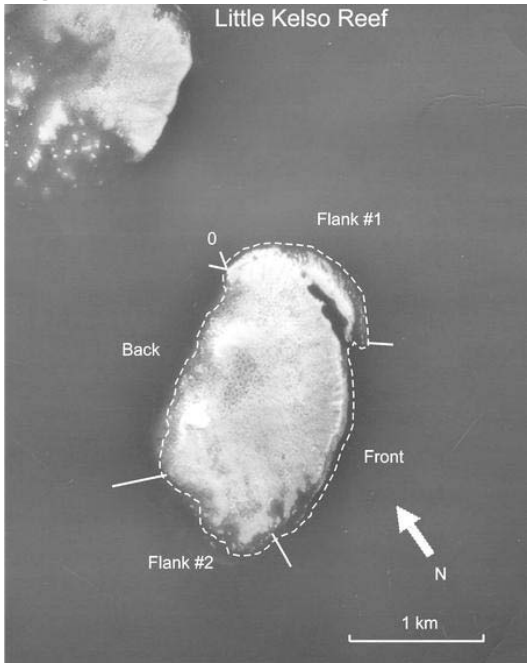
Little Kelso Reef has been surveyed using manta tow five times since 1989. It was initially classified as Recovering from COTS activity. Coral cover was low (1-10%) initially and no COTS were observed. Coral cover showed some recovery over the decade that followed and had reached moderate levels (11-30%) by 2002. However at this time, COTS were observed in sufficient numbers for the reef to be reclassified as an Incipient Outbreak. Surveys in 2003 indicated a dramatic increase in COTS numbers and the reef was reclassified as Active Outbreak. Surveys in 2006 showed that while COTS activity has ceased on this reef median reef-wide coral cover was very low (1-5%). Little Kelso Reef was reclassified as Recovering in 2006. No coral bleaching or signs of black band disease were recorded in 2006. White syndrome disease was observed on a few scattered coral colonies around the reef perimeter.

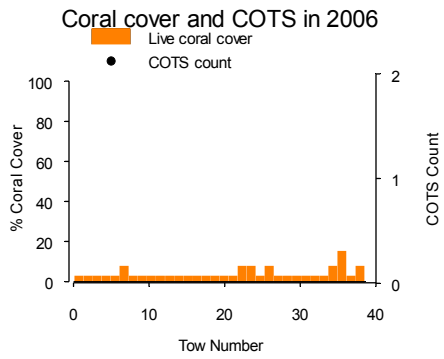
In 2006 intensive survey sites were established at Little Kelso Reef. The first survey showed that algae was the dominant benthic group (83% cover). The primary constituent of the algal community was turf algae, accounting for 71% of the benthic cover. Hard coral cover at the survey sites was low at 7%. The dominant hard coral family, although marginally so, was Acroporidae with 3% cover. Tabulate and branching growth forms of the genus *Acropora* accounted for the majority of the Acroporidae recorded. The Faviidae and Poritidae contributed approximately 1% each to the benthic cover. The high density of COTS that was observed during 2003 broadscale surveys was considered responsible for the low cover of hard coral observed at the intensive survey sites in 2006. Soft coral cover was low with an average of 4%. White syndrome was rare and no COTs were found in 2006. *Drupella* spp. were observed at a density of 60/ha.

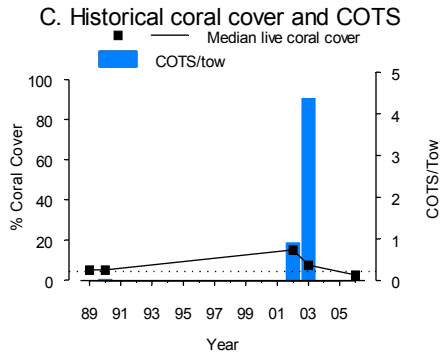
The benthic community was dominated by algae, with live hard coral cover representing less than 10% of the benthic cover. This is reflected in the large mobile fish community, with herbivorous families such as Acanthuridae and Scaridae accounting for the majority of abundance. Coral affiliated species from the Chaetodontidae were represented by just a couple of species with low abundance. There were moderate numbers of the commercially important coral trout species, *Plectropomus* spp. Numbers of damselfishes were largely accounted for by a single species, *Pomacentrus lepidogenys*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.97

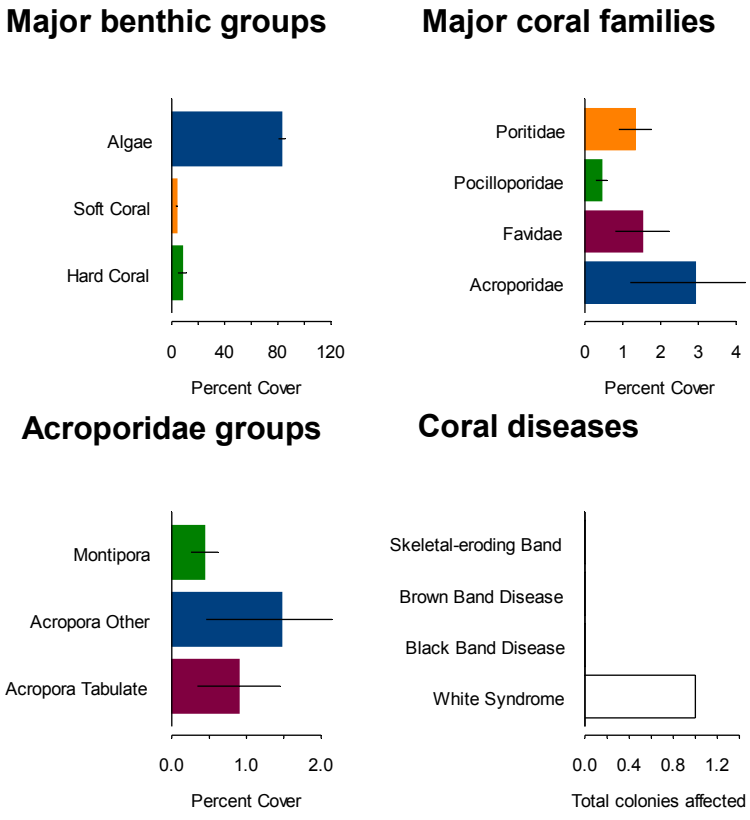


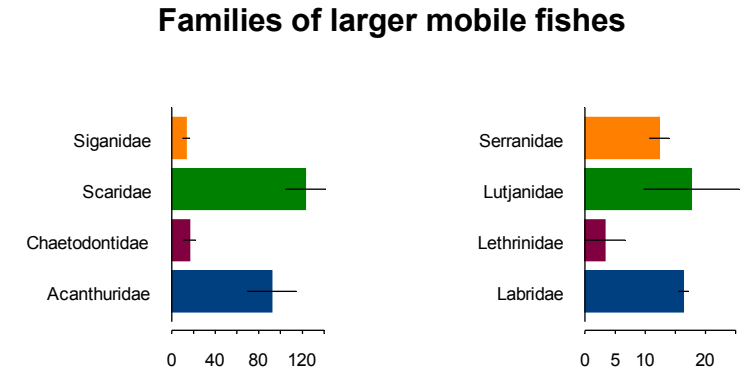


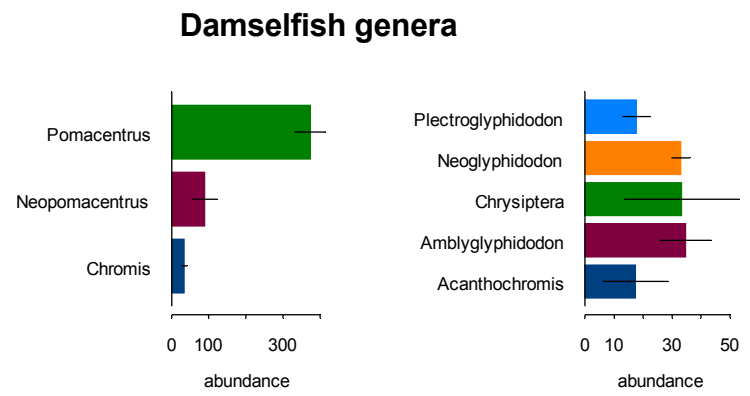


Little Kelso Reef (No. 18-031) is a mid-shelf planar reef with an area of 3.8 sq.km.

Figure 5.97 (cont.)
Little Kelso Reef was last surveyed in July 2006.







LYNCHS

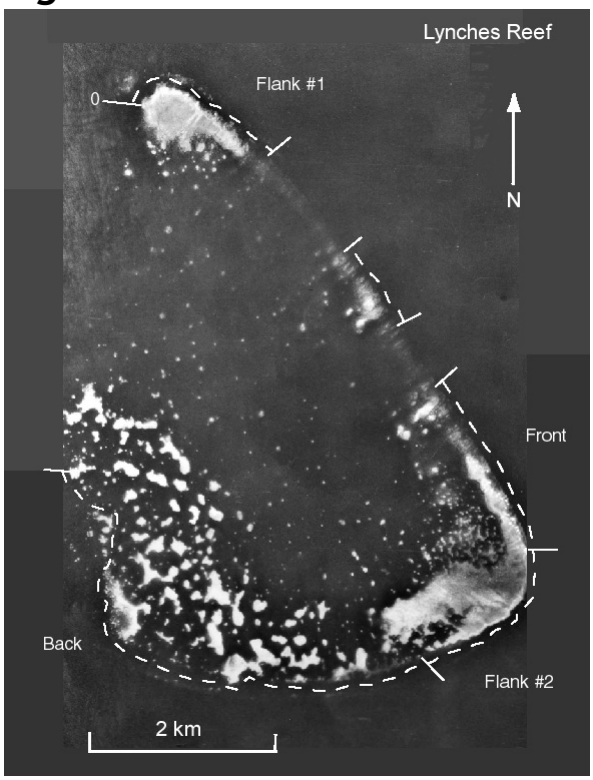
Lynchs Reef was previously surveyed using manta tow in 1992. At this time elevated levels of COTS were recorded and the reef was classified as Incipient Outbreak. Median reef-wide live coral cover was very low (1-5%) probably as a result of COTS feeding activity. Lynchs Reef was not surveyed again until 2006. No COTS were recorded and coral cover remained very low in 2006. Lynchs Reef was consequently reclassified as Recovering. No coral bleaching was observed and white syndrome disease was common on coral colonies on the back reef during surveys in 2006.

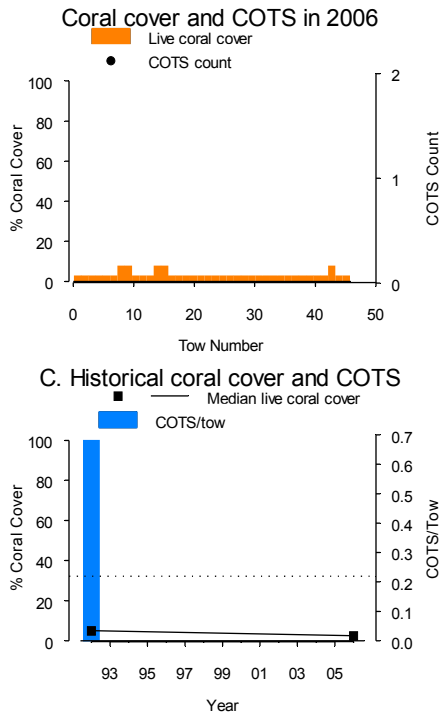
Intensive survey sites at Lynchs Reef were first established in 2006. The initial survey showed that algal cover was extremely high at 88%. The algal community primarily consisted of turf algae, which accounted for 74% of the benthic cover. Coralline algae was the next most abundant benthic group with 7% cover. Soft coral cover was 4% and, although very low, was marginally greater than that of hard coral and sponges, which each accounted for 2% of the benthos. The dominant hard coral family was Pocilloporidae with 1% cover, while Faviidae, Poritidae and Acroporidae had a combined cover of 1%. On the survey sites skeletal eroding band were rare and white syndrome was absent. There were no COTS found along the fixed transects in 2006. The density of *Drupella* spp. was recorded at 26.7/ha.

The benthic community at Lynchs Reef was dominated by turf algae, so it was no surprise that herbivorous fish families accounted for the majority of the abundance of large mobile fishes. Acanthuridae were predominately represented by *Ctenochaetus* spp. and *Acanthurus lineatus*, while the Scaridae were comprised mainly of three species, *Chlorurus microrhinos*, *C. sordidus* and *Scarus frenatus*. The Chaetodontidae and the commercially important *Plectropomus* spp. were present only in low numbers. Damselfishes were numerically dominated by species from the genus *Pomacentrus*, including *P. wardi*, *P. bankanensis* and *P. lepidogenys*. All other damselfish genera were present in moderate numbers. The more abundant species were generally those associated with herbivory or planktivory.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

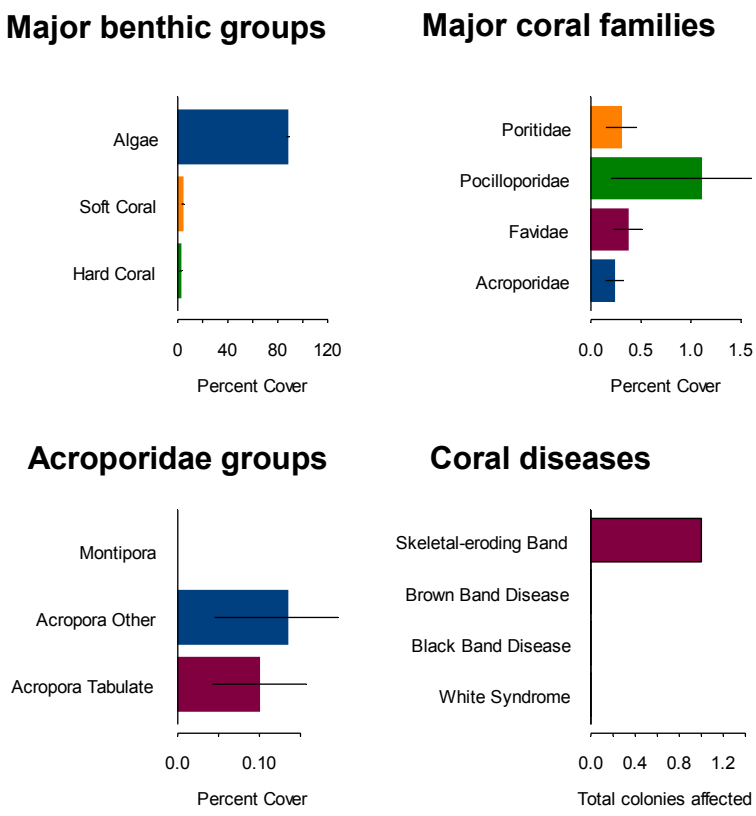
Figure 5.98





Lynchs Reef (No. 18-091) is a mid-shelf patch reef with an area of 36.9 sq.km.

Figure 5.98 (cont.)
Lynchs Reef was last surveyed in September 2006.



MIDDLE

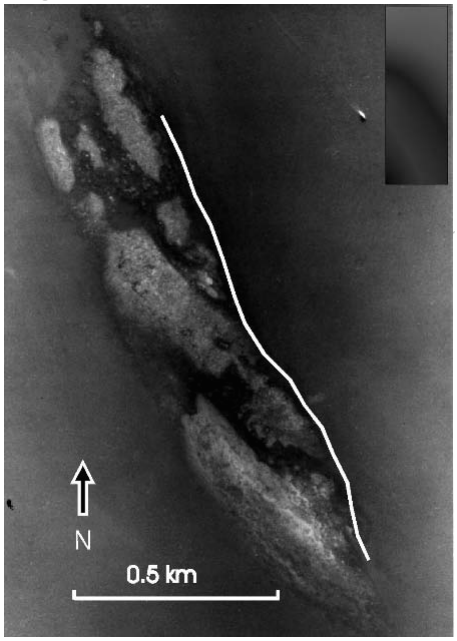
Manta tow surveys are not conducted on this reef due to poor underwater visibility.

Surveys at intensive survey sites at Middle Reef showed that hard coral cover was high at 45% in 2007. Widespread bleaching of hard and soft corals was observed in the region in 1998 and 2002. These bleaching events presumably played an important role in the continual decline in soft coral cover from a moderate (21-30%) level in 1995 to a very low (1-5%) level in 2007. Both major bleaching events resulted in marginal declines in hard coral cover and hard corals recovered promptly in both cases. In 2007 hard corals were dominated by *Goniopora* spp. from the Poritidae family, followed by *Acropora* spp. (6%) *Montipora* spp (6%) and *Pachyseris* spp. (5%). Acroporidae and Poritidae corals were at the highest cover observed at Middle Reef since intensive surveys began in 1992. Algae cover declined from 34% in 2005 to 25% in 2007. Bleaching was recorded on individual colonies of *Goniopora* spp. in 2007. Atramentous necrosis was present on a few genera of hard corals. White syndrome was observed on two colonies in 2007 and no *Drupella* spp. were recorded.

Surveys of large, mobile reef fish species are not conducted on this reef as visibility is typically too low. The damselfish fauna is dominated by just three species, *Pomacentrus wardi*, *Neopomacentrus bankieri* and *Acanthochromis polyacanthus*. Populations of these fishes have mostly been variable over the survey period. Numbers of *N. bankieri* have increased since 2001, when their abundance had reached its lowest point.

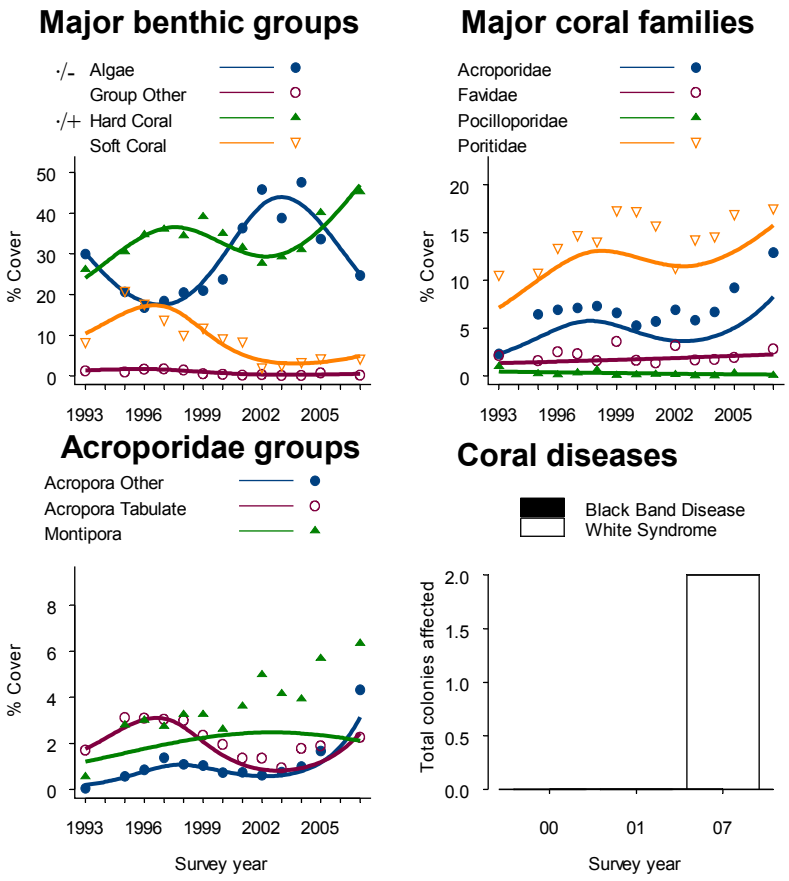
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

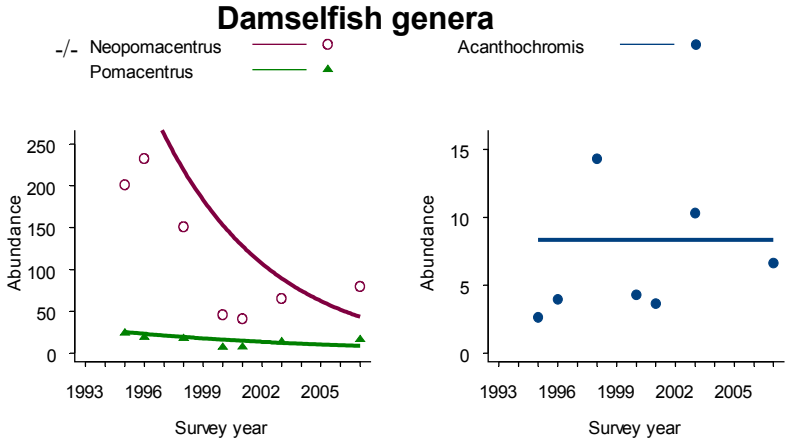
Figure 5.99



Middle Reef (No. 19-011) is an inshore planar reef with an area of 1.2 sq.km.

Figure 5.99 (cont.)
Middle Reef was last surveyed in July 2007.





MYRMIDON

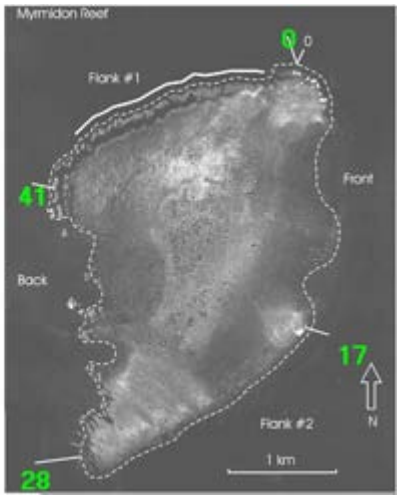
Myrmidon Reef has been surveyed using manta tow regularly since 1988. Median reef-wide live coral cover has remained at moderate levels (11-30%) during the survey period. COTS have only been observed once (1998) and in numbers too low to cause significant coral mortality. Surveys in 2007 indicated that reef-wide live coral cover had declined to a low (6-10%) level. This reef was not surveyed in 2006 and the exact reason for the decline in coral cover after 2005 is enigmatic. Myrmidon Reef remained classified as No Outbreak in 2007. No COTS, coral bleaching or signs of black band disease were observed. Signs of white syndrome disease were restricted to a few scattered coral colonies on the north flank of Myrmidon Reef in 2007.

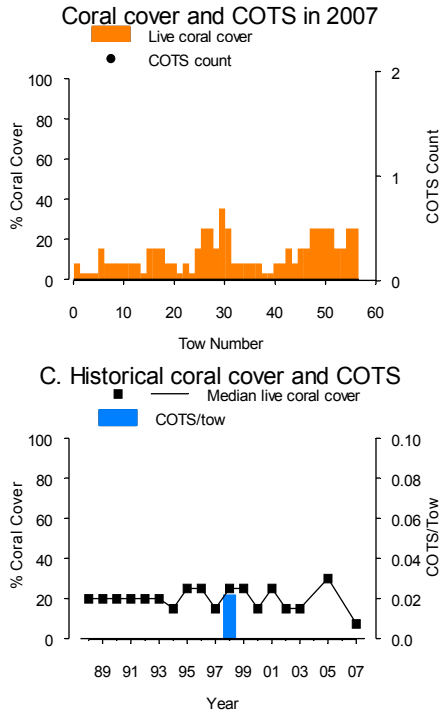
Intensive SCUBA surveys of the benthic community commenced in 1993. Hard coral cover increased up until 1999, reaching a maximum of 39%. It then decreased marginally in 2000, probably because of Cyclone Tessi in April 2000. The more substantial decrease observed in 2003, particularly among the Acroporidae and Favidae, was a result of the bleaching event of 2002. Hard coral cover had decreased from 29% in 2005 to 24% in 2007, perhaps due to damage caused by Cyclone Larry, which tracked towards Innisfail in 2006. There were also declines in soft coral abundance following the 1998 and 2002 bleaching years. In 2007 soft coral was 7%. Algae had been the dominant benthic group since 2000 and covered 61% of the substrate in 2007.*Drupella* spp. were observed at 73/ha in 2007. White syndrome and coralline lethal orange disease (CLOD) were both present, but rare.

Abundances of large reef fish taxa have varied over the study period with few clear trends, aside from an increase in Scaridae (driven largely by *S. altipinnis*). It is notable though, that large declines in abundances of Acanthuridae, Chaetodontidae and Labridae had occurred between 2005 and 2007 when coral cover was stable. Abundances of the small damselfishes, *Chromis* spp., had also decreased similarly over the same period. Perhaps recruitment failure on this relatively isolated outer reef caused these patterns. Abundances of *Plectroglyphidodon* spp. increased throughout the study period, driven by the algal farming *P. lacrymatus*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.100

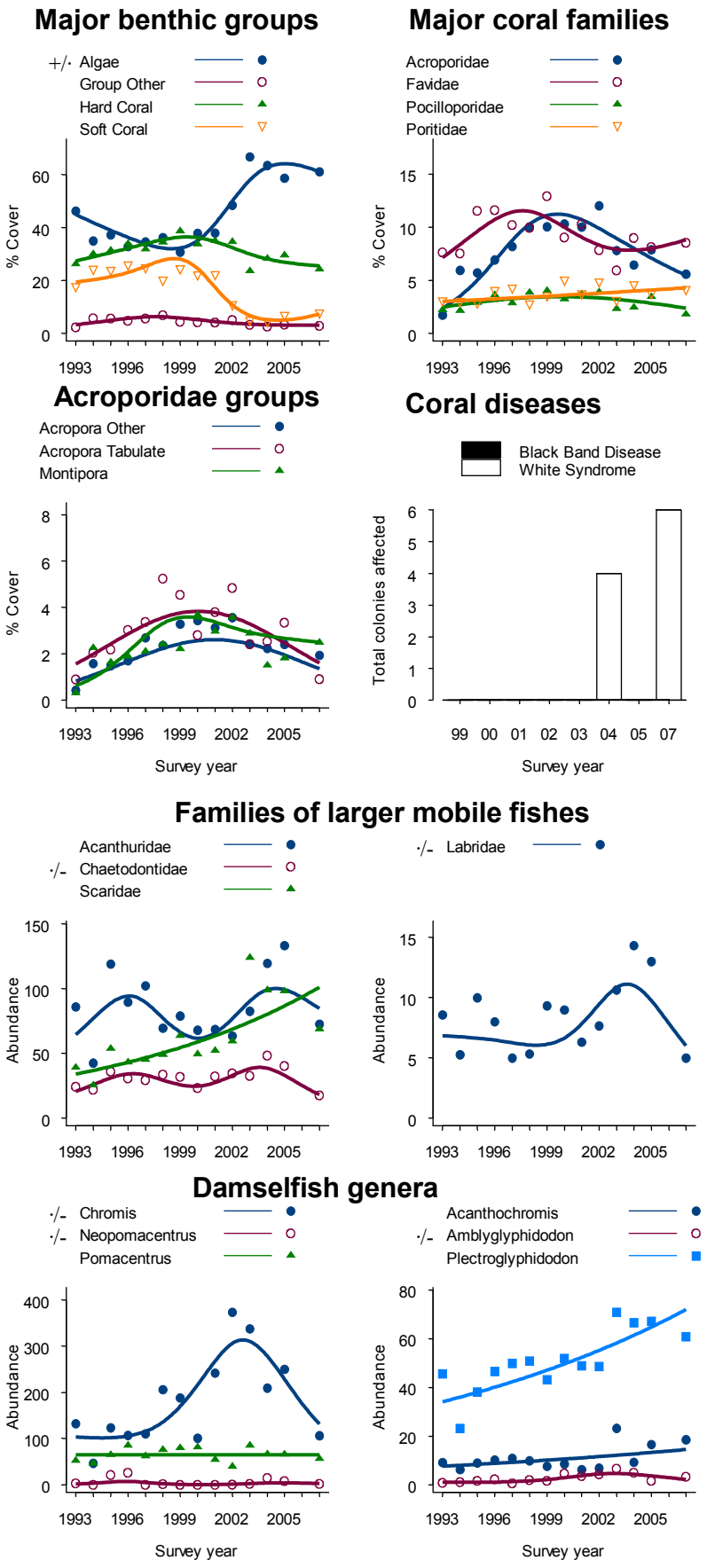




Myrmidon Reef (No. 18-034) is an outer shelf planar reef with an area of 6.2 sq.km.

Figure 5.100 (cont.)

Myrmidon Reef was last surveyed in May 2007.



PANDORA

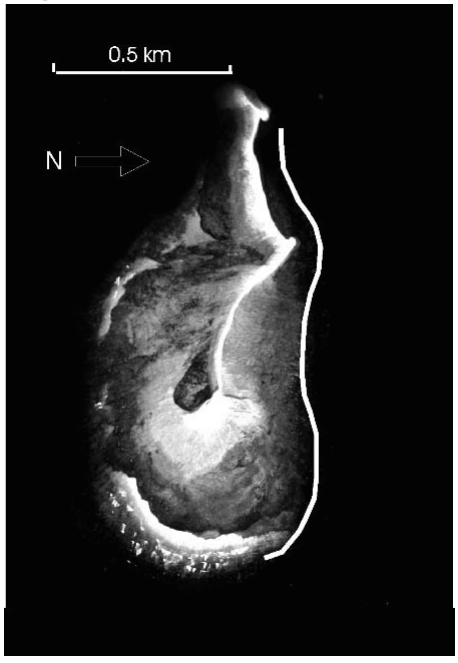
Manta tow surveys are not conducted on this reef due to poor underwater visibility.

Between 1993 and 1997 cover of hard coral increased on the intensive survey sites by approximately 11% to a maximum cover of 58%. Moderate bleaching had affected all abundant hard and soft coral families during the surveys in January 1998. Further bleaching mortality caused by flooding in the region reduced coral cover to 46% in 1999, with the Acroporidae most affected. There were further small declines in hard coral since, possibly due to the impact of Cyclone Tessi in 2000, with foliose corals *Echinopora* spp. and *Turbinaria* spp. the most affected. Hard coral cover was high in 2007 at 50%. Poritidae cover was 24% , the highest level observed for this family on any survey reef in 2007. It was comprised of *Porites* spp. at 5% and *Goniopora* spp. at 18%. *Goniopora* spp. cover remained stable throughout the survey period. Soft coral cover was 13% in 2007. The dominant algal lifeform in 2007 was turf algae at 20%. Macroalgae has averaged around 10% cover since 2003. Bleaching was observed on individual coral colonies in 2007. White syndrome and *Drupella* spp. were also recorded at very low levels in 2007.

Abundances of most large fish taxa were relatively low in 2007. With the exception of the Chaetodontidae, whose abundances had declined since 1998, most taxa suffered decreases from around 2004. Many of these decreases occurred in a number of species within each family. There is no obvious reason for this pattern, particularly as coral cover has consistently been high throughout the study period. Patterns among damselfishes were more variable, although abundances of *Neoglyphidodon* (driven by N. *nigroris*) reached a 15-year low in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

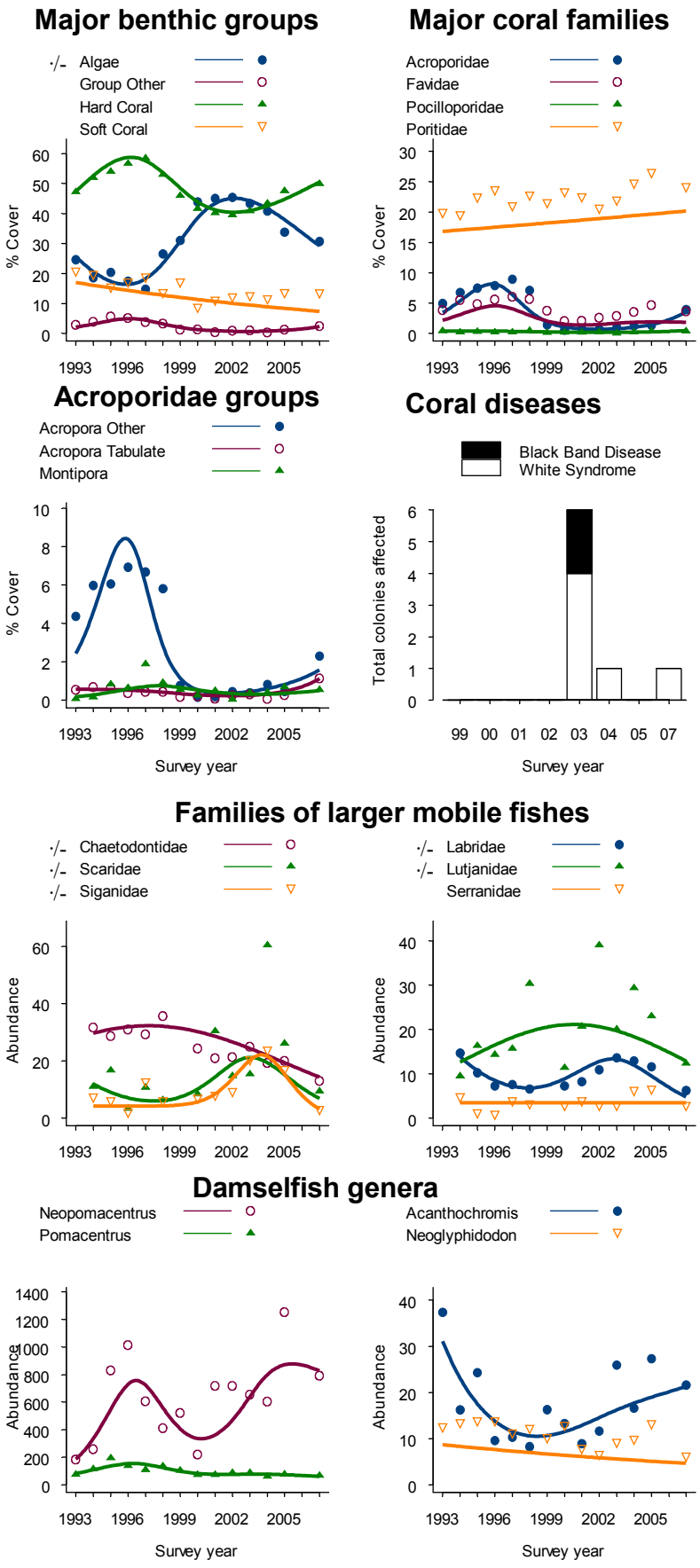
Figure 5.101



Pandora Reef (No. 18-051) is an inshore planar reef with an area of 0.6 sq.km.

Figure 5.101 (cont.)

Pandora Reef was last surveyed in May 2007.



RIB

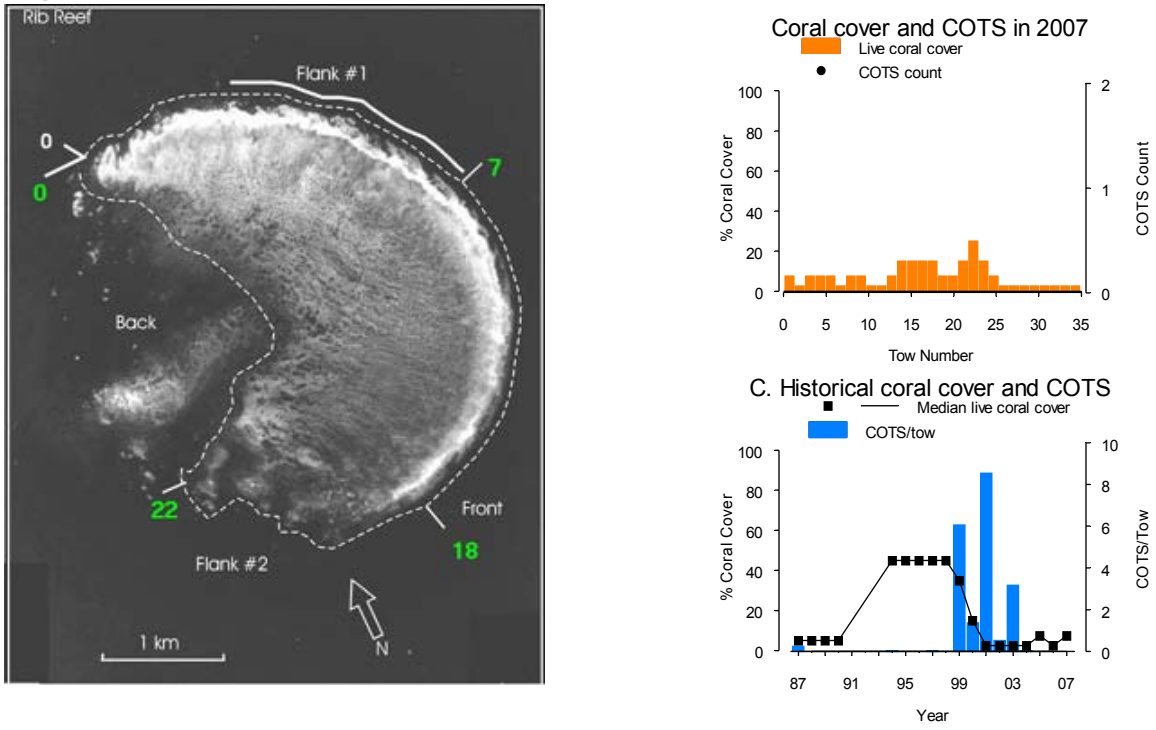
Rib Reef has been surveyed using manta tow regularly since 1987. A residual COTS population and large areas of old dead coral indicated that Rib Reef had been subject to high COTS populations prior to 1987. No COTS were observed in 1988 and the reef was classified as Recovering. Between 1990 and 1994, in the absence of COTS activity, median reef-wide live coral cover increased markedly from low to high levels (41-50%). Cover remained high through to 1998. In 1999 large numbers of COTS were observed and the reef was reclassified as Active Outbreak. Annual surveys through to 2003 showed that COTS numbers remained at Active Outbreak levels with a corresponding drop in reef-wide live coral cover to a very low (1-5%) level by 2001. Surveys in 2004 indicate COTS were no longer at outbreak levels and the reef was reclassified as Recovering. No COTS were recorded in 2005 for the first time since 1999. Surveys in 2007 showed that reef-wide live coral cover remained low (1-10%) and the reef retained a Recovering classification. No COTS, coral bleaching or signs of coral disease were recorded during manta tow surveys in 2007.

Intensive survey sites were established in 1994 and initial surveys showed that hard coral cover reached a maximum of 66% in 1996. The decrease in hard coral cover to 46% in 1997 was attributed to the impact of Cyclone Justin on tabulate *Acropora* spp. Declines in hard coral since 1999 can be attributed to feeding activity of COTS. Rib Reef has had a history of COTS (especially between 1999 and 2003), but no COTS were observed during the SCUBA search surveys from 2004 to 2007. Hard coral cover had decreased to 3% by 2003. Hard coral cover increased slightly beyond 2004 and was recorded at 6% in 2007. Soft coral cover has persisted at a low level (between 2% and 8%) since surveys began. In 2007 soft coral cover was 4% . Algae cover was extremely high in surveys from 2001 through to 2007, ranging from 82-89%. In 2007, algae cover was mostly comprised of turf algae, which covered 70% of the substrate along the fixed transects. *Drupella* spp. at Rib Reef have been recorded at densities of up to 1127/ha (in 1999). However, in 2007 these corallivorous snails were found at a density of only 20/ha. White syndrome was rare in 2006 and 2007 surveys.

Most fish taxa showed little change in abundance from 2005 to 2007, indicating a relatively stable "low coral cover" period. Major changes in abundance of a number of taxa had previously occurred during and following dramatic coral cover declines between 1999 and 2001. In 2007 the abundance of both the Chaetodontidae and the Scaridae were around a survey maximum, probably reflecting differing responses to loss of coral cover and increasing cover of turf algae. In 2007 the abundance of the small damselfish genus *Chromis* persisted at the very low level that has been recorded since 2004, reflecting the lack of recovery of their preferred coral habitat. This pattern was driven by a range of *Chromis* species.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

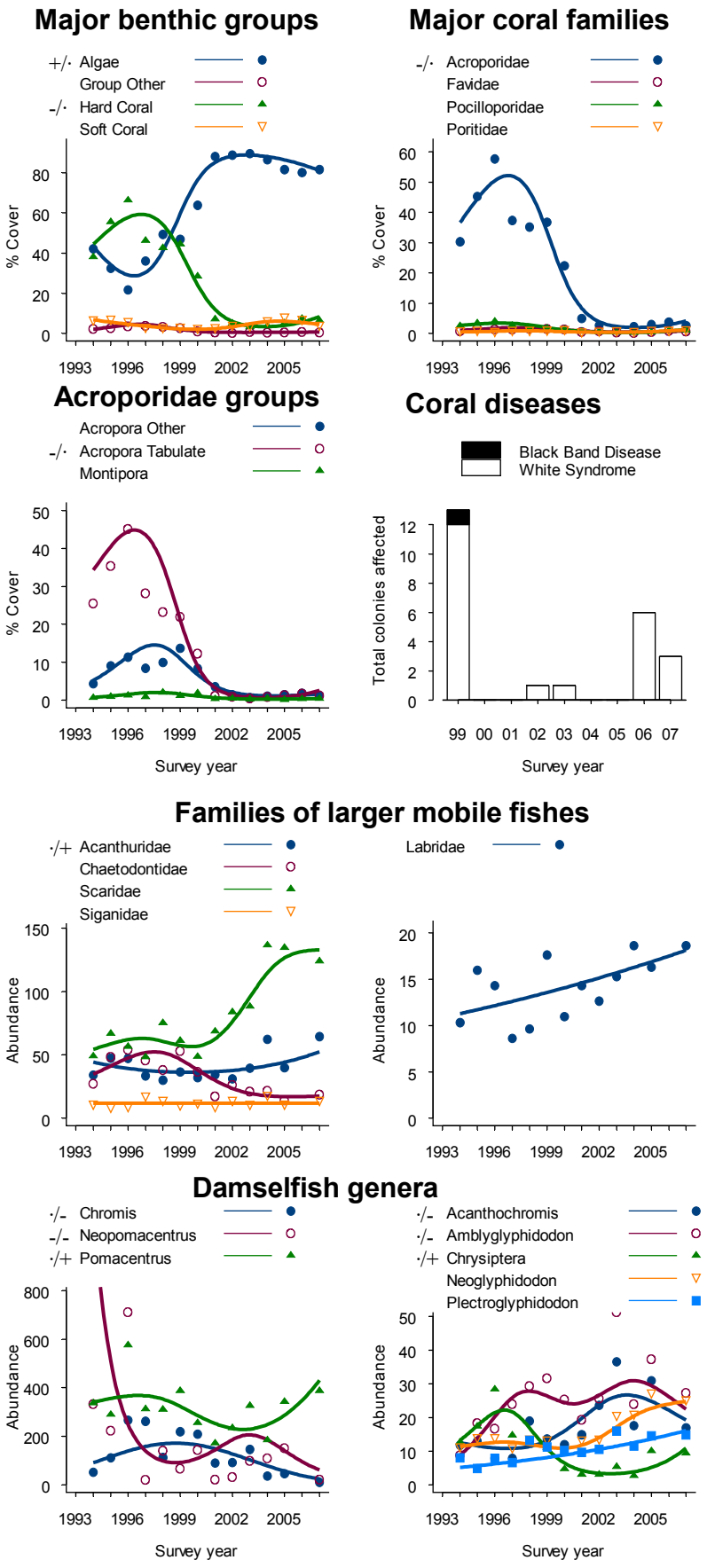
Figure 5.102



Rib Reef (No. 18-032) is a mid-shelf crescentic reef with an area of 5 sq.km.

Figure 5.102 (cont.)

Rib Reef was last surveyed in June 2007.



ROXBURGH

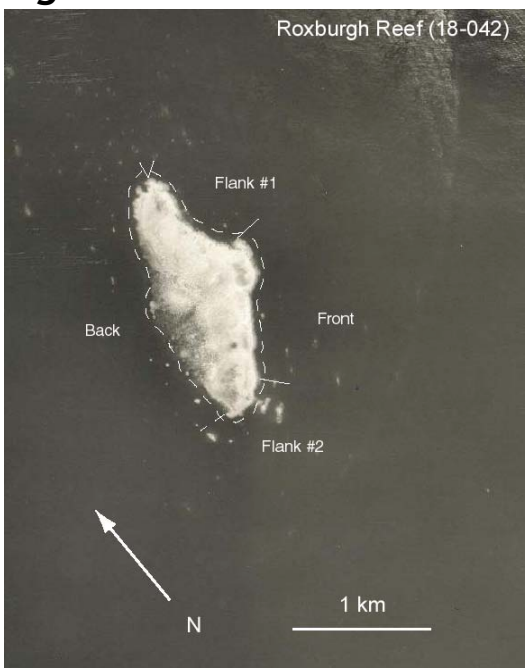
2006 was the first time Roxburgh Reef had been surveyed using manta tow. Median reef-wide live coral was moderate (11-20%) and no COTS were observed. No coral bleaching was observed in 2006, however, there were signs that white syndrome disease had affected many scattered coral colonies on the back reef.

In 2006 intensive SCUBA surveys were carried out at newly established sites for the first time on Roxburgh Reef. The benthic community was dominated by algae (79% cover) in 2006. Turf algae was the major constituent of the algal community, accounting for 65% of the benthic cover. Coralline algae followed with 9% cover. Hard coral cover was moderate at 13%. The Acroporidae and Poritidae families contributed equally to the benthic community, each with 4% cover. Soft coral abundance was low at 5% cover and was comprised of 1% cover of Alcyoniidae and 2% cover of Xeniidae. White syndrome was rare along the fixed transects. Only one juvenile COTS was present in 2006. *Drupella* spp. were observed at a density of 20/ha.

Numbers of reef fishes were generally lower at Roxburgh Reef compared to those recorded on surrounding reefs. Due to the predominance of algae at this reef, herbivorous fishes from the families Acanthuridae and Scaridae formed the bulk of the abundance of large mobile fishes. Butterflyfishes (Chaetodontidae) were present in moderate numbers, but the species of highest abundance were generalist feeders. Hard coral feeders of the butterflyfish family were present in low numbers or not at all. Three genera of damselfishes, *Pomacentrus*, *Acanthochromis* and *Plectroglyphidodon*, constituted the bulk of abundance in this family. Species of the highest abundance were affiliated with herbivory or planktivory and included, *Pomacentrus wardi*, *P. lepidogenys*, *Acanthochromis polyacanthus* and *Plectroglyphidodon lacrymatus*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.103



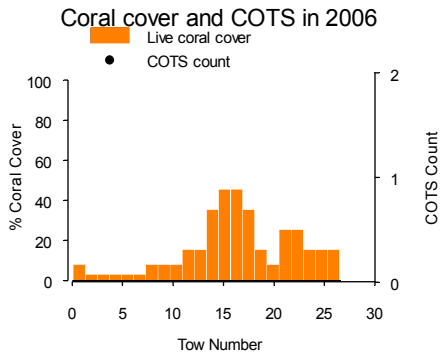
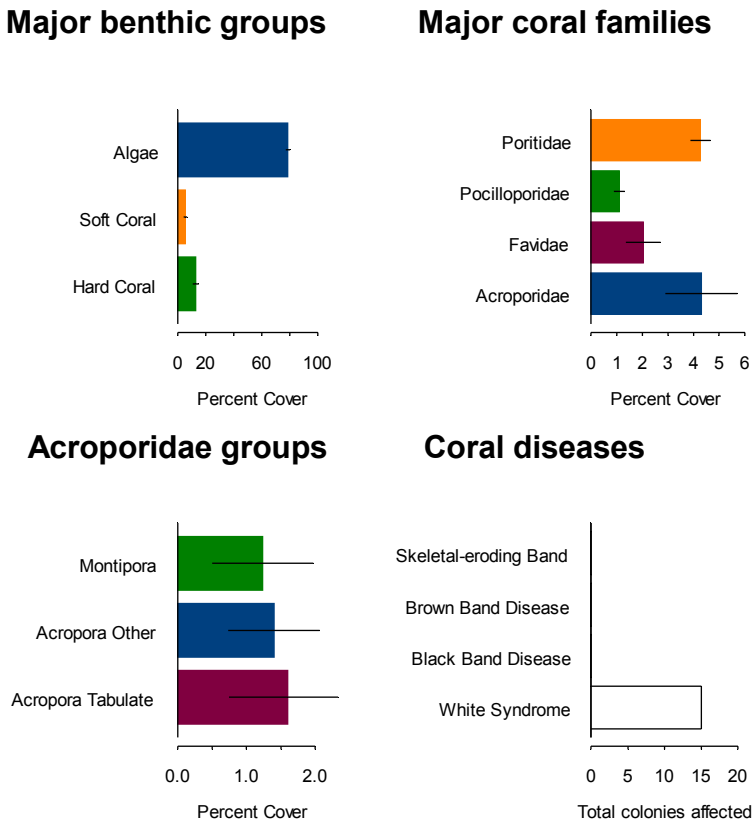
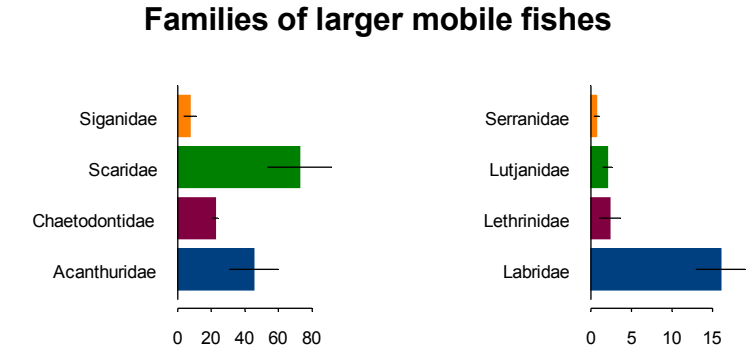
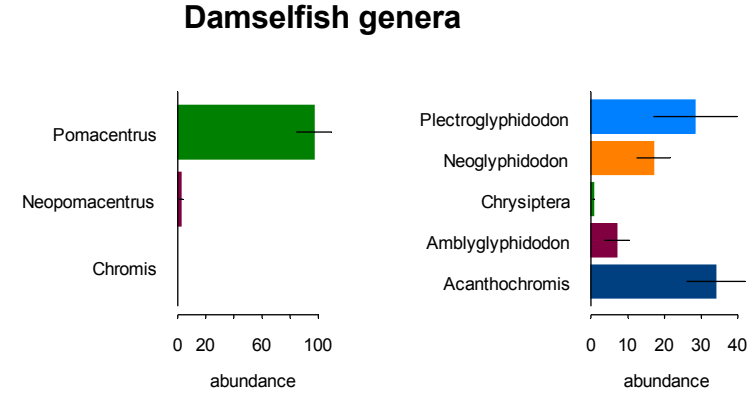


Figure 5.103 (cont.)
Roxburgh Reef was last surveyed in September 2006.





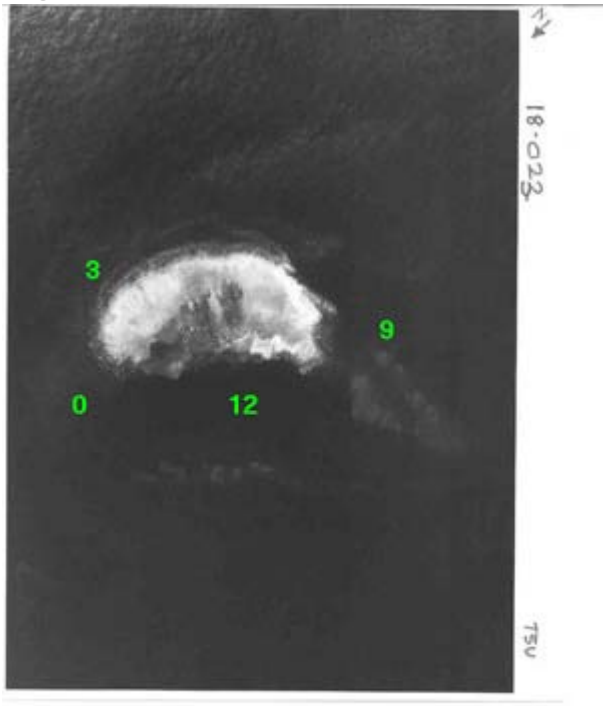


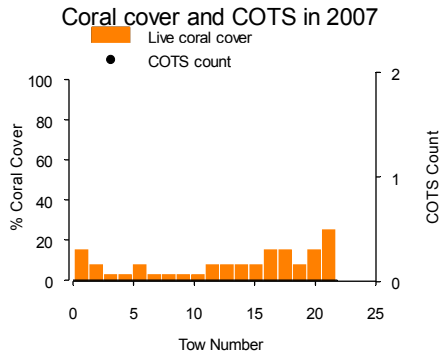
18-023

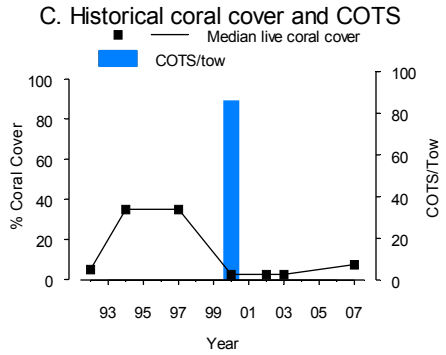
Reef 18-023 has been surveyed using manta tow seven times since 1992. Median reef-wide live coral cover was initially low (1-10%). As there was no COTS history prior to 1992, the reef was classified as No Outbreak. Reef-wide live coral cover subsequently increased to a high level (31-50%) in 1994 and remained at this level in 1997. Surveys in 2000 revealed extremely high COTS densities and the reef was reclassified as an Active Outbreak. At the time, approximately 85 COTS were counted during every two-minute manta tow. This is the highest density of COTS ever recorded on any reef since the LTMP broadscale surveys began in 1983. COTS feeding activity dramatically reduced the median reef-wide live coral cover from 31-40% in 1997 to less than 5% in 2002, when no COTS were found and the reef was reclassified as Recovering. In 2007 median reef-wide live coral cover on this reef appeared to be showing some signs of recovery but still remained low (6-10%). No COTS were observed and no bleaching or signs of disease were recorded at Reef 18-023 in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.104







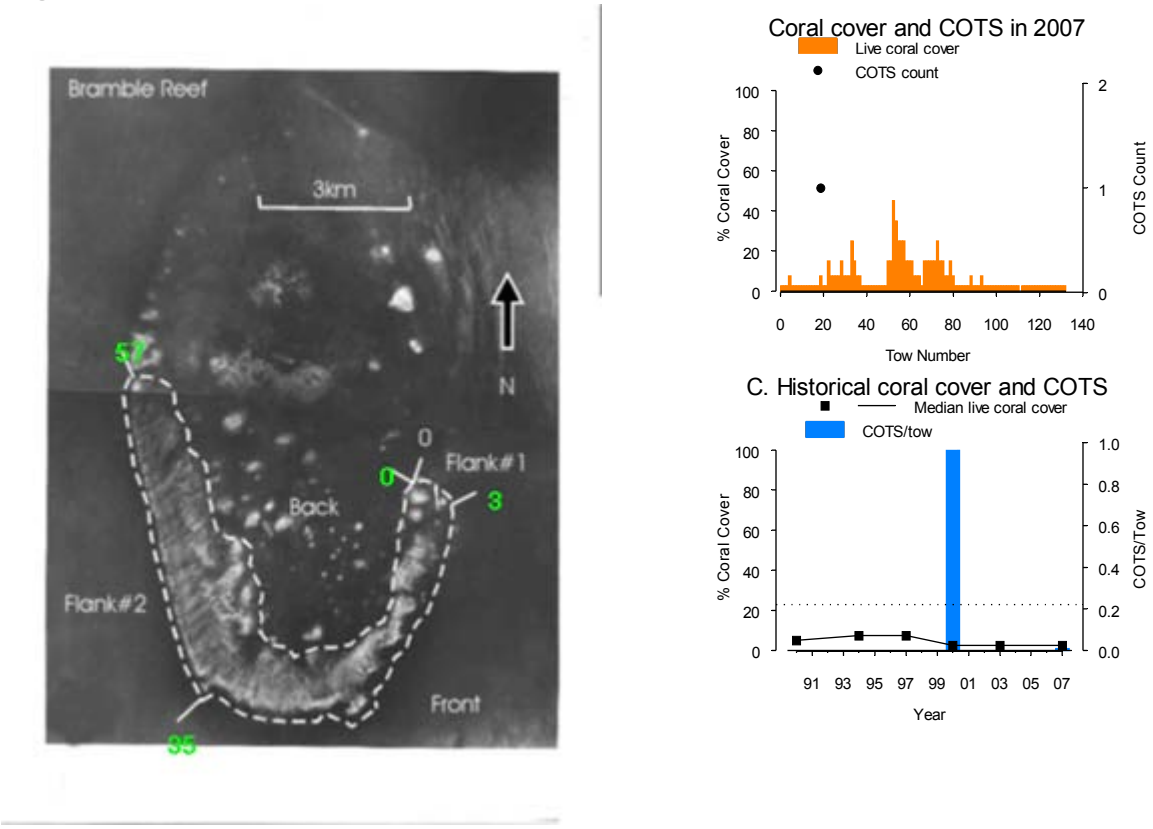
Reef 18-023 (No. 18-023) is an outer shelf patch reef with an area of 3.1 sq.km.

BRAMBLE

Bramble Reef has been surveyed using manta tow six times since 1990. There was evidence of COTS activity prior to the commencement of surveys so the reef was initially classified as Recovering. Recovery was slow and median reef-wide live coral cover remained low (1-10%) until 1997, by which time there were extensive areas of moderate to high coral cover on the front and flanks of the reef. Large sandy areas on the back of Bramble Reef tend to drive reef-wide estimates of coral cover down. Incipient Outbreak levels of COTS were recorded in 2000, along with a drop in median reef-wide live coral cover to a low (1-5%) level, and the patches of high coral cover disappeared. Reef-wide live coral cover was very low (1-5%) in 2003. Surveys in 2007 showed encouraging signs of recovery on the front and flanks of this reef, though overall reef-wide live coral cover remained low. No COTS, bleaching or signs of black band disease were recorded during surveys in 2007. Signs of white syndrome disease were observed on small numbers of scattered individual colonies on the front reef. Bramble Reef remained classified as Recovering in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.105



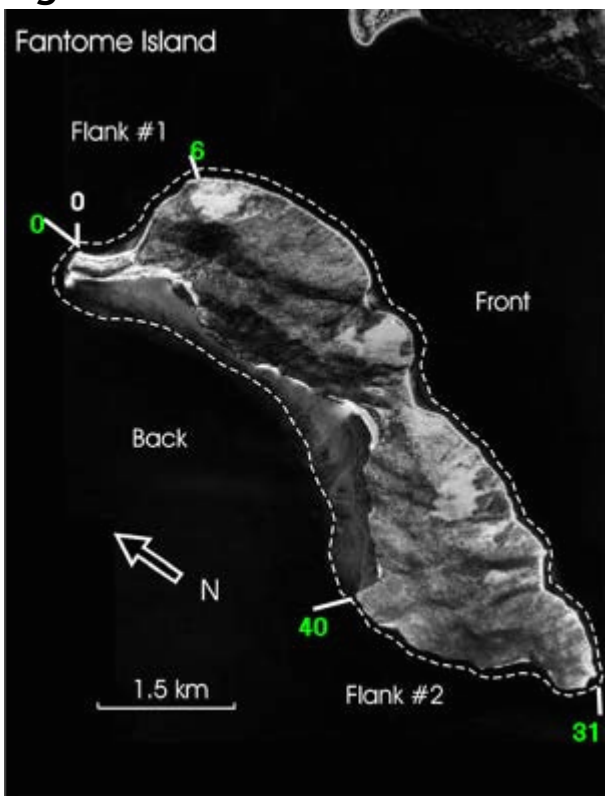
Bramble Reef (No. 18-029) is a mid-shelf crescentic reef with an area of 61.3 sq.km.

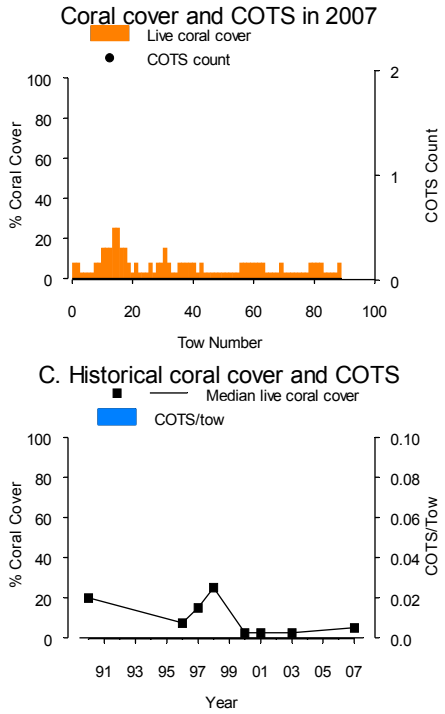
FANTOME IS

Fantome Island Reef has been surveyed using manta tow eight times since 1990. Median reef-wide live coral cover has varied between moderate and low levels over this time. No COTS have been recorded and the reef has remained classified as No Outbreak. After a number of years of increase, reef-wide live coral cover declined from the moderate levels (11-30%) observed in 1998 to a low level (1-5%) recorded in 2000. This substantial reduction was most likely due to the coral bleaching event that severely affected reefs in the area in 1998. Reef-wide live coral cover remained low in 2007. No COTS, coral bleaching or signs of disease were recorded during surveys in 2007. Fantome Is Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.106





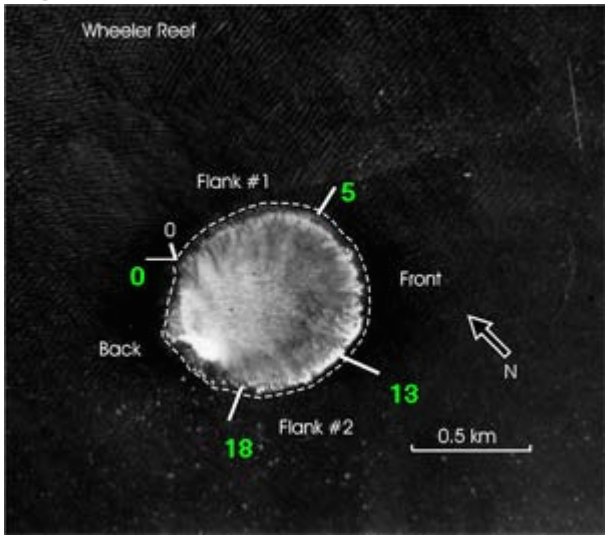
Fantome Is Reef (No. 18-053) is an inshore fringing reef with an area of 1.9 sq.km.

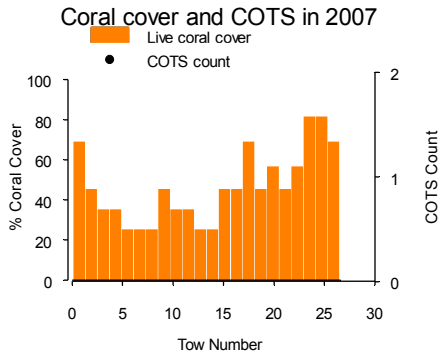
WHEELER

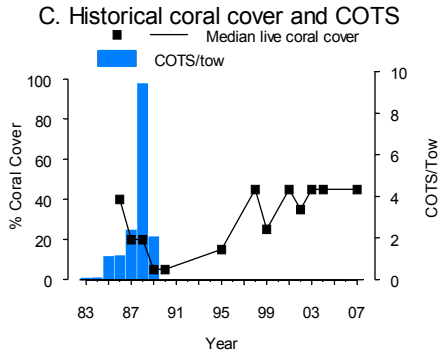
Wheeler Reef has been surveyed using manta tow 13 times since 1983, when it was classified as No Outbreak. Active Outbreak levels of COTS were first observed in 1985 and persisted through to 1989, with the population size peaking in 1988. No COTS have been observed from 1990 to 2007 and the reef was reclassified as Recovering in 1991. Median reef-wide live coral cover dropped from a high level (31-50%) in 1986 to a low level (1-10%) in 1988. By 2003 coral cover had recovered to the high levels (31-50%) that were recorded prior to COTS outbreaks in the early 1980s. Wheeler Reef was reclassified from Recovering to No Outbreak in 1998. Reef-wide coral cover declined to a moderate level (21-30%) following the bleaching event of 1998. However, it recovered quickly and was recorded at a high level again in 2001. Surveys in 2007 showed median reef-wide coral cover remained high. No COTS coral bleaching or signs of black band disease were recorded in 2007. Signs of white syndrome affected a few scattered coral colonies around the reef perimeter. Wheeler Reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.107







Wheeler Reef (No. 18-095) is a mid-shelf planar reef with an area of 1.9 sq.km.

Cape Upstart

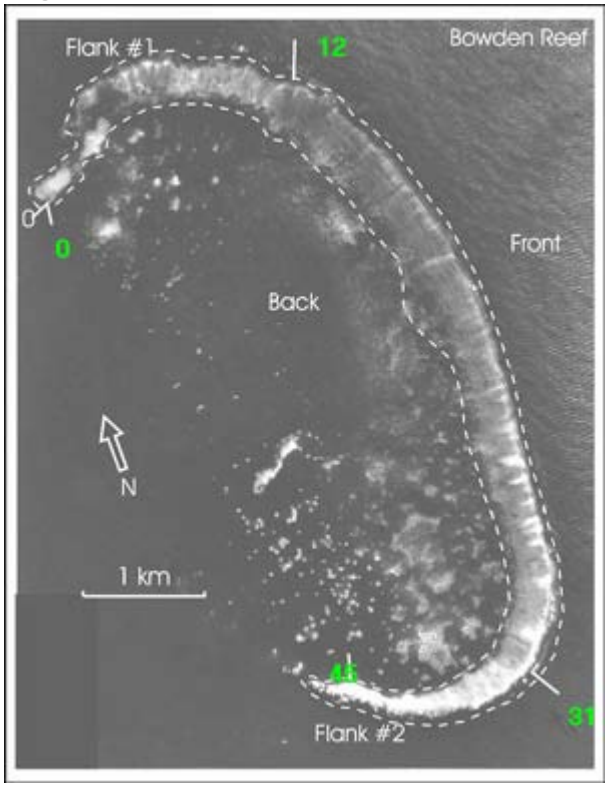
Reef Pages

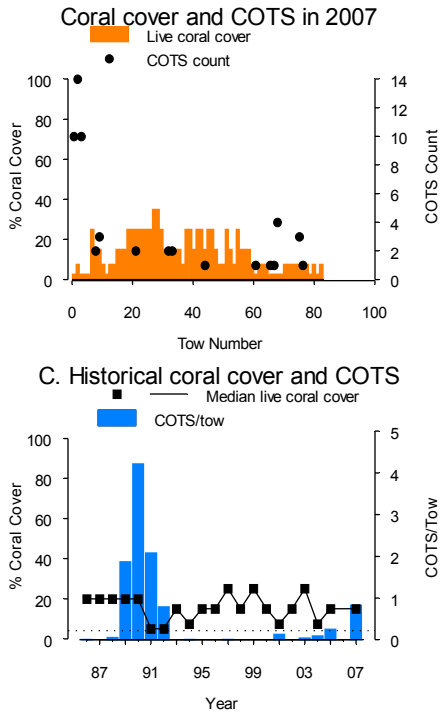
BOWDEN

Bowden Reef has been surveyed using manta tow regularly since 1986. A major outbreak of COTS between 1989 and 1992 resulted in a sharp decline in median reef-wide live coral cover from a moderate (11-30%) to a low level (1-10%). From 1993, COTS numbers only persisted at a very low and reef-wide live coral cover slowly increased. In 2001 the COTS population began to increase. Surveys in 2007 showed that COTS numbers had continued to increase and had reached the highest level recorded since the end of the previous outbreak in 1992. Bowden Reef was reclassified as an Incipient Outbreak in 2005 and retained this classification in 2007. COTS numbers in 2007 occurred at a level expected to cause notable loss in reef-wide live coral cover, however, at the time of survey coral cover remained at moderate (11-20%) levels. Coral bleaching was observed on a few scattered coral colonies on the front reef. Signs of white syndrome were also observed on a few scattered coral colonies on the northern and southern flanks as well as on the front reef. No signs of black band disease were observed during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.108





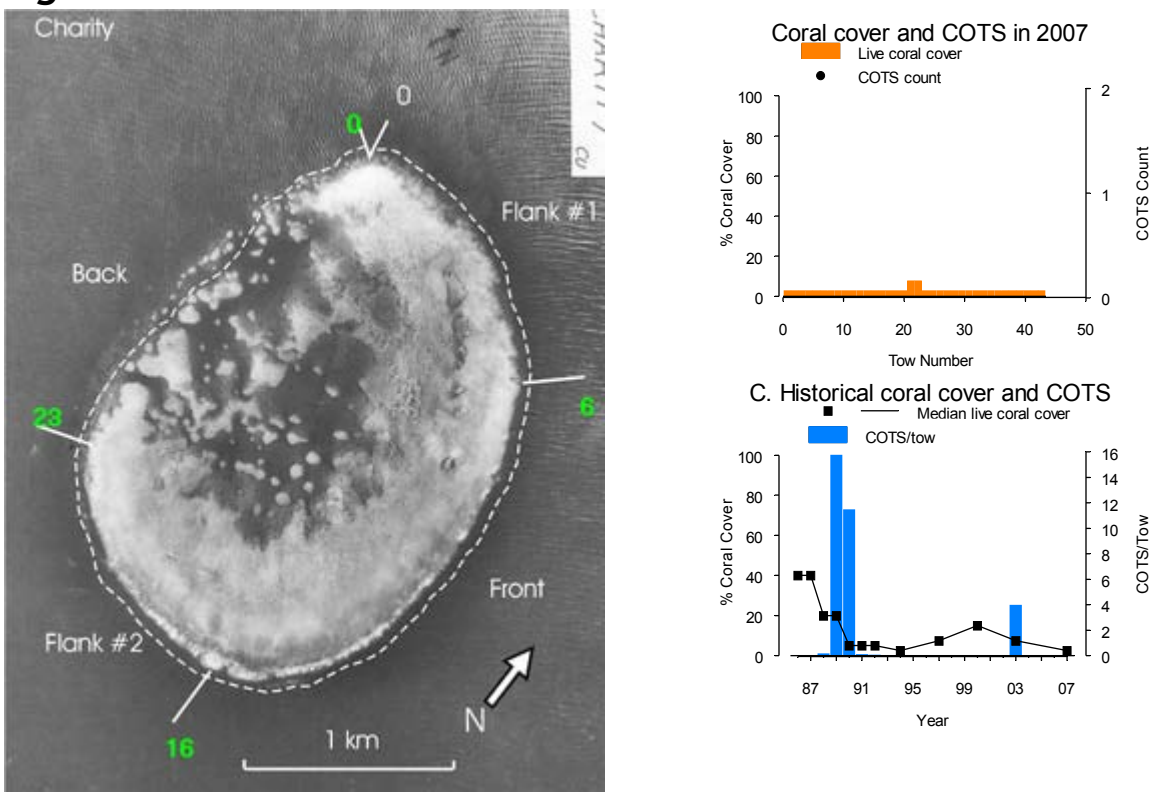
Bowden Reef (No. 19-019) is a mid-shelf crescentic reef with an area of 9.4 sq.km.

CHARITY

Charity Reef has been surveyed using manta tow twelve times since 1986. Median reef-wide live coral cover was initially high (31-50%) but dropped to less than 10% in 1990 due to a COTS outbreak. Coral cover remained low (1-10%) until 1994, at which point it began to recover. No COTS were present from 1992 until 2003. Reef-wide live coral cover reached moderate levels (11-30%) over this time, peaking in 2000. By 2003 there was a new Active Outbreak of COTS and a corresponding decline in coral cover to a low level (6-10%). Interestingly, in the period between outbreaks coral cover on this reef did not recover to a level seen prior to the first recorded outbreak. Surveys in 2007 showed that reef-wide live coral cover has declined further on this reef to a very low (1-5%) level. No COTS were observed and the reef was reclassified as Recovering. No signs of bleaching or coral disease were observed in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.109



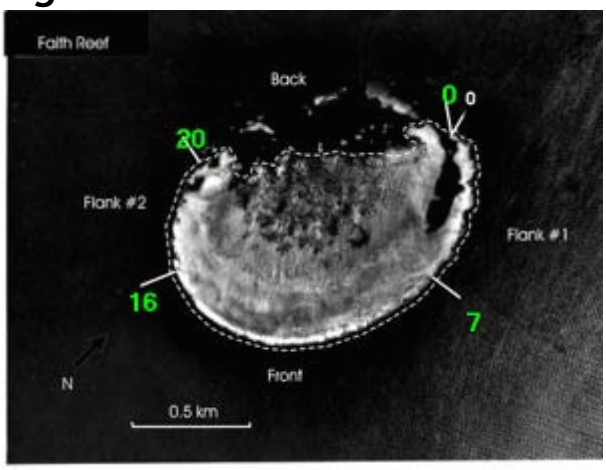
Charity Reef (No. 19-047) is a mid-shelf crescentic reef with an area of 3.8 sq.km.

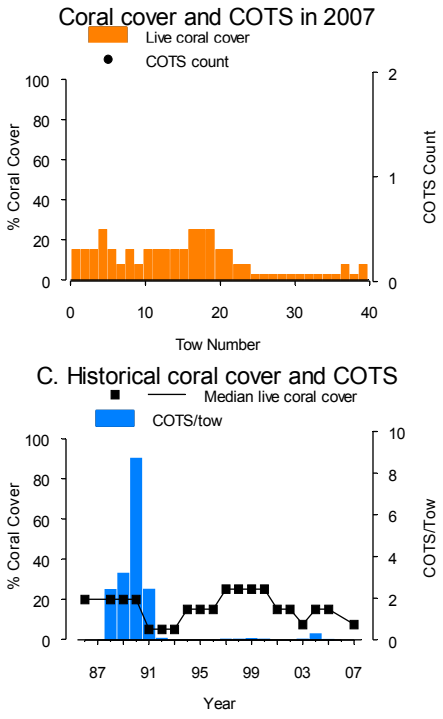
FAITH

Faith Reef has been surveyed using manta tow regularly since 1986. Median reef-wide live coral cover was moderate (11-30%) until 1990, when an outbreaking population of COTS reduced coral cover to below 10%. Reef-wide live coral cover had recovered to former levels by 1997 and the reef was reclassified as No Outbreak. Coral cover then declined to a low level (1-10%) in 2003 for unknown reasons. Although COTS population sizes recorded between 1999 and 2007 were considered too small to affect reef-wide live coral cover, low level COTS feeding activity, together with the bleaching events of 1998 and 2002, are considered responsible for the observed decline in reef-wide live coral cover. A small recovery in coral cover to moderate (11-20%) levels came to a hault in 2004 when COTS numbers increased and Faith Reef was reclassified as an Incipient Outbreak. Small numbers of COTS were observed during surveys in 2005 and the reef was reclassified as No Outbreak. Surveys in 2007 indicated reef-wide live coral cover had declined once more to a low level (6-10%), most likely due to past COTS feeding activity. No COTS, coral bleaching or signs of coral disease were recorded during surveys in 2007. The reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.110





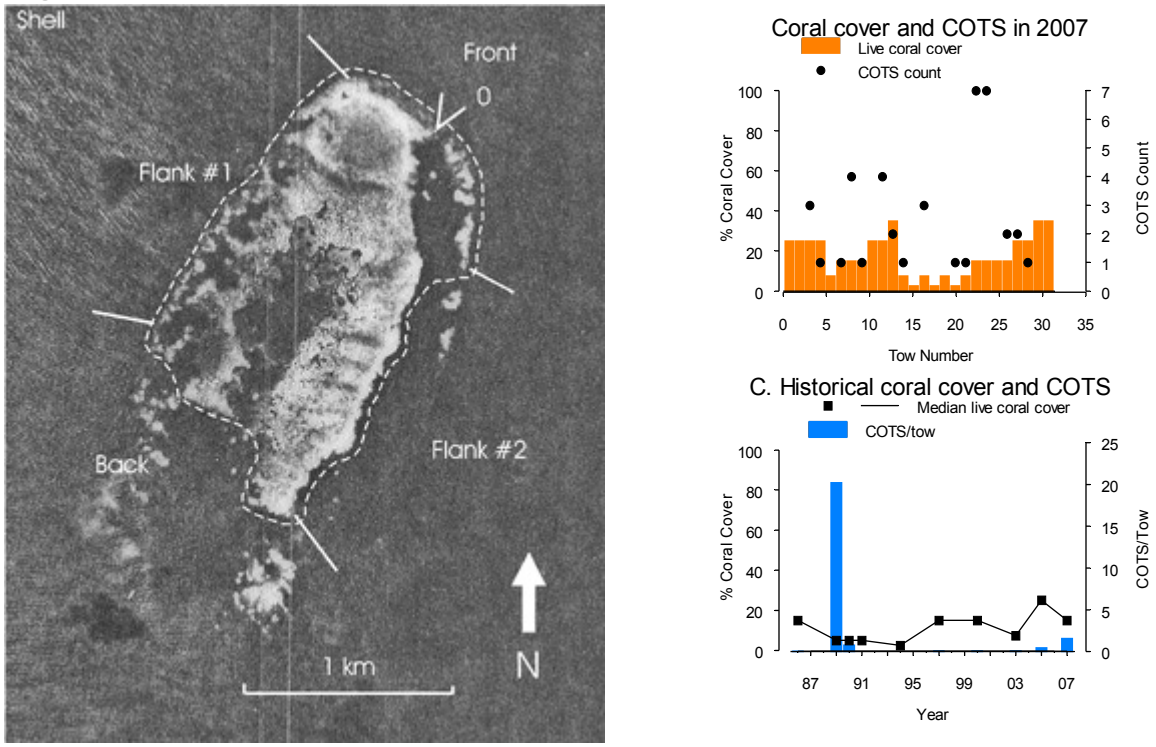
Faith Reef (No. 19-044) is a mid-shelf crescentic reef with an area of 3.8 sq.km.

SHELL

Shell Reef has been surveyed ten times using manta tow since 1986. Initially median reef-wide live coral cover was moderate (11-30%) but dropped to a low level (1-10%) by 1990 following a COTS outbreak in 1989 and 1990. Shell Reef was classified as Recovering in 1991. From 1995, reef-wide live coral cover slowly increased to a moderate level in 1997 but had decreased again by 2003. The reasons for the decrease in reef-wide live coral cover are unknown. COTS were observed in all three surveys between 1997 and 2003 but in numbers considered too low to affect reef-wide live coral cover. Surveys in 2005 indicated an increase in COTS activity and Shell Reef was reclassified as Incipient Outbreak. Surveys in 2007 showed COTS numbers had continued to increase and the reef was reclassified as an Active Outbreak. With the increased COTS activity, reef-wide coral cover declined to a moderate (11-20%) level. No bleaching or signs of black band disease were observed in 2007. Signs of white syndrome disease were observed on only a few scattered coral colonies on the front of the reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.111



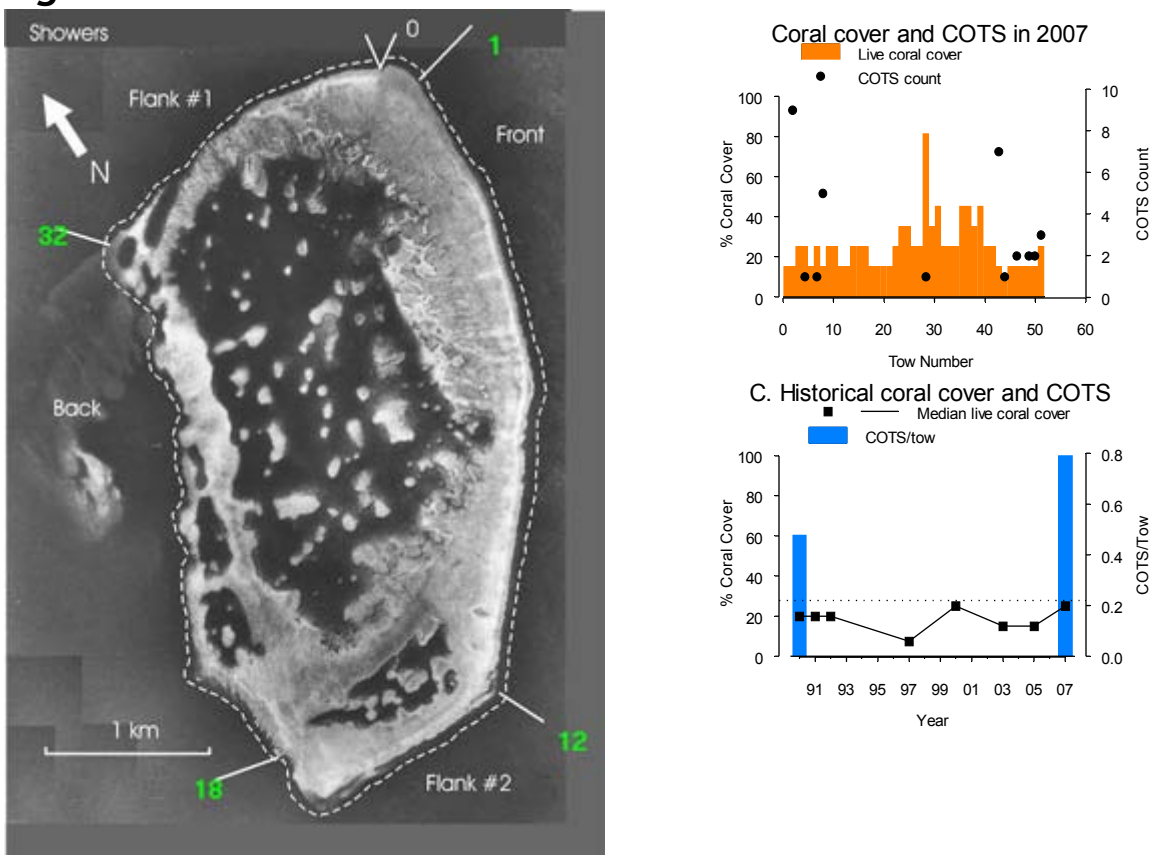
Shell Reef (No. 19-028) is a mid-shelf crescentic reef with an area of 2.5 sq.km.

SHOWERS

Showers Reef has been surveyed using manta tow eight times since 1990, when there was an Incipient Outbreak of COTS and median reef-wide live coral cover was moderate (11-30%). Reef-wide live coral cover has remained moderate since this time. Surveys in 2007 indicated elevated COTS numbers for the first time since 1990 and the reef was reclassified as Incipient Outbreak. Reef-wide live coral cover remained moderate in 2007. Coral bleaching was observed on a few scattered coral colonies on the back reef, along with signs of black band disease. Signs of white syndrome were observed on a few scattered coral colonies on the northern and southern flanks and also on the back reef during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.112



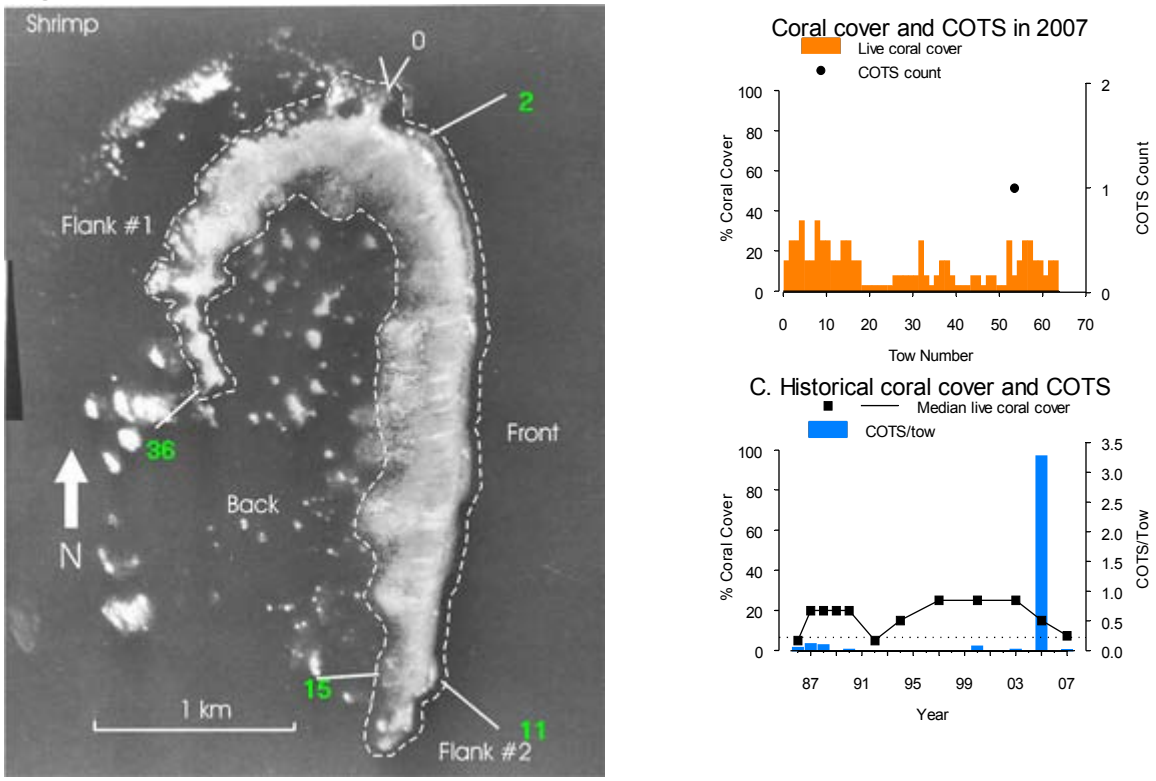
Showers Reef (No. 19-076) is a mid-shelf lagoonal reef with an area of 8.79 sq.km.

SHRIMP

Shrimp Reef has been surveyed using manta tow 12 times since 1986. Median reef-wide live coral cover was initially low (1-10%) but reached moderate levels (11-30%) by 1990, before declining to a low level by 1992. Low COTS numbers were recorded during this period and are likely to have contributed to this decline. Between 1992 and 1997, reef-wide live coral cover gradually increased, returning to moderate levels (11-30%). COTS were observed on Shrimp Reef in 2000 and 2003, but in numbers considered too low to affect reef-wide live coral cover. Reef-wide live coral cover had declined by 2005 (though it was still moderate). A large COTS population was present in 2005 and the reef was reclassified as an Active Outbreak. Surveys in 2007 showed COTS numbers had declined on Shrimp Reef and it was reclassified as Recovering. There had been a further decline in reef-wide live coral cover to a low (1-10%) level as a result of COTS feeding activity. No bleaching or signs of black band disease were recorded in 2007, while signs of white syndrome disease affected a few scattered coral colonies on the back reef and the first flank.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.113



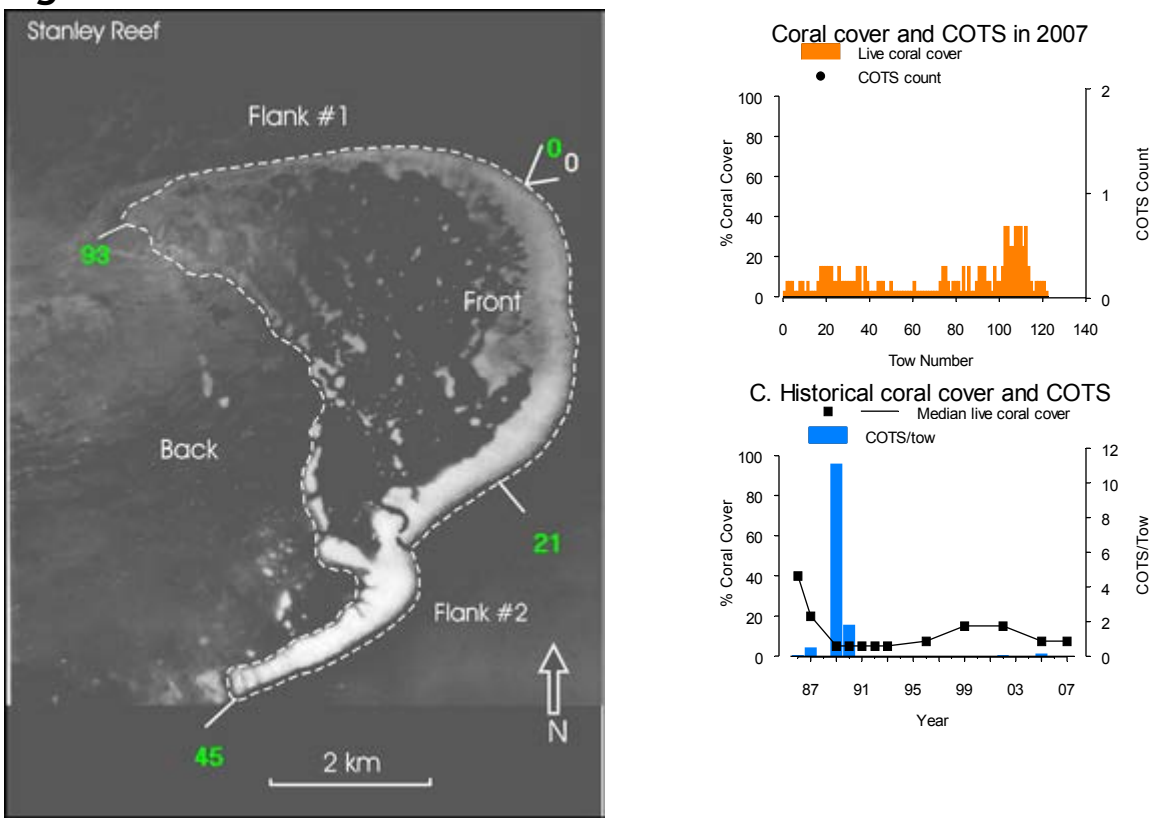
Shrimp Reef (No. 18-118) is a mid-shelf crescentic reef with an area of 7.5 sq.km.

STANLEY

Stanley Reef has been surveyed using manta tow 12 times since 1986, when median reef-wide live coral cover was at a high (31-50%) level. Coral cover declined to a low level (1-10%) in 1989 due to a COTS outbreak, which persisted through to 1990. Reef-wide live coral cover increased gradually through the 1990s to a moderate level by 1999. COTS were recorded in 2002, but in numbers considered too few to affect reef-wide live coral cover, which remained moderate (11-30%). Surveys in 2005 indicated a decline in reef-wide coral cover to a low level (1-10%). While COTS were observed on the reef they were below outbreak levels, but local populations were large enough to cause significant coral mortality on the parts of the reef affected. No COTS were observed during surveys in 2007 and coral cover remained low. Stanley Reef remained classified as Recovering. No bleaching or signs of coral disease were recorded during surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.114



Stanley Reef (No. 19-045) is a mid-shelf crescentic reef with an area of 58.1 sq.km.

Whitsundays

Reef Pages

19-131

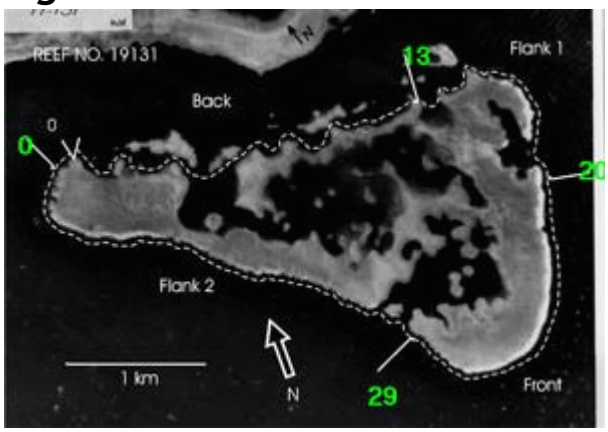
Reef 19-131 has been surveyed using manta tow 16 times since 1989. Median reef-wide live coral cover was moderate (11-30%) from 1989 until 1996. Reef-wide live coral cover declined in 1997, although it was still moderate (11-20%) and it was similar in 1998 surveys. The small decline may be attributed to damage caused by Cyclone Justin which passed the Whitsunday coast before surveys were done in 1997. Coral mortality from the bleaching event in 1998 may not have been evident in the surveys done in 1998, however a decline to low levels of reef-wide coral cover was seen in 1999. Reef-wide live coral cover then increased to a moderate level in 2002. Surveys in 2003 recorded a decline to low cover (1-10%), most likely a result of coral bleaching in 2002. Since 2004, reef-wide coral cover has increased slightly but remained at moderate levels in 2007. No COTS have been recorded at Reef 19-131 and it remained classified as No Outbreak in 2007. No signs of black band disease or coral bleaching were observed during manta tow surveys in 2007. Low levels of white syndrome, restricted to small numbers of scattered coral colonies, were observed on the front and southern flank of the reef.

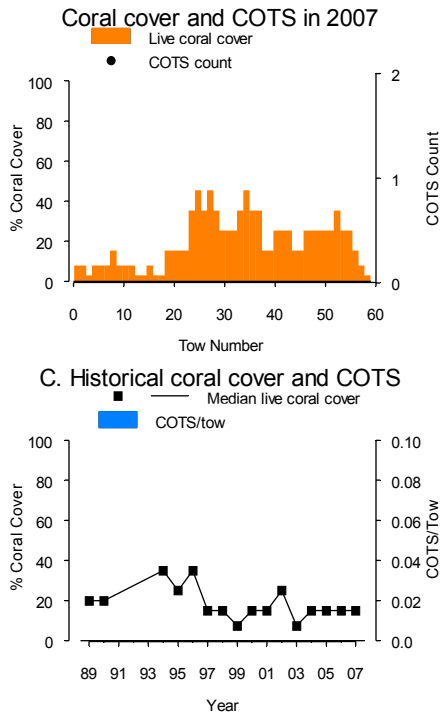
Intensive surveys of benthos showed that hard coral cover peaked at 60% in 1996 followed by a marked decline to 37% cover by April 1997, just after Cyclone Justin had passed the area in March 1997. This decline is quite substantial compared with the small decline observed at the same time in broadscale surveys. Hard corals in the family Acroporidae were most susceptible to this disturbance with large declines recorded in the genus *Montipora* spp. and in tabulate *Acropora* spp. While there was a slight decline in 1998, it is difficult to attribute this to the bleaching event, as there was such a large disturbance less than a year before. After gradually increasing until 2002, another sudden decrease in hard coral cover was recorded in 2003, which may be attributed to the bleaching event in 2002. By 2007 hard coral cover had increased to 42%. The increase in hard coral cover was attributed to the increase in abundance of the Acroporidae family. The percent cover of Faviidae, Pocilloporidae and Poritidae have been consistent since the start of intensive surveys. In 2007 the highest Faviidae cover recorded for any reef in that survey year was 12% at Reef 19-131. Soft coral cover has been consistently low (approximately 1%) over the survey period. Algal cover has generally increased since 1997, complementing the changes in hard coral cover. In 2007 the algal community had 48% cover and was mainly comprised of turf algae. The occurrence of white syndrome was low in 2007 and the density of corallivorous snails (*Drupella* spp.) was 53/ha.

Numbers of many fish taxa fluctuated greatly between 1994 and 2007 but there have been no prolonged increases or decreases. Abundance values for all families and genera in 2007 were within the previously recorded range. In this sense, most fish taxa have remained relatively stable over the whole survey period.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.115

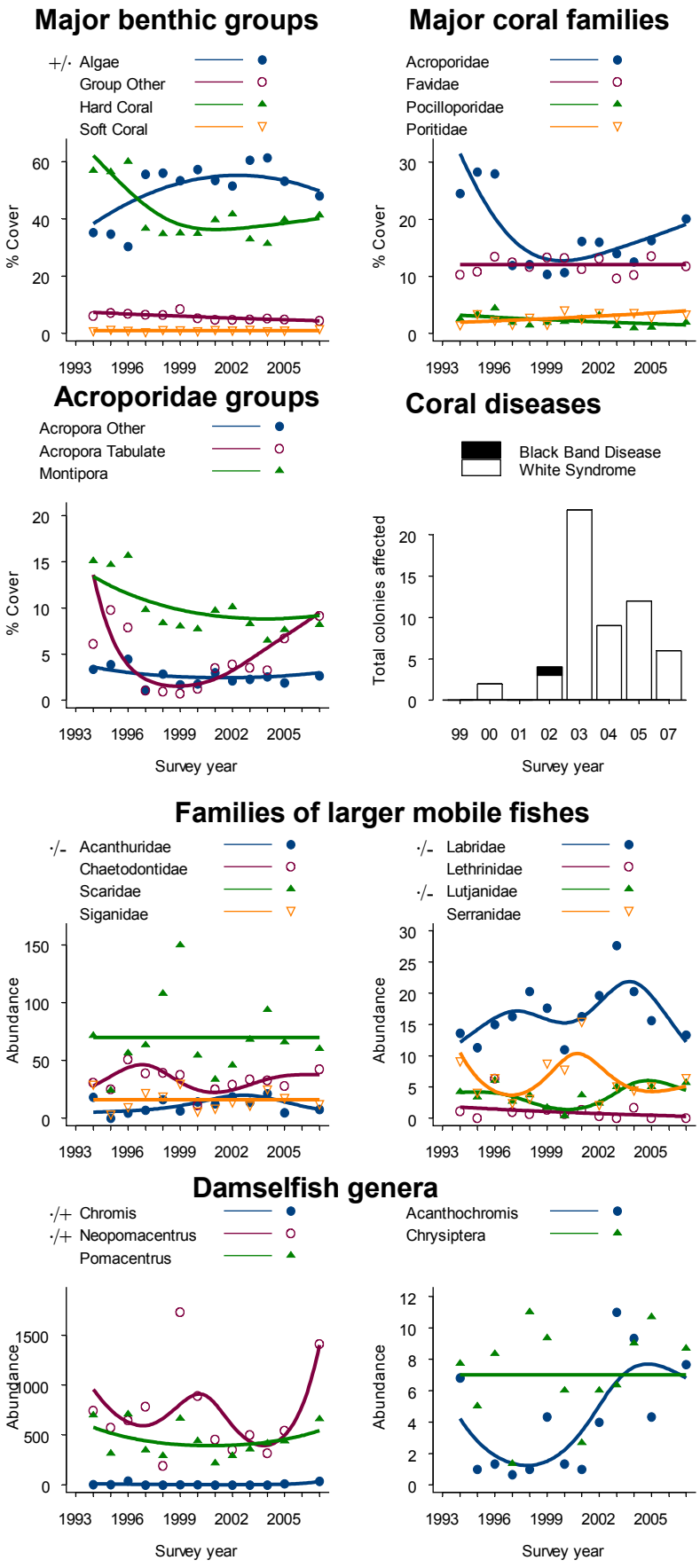




Reef 19-131 (No. 19-131) is a mid-shelf lagoonal reef with an area of 5.6 sq.km.

Figure 5.115 (cont.)

Reef 19-131 was last surveyed in March 2007.



19-138

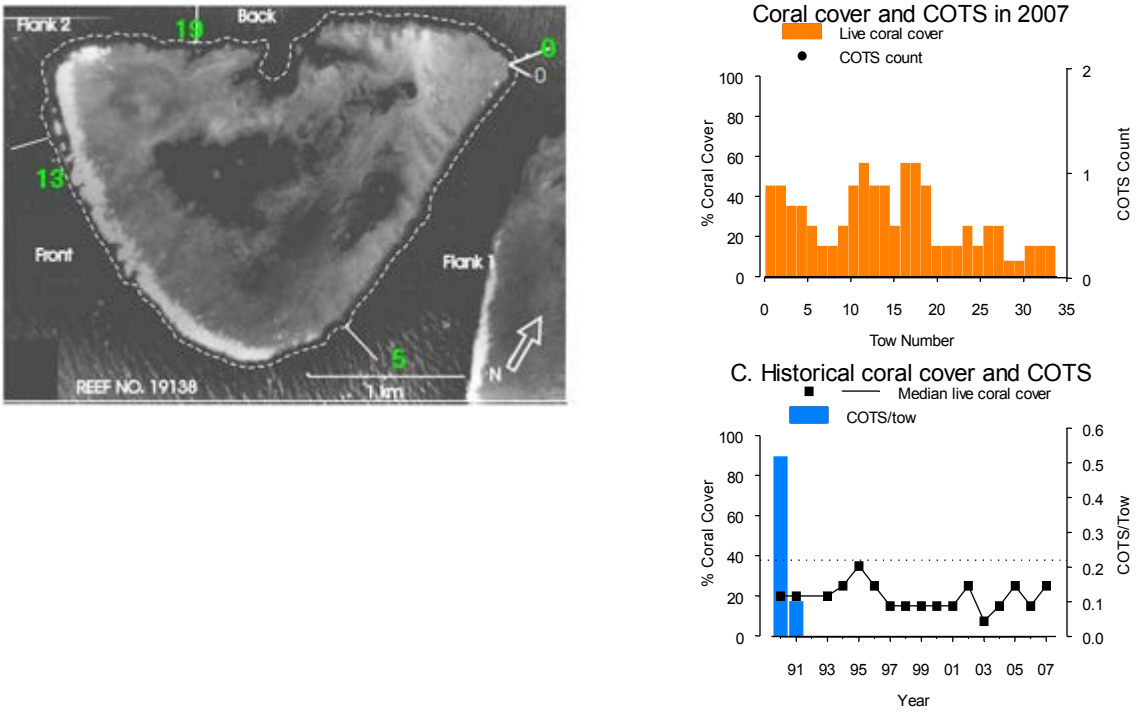
Reef 19-138 has been surveyed by manta tow 17 times since 1990, when there were relatively high numbers of COTS and the reef was classified as an Incipient Outbreak. COTS numbers subsequently declined without having a large affect on median reef-wide live coral cover. Live hard coral cover increased until 1995 before declining to a moderate level (11-30%) by 1997. The decline was probably due to Cyclone Justin in March 1997. Reef-wide live coral cover remained moderate before declining once more in 2003. No COTS were recorded, so the most likely cause of decline is the coral bleaching event in 2002. Subsequent surveys indicate reef-wide live coral cover has increased since this time and is currently moderate (21-30%). No COTS were observed during surveys in 2007 and Reef 19-138 remains classified as Recovering. No bleaching or signs of black band disease were recorded while signs of white syndrome disease were restricted to a few scattered colonies on the southern flank and were common (more than ten colonies per two minute manta tow) on the front reef.

The intensive survey sites were established in 1993, when hard coral cover was moderate at 35%. Hard coral cover increased to a maximum of 41% in 1996 before dropping sharply to 16% in 1997. This decline was attributed to the effects of Cyclone Justin as surveys were done after the cyclone had passed the area in March 1997. Hard coral cover increased slowly from 1998 to 2003 when it reached 23%. From 2004 until 2007 hard coral cover increased from 33% to 47% mainly due to increases in tabulate *Acropora* spp. Unlike the hard corals at Reef 19-138, soft coral cover has been low (1%) since the inception of the detailed surveys. Algal cover has complemented changes in hard coral cover and was 48% in 2007, the lowest cover recorded since surveys began. Corallivorous snails, *Drupella* spp., were observed at a density of 67/ha in 2007 during SCUBA search surveys. The incidence of white syndrome disease has gradually increased since 2002 but was still low in 2007. One medium sized adult COTS was seen on SCUBA search in 2007.

Numbers of many fish taxa fluctuated greatly over the study period with few prolonged increases or decreases. Abundances in 2007 were often within the range of previous years. However, four taxa (Chaetodontidae, *Chromis* spp., *Pomacentrus*spp. and *Amblyglyphidodon*spp.) increased steadily in abundance from around 2003 when coral cover recovery began to escalate after about 50% of hard coral was lost due to Cyclone Justin in March 1997. These taxa contain fish species that often depend heavily on corals for habitat, food or both. Many species drove patterns in Chaetodontidae and *Chromis*spp., while recovery of *Pomacentrus*spp. was driven largely by *P. moluccensis* (a highly coral dependent species) with numbers having returned to pre-cyclone levels in 2007 had hard coral cover. Changes in *Amblyglyphidodon*spp. were driven by *A. curacao* and *A. leucogaster*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

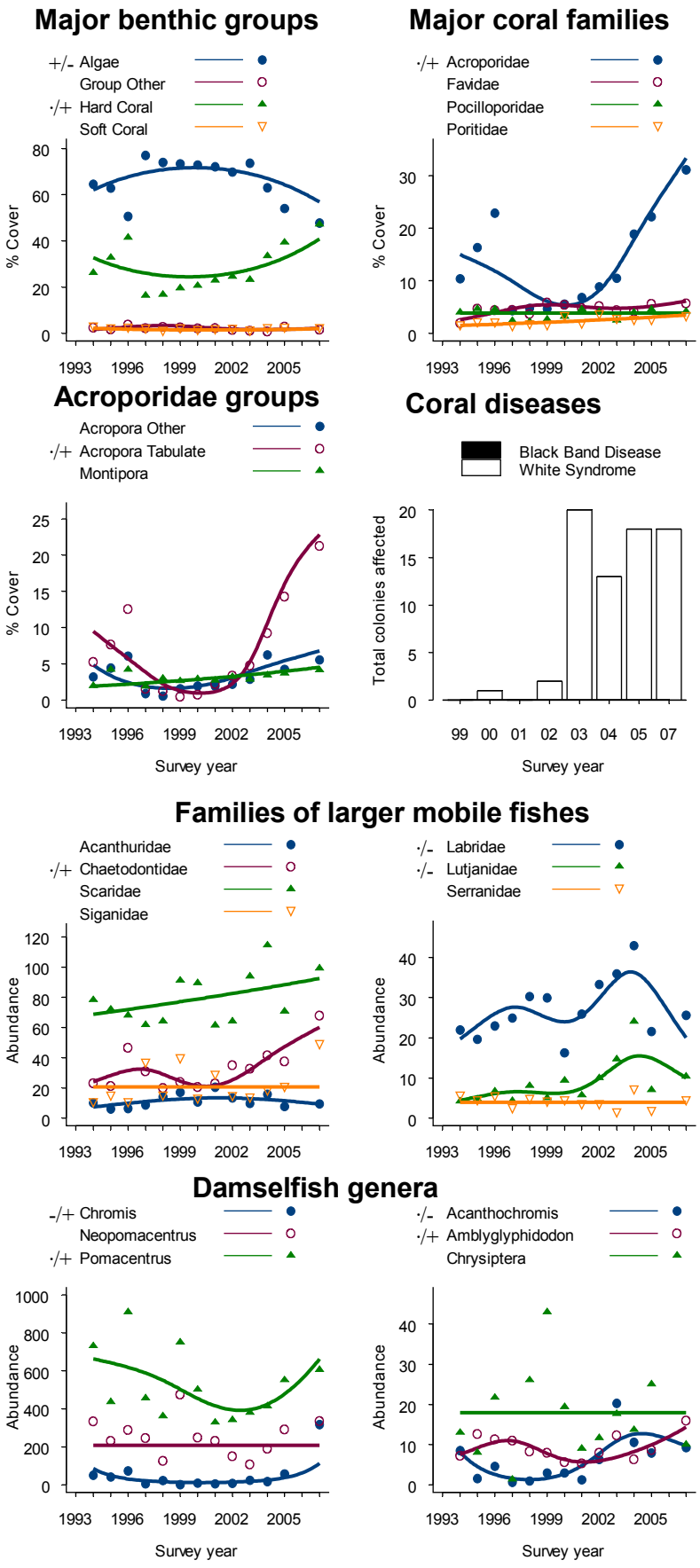
Figure 5.116



Reef 19-138 (No. 19-138) is a mid-shelf lagoonal reef with an area of 2.5 sq.km.

Figure 5.116 (cont.)

Reef 19-138 was last surveyed in March 2007.



20-104

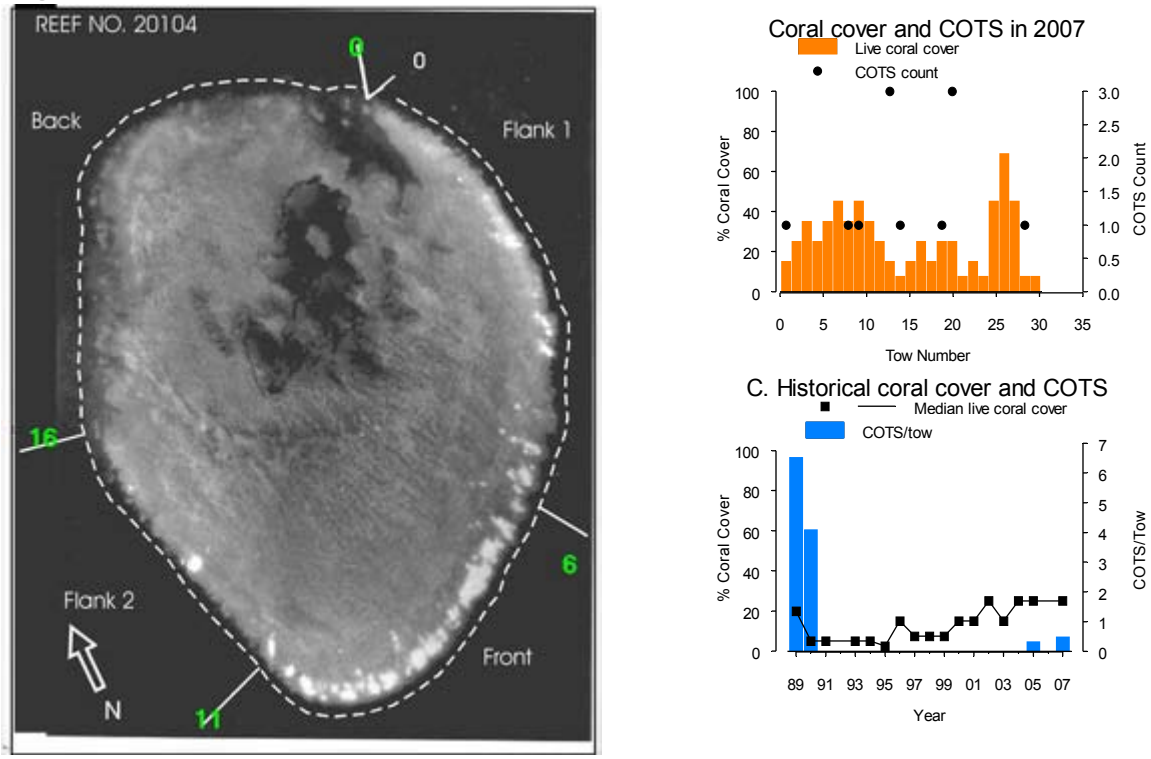
Reef 20-104 has been surveyed regularly by manta tow since 1989 when it had a moderate level (11-30%) of median reef-wide live coral cover. However Reef 20-104 was initially declared an Active Outbreak due to the presence of a large number of COTS. Reef-wide live coral cover declined to low levels (1-10%) in the early 1990s. Reef 20-104 was reclassified as Recovering from COTS in 1991. Reef-wide live coral cover then gradually increased to a moderate level (11-30%) by 2004, although during this time there were a couple of small decreases. The decrease in coral cover in the survey after Cyclone Justin in 1997 was most likley due to cyclone damage as no COTS were recorded.The decrease in coral cover in 2003 was most likely from mortality of coral colonies from the 2002 bleaching event, as no COTS were recorded. Surveys in 2005 revealed increased COTS activity on Reef 20-104 and it was reclassified as an Incipient Outbreak. Surveys in 2007 showed COTS numbers continued to increase on Reef 20-104 and it remained classified as Incipient Outbreak. Coral bleaching and signs of white syndrome disease were restricted to a few scattered colonies on the first flank and low levels of white syndrome were recorded on the front reef. No signs of black band disease were recorded during manta tow surveys in 2007.

Hard coral cover on the intensive survey sites increased consistently from 14% in the initial survey in 1993 to 48% in 2007, although there was a slight decline in 1997, which could be attributed to disturbance of hard corals when Cyclone Justin passed Reef 20-104. The increase in hard coral cover was mainly driven by encrusting *Montipora* spp. and tabulate *Acropora* spp. within the Acroporidae family, which increased from 1% cover in 1993 to 31% in 2007. Soft coral cover has remained low (1-2%) over the survey period. Algal cover decreased steadily from 74% in 1993 to 46% in 2007, with *Halimeda* spp. showing the largest decline from 37% in the initial survey in 1993, to <1% in recent surveys. The algal community has been dominated by turf algae since 1997, with 38% cover recorded in 2007. Incidence of white syndrome disease was very low in 2007 and the density of corallivorous snails, *Drupella* spp., was 113/ha. 6 COTS were seen on SCUBA search surveys in 2007 along with numerous feeding scars. COTS observed at this frequency may be enough to exceed the threshold density required to cause a reduction in hard coral cover.

Although many fish species have fluctuated in abundance over the study period, only some have shown consistent long-term trends and these patterns were mostly driven by increases in abundance of coral dependent species. Two closely related butterflyfish species (*Chaetodon aureofasciatus* and *C. rainfordi*) dominated increases in abundance up to 2007 as hard coral cover increased. Other *Chaetodon* spp. also increased in abundance. 2007 also saw a continued increase in abundance of small *Chromis*spp. damselfishes driven by, *C. atripectoralis* and *C. nitida*. Similarly, *Pomacentrus moluccensis* (a true coral specialist) drove increasing trends in that genera since 2001. Other damselfish genera remained relatively stable except for *Chrysiptera* spp. Decreasing abundance in this genus were driven by *C. rollandi*, whose numbers were at a 15-year low in 2007. This species preferentially inhabits gullies between coral outcrops. It is likely that steady increases in coral cover have reduced habitat for *C. rollandi*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

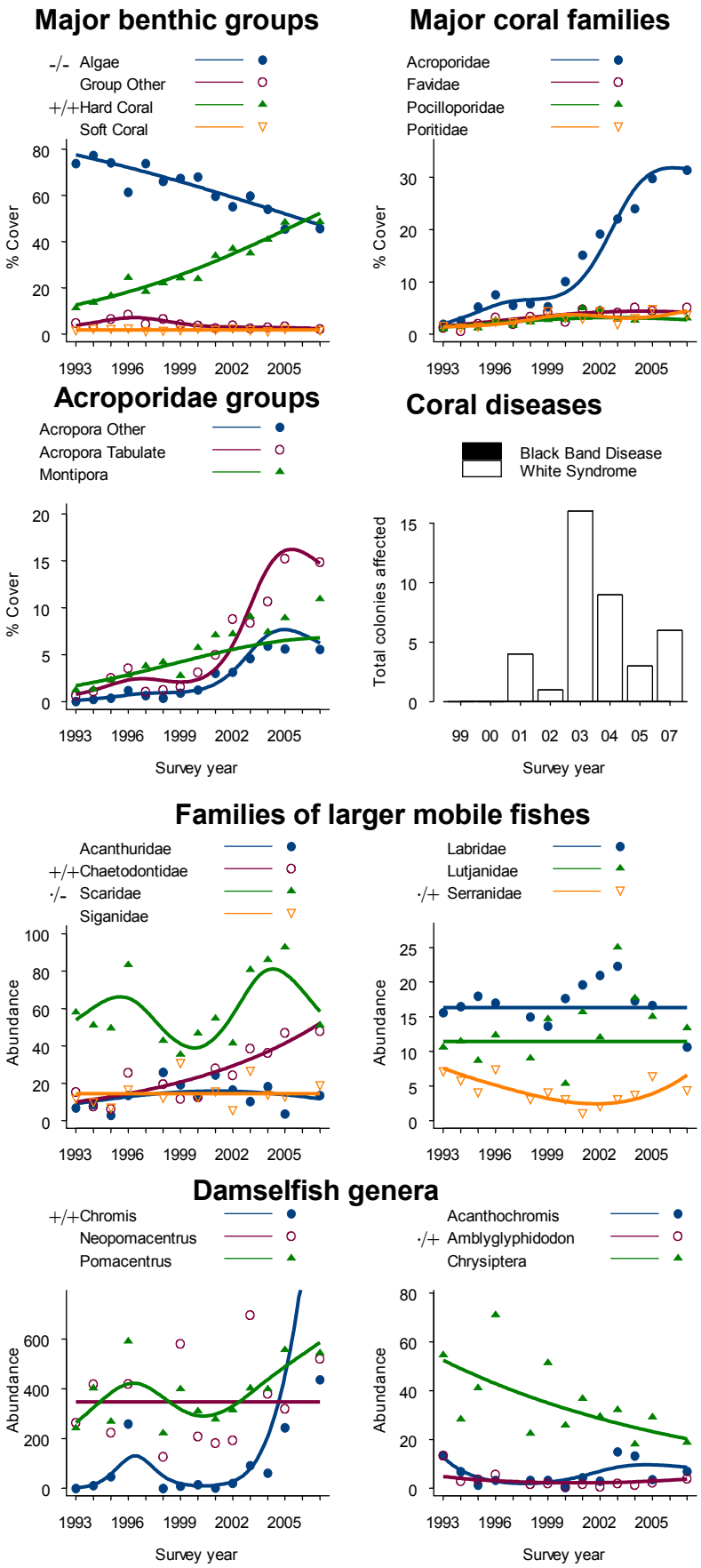
Figure 5.117



Reef 20-104 (No. 20-104) is a mid-shelf lagoonal reef with an area of 1.9 sq.km.

Figure 5.117 (cont.)

Reef 20-104 was last surveyed in March 2007.



HYDE

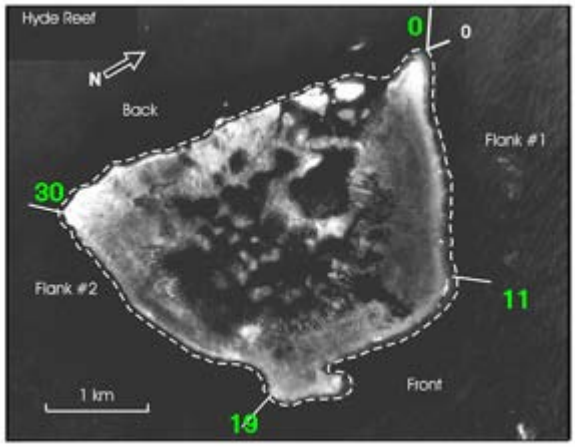
Hyde Reef has been surveyed regularly since 1986. Median reef-wide live coral cover was moderate (11-30%) in 1986 and has changed little since. No COTS have been observed during any survey year and Hyde Reef is classified as No Outbreak. Surveys in 2007 show reef-wide live coral cover remains moderate (21-30%). Coral bleaching was recorded on a few scattered colonies on the second flank while signs of white syndrome disease were restricted to a few scattered coral colonies on the back reef. Signs of black band disease were also recorded from a few scattered coral colonies on the back reef and second flank during manta tow surveys in 2007.

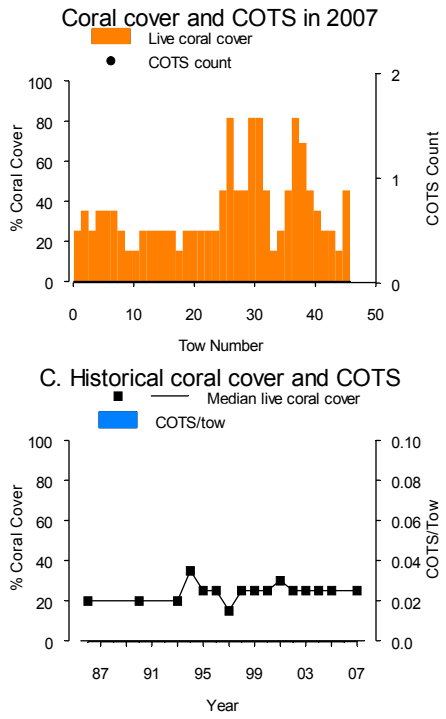
Surveys of the intensive study sites since 1993 indicate a stable benthic community. Hard coral cover in 2007 was moderate (17%). In all intensive surveys from 1993 to 2007 the cover of soft corals has remained high (39-49%) and algal cover has remained moderate (16-29%). Soft corals on Hyde Reef are dominated by the family Xeniidae. In 2007 Hyde Reef had the highest cover of soft coral of all reefs surveyed with 40%. The cover of sponges was also relatively high (about 10%). No white syndrome was recorded on SCUBA search surveys in 2007. Corallivorous snails, *Drupella* spp., were observed at a density of 7/ha and CLOD was noted on coralline algae.

Although numbers of most fish taxa have varied from year to year there has been little tendency for prolonged increases or decreases over the study period. This may reflect the relative stability of the benthos over the same period. Numbers of Scaridae had increased markedly in 2004, but this was due to localised aggregations of spawning species, particularly *Scarus rivulatus*, *S. globiceps* and *S. psittacus*. Scaridae numbers had returned to pre-2004 survey levels in 2005. Abundances of *Chrysiptera* spp. (driven by *C. rex*) declined to very low levels in 2004 but had increased by 2007. *Plectroglyphidodon* spp. abundances have tended to increase since 1995. This trend was driven largely by the algal farmer, *P. lacrymatus*, whose numbers were at their highest in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.118

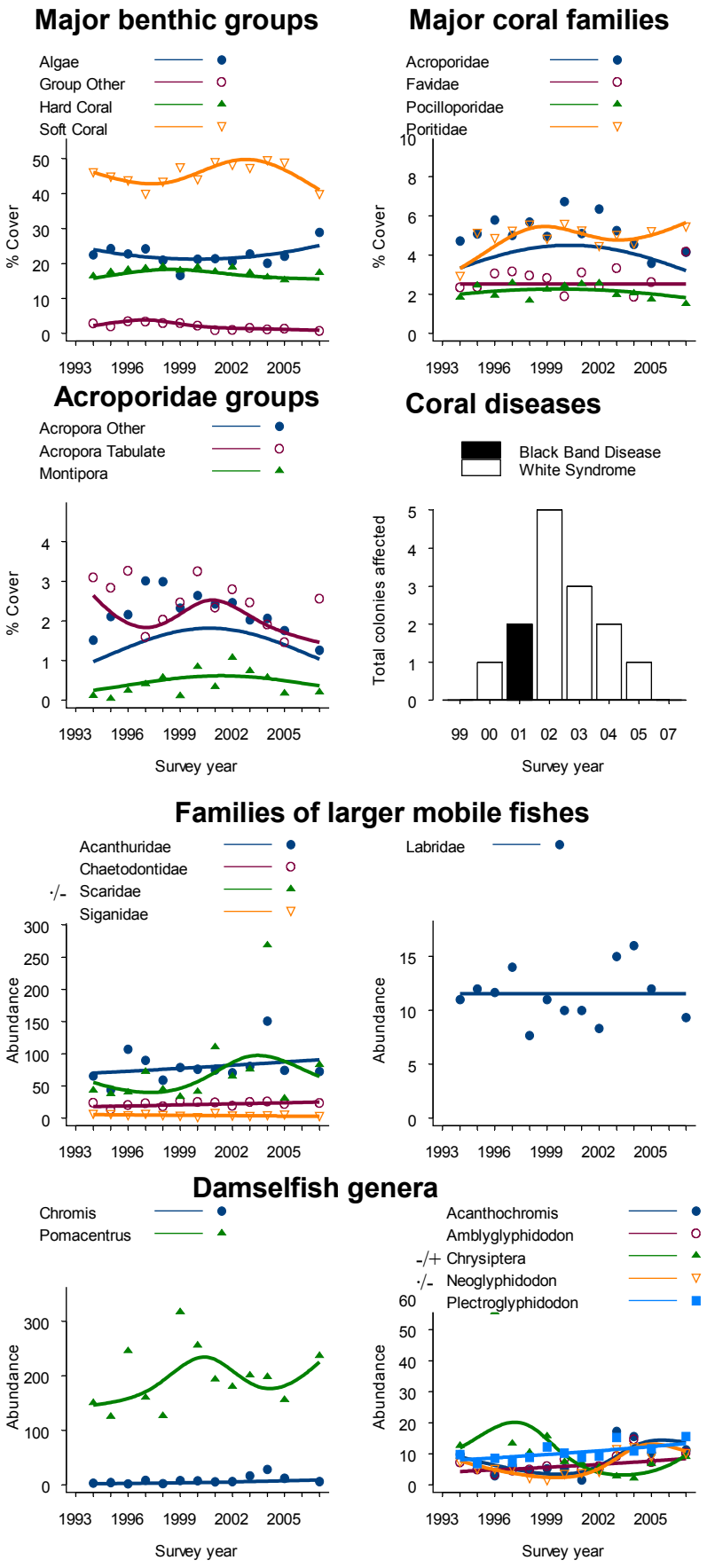




Hyde Reef (No. 19-207) is an outer shelf lagoonal reef with an area of 12.5 sq.km.

Figure 5.118 (cont.)

Hyde Reef was last surveyed in March 2007.



SLATE

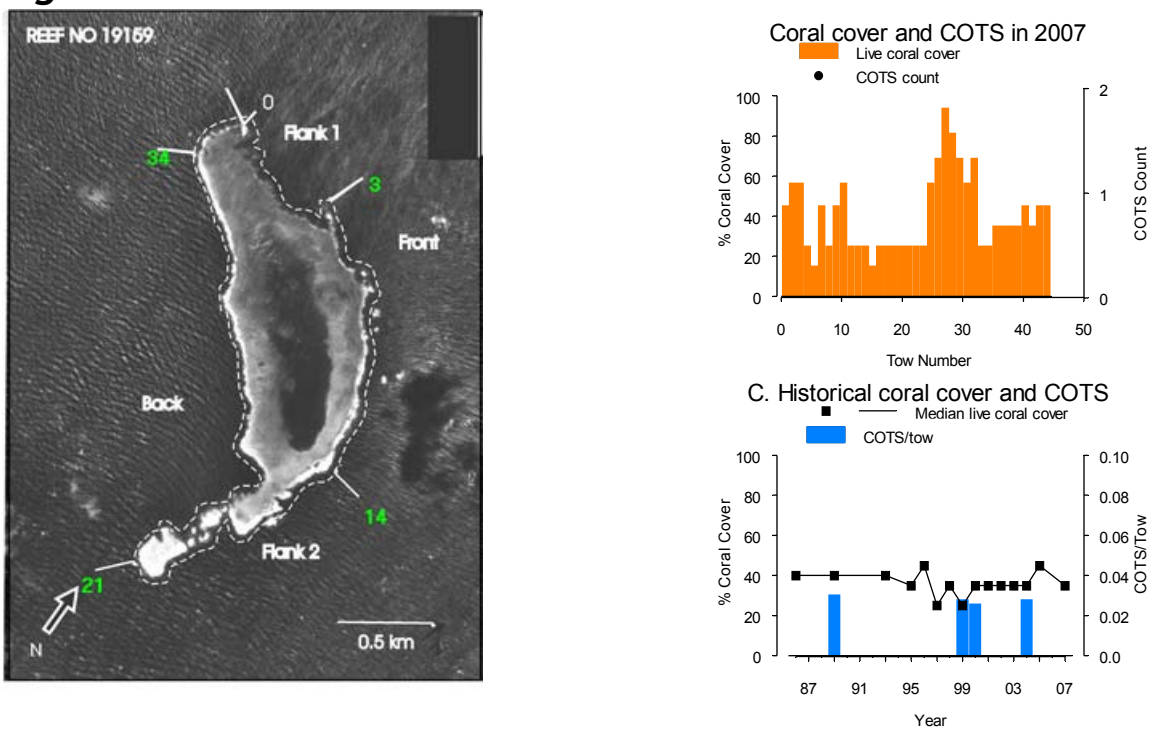
Reef 19-159 was renamed Slate Reef, when the new zoning of the Great Barrier Reef Marine Park was implemented in July 2004 by the Great Barrier Reef Marine Park Authority. Slate Reef has been surveyed regularly by manta tow since 1986 when it was classified as No Outbreak. At that time it had a high median reef-wide live coral cover (31-50%). Coral cover remained relatively stable until 1997 when there was a decline reef-wide coral cover to a 30%, just within the moderate range of coral cover(11-30%). The decline in reef-wide coral cover was most likely due to Cyclone Justin. Subsequently coral cover increased to high levels (31-50%) from 1998 but kept increasing, although coral cover was still at high levels in 2007 surveys. Small numbers of COTS, below outbreak densities, were recorded in 1999, 2000 and 2004 in all cases at levels too low to impact on reef wide live coral cover. No COTS were recorded from this reef during manta tow surveys in 2007 and Slate Reef remained classified as No Outbreak. No signs of bleaching or black band disease were recorded and signs of white syndrome disease were restricted to a few scattered coral colonies on the reef flanks.

Surveys at the intensive surveys sites were established in 1992 and hard coral cover was 38% in the initial survey. Since surveys began on Slate Reef the hard coral has remained within the high cover category, with some variation, of 10%, over the 15 year survey period. In 1996 hard coral cover was 46%, the highest value recorded for Slate Reef. Hard coral cover reached 44% in 2003 and remained at this level in 2004 and 2005, By 2007 hard coral cover had decreased to 38%. Changes in hard coral cover have been influenced mostly by the abundance of branching *Acropora* spp. as well as encrusting and submassvie *Isopora* spp., even though tabulate *Acropora* spp. is the dominant growth form. Juvenile and sub-adult COTS were seen on SCUBA search surveys in 2007 at a level that may cause significant coral mortality. Incidence of white syndrome was very low. Corallivorous snails *Drupella* spp. were observed at a density of 47/ha.

The benthic community has remained remarkably stable (with high hard coral cover) over the 13-year study period and this is reflected in the fish community. Abundances of most fish taxa have fluctuated from year to year but there have been few obvious long-term trends over the study period with the possible exception of an increase in abundance of Scaridae and Siganidae. Numbers of the commercially important coral trout (*Plectropomus leopardus*) increased greatly in 2004 and reached a survey maximum in 2005. Numbers of this species had dropped in 2007 but were still high.

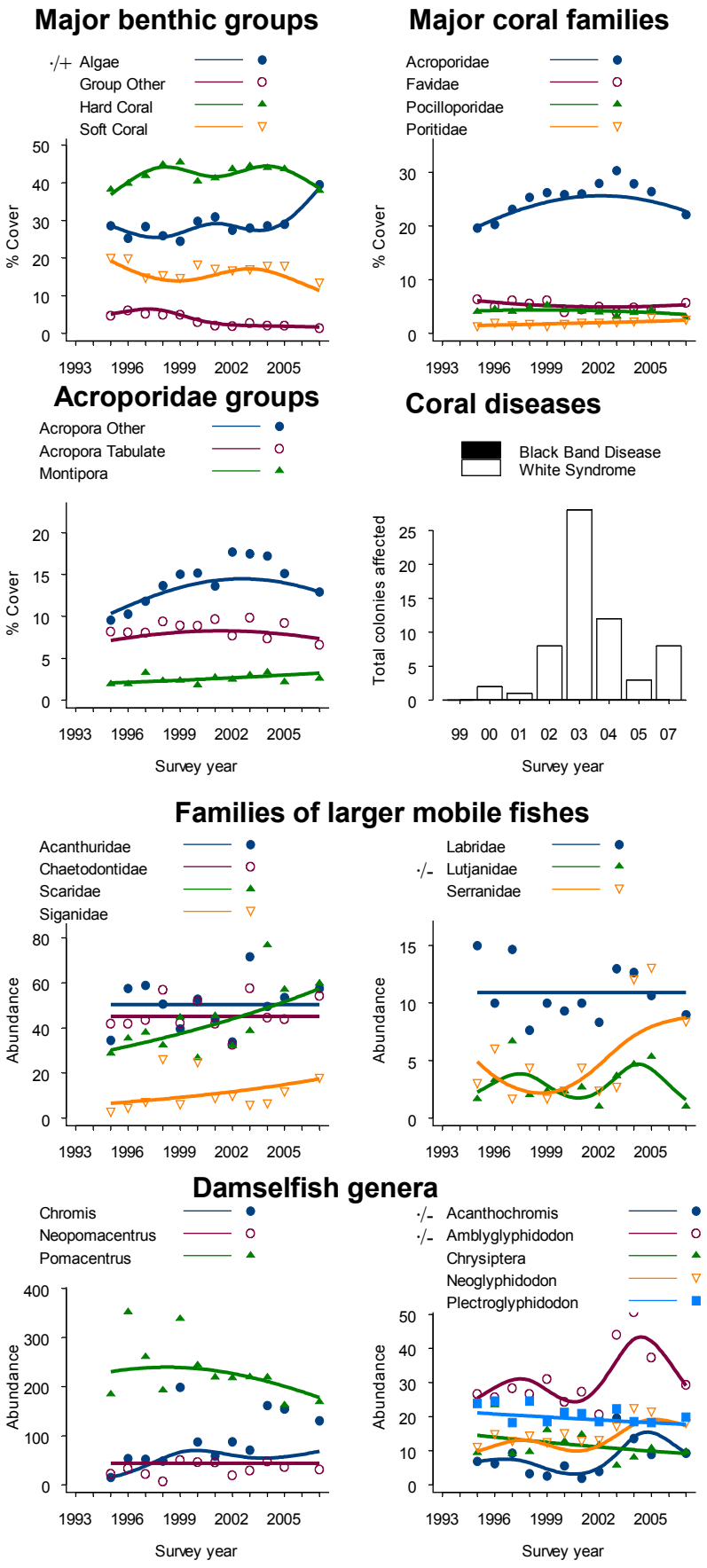
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.119



Slate Reef (No. 19-159) is an outer shelf lagoonal reef with an area of 3.8 sq.km.

Figure 5.119 (cont.)
Slate Reef was last surveyed in March 2007.



Pompey

Reef Pages

20-348

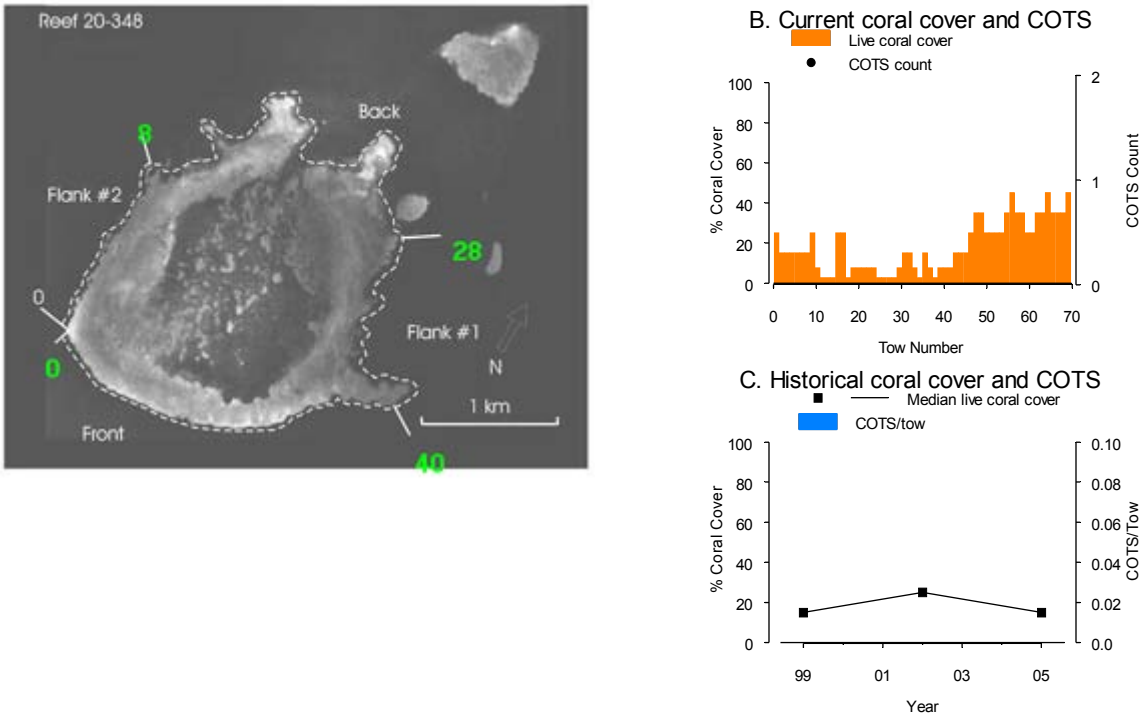
Reef 20-348 has been surveyed three times since 1999. No COTS have been observed during any survey. The last survey was in 2005. Strong winds, rough seas and swift currents precluded sampling in 2006. In 2005, median reef-wide live coral cover was moderate (11-20%) and at a level similar to that seen in previous years. Reef 20-348 remains classified as No Outbreak. No bleaching was recorded and white syndrome disease affected only a few scattered coral colonies around the reef perimeter in 2005.

In 2006 initial intensive surveys began on Reef 20-348 and the hard coral cover was moderate at 22%. The most common colony forms were massvie and foliose non-Acroporidae corals. Branching and bottlebrush *Acropora* spp. were the most common colony forms representing the Acroporidae family. Algae dominated the benthic community with 59% cover. The major constituent of the algal community was turf algae (57% cover). Soft coral abundance was very low at 1% cover. Sponges were well represented at the survey sites with 9% cover. The dominant hard coral families were the Faviidae and the Acroporidae with 8% and 7% cover respectively. Sand accounted for 8% of the benthos in 2006. White syndrome had affected low numbers of colonies at the intensive survey sites in 2006 while brown band disease was rare. The density of the corallivorous snail *Drupella* spp. was recorded at 467/ha.

Abundances of Acanthuridae, Lethrinidae and *Chromis* were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were high (driven by *C. rollandi*).

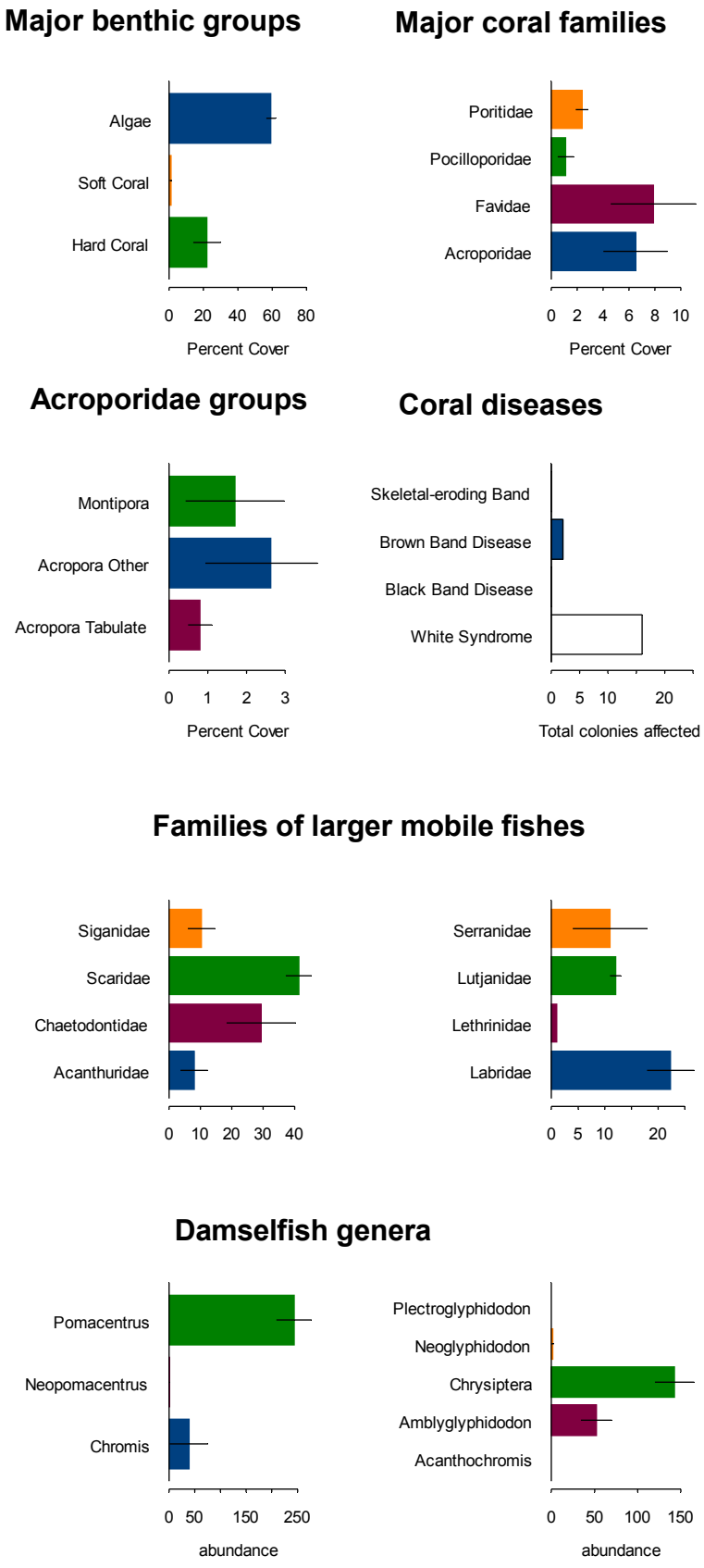
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.120



Reef 20-348 (No. 20-348) is a mid-shelf lagoonal reef with an area of 12.5 sq.km.

Figure 5.120 (cont.)
Reef 20-348 was last surveyed in May 2006.



20-353

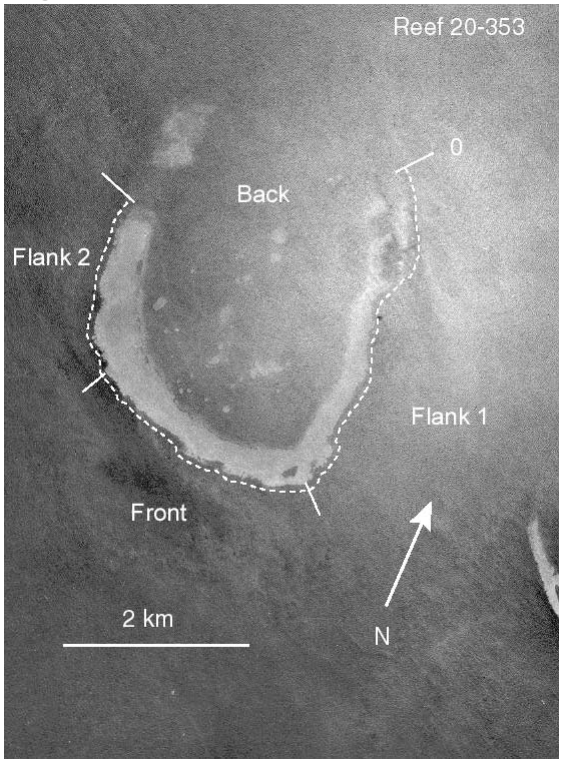
2006 was the first time that Reef 20-353 has been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was high (31-40%) and the reef has been classified as No Outbreak. No COTS, coral bleaching or signs of black band disease were observed at the time of survey. Signs of white syndrome disease were observed on small numbers of scattered coral colonies around the entire perimeter of the reef.

Hard coral cover at the intensive survey sites of Reef 20-353 was high (38%) in 2006. Acroporidae was the dominant hard coral family (16% cover), primarily represented by foliose and encrusting *Montipora* spp., while Faviidae followed with 7% cover. Soft coral abundance was low at 2% cover. The algal community was dominated by turf algae, which accounted for 39% of the benthic cover. Coralline algal cover was relatively high at 18%. At the intensive survey sites signs of white syndrome and brown band were rare. *Drupella* spp. were recorded at a density of 53/ha.

The abundances of Acanthuridae, Lethrinidae and *Chromis* spp. were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community while Siganidae were under-represented. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* abundances were high (driven by *C. rollandi*).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.121



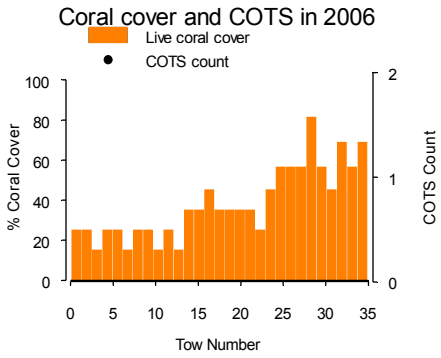
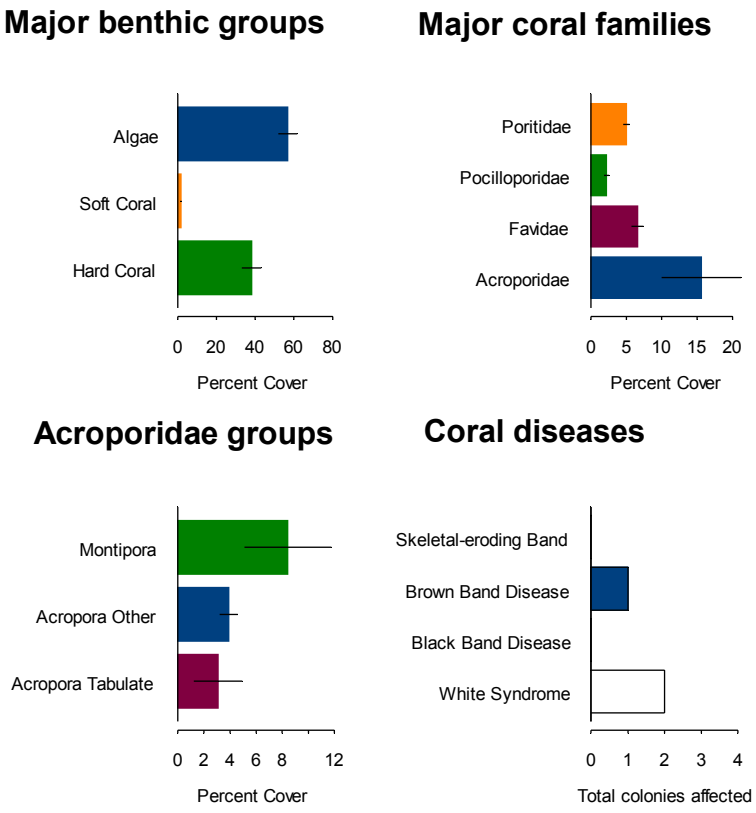
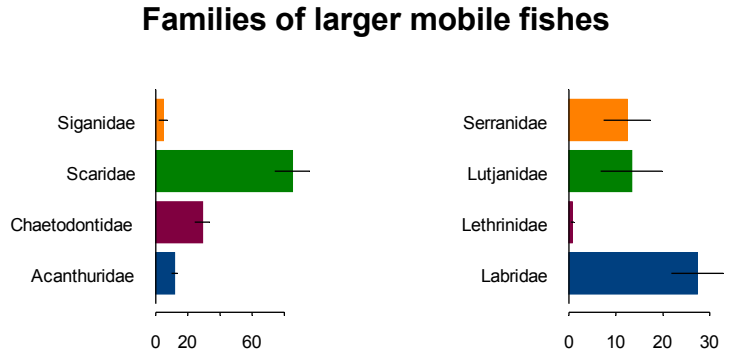
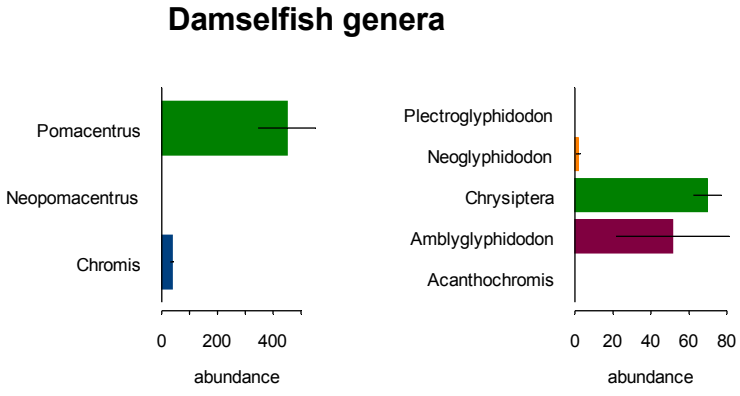


Figure 5.121 (cont.)
Reef 20-353 was last surveyed in July 2006.







21-060

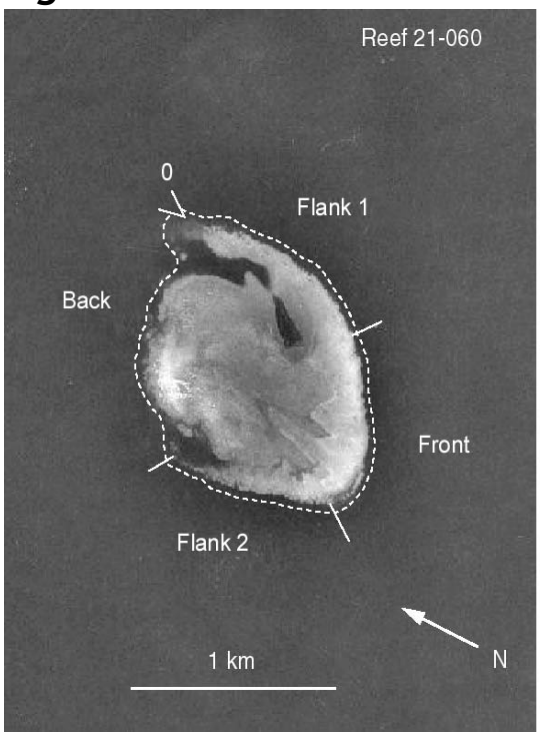
Reef 21-060 was surveyed by manta tow for the first time in 2006. Median reef-wide coral cover was high (41-50%) and the reef has been classified as No Outbreak. Small numbers of COTS were observed but in numbers well below those considered to threaten reef-wide coral cover. No coral bleaching was observed at the time of survey. Signs of black band disease were observed on small numbers of scattered coral colonies on the back reef. Signs of white syndrome disease were observed on small numbers of scattered coral colonies in all areas manta towed around the reef perimeter.

In 2006 intensive survey sites were set up on Reef 21-060. The hard coral abundance at the intensive survey sites of Reef 21060 was high, with 45% cover recorded. Algal cover was virtually equal to that of hard coral at 47%. The hard coral community consisted largely of Acroporidae colonies (30% cover), particularly branching *Acropora* spp. (12% cover). Encrusting and foliose colonies of the genus *Montipora* also made a substantial contribution (9%) to the benthic cover. The other major hard coral families each accounted for less than 5% of the benthic cover. Soft coral cover was low at 3%. The primary constituent of the algal community was turf algae at 41% of the benthic cover. Brown band disease was observed on at a low incidence on SCUBA search surveys. A total of seven COTS were found along the fixed transects including three adults, two sub-adults and two early juveniles. The density of the corallivorous snail *Drupella* spp. was 7/ha.

Abundances of Acanthuridae, Lethrinidae and *Chromis* spp. were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were relatively low and *Amblyglyphidodon* spp. abundances were high (driven by *A. curacao*).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.122



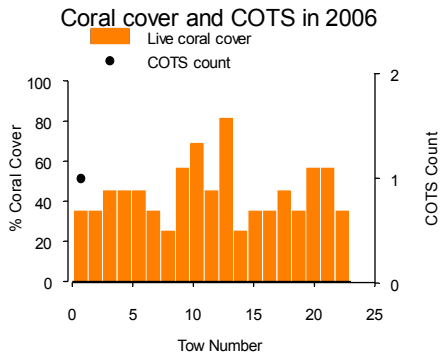
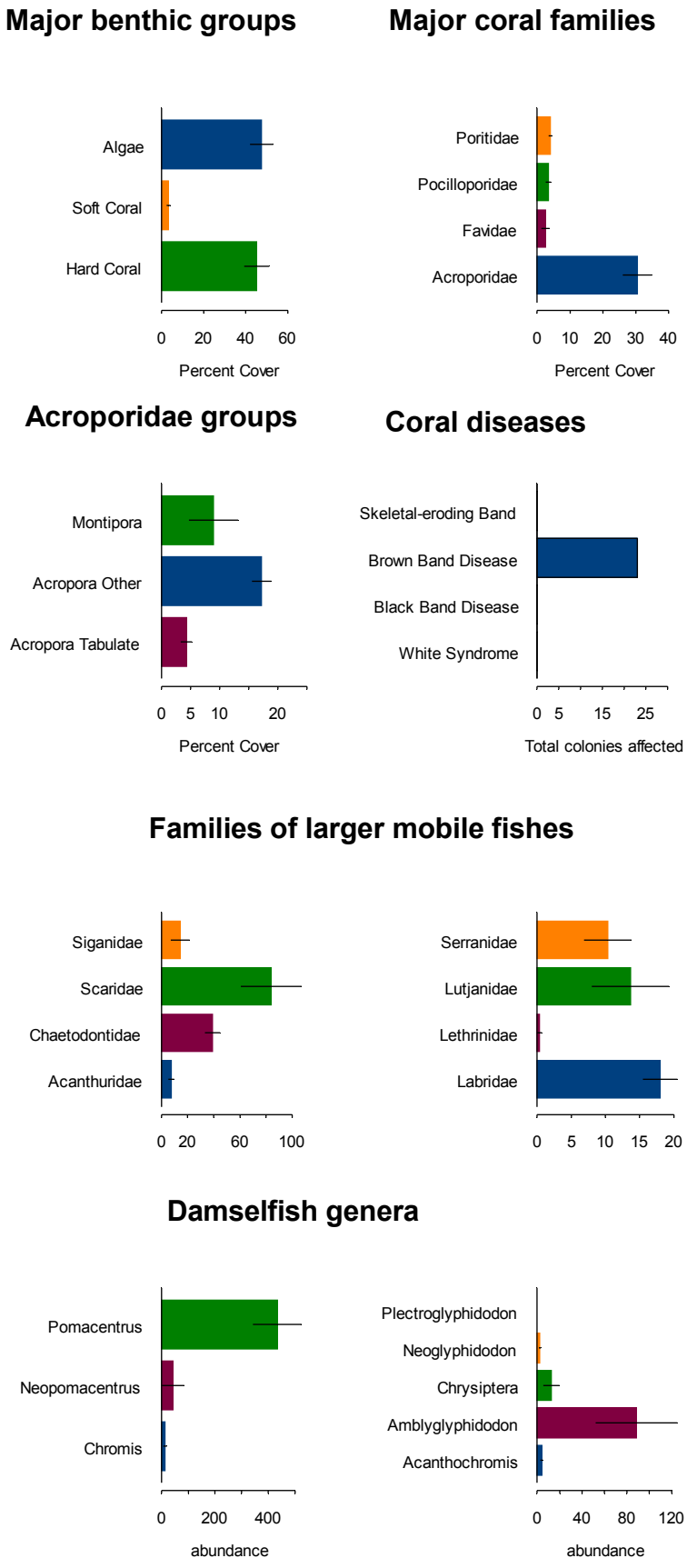


Figure 5.122 (cont.)
Reef 21-060 was last surveyed in July 2006.



21-062

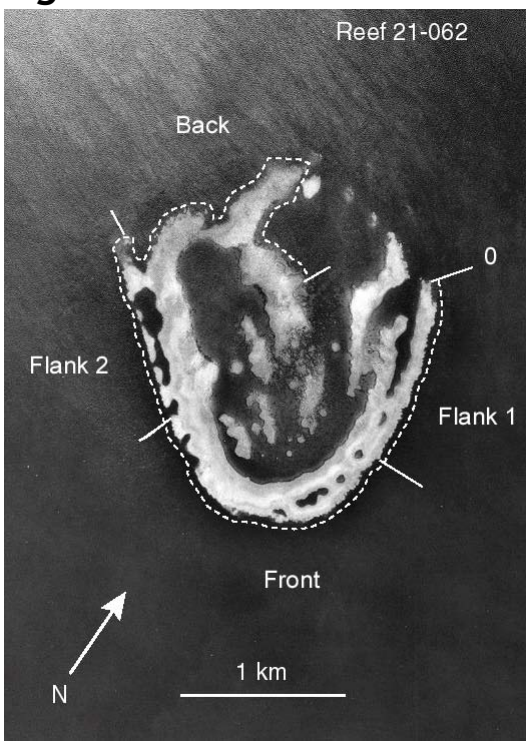
2006 was the first time that Reef 21-062 has been surveyed using manta tow by the LTMP. The median reef-wide live coral cover was moderate (21-30%) and the reef has been classified as No Outbreak. Small numbers of COTS were observed but in numbers well below those considered to threaten reef-wide coral cover. No signs of coral bleaching or black band disease were observed. Signs of white syndrome disease were observed on small numbers of scattered coral colonies on the back, north and south flanks of the reef.

Reef 21-062 was surveyed for the first time in 2006. Hard coral cover was a high 33% at the intensive survey sites in 2006. The hard coral community was dominated by Faviidae (13%), particularly foliose and encrusting forms of the genus *Echinopora* spp. (9% cover). Acroporidae contributed 10% to the benthic cover, strongly represented by encrusting and foliose colonies of *Montipora* spp. (5% cover). Poritidae and Pocilloporidae both had low cover at 2% and 1% respectively. The algal community was the most dominant benthic group with 62% cover and it was mostly comprised of turf algae (60%). Soft coral cover was low at 2%. White syndrome was observed at moderate levels, while brown band disease was rare (observed on less than 15 colonies) on SCUBA searches. Low incidence of bleaching was recorded during SCUBA search surveys. *Drupella* spp. were recorded at a density of 107/ha.

Abundances of Acanthuridae, Lethrinidae and *Chromis* were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community while Siganidae and Serranidae were relatively under-represented. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were high (driven by *C. rollandi*).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.123



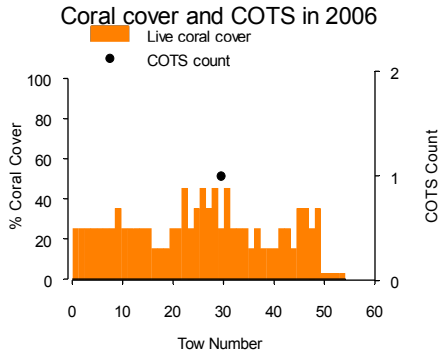
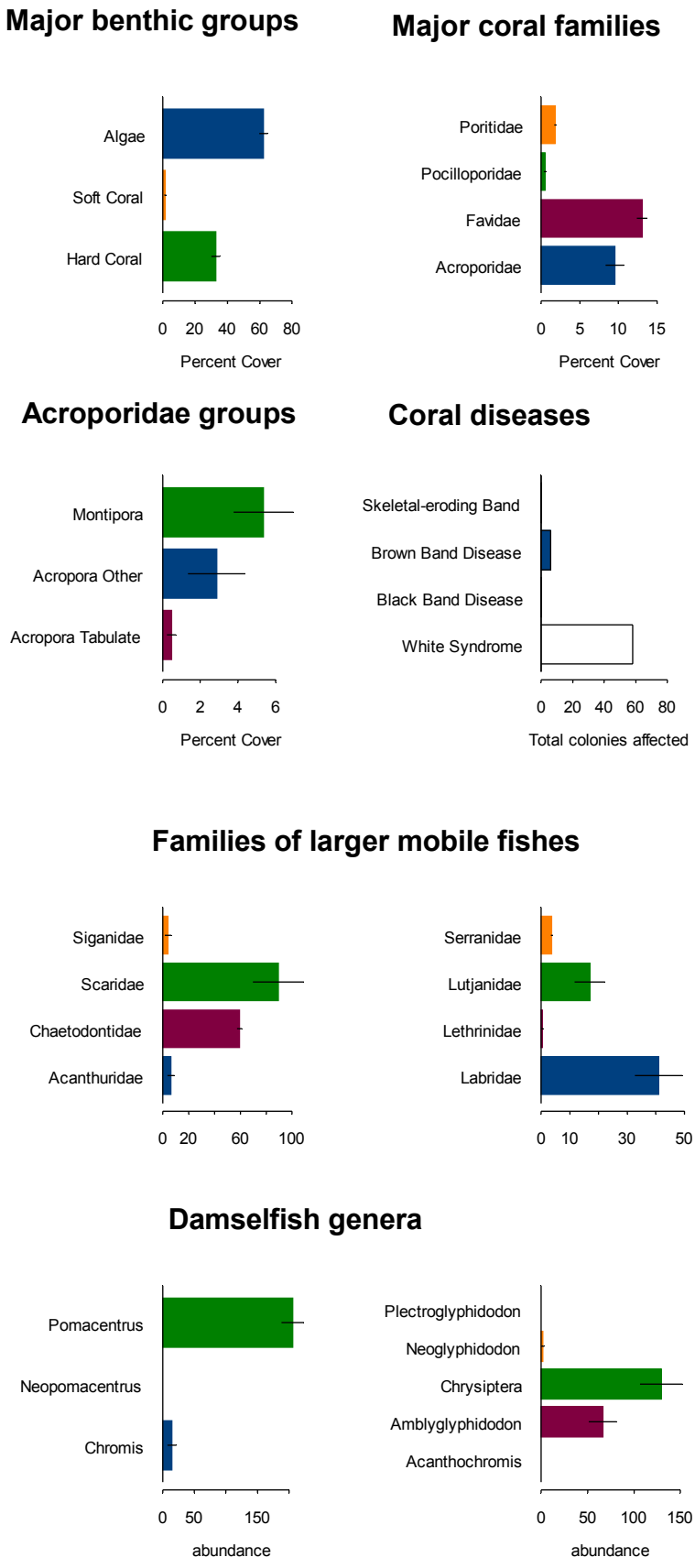


Figure 5.123 (cont.)
Reef 21-062 was last surveyed in May 2006.



21-064

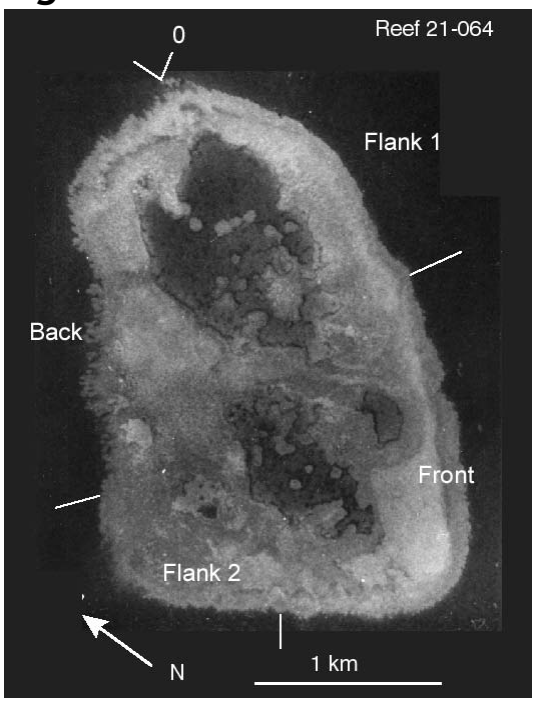
In 2006 Reef 21-064 was surveyed using manta tow for the first time. Median reef-wide live coral cover was high (41-50%) and the reef has been classified as No Outbreak. No COTS, coral bleaching or signs of black band disease were observed. Signs of white syndrome disease were common (more than ten colonies observed per two-minute manta tow) on the north flank of the reef while it was less common (observed on small numbers of scattered coral colonies) on the back, front and southern flank of the reef.

In 2006, the first year of intensive surveys at fixed sites, hard coral cover at Reef 21-064 was high at 39%. Acroporidae was the dominant hard coral family (18% cover), represented primarily by branching colonies of the genus *Acropora* and foliose colonies of *Montipora* spp. Foliose non-*Acropora* spp. corals were the dominant growth form of colonies at 11% cover. The Faviidae and Poritidae each accounted for 5% of the benthic cover. Faviidae was almost solely represented by foliose *Echinopora* spp. The two major representatives of the algal community, turf algae and coralline algae, contributed 40% and 15% to the benthic cover respectively. Soft coral abundance was low (3% cover). Brown band disease was rare on SCUBA searches at the intensive survey sites. A total of three COTS were observed at the survey sites including a juvenile, a sub-adult and an adult. Bleaching was not observed at the survey sites in 2006. The density of the corallivorous snail *Drupella* spp. was 20/ha.

Abundances of Acanthuridae, Lethrinidae and *Chromis* spp. were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae, Siganidae and Labridae dominated the large, mobile fish community. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). Abundances of *Chrysiptera* spp. (driven by *C. rollandi*) and *Amblyglyphidodon* spp. (driven by *A. curacao*) were high.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.124



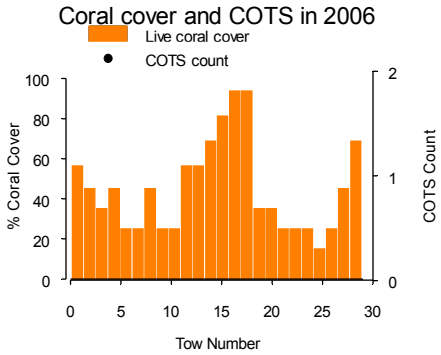
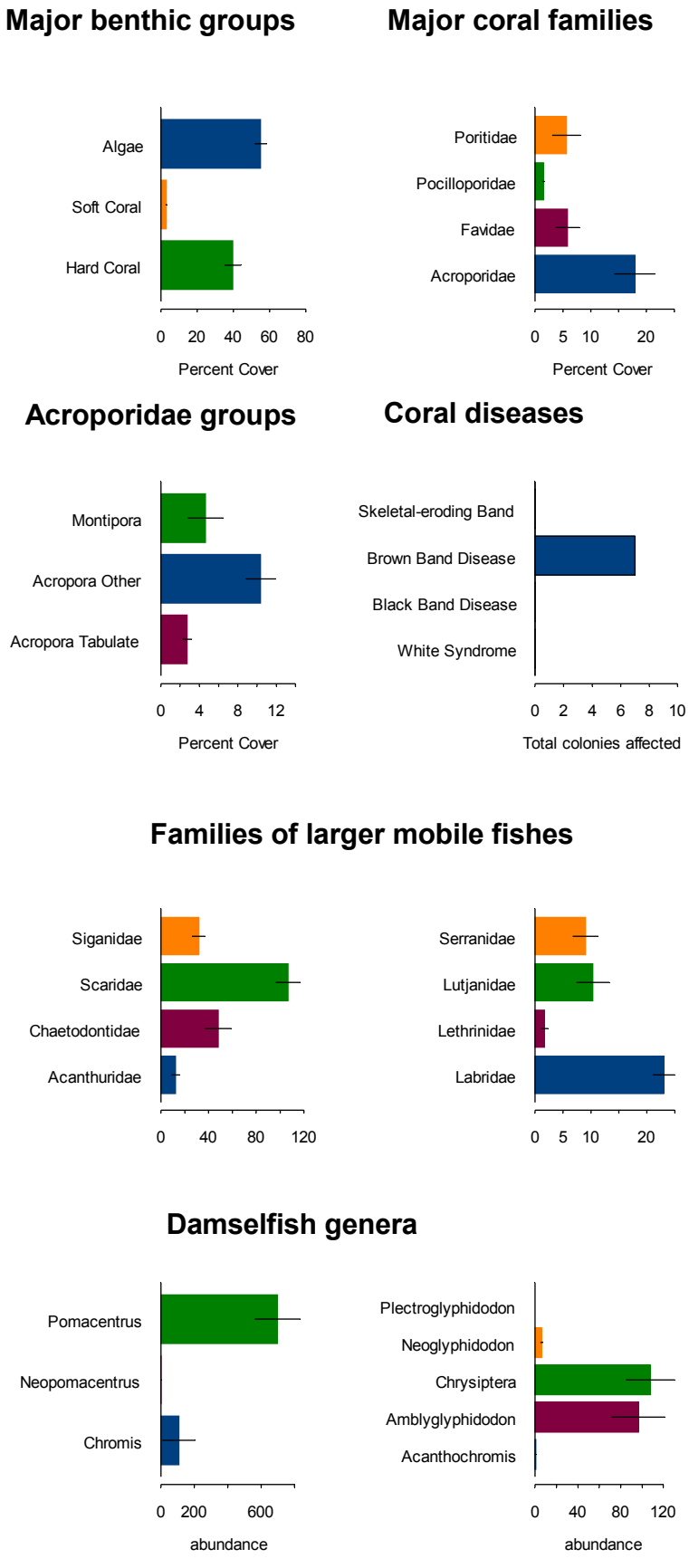


Figure 5.124 (cont.)
Reef 21-064 was last surveyed in July 2006.



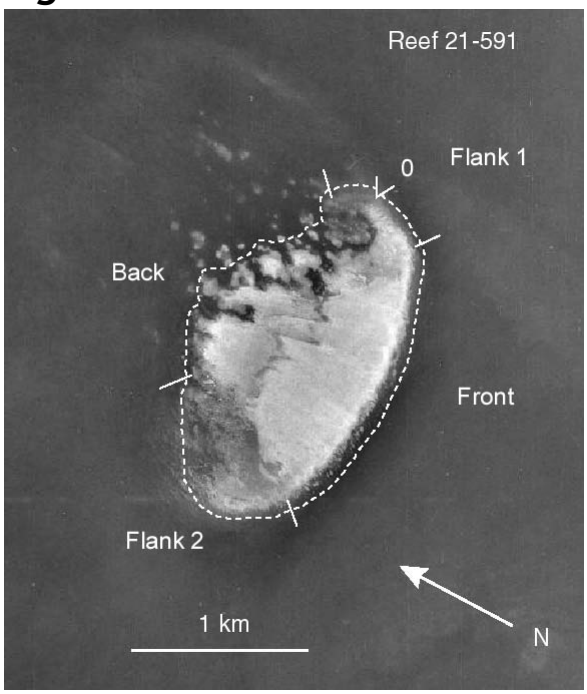
2006 was the first time that this reef has been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was high (31-40%) and the reef has been classified as No Outbreak. No COTS were observed. Low levels (restricted to small numbers of individual scattered coral colonies) of coral bleaching, signs of black band disease and white syndrome were observed on the front reef area at the time of survey.

In the first year of intensive surveys (2006) Reef 21-591 had moderate hard coral cover (29%). Acroporidae, particularly branching *Acropora* spp., accounted for the majority of the hard corals with 19% cover. Soft coral abundance was moderate at 13% cover. Turf algae dominated the algal community, which comprised 51% of the benthic cover. *Halimeda* spp., a calcareous green macroalgae, had 3% cover. Sponges contributed 5% to the benthos. Skeletal eroding band disease and brown band disease were rare on SCUBA searches along the fixed transects. A low incidence of bleaching was observed. *Drupella* spp. were present at a density of 133/ha.

Abundances of Acanthuridae and Lethrinidae were particularly low, even though abundances of these two families are often relatively low on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were relatively low for mid-shelf reefs in this sector, while abundances of *Neopomacentrus* spp. were relatively high. *Chromis* spp. abundances were moderate but very variable among sites (large error bars in Figure 2.125).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.125



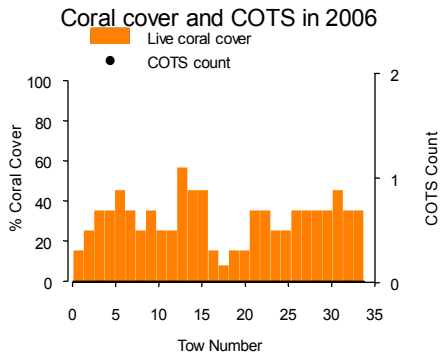
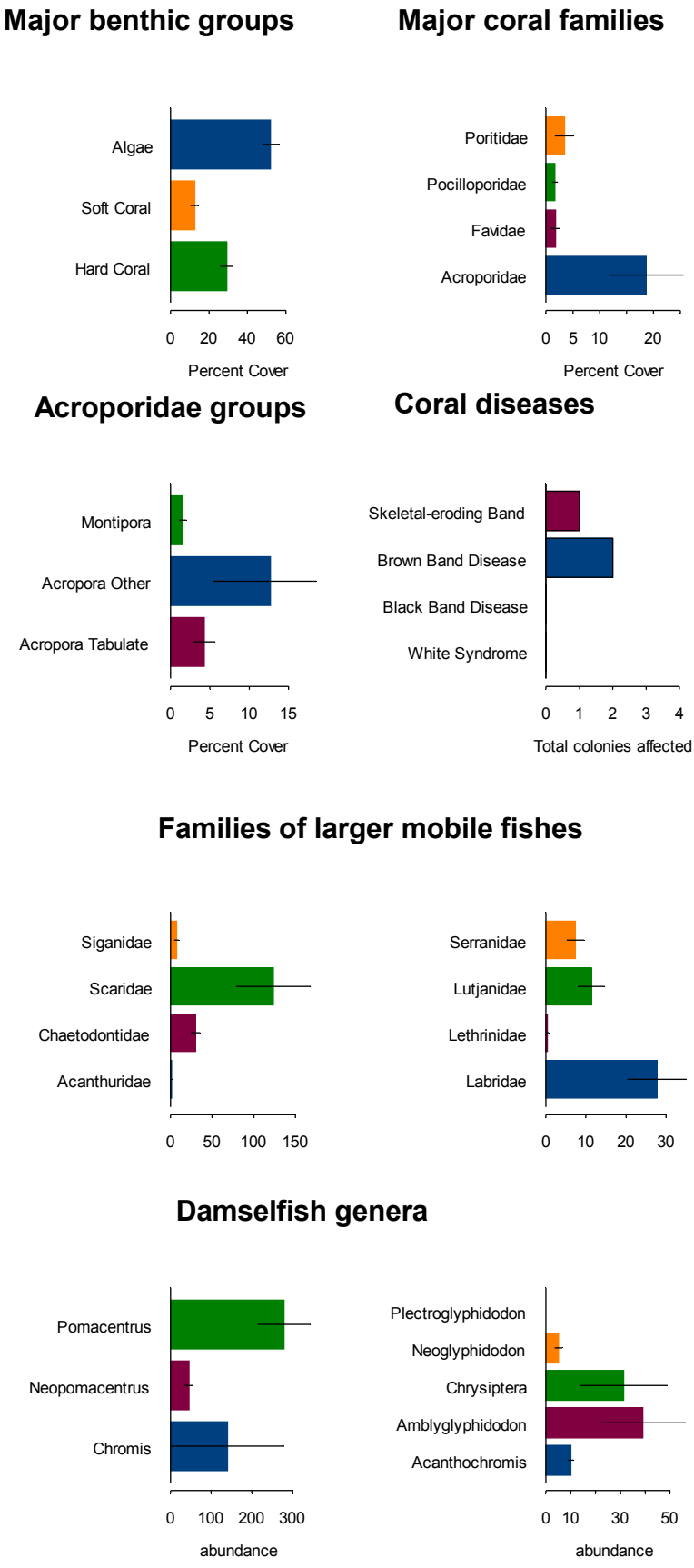


Figure 5.125 (cont.)
Reef 21-591 was last surveyed in March 2006.



PENRITH IS

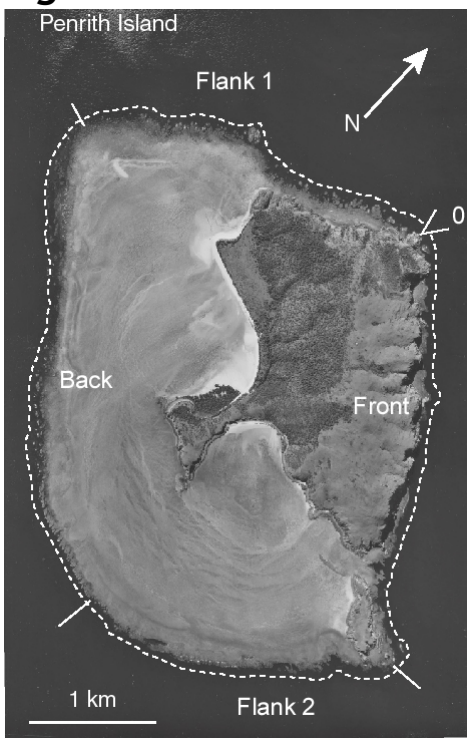
2006 was the first time that Penrith Island Reef has been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was moderate (21-30%) and the reef has been classified as No Outbreak. No COTS, coral bleaching or signs of black band disease were observed. Signs of white syndrome were observed on small numbers of scattered coral colonies on the back, front and southern flank of the reef.

In 2006, the first year of intensive surveys, the hard coral cover at Penrith Island Reef was moderate at 28%. The hard coral community was primarily comprised of Acroporidae, which contributed 13% to the benthic cover. Within this family, branching and bottlebrush growth forms of *Acropora* spp. were the most common colonies recorded. Poritidae accounted for 5% of the benthic community while genera from Faviidae and Pocilloporidae were considerably less abundant. Soft coral cover reached a moderate level of 20%. Algae was the dominant benthic group at Penrith Island Reef with 36% cover and consisted almost entirely of turf algae. Rare incidence of white syndrome was recorded at the survey sites. The corallivorous snail *Drupella* spp. was recorded at a density of 147/ha.

Abundances of Acanthuridae, Lethrinidae and Lutjanidae were particularly low, even though abundances of the former three families are often relatively low on mid-shelf reefs in the Pompey sector. The large mobile fish assemblage was dominated by Chaetodontidae, Scaridae, Siganidae and Labridae. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were relatively low for mid-shelf reefs in this sector, while abundances of *Neopomacentrus* spp. were relatively high, although estimates were very variable among sites (large error bars). Numbers of *Acanthochromis polyacanthus* were particularly high at this reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.126



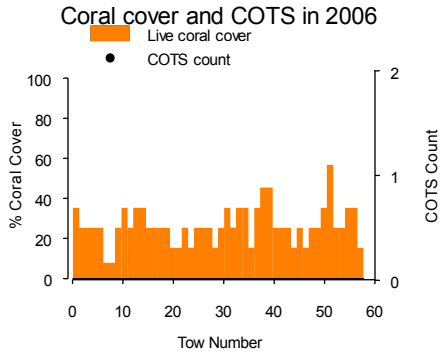
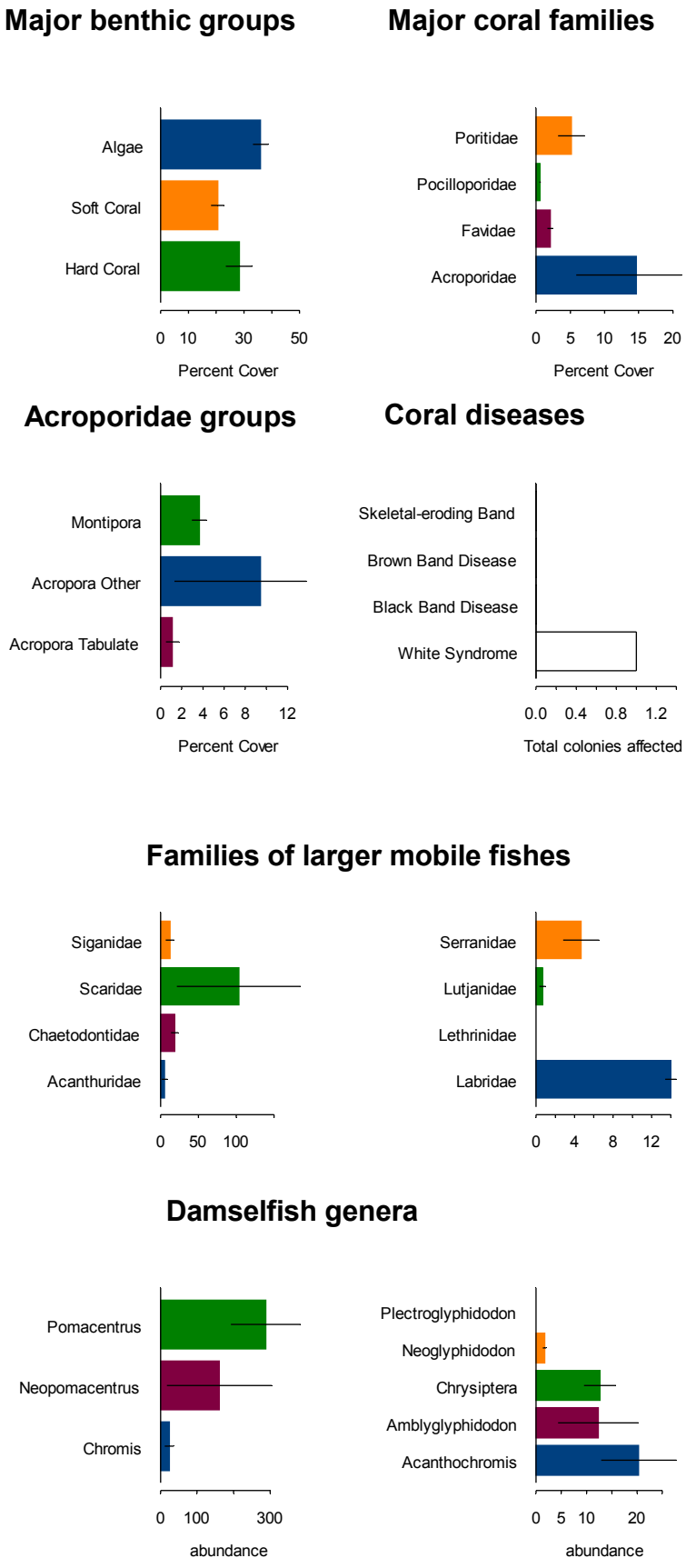


Figure 5.126 (cont.)
Penrith Is Reef was last surveyed in July 2006.



POMPEY No. 1

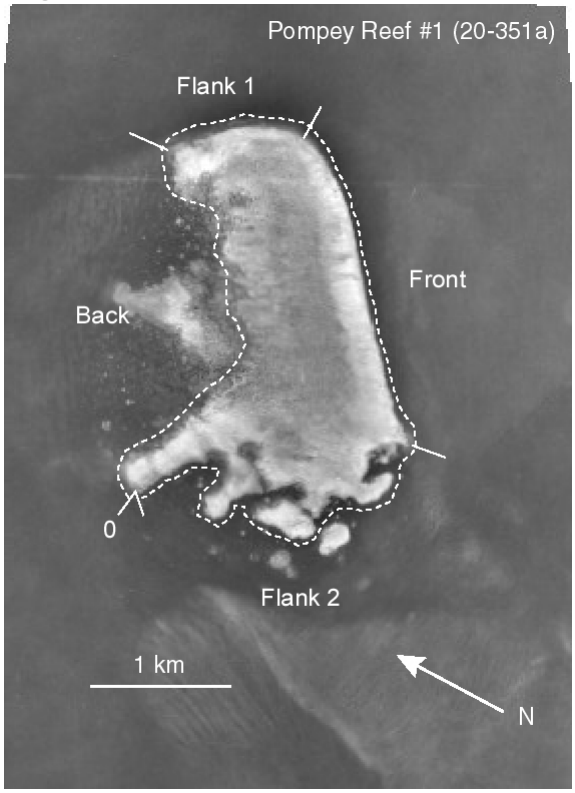
2006 was the first time that Pompey No. 1 Reef has been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was moderate (21-30%). No COTS were recorded on broadscale surveys and Pompey No. 1 Reef was classified as No Outbreak. Coral bleaching were observed during surveys. Low levels of black band disease, restricted to small numbers of scattered individual coral colonies, were observed on the northern flank. Signs of white syndrome were common (more than ten colonies observed per two-minute manta tow) on the southern flank of the reef while it was less common (observed on small numbers of scattered coral colonies) on the front and northern flank of the reef in 2006.

Hard coral was the dominant benthic group at the intensive survey sites of Pompey No. 1 Reef in 2006. Hard coral cover was very high (51%) and dominated by colonies of the family Acroporidae (23% cover). Branching *Acropora* spp. and the various forms of *Montipora* spp. were the most common growth forms observed for this family (8% cover each). Poritidae was the next major contributing family with 10% cover. The algal community consisted primarily of turf algae (29% cover) and coralline algae (13% cover). Soft coral cover was low at 2%. The incidence of brown band disease and white syndrome were rare on SCUBA searches. One sub-adult COTS and two juveniles were found on the intensive survey sites during SCUBA search surveys. There were no *Drupella* spp. were found on Pompey No. 1 Reef.

Abundances of Acanthuridae, Lethrinidae and *Chromis* spp. were relatively low but this generally appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae, Serranidae and Labridae dominated the large, mobile fish community. Serranids (dominated by the commercially important coral trout, *Plectropomus leopardus*) were particularly abundant at this reef. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). Abundances of *Amblyglyphidodon* spp. (driven by *A. curacao*) were high and *Chrysiptera* spp. abundances were relatively low, possibly reflecting preferences for high and lower coral cover, respectively.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.127



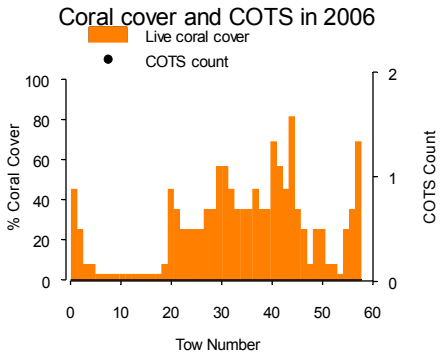
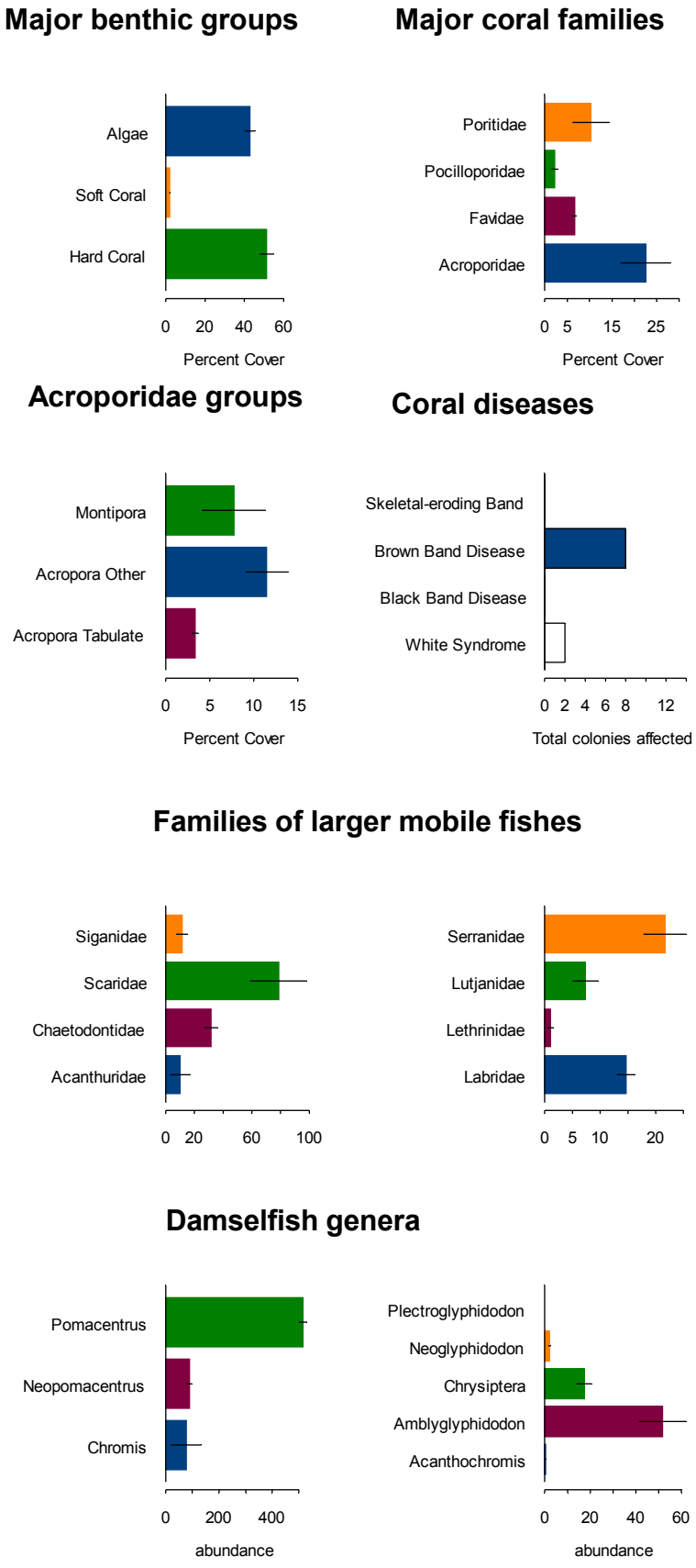


Figure 5.127 (cont.)
Pompey No. 1 Reef was last surveyed in July 2006.



POMPEY No. 2

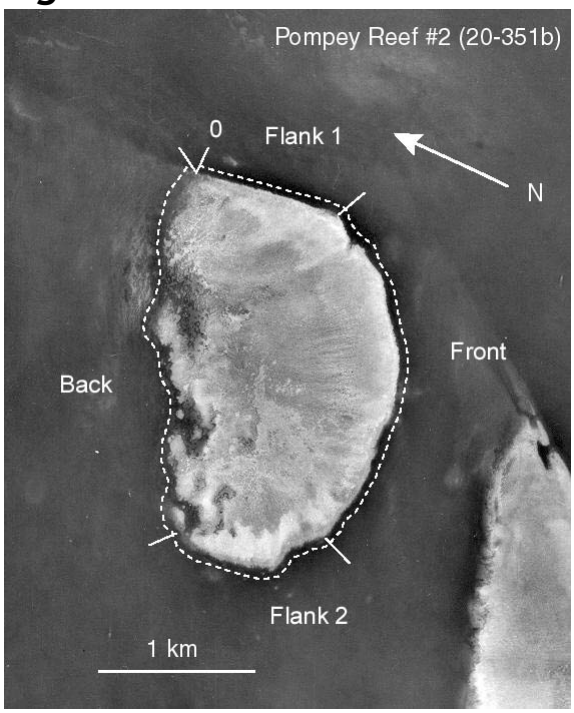
Pompey No. 2 Reef was surveyed by manta tow for the first time in 2006. Median reef-wide live coral cover was moderate (21-30%). No COTS were observed and Pompey No. 2 Reef was classified as No Outbreak. At the time of survey in 2006 low levels (restricted to small numbers of scattered coral colonies) of coral bleaching were observed on the north and south flanks and front reef areas. Low levels of black band disease were observed on the back reef. Similarly low levels of white syndrome were observed on the back, front and northern flank of the reef in 2006.

During 2006 intensive surveys at Pompey No. 2 Reef hard coral was recorded as moderate at 25% cover. The dominant hard coral family was Acroporidae with 15% cover. Tabulate and bottlebrush *Acropora* spp. and encrusting *Montipora* spp. were equally common at around 4% cover. The other major hard coral families each accounted for less than 4% of the benthic cover. Soft coral cover was low at 6%. Algae was the dominant benthic group with 65% cover. The algal community was comprised of turf algae (57% cover) and coralline algae (8% cover). White syndrome was rare on intensive survey sites. Incidence of bleaching were observed for all but two transects, with up to 50% of colonies bleached along one transect. *Drupella* spp. density at the survey sites was recorded at 47/ha.

Abundances of Acanthuridae, Lethrinidae and *Chromis* spp. were particularly low but this often appears to be the case on mid-shelf reefs in the Pompey sector. Chaetodontidae, Scaridae, Siganidae and Labridae dominated the large, mobile fish community. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chrysiptera* spp. abundances were high (driven by *C. rollandi*).

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.128



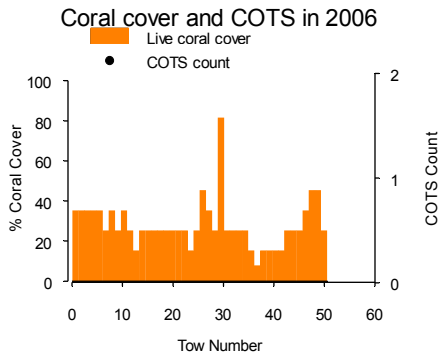
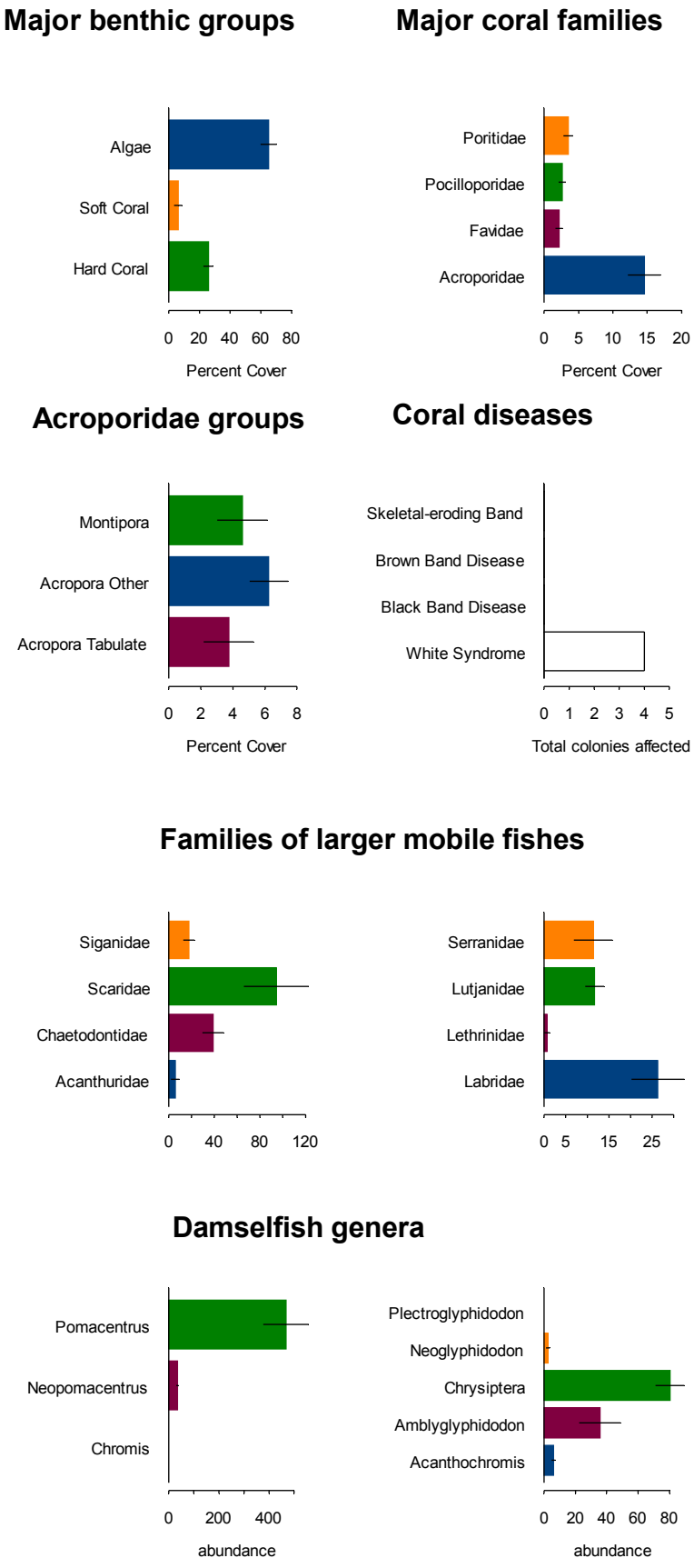


Figure 5.128 (cont.)
Pompey No. 2 Reef was last surveyed in March 2006.



TERN IS

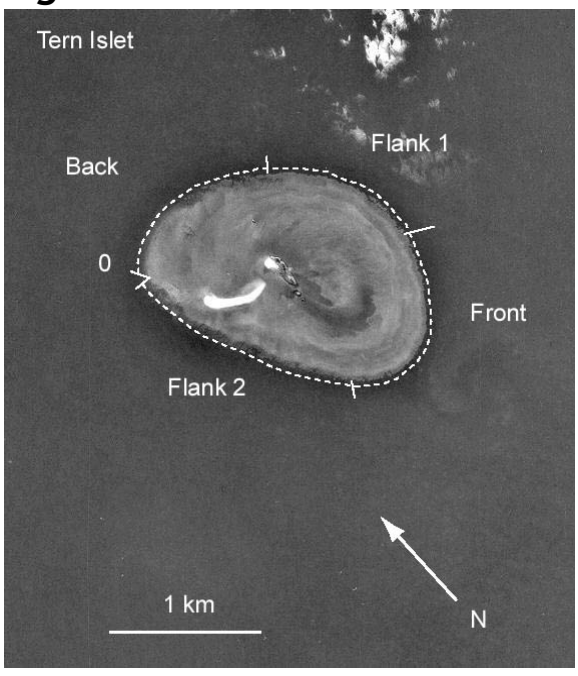
2006 was the first time that Tern Island Reef has been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was high (31-40%). No COTS were observed during broadscale surveys and Tern Island Reef was classified as No Outbreak. Coral bleaching was observed during manta tow surveys. Low levels of black band disease, restricted to small numbers of scattered individual coral colonies, were observed on the southern flank. Low levels of white syndrome were also observed on the northern flank, front and southern flank of the reef in 2006.

Intensive surveys sites were set up in 2006 at Tern Island Reef and in the initial survey indicated that hard coral cover was high (45%). Algal cover was similar at 43% while soft coral cover was low at 6%. The hard coral community was dominated by the family Acroporidae (30% cover), particularly branching *Acropora* spp. (17% cover). The algal community consisted mostly of turf algae, which represented 41% of the benthic cover. The occurences of brown band disease, skeletal eroding band disease and white syndrome were rare on the SCUBA search surveys. One early juvenile, two juveniles and one sub-adult COTS were also found along the transects. No colonies appeared to be affected by bleaching in 2006. The density of *Drupella* spp. at the survey sites was 100/ha.

Abundances of Acanthuridae and Lethrinidae were particularly low but this often appears to be the case on mid-shelf reefs in the Pompey sector. Aside from this, the reef fish community structure was quite different to that observed on other reefs in this sector. Chaetodontidae, Scaridae and Siganidae dominated the large, mobile fish community but Labridae were relatively under-represented. Siganidae abundances were particularly high. Amongst the damselfishes, *Pomacentrus* species were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). *Chromis* spp.abundances (driven by *C. atripectoralis*) were the highest recorded among the Pompey survey reefs while *Chrysiptera* spp. abundances were extremely low. Abundances of *Neopomacentrus* spp. (driven by N. *azysron*) and *Acanthochromis polyacanthus* were relatively high.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.129



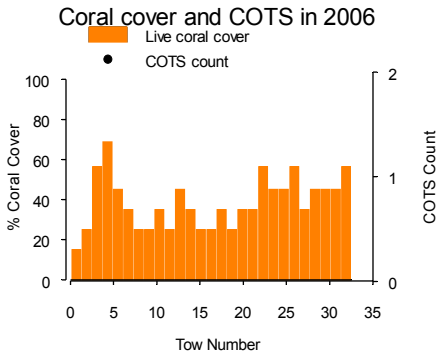
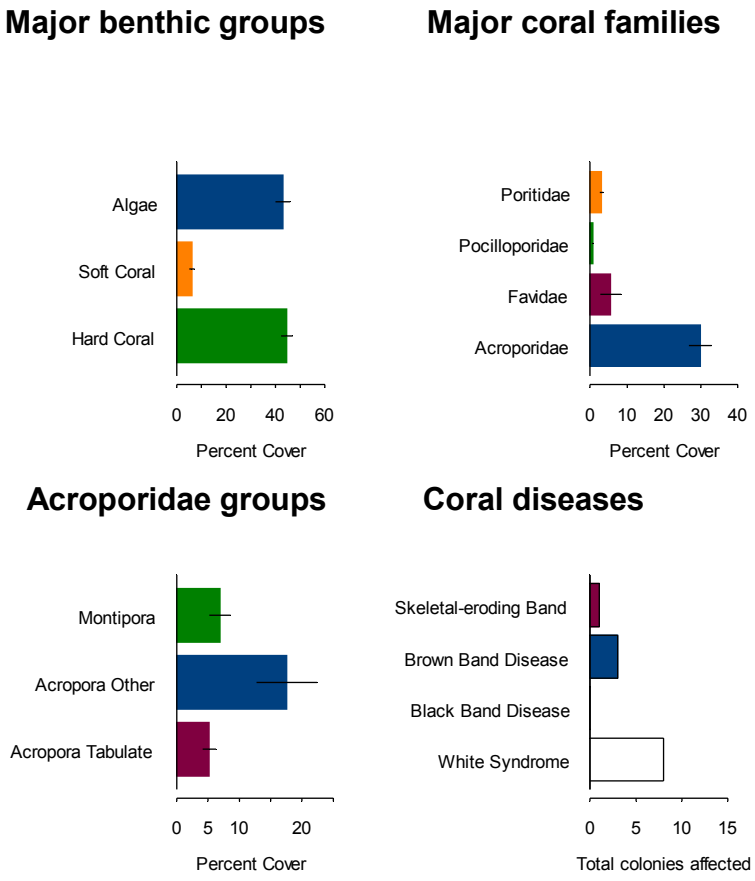
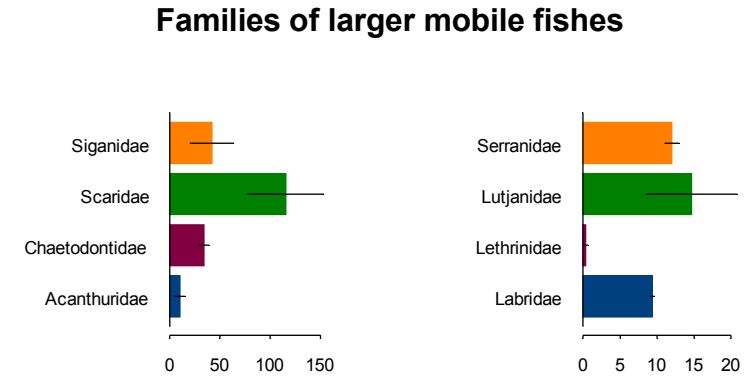
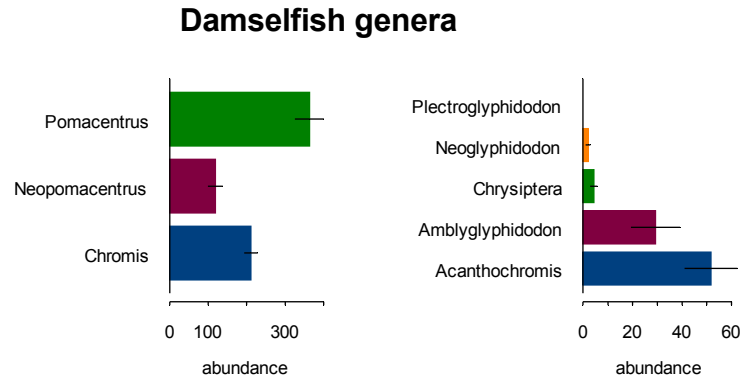


Figure 5.129 (cont.)
Tern Island Reef (20309) was last surveyed in July 2006.





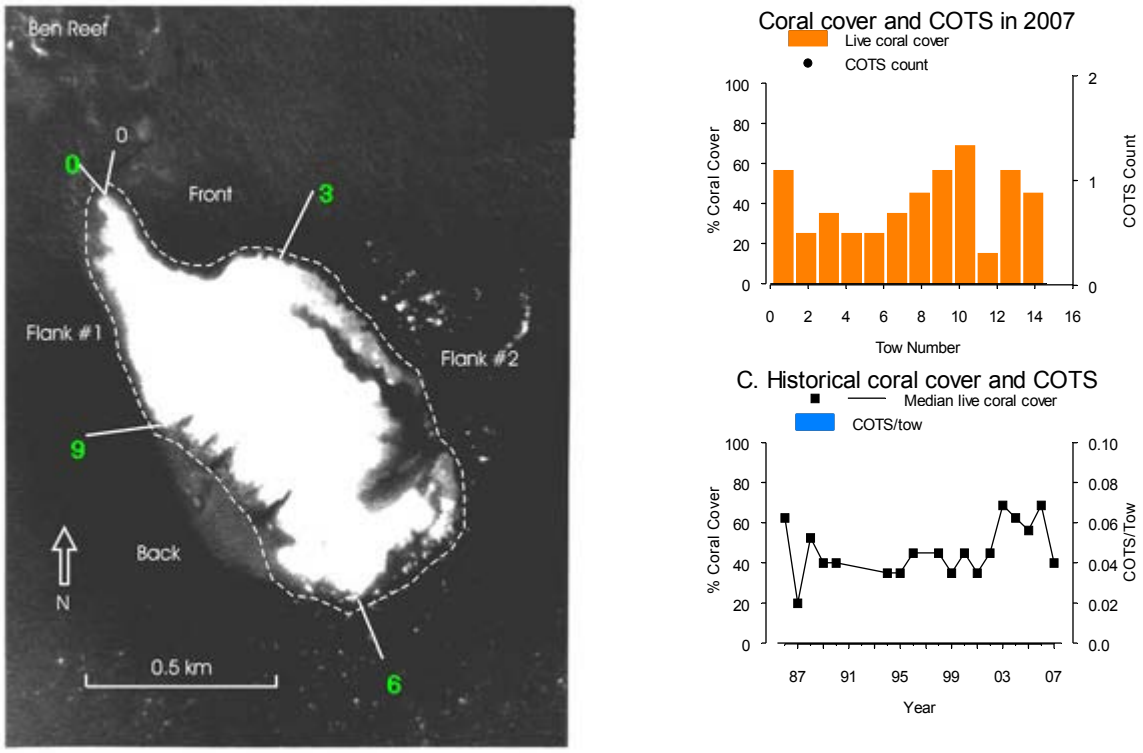


BEN

Ben Reef has been surveyed regularly using manta tow since 1986. Median reef-wide live coral cover was initially very high (51-75%) but declined to high levels (31-50%) during the 1990s before returning to very high levels (51-75%) by 2003. In the 2007 broadscale survey the reef-wide coral cover had declined to high levels (31-50%). No bleaching or signs of black band disease were observed during manta tow surveys. Signs of white syndrome were restricted to small numbers of scattered coral colonies on the front and flanks of the reef. The reason for the observed decline in hard coral cover in 2007 is unknown. No COTS were observed, signs of bleaching were absent in 2006 and 2007 surveys and signs of white syndrome in 2007 were too low and patchy to contribute to the reef-wide decline in coral cover. However, it is possible that storm damage may have contributed to the hard coral cover decline. Ben Reef remained classified as No Outbreak in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.130



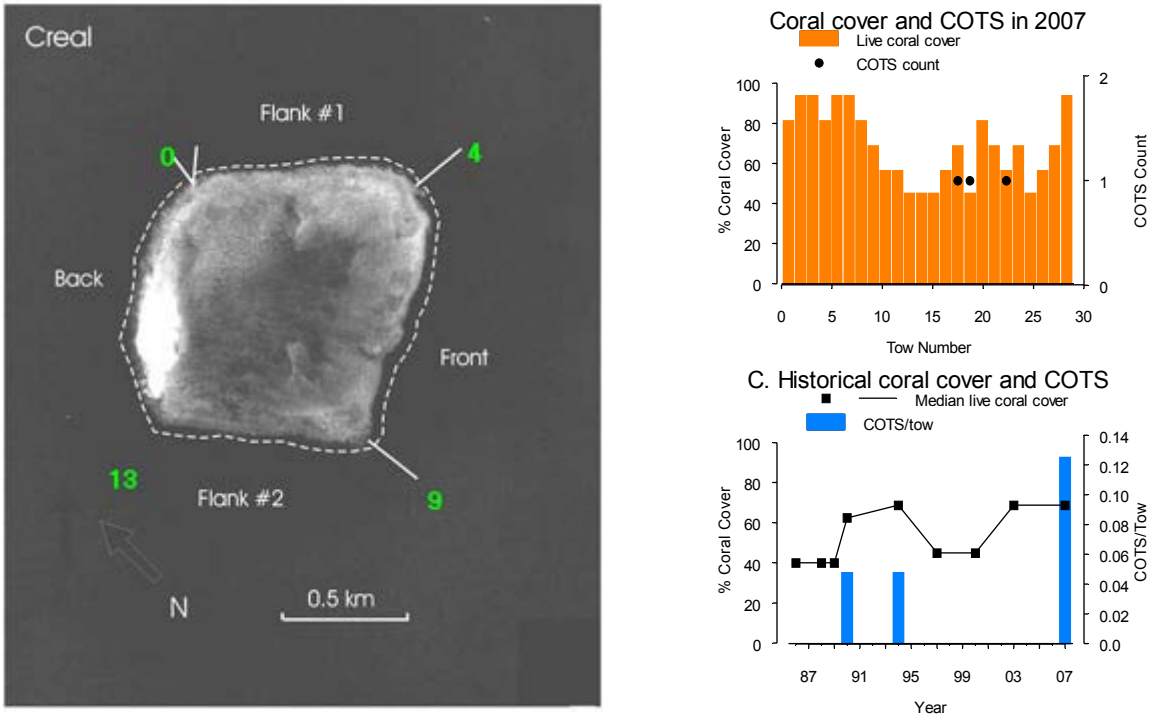
Ben Reef (No. 20-113) is an outer shelf planar reef with an area of 1.2 sq.km.

CREAL

Creal Reef has been surveyed by manta tow nine times since 1986. Median reef-wide live coral cover was high (31-50%) in initial surveys. In 1990 coral cover dramatically increased despite a Non-Outbreaking population of COTS being present and stayed very high (51-75%) until 1994. By 1997 reef-wide live coral cover declined to previous levels (around 31-50%) possibly due to damage caused by Cyclone Justin. Reef-wide coral cover showed an increase to very high levels (51-75%) in the following survey in 2003 and remained very high in the 2007 broadscale surveys. Small numbers of COTS were observed in 2007 but well below those expected to affect reef-wide live coral cover and the reef remained classified as No Outbreak. No bleaching or signs of black band disease were recorded, while signs of white syndrome were observed on small numbers of scattered coral colonies around the reef perimeter during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.131



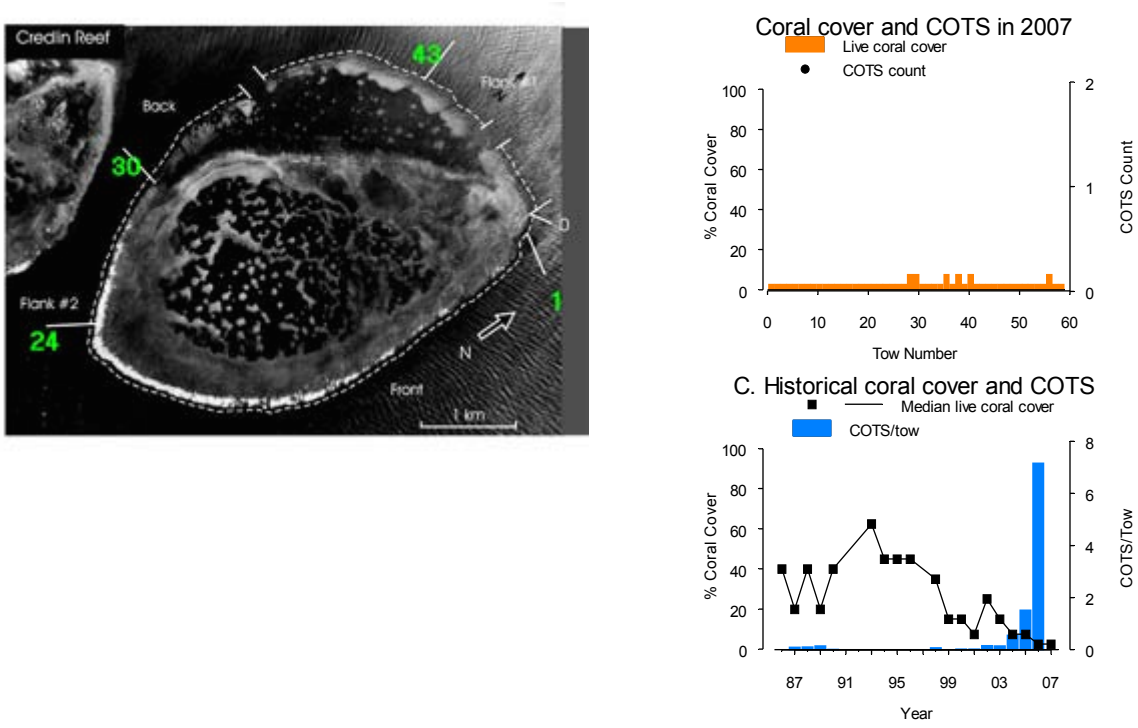
Creal Reef (No. 20-297) is a mid-shelf planar reef with an area of 1.6 sq.km.

CREDLIN

Credlin Reef has been surveyed using manta tow regularly since 1986 when it had high median reef-wide live coral cover (31-50%) and no COTS. COTS were observed between 1987 and 1990, although in numbers usually considered too low to have an affect on overall coral cover. Reef-wide live coral cover subsequently increased and peaked in 1993 at very high levels (51-75%), then declined to low levels (1-10%) by 2001. The reasons for this decline were unclear, but Cyclone Justin in 1997 may have contributed. COTS almost certainly have contributed with elevated populations observed in 1998 and from 2000 through to 2003. A further decrease in reef-wide live coral cover in 2003 may have been due to bleaching in 2002, combined with low level COTS activity. Credlin Reef was classified as an Incipient Outbreak in 2004. In 2005 COTS activity increased on Credlin Reef and it was reclassified as an Active Outbreak. Outbreak levels of COTS were again recorded in 2006 along with a further decline in reef-wide coral cover to a very low level (1-5%). Surveys in 2007 show COTS had disappeared from Credlin Reef along with nearly all the live coral cover which remains very low (1-5%). Credlin Reef was reclassified as Recovering in 2007. No bleaching or signs of black band disease were recorded while signs of white syndrome were observed on small numbers of scattered coral colonies on the front reef during manta tow surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.132



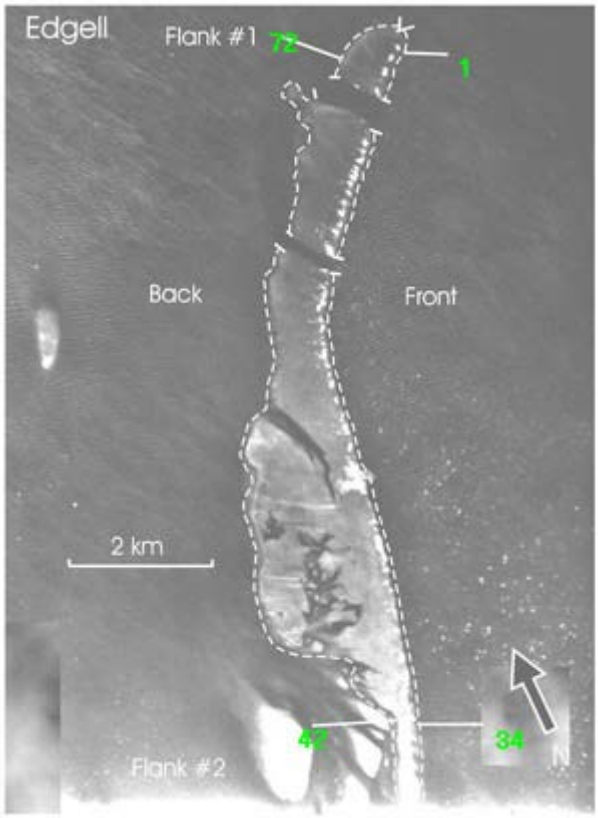
Credlin Reef (No. 20-287) is a mid-shelf lagoonal reef with an area of 9.4 sq.km.

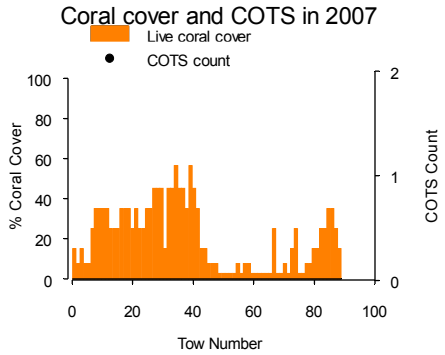
EDGELL

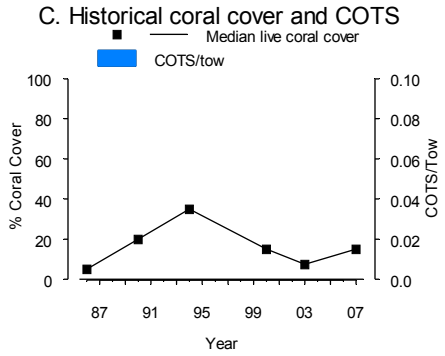
Edgell Reef has been surveyed six times by manta tow since 1986, when median reef-wide live coral cover was low (1-10%) and no COTS were observed. Reef-wide live coral cover increased steadily to high levels (31-50%) by 1994, then declined to a low level (1-10%) in 2003. The cause of this decline is unknown. However the combined effects of Cyclone Justin, which affected reefs in the area in 1997, and the 2002 bleaching event may have contributed. Edgell Reef remained classified as No Outbreak in 2007 and coral cover showed some sign of increase and was at a moderate (11-20%) level. No bleaching or signs of black band disease were observed while signs of white syndrome were restricted to small numbers of scattered coral colonies around the reef perimeter during surveys in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.133







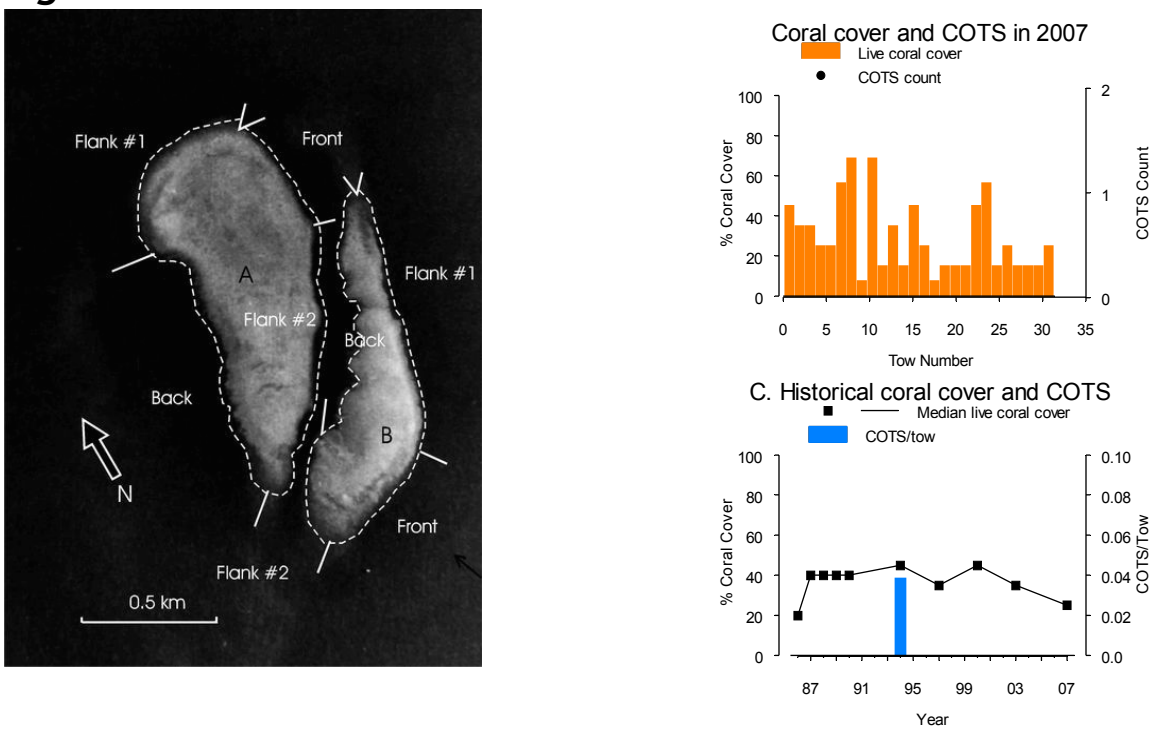
Edgell Reef (No. 20-112) is a mid-shelf patch reef with an area of 13.1 sq.km.

PACKER

Packer Reef was first surveyed by manta tow in 1986 when median reef-wide live coral cover was moderate (11-30%) and no COTS were observed. Reef-wide live coral cover then increased to a high level (31-50%) by 1994. COTS were detected once in 1994 at non-outbreaking levels. Reef-wide live coral subsequently remained at high levels through to 2000 before showing a gradual decline. The reason for this decline, in the absence of COTS, remains unknown. Surveys in 2007 showed reef-wide live coral cover is currently moderate (21-30%) and Packer Reef remained classified as No Outbreak.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.134



Packer Reef (No. 20-145) is a mid-shelf crescentic reef with an area of 1.6 sq.km.

Swain

Reef Pages

21-139

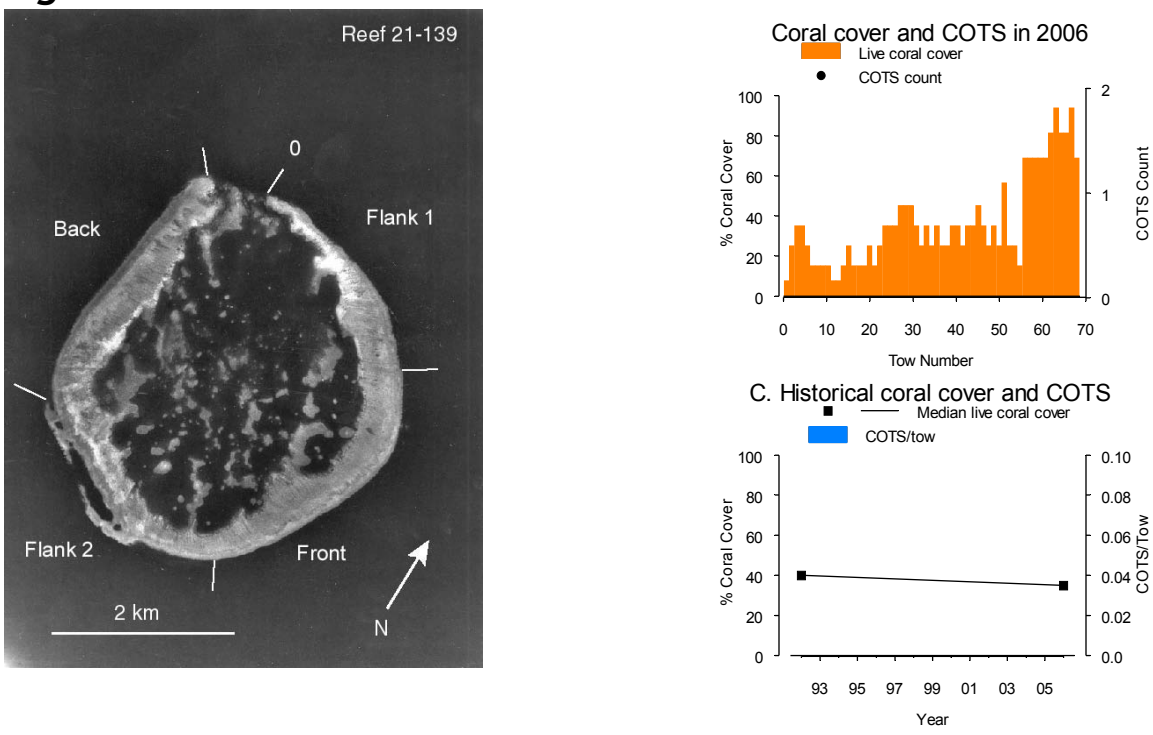
2006 was only the second time that Reef 21-139 has been surveyed using manta tow since 1992. The long period between surveys means little can be inferred about changes in reef-wide coral cover other than it is at a similar high level (31-50%) to that recorded when first surveyed. No COTS were observed in 2006 and the reef remained classified as No Outbreak. At the time of survey in March 2007 low levels (restricted to small numbers of scattered coral colonies) of bleaching were observed around the reef perimeter. Low levels of black band disease were observed on the back reef while low levels of white syndrome was observed on the northern flank of the reef.

Detailed surveys at Reef 21-139 started in 2006. In the initial survey hard coral cover was 22%. Poritidae was the most abundant hard coral family with 9% cover consisting mostly of branching species, while Acroporidae had 6% cover and Faviidae had 4%. Branching, massive and encrusting non-*Acropora* spp. corals were the dominant growth forms. Soft coral cover was low at 2% in 2006. Algae dominated the reef with 57% cover, mostly represented by turfing algae with some coralline algae and the calcareous green algae, *Halimeda* spp. Sand cover was high at 17% indicating a protected environment. On SCUBA search surveys white syndrome had a rare incidence. *Drupella* spp, a corallivore, was seen at densities of 220 snails/ha.

Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community. Abundances of Acanthuridae were particularly low. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. moluccensis*. This species is largely coral dependent and thrives on reefs with moderate to high hard coral cover (>20%). Abundances of *Chromis* spp. and *Neopomacentrus* spp. were very low.

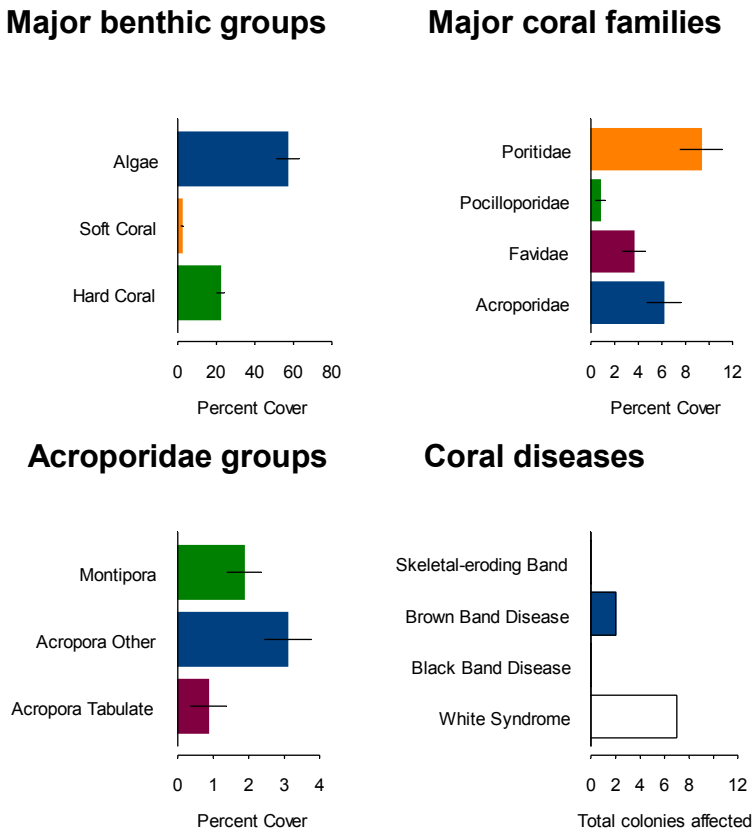
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.135



Reef 21-139 (No. 21-139) is a mid-shelf lagoonal reef with an area of 13.8 sq.km.

Figure 5.135 (cont.)
Reef 21-139 was last surveyed in March 2006.



21-187

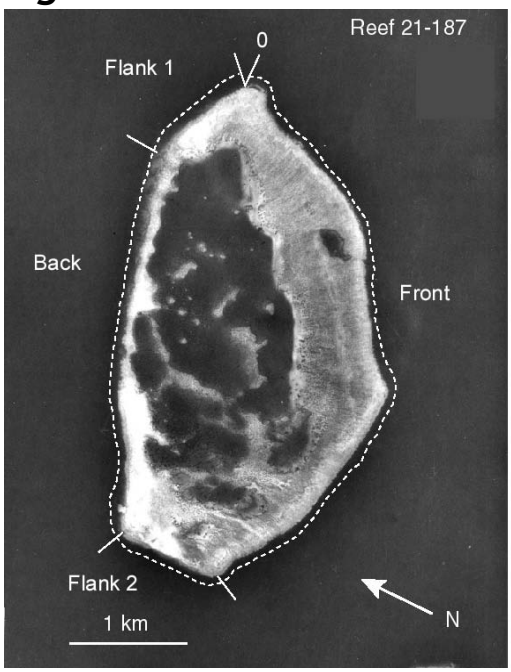
Reef 21-187 was initially surveyed by manta tow in 1991 and the third survey was done in 2006. With long periods between surveys there is little information on what changes have occurred since surveys began. In surveys in 1991, 1992 and 2006 median reef-wide coral cover was at a very high level (51-63%). COTS were present in the first two surveys but no COTS were observed in 2006 and the reef was classified as No Outbreak. No coral bleaching or signs of black band disease were observed in 2006. At the time of survey in 2006 low levels of white syndrome disease, restricted to small numbers of individual coral colonies, were observed on the back, front and southern flank of the reef.

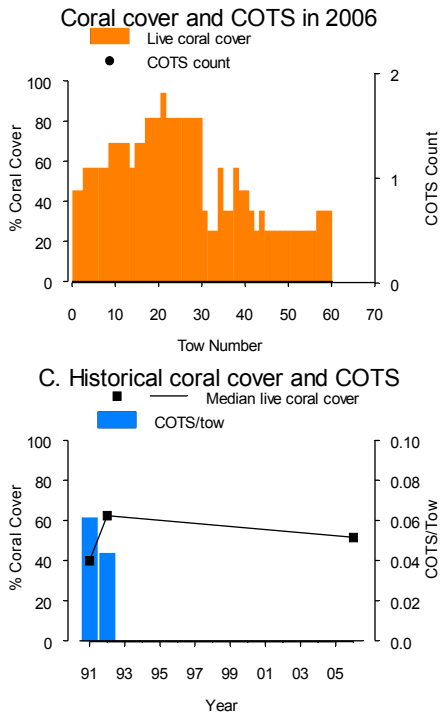
Intensive survey were conducted on Reef 21-187 for the first time in 2006. Hard coral cover was 34% and was comprised of 15% Acroporidae, 5% Faviidae, 5% Poritidae, 3% Pocilloporidae. *Acropora* spp. cover was 13% with tabulate, bottlebrush and branching growth forms at 8%, 3% and 1% cover respectively. Within the non-*Acropora* spp. corals, massive corals were the dominant growth form. Soft coral cover was low at 4%. Sponges covered 2% of the survey sites. Algae was the dominant benthos at 54% cover, composed of fine turfing algae and crustose coralline algae. White syndrome incidence was low on SCUBA search surveys. *Drupella* spp., a corallivorous gastropod, were recorded at a density of 553 animals/ha.

Chaetodontidae, Scaridae and Labridae dominated the large, mobile fish community. Abundances of Acanthuridae were particularly low. Amongst the damselfishes, *Pomacentrus* spp. and *Chromis* spp. were comparably dominant. However, patterns for *Pomacentrus* spp. were driven by relatively high numbers of *P. moluccensis* among all sites while patterns for *Chromis* spp. were driven by variable counts of *Chromis nitida* (hence the large error bars). *P. moluccensis* is a largely coral dependent species and thrives on reefs with moderate to high hard coral cover (>20%). *C. nitida* is predominantly found on the southern GBR and often forms massive schools that randomly intersect survey lines, resulting in high between site variability in counts. *Neopomacentrus* species were not recorded at this reef.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

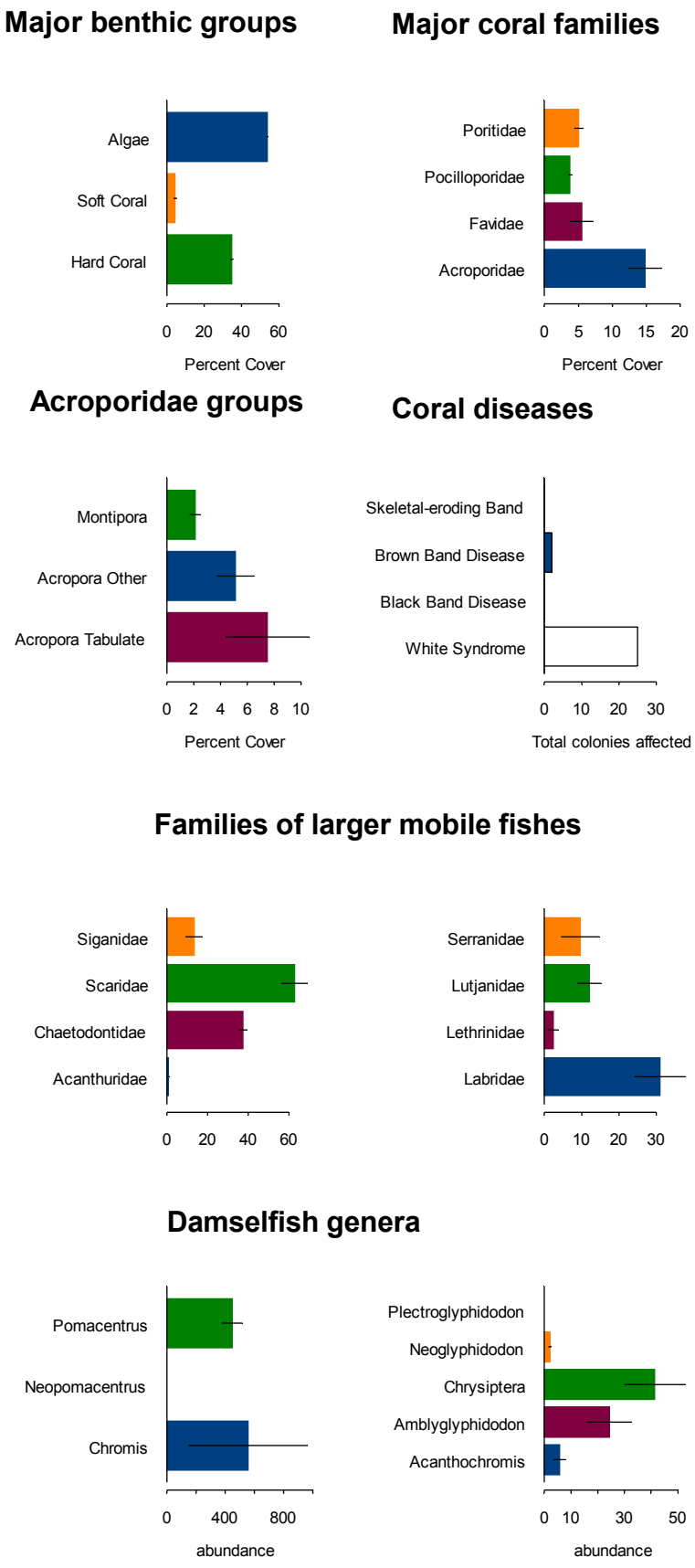
Figure 5.136





Reef 21-187 (No. 21-187) is a mid-shelf lagoonal reef with an area of 16.3 sq.km.

Figure 5.136 (cont.)
Reef 21-187 was last surveyed in May 2006.



21-245

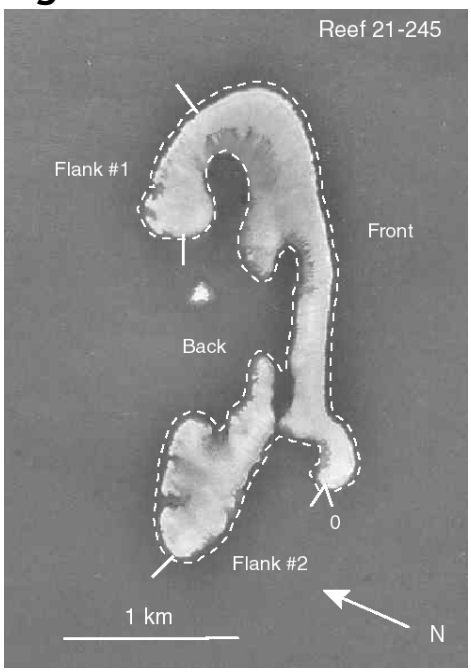
2006 was the first time that Reef 21-145 was surveyed using manta tow by the LTMP. Median reef-wide live coral cover was moderate (21-30%). COTS were observed but in numbers considered too low to cause changes in reef-wide live coral cover and the reef was classified as No Outbreak. At the time of survey low levels (restricted to small numbers of scattered individual coral colonies) of coral bleaching were observed on the north flank and front reef areas. No signs of black band disease were observed and low levels of white syndrome were recorded from the back, front and northern flank of the reef in 2006.

Detailed surveys commenced in 2006. Hard coral cover was high at 35%. Half of this cover was accounted for by colonies from the Acroporidae family, at 18%. Poritidae, Faviidae and Pocilloporidae corals accounted for another 14% of hard coral cover. Tabulate *Acropora* spp. cover was 7%. Soft coral cover was low in 2006. Algae had a very high cover at 61%. Turfing algae was the most abundant algae observed with an average cover of 42%, while coralline algae cover was 13%. In SCUBA search surveys white syndrome was rare and the corallivore *Drupella* spp. was seen at a low density of 13 snails/ha.

Acanthuridae and Scaridae dominated the large, mobile fish community although a number of other taxa were also relatively abundant. Abundances of Acanthuridae were relatively high for Swain reefs and were driven by *Ctenochaetus* spp.. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys* and to a lesser extent by *P. moluccensis*. Most other damselfish taxa appeared to have healthy abundances apart from *Chromis* spp. and *Neopomacentrus*. spp. Abundances of these two taxa were very low but this is not unusual among Swain mid-shelf reefs where their counts can be highly variable.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.137



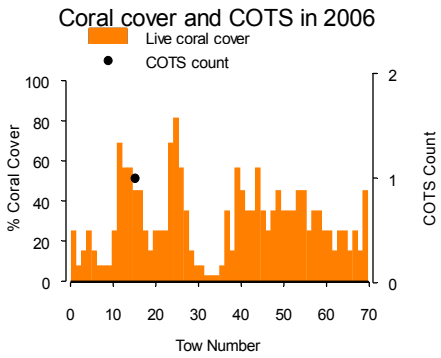
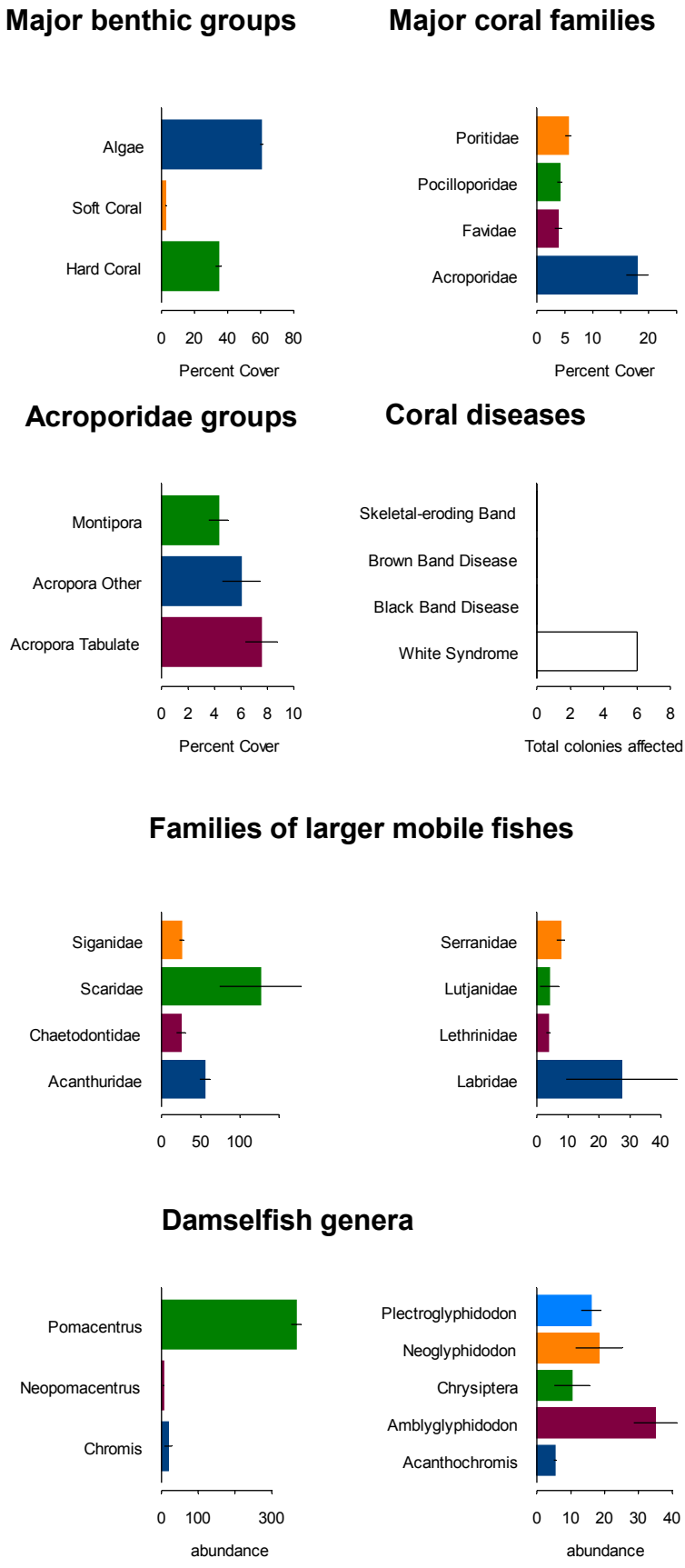


Figure 5.137 (cont.)
Reef 21-245 was last surveyed in January 2006.



21-278

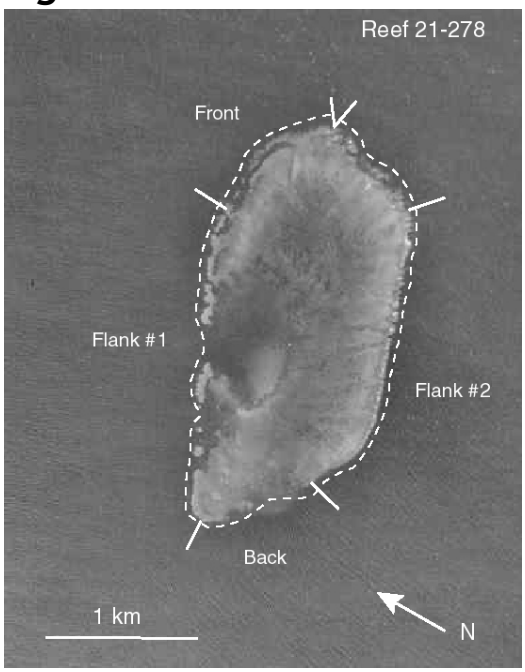
2006 was the first time that Reef 21-278 was surveyed using manta tow by the LTMP. Median reef-wide live coral cover was moderate (21-30%). No COTS were observed and the reef had been classified as No Outbreak. At the time of survey low levels (restricted to small numbers of scattered individual coral colonies) of coral bleaching were observed on the southern flank of the reef. No signs of black band disease were observed and low levels of white syndrome were recorded from the southern flank of the reef.

Intensive surveys commenced in 2006. Moderate hard coral cover was recorded in the first survey, with an average of 26% on the surveyed sites. Acroporidae and Poritidae were the most abundant families with 8% and 7% cover respectively. Massive and encrusting non-*Acropora* spp. corals were the most abundant lifeforms. Algae cover was 59% and mostly consisted of turfing algae (41% cover) and coralline algae (11% cover). Soft coral cover was low at 9%, half of which were colonies of the Xeniidae family. Sponge cover was 3%. The corallivore *Drupella* spp. was observed at a density of 7/ha. White syndrome was rarely observed during SCUBA search surveys.

Acanthuridae, Chaetodontidae and Scaridae dominated the large, mobile fish community. Abundances of Acanthuridae and Chaetodontidae were particularly high for Swain reefs and were driven by *Ctenochaetus* spp., and *Chaetodon trifasciatus* and *C. kleinii*, respectively. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys*. Abundances of *Chromis* spp. were very low and *Neopomacentrus* spp. was not recorded. However, this is not unusual among Swain mid-shelf reefs where abundances of these two genera can be highly variable. *Chrysiptera* spp. abundances were also relatively low.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.138



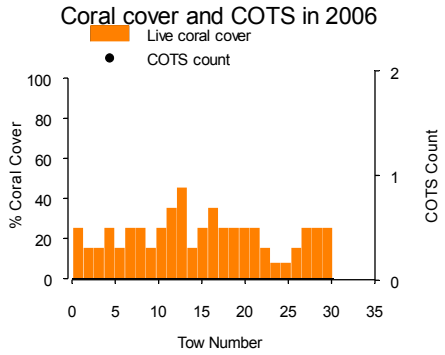
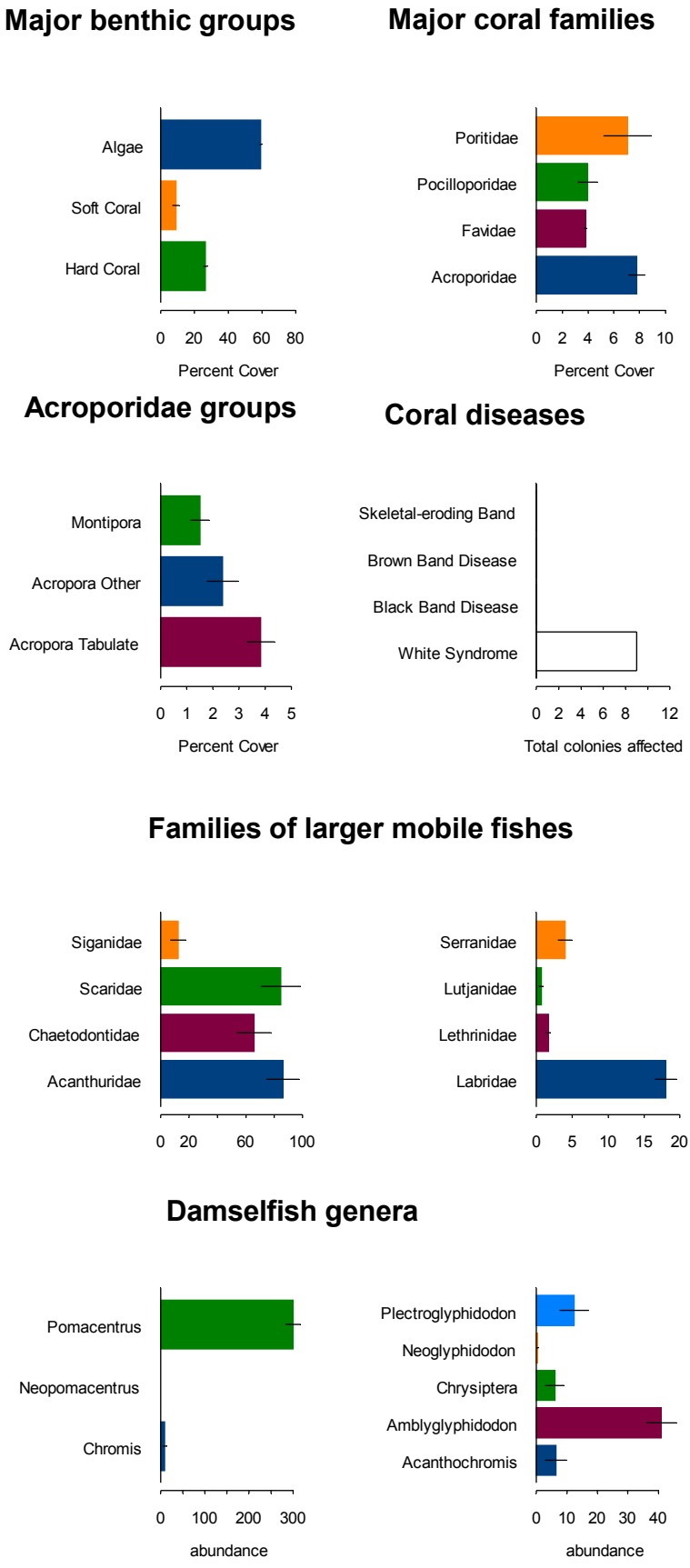


Figure 5.138 (cont.)
Reef 21-278 was last surveyed in January 2006.



21-296

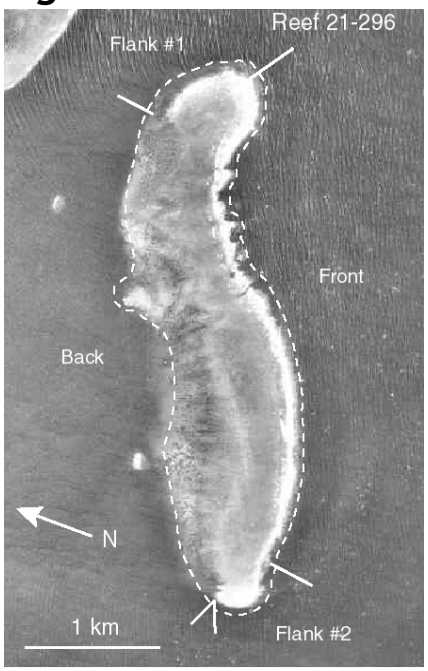
2006 was the first time Reef 21-296 was surveyed using manta tow by the LTMP. Median reef-wide live coral cover was low (6-10%). Since Reef 21-296 had no history of survey it was not possible to ascribe reasons for the apparent low coral cover. No COTS were observed and the reef has been classified as No Outbreak. At the time of survey low levels (restricted to small numbers of scattered individual coral colonies) of coral bleaching and white syndrome were observed on the back and northern flank of the reef. No signs of black band disease were observed in 2006.

Surveys were first conducted in 2006. Hard coral cover was 25%. Acroporidae was the most abundant family at 17%. The tabulate growth form of *Acropora* spp. occupied 7% of the substrate, while encrusting *Isopora* spp. occupied 5%. Digitate and branching forms of *Acropora* spp. accounted for 2% and 1% cover respectively. The cover of soft coral was 4%. Algal cover was high at 67%. Turfing algae (44%) and coralline algae (18%) were the most abundant in the algal community. The cover of sponges was low at 1%. The corallivorous snail was not observed during SCUBA search surveys. White syndrome was rarely seen in 2006.

Acanthuridae and Scaridae dominated the large, mobile fish community on this outer reef. Abundances of Acanthuridae were particularly high (compared to other Swain survey reefs) and were driven by *Ctenochaetus* spp. and to a lesser extent by *Acanthurus nigrofuscus*. This pattern is probably related to the fact that many genera from Acanthuridae appear to prefer more exposed reef habitats; most of the Swain survey reefs are located on the mid-shelf. Unusually, no species from Lutjanidae were recorded. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven fairly equally by *P. lepidogenys* and *P. bankanensis*. *Acanthochromis polyacanthus* was relatively abundant although counts were variable among sites (large error around the mean). In contrast, *Amblyglyphidodon* spp. abundances were relatively low.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.139



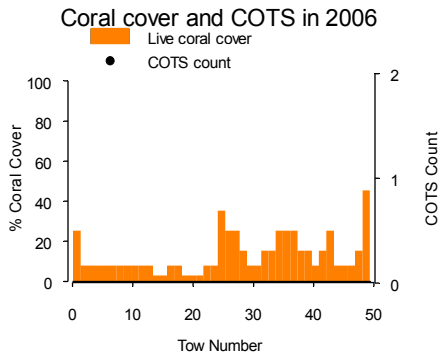
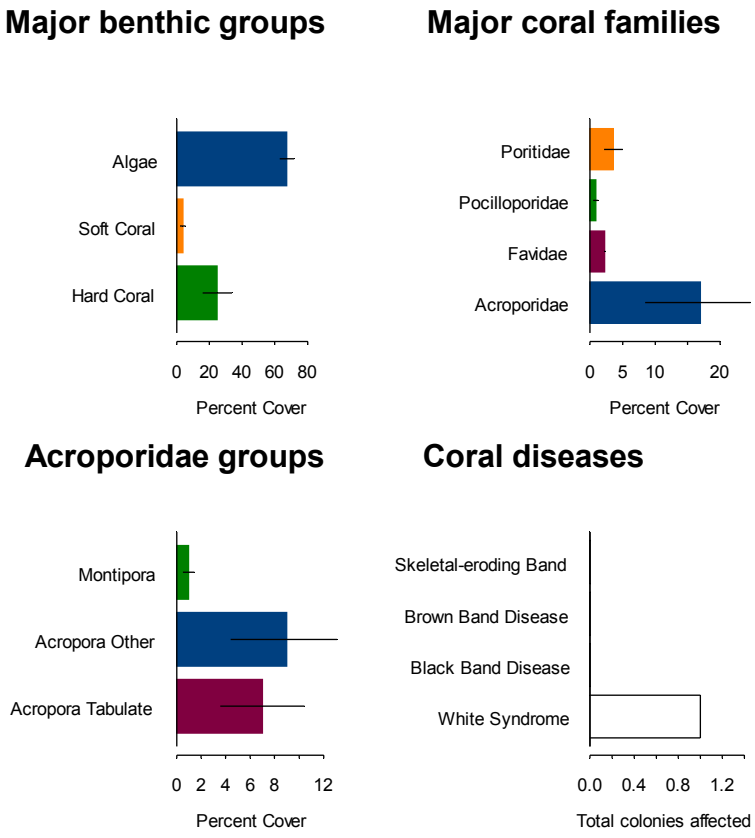
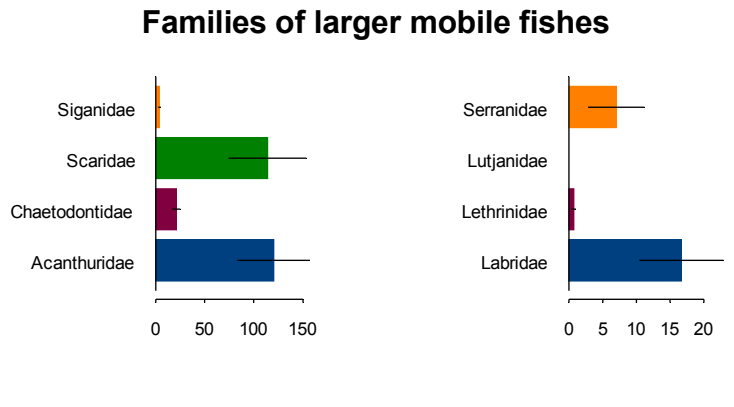
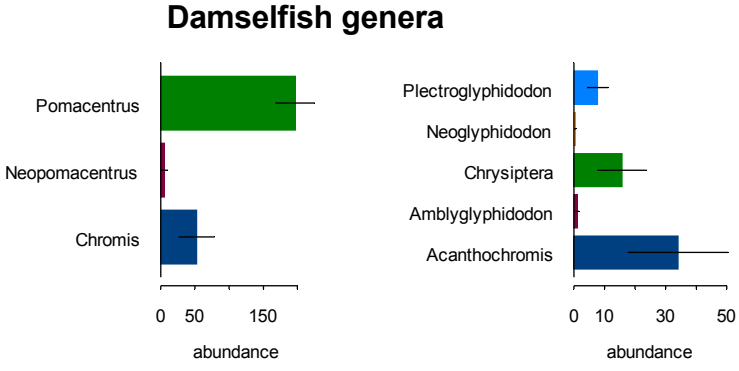


Figure 5.139 (cont.)
Reef 21-296 was last surveyed in January 2006.







21-302

2006 was the first time that Reef 21-302 had been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was high (41-50%). No COTS were observed and the reef had been classified as No Outbreak. No coral bleaching or signs of coral disease were observed during surveys in 2006.

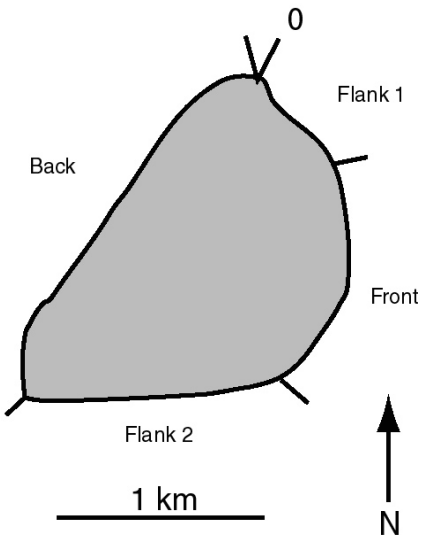
The cover of hard coral recorded during the initial survey in 2006 at Reef 21-302 was 31%. The most abundant hard coral family was the Acroporidae at 18%. The two most common genera were *Acropora* spp., with a cover of 17% while *Porites* spp. had 8% cover. The most prevalent growth forms of hard coral were tabulate *Acropora* spp. and encrusting *Isopora* spp. Soft coral cover was moderate, at 22%. Xeniidae was the most abundant soft coral family with 14% cover. Nearly half of the benthic cover (45%) was algae. Coralline algae was the most abundant at 24% cover while turfing algae covered 18%. Rare incidence of white syndrome was recorded during surveys. The corallivorous snail *Drupella* spp. was not observed during SCUBA search surveys.

Acanthuridae and Scaridae dominated the large, mobile fish community on this outer reef. Abundances of Acanthuridae were quite high (compared to many other Swain survey reefs) and were driven by *Ctenochaetus* spp. and to a lesser extent by *Acanthurus nigrofuscus*. This pattern is probably related to the fact that many species within Acanthuridae appear to prefer more exposed reef habitats; most of the Swain survey reefs are located on the mid-shelf. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys* and to a lesser extent by *P. bankanensis*. *Amblyglyphidodon* spp. abundances were relatively low.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.140

Reef 21-302



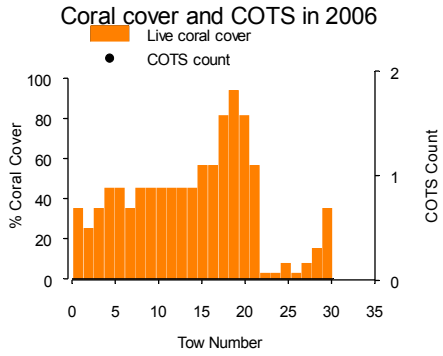
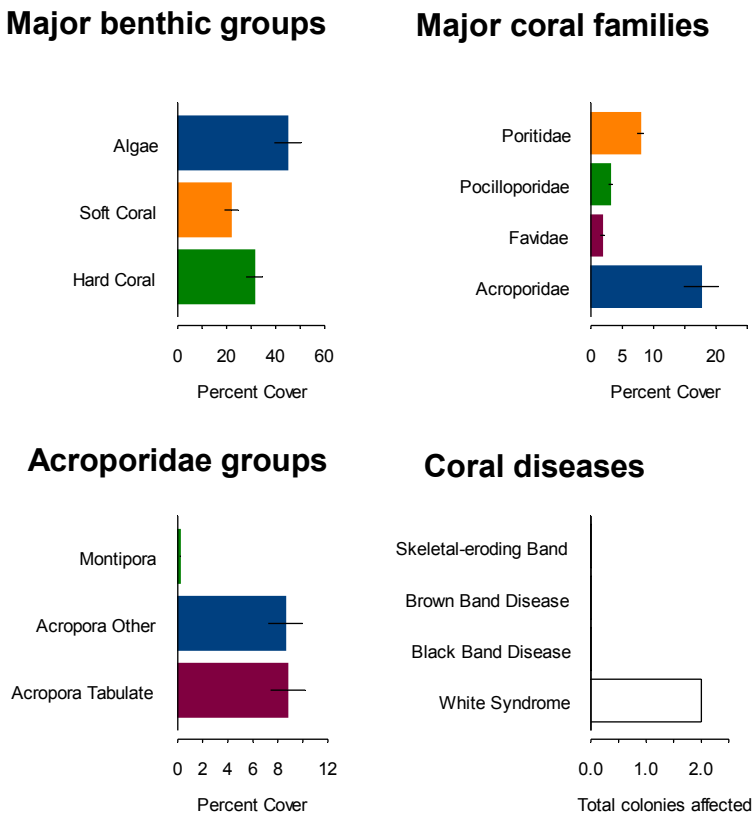


Figure 5.140 (cont.)
Reef 21-302 was last surveyed in January 2006.



21-529

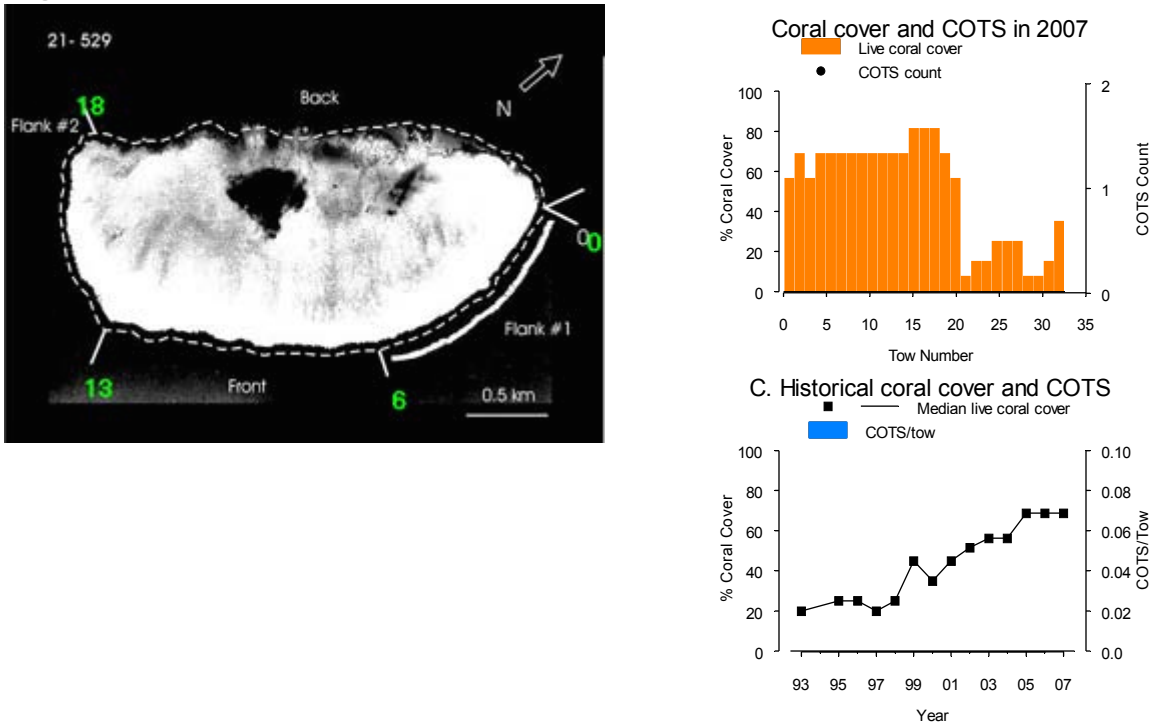
Reef 21-529 is a Preservation Reef within the GBRMP and so has the highest protection status. Reef 21-529 has been surveyed extensively using manta tow since 1993. Broadscale surveys show that median reef-wide live coral cover remained at moderate levels (11-30%) until 1997. From 1998 up until 2004 reef-wide live coral increased steadily to very high values (51-75%). Subsequent surveys including those in 2007 indicated reef-wide live coral cover continued to be very high (63-75%). No COTS had been observed during any manta tow survey and Reef 21-529 remained classified as No Outbreak in 2007. No bleaching was observed and signs of black band disease only affected a few scattered coral colonies on the front reef. Signs of white syndrome were more widespread, around the entire reef perimeter, but again at a low level affecting only small numbers of scattered coral colonies.

Intensive survey sites were set up in 1993 and on the first detailed coral surveys hard coral cover was 37%. This level of cover dropped to 29% in 1995, but then increased in the following years to reach a maximum of 64% in 2002. In 2005 hard coral cover was 51% and declined slightly to 46% in 2007. The increase in algal cover to 50% in 2007 was driven by the increase in turf algae . Soft coral cover remained low (<2%) since the first survey. Changes in hard coral cover have largely been due to changes in cover of branching *Acropora* spp., but to a lesser extent bottlebrush *Acropora* spp. and these taxa have remained dominant throughout this study. *Porites* spp. have also been declining since 2002. It is unknown what caused the decline of coral cover. However high sea surface temperatures were recorded in the summer of 2002 with a 3 day maximum of over 32 degrees while summer maximums since then have been below 30 degrees. These high temperatures may have stressed the corals and possibly led to bleaching, then mortality or to an increase in the incidence of coral diseases around that time. The prevalence of white syndrome was high on Reef 21-529 in 2003 but has remained low since that time. In 2007 incidence of brown band disease, skeletal eroding band disease and white syndrome were rare on SCUBA searches. The density of corallivorous snails *Drupella* spp. was 80/ha in 2007.

Although abundances of fishes varied from year to year there was little tendency for prolonged increases or decreases in most taxa over the 15-year study period. One genus (*Pomacentrus*), tended to decline in abundance from peaks in 1996. In 2002, numbers of three *Pomacentrus* species, *P. wardi*, *P. brachialis* and *P. lepidogenys*, were the lowest since surveys began and for the first time *P. coelestis* was not recorded in surveys. *Pomacentrus* spp. abundances were still low in 2007, although it must be noted that there were still over 300 fish per site which is high compared to many other reefs. Abundances of *Chrysiptera* spp. (driven by *C. rollandi*) tended to decrease after 1996 and reached a 15-year low in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

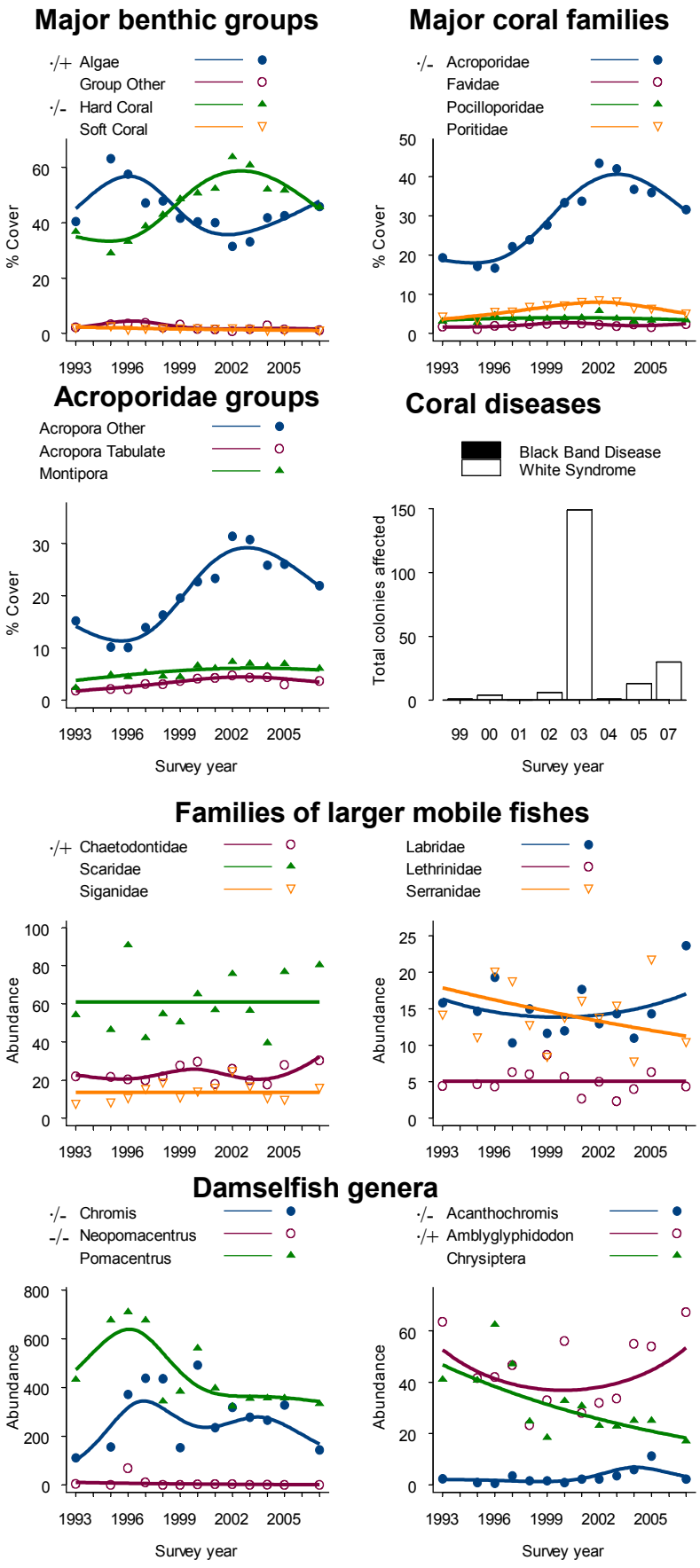
Figure 5.141



Reef 21-529 (No. 21-529) is a mid-shelf crescentic reef with an area of 6.3 sq.km.

Figure 5.141 (cont.)

Reef 21-529 was last surveyed in November 2006.



21-550

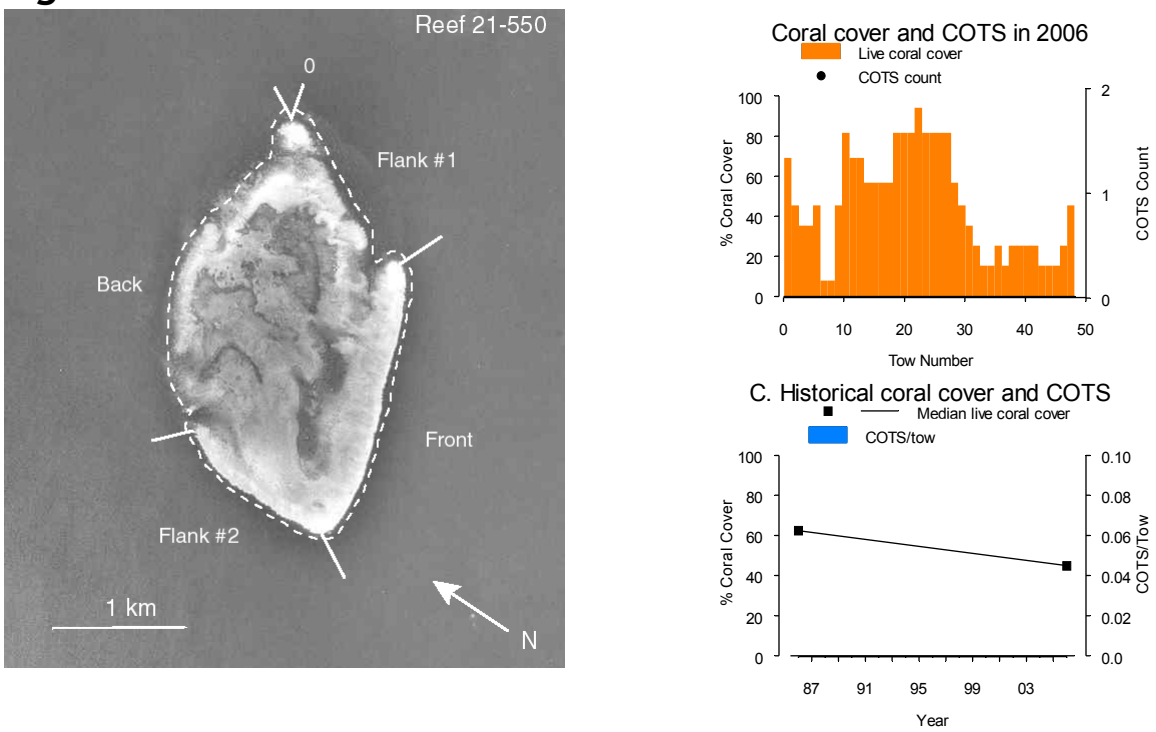
Reef 21-550 was first surveyed using manta tow in 1986 and for the second time in 2006. As it was 20 years between surveys, no interpretation for the change in median reef-wide live coral cover can be given. In 1986 reef-wide coral cover was at a very high level (50-75%) and in 2006 it was at a high level (31-50%). No COTS or coral bleaching were observed in 2006 and the reef was classified as No Outbreak. Low levels (restricted to small numbers of scattered individual coral colonies) of black band disease were observed on the back reef and northern flank, while low levels of white syndrome were observed on the back reef, northern flank and front of the reef.

Intensive surveys were first conducted in 2006. On this initial survey hard coral cover was very high at 56%. The Acroporidae family was the most abundant with a high cover of 41% and was comprised equally of *Acropora* spp. and *Montipora* spp. The most common growth forms of colonies were encrusting non-*Acropora* spp., branching *Acropora* spp., foliose non-*Acropora* spp. and tabulate *Acropora* spp.. The cover of soft coral was very low at 1%. Algal cover in 2006 was 42%. The most prevalent algae was turfing algae with 37% cover, while coralline algae occupied 4% of the benthos. Brown band disease, black band disease, skeletal-eroding band disease and white syndrome were rare on SCUBA search surveys and *Drupella* spp. were present at a low density of 7/ha.

Scaridae, Siganidae and Chaetodontidae dominated the large, mobile fish community. Abundances of Siganidae were particularly high and were driven by the presence of mid-water schools of *Siganus argenteus*.This species tends to school in larger numbers than many other siganids. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. moluccensis* and *P. lepidogenys*. *P. moluccensis* is a highly coral dependent species and it is not surprising that numbers were particularly high on this reef where coral cover was very high (56%). The abundances of the genera*Neopomacentrus* and *Amblyglyphidodon* (driven by N. *azysron* and *A. curacao* respectively) were relatively high.

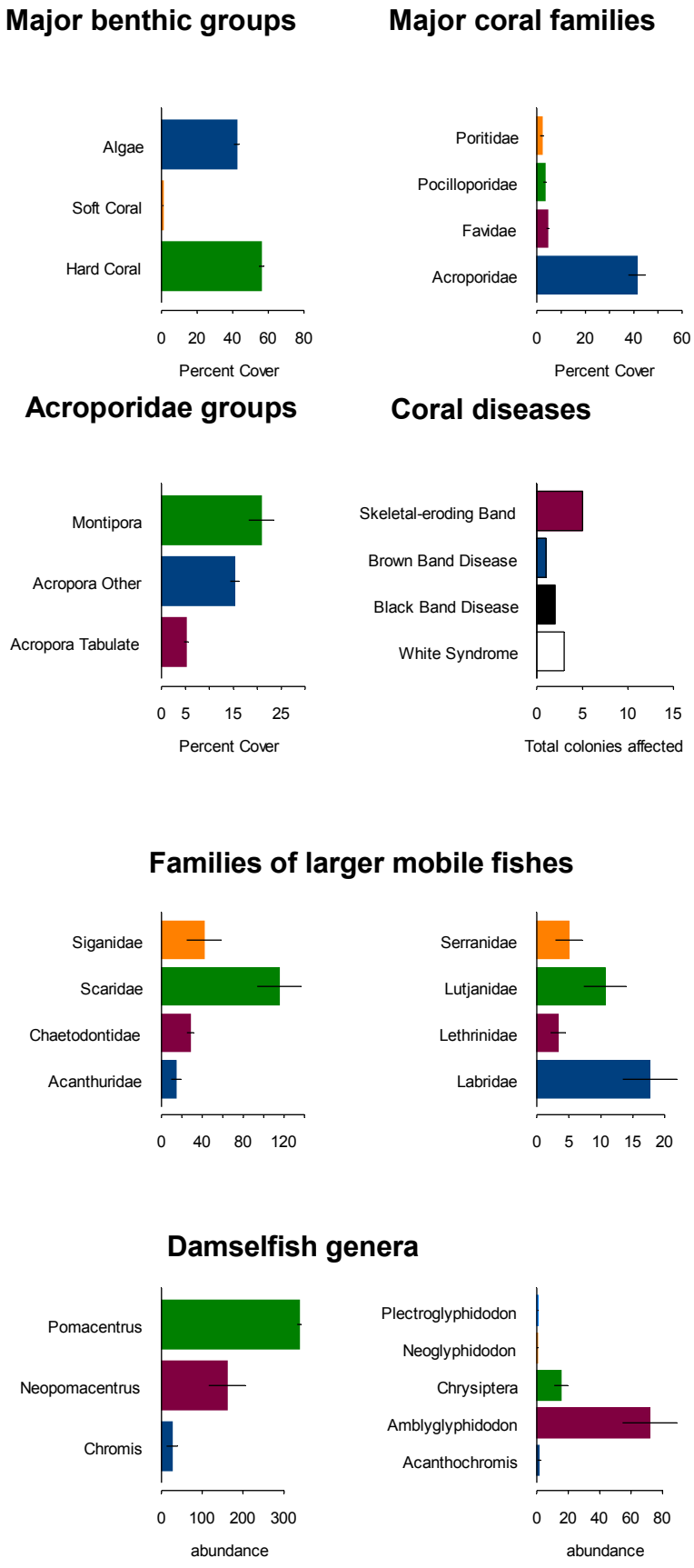
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.142



Reef 21-550 (No. 21-550) is a mid-shelf lagoonal reef with an area of 5.6 sq.km.

Figure 5.142 (cont.)
Reef 21-550 was last surveyed in January 2006.



21-558

In 2006 Reef 21-558 was surveyed using manta tow by the LTMP for the first time. Median reef-wide live coral cover was high (41-50%). COTS were observed but in numbers considered too low to cause changes in reef-wide live coral cover and the reef had been classified as No Outbreak. At the time of survey low levels (restricted to small numbers of scattered individual coral colonies) of white syndrome were observed on the southern flank. No coral bleaching or signs of black band disease were observed in 2006.

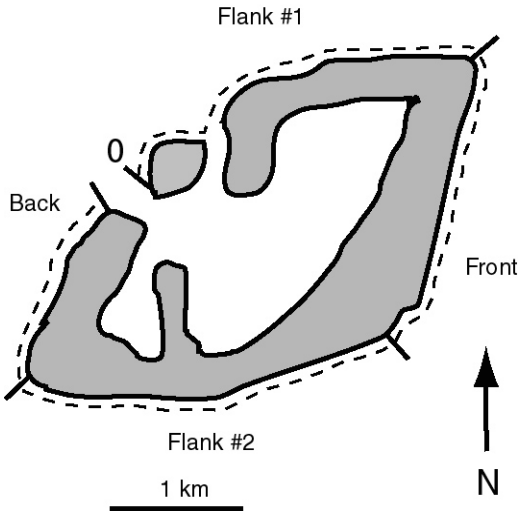
Hard coral cover was moderate at 18% on the initial surveys in 2006. The most common family encountered was Acroporidae, with colonies of the genus *Acropora* accounting for 7% of the benthic cover. Within this group, encrusting *Isopora* spp. and tabulate *Acropora* spp. each had 3% cover. Following *Acropora* spp., the most abundant genus in 2006 was *Porites* spp. at 4% cover. Soft coral cover was 26% with Xeniidae being the most abundant family. The cover of algae was dominated by turfing filamentous types (28%), and coralline algae was 9%. Sand covered 11% of the substrate at the intensive survey sites. The cover of sponges was relatively high at 4%. No incidence of coral disease was recorded in SCUBA search surveys. The corallivorous COTS and *Drupella* spp. were not observed at the survey sites.

Acanthuridae and Scaridae dominated the large, mobile fish community on this outer reef. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys* and to a lesser extent by *P. wardi*, *P. moluccensis* and *P. bankanensis*. Abundances of most other damselfish genera appeared relatively healthy with the exception of *Chromis* and *Neopomacentrus* which, unusually, were not recorded at all. While hard coral cover was moderate in 2006, it was certainly sufficient to house these taxa. Reasons for their absence, particularly of *Chromis* spp. that contains a range of species, is not clear but may be related to poor recruitment.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.143

Reef 21-558



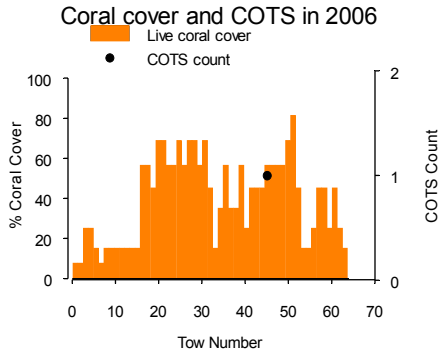
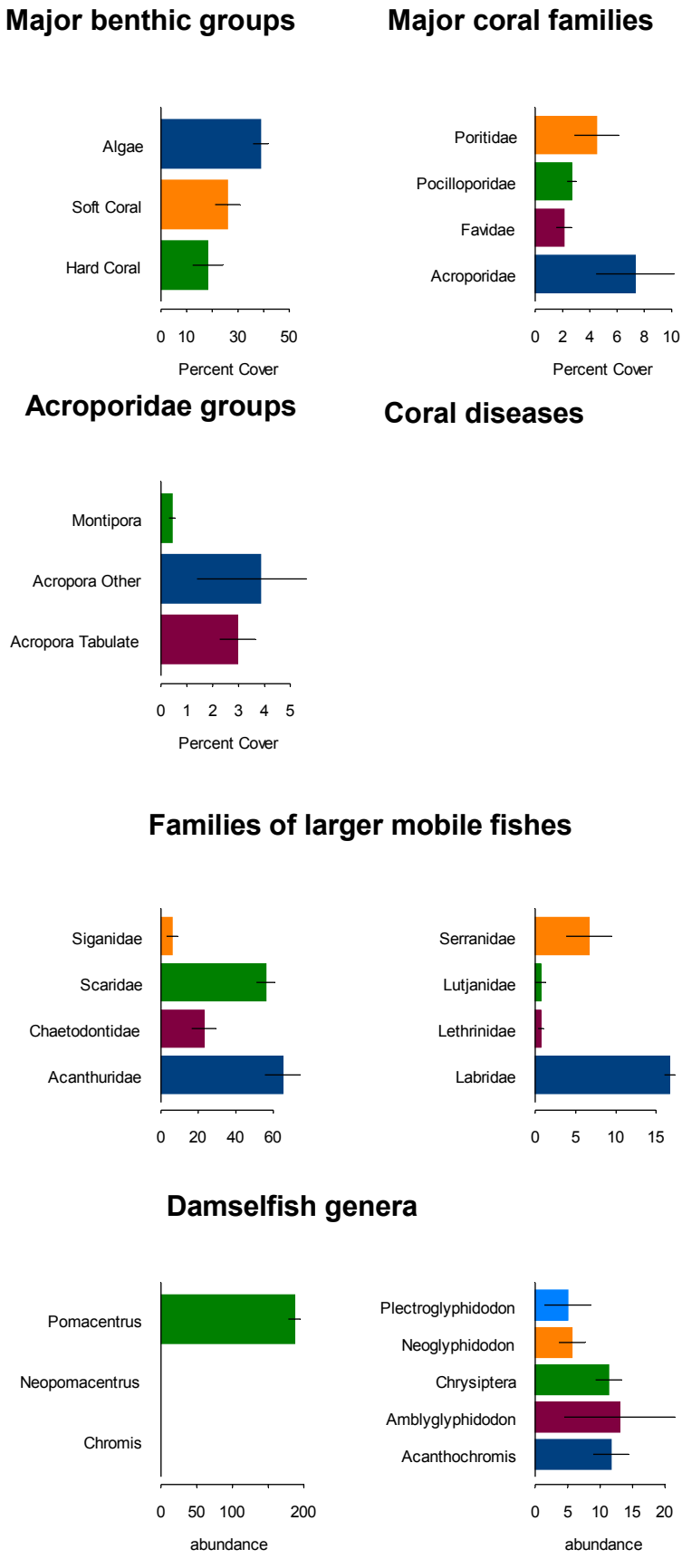


Figure 5.143 (cont.)
Reef 21-558 was last surveyed in January 2006.



22-084

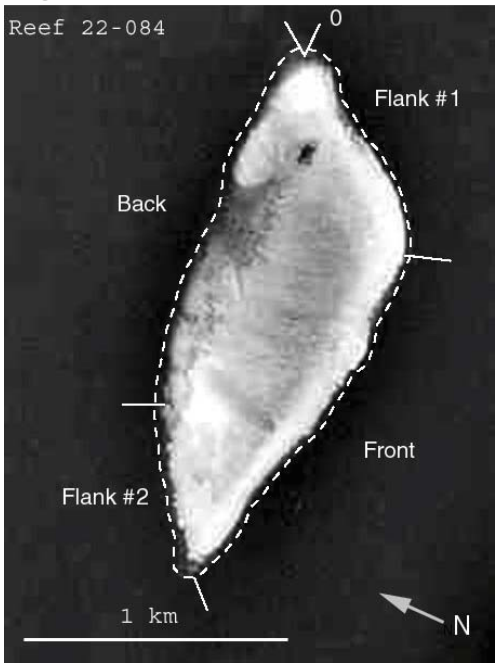
2006 was the first time that Reef 22-084 was surveyed using manta tow by the LTMP. Median reef-wide live coral cover was low (1-5%) and no COTS were observed. It is almost certain that the low live hard coral cover on Reef 22-084 is a result of a recent COTS outbreak, since COTS activity has been recorded on nearby reefs. In particular Gannet Cay reef, an adjacent reef had COTS recorded for 13 years until 2004. Therefore Reef 22-084 was classified as Recovering. No coral bleaching or signs of coral disease were observed during surveys in 2006.

The initial intensive surveys were carried out in 2006. Hard coral cover was low at 8%. Encrusting non-*Acropora* spp., branching non-*Acropora* spp. and tabulate *Acropora* spp. colonies were the dominant lifeforms, each with 2% cover. *Acropora* spp. and *Seriatopora* spp. occupied 2% of the benthic community, while *Porites* spp. had 1% cover. The cover of soft coral was low at 5%, with half from the family Xeniidae.The dominant benthic group at Reef 22-084 was algae, with an extremely high cover of 84%. Turfing algae occupied 67% while coralline algae accounted for 17% of the benthic cover. Diseased hard coral colonies were rarely encountered and no corallivorous *Drupella* spp. or COTS were recorded during SCUBA search surveys.

Considering the low hard coral cover at this reef (8%), indicative of a disturbed system, the fish community appeared surprisingly healthy. Although Scaridae dominated the large, mobile fish community (probaly a reflection of the extremely high turfing algae cover in 2006, a major food source for this fish family), abundances of many other families were relatively high. Abundances of Siganidae and Serranidae (driven by the commercially important coral trout: *Plectropomus leopardus*) were particularly high. The damselfish community was dominated by the genera *Pomacentrus* (driven by *P. moluccensis* and *P. lepidogenys*), *Chromis* (mainly *C. nitida*) and *Neopomacentrus* (all N. *azysron*). Counts of *Chromis* spp. were highly variable among sites reflecting the swarming nature of *C. nitida* and the often random nature of encounters with this species along survey lines. Abundances of the genus *Amblyglyphidodon* (driven by *A. curacao*) were particularly high.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.144



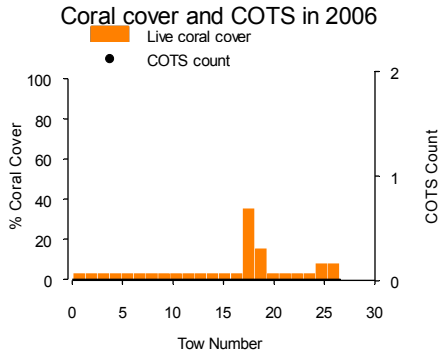
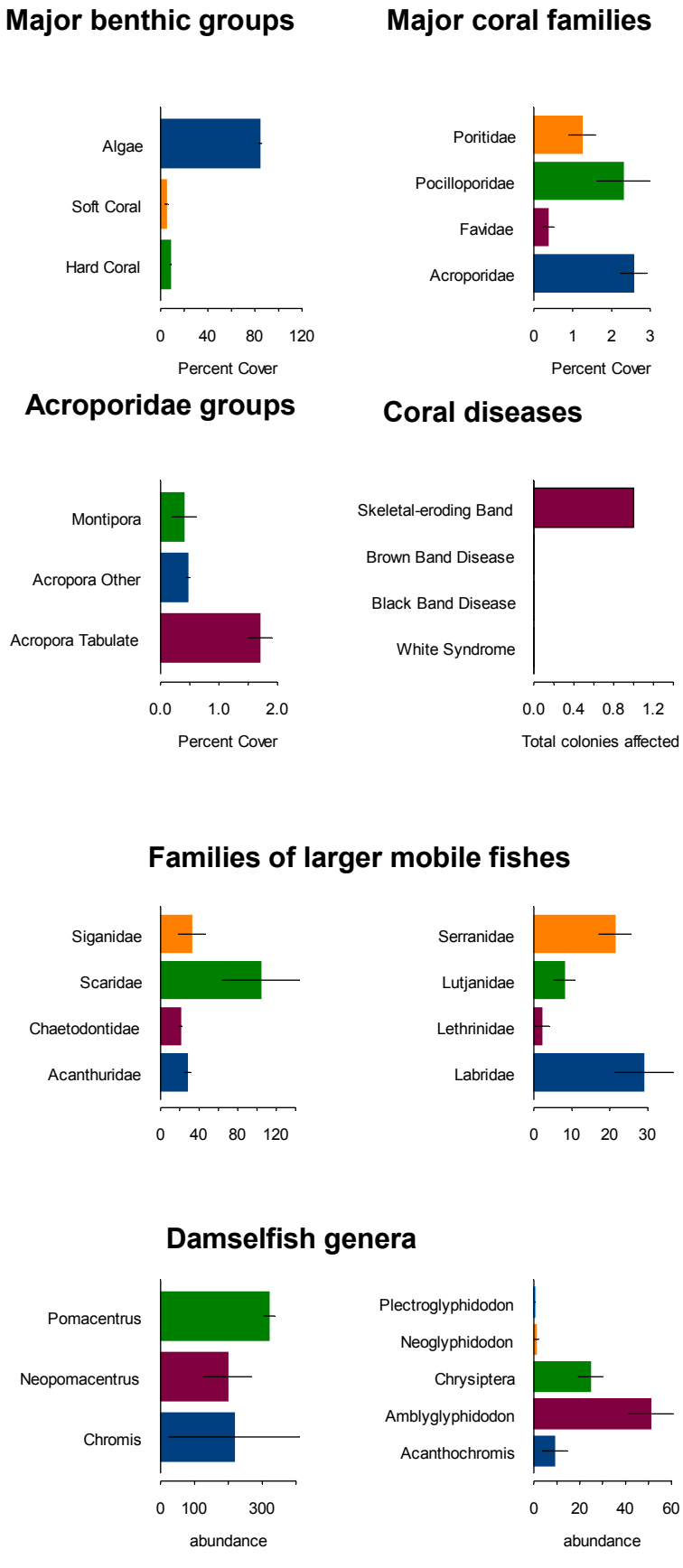


Figure 5.144 (cont.)
Reef 22-084 was last surveyed in January 2006.



CHINAMAN

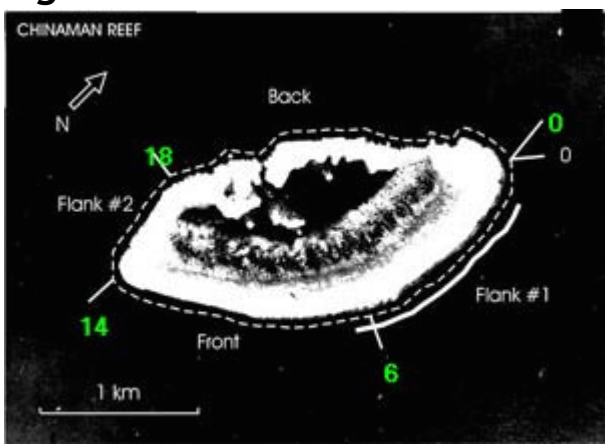
Chinaman Reef has been surveyed extensively using manta tow since 1986. Median reef-wide live coral cover has fluctuated over the period of survey. There was a notable drop in coral cover between 1988 and 1990, coinciding with similar declines on reefs in the Capricorn Bunker group. Storm damage is considered the most likely cause, as no COTS were recorded on surveys. From 1990 reef-wide live coral cover increased, reaching high levels (31-50%) in 1999. Although COTS have been recorded regularly during manta tow surveys, Chinaman Reef was only classified as an Active Outbreak in 1998 and subsequently there was a decline in reef-wide live coral cover to low levels (1-10%) by 2002. In 2005 one COTS was observed and as this number considered too low to cause a decline in reef-wide live coral cover, so at Chinaman Reef was reclassified as Recovering. Reef-wide live coral cover increased moderate (11-20%) levels in 2005 and remained moderate in 2006. No bleaching or signs of disease were recorded during surveys in 2006 and Chinaman Reef remained classified as Recovering.

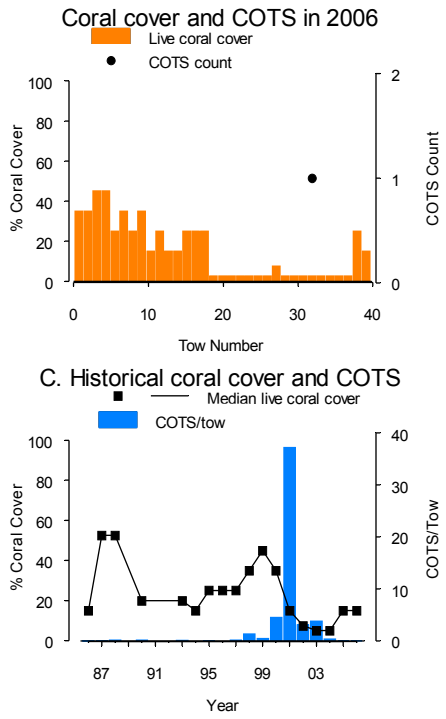
Intensive surveys sites were set up in 1993. Hard coral cover increased from the initial surveys when it was 22% to 44% in 2003, and was moderate at 38% in 2006. Acroporidae was the most abundant family with 16% cover, and Poritidae had 9% cover. The most common growth form was tabulate *Acropora* spp.. The cover of soft coral was moderate with 25% recorded. At 18% cover, Xeniidae was the most abundant soft coral family, with Nephtheidae and Asterospiculariidae covering 3% and 2% respectively. Algal cover was moderate at 36%, comprised mostly of coralline algae (11% cover) and turfing algae (25% cover). The cover of hard coral, soft coral, and algae and their constituent families have remained stable for the last three years, with only slight variation (2-3%) in values. In SCUBA search surveys the incidence of white syndrome was rare and *Drupella* spp. were not observed in 2006.

Acanthuridae, Chaetodontidae and Scaridae dominated the large, mobile fish community in roughly equal numbers in 2006. It was a little unusual for Chaetodontidae to be equally dominant, most often the herbivorous Scaridae tend to be far more abundant. Chaetodontidae numbers have increased over the 14 years of surveys simultaneously with hard coral cover, driven by the coral-associated species, *Chaetodon rainfordi*. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys*, although numbers of this genus were the lowest over the 14 year survey period in 2006. Among other damselfish genera in 2006, abundances of *Amblyglyphidodon* (driven by *A.*, *curacao*) were high and *Chrysiptera* spp. abundances were low.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.145

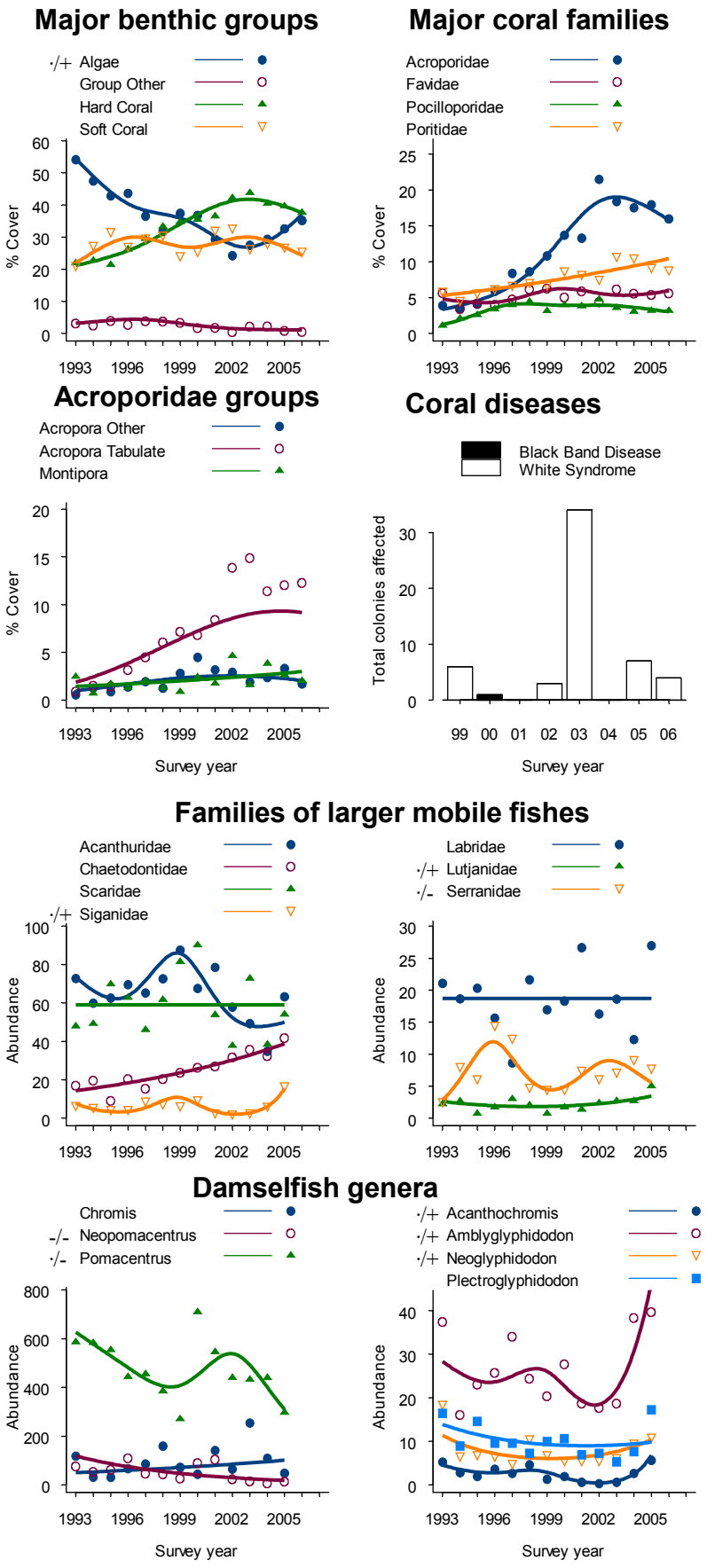




Chinaman Reef (No. 22-102) is a mid-shelf lagoonal reef with an area of 3.1 sq.km.

Figure 5.145 (cont.)

Chinaman Reef was last surveyed in January 2006.



EAST CAY

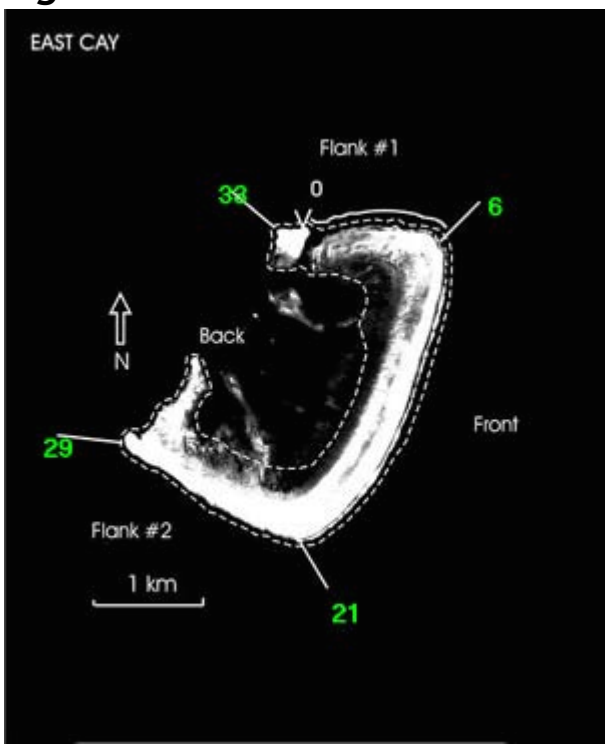
East Cay Reef has been surveyed using manta tow regularly since 1992 when median reef-wide live coral cover was high (31-50%). Coral cover dropped to moderate levels (11-30%) in 1994 for unknown reasons. Low numbers of COTS were observed in 2002, 2003 and 2004 and East Cay Reef was classified as No Outbreak. Though these numbers of COTS were below levels normally expected to impact on reef-wide coral cover they are likely to have played an important role delaying recovery in hard coral cover on this reef. No COTS were observed in 2005 and 2006 when there was a corresponding increase in reef-wide live coral cover to a high (31-40%) level. Coral cover remained high and in 2007 surveys small numbers of COTS were recorded on this reef, but at a level well below that considered to have an impact on reef-wide coral cover. East Cay Reef remained classified as No Outbreak. No bleaching was observed and signs of black band disease and white syndrome only affected a few scattered coral colonies on the front reef in 2007.

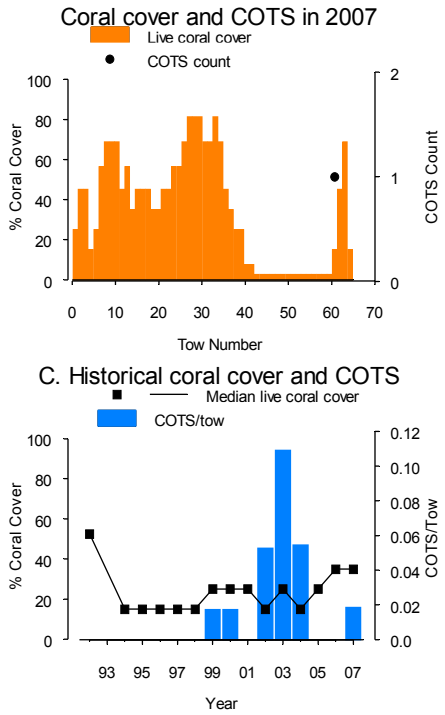
Hard coral cover at the intensive survey sites increased gradually since the first benthic survey in 1994 when coral cover was 17%, and was stable around 20% up until and including 2007. Turfing algae and soft corals have consistently been the dominant benthic groups with moderate cover, both averaging 35% in 2007. High sea surface temperatures were recorded in the summer of 2002 and bleaching mortality was the likely cause of a decline in Xeniidae soft corals from 26% to 12% around that time. The Xeniidae soft coral cover has been increasing since 2005. The cover of sponges was the highest in the Swain sector at 3% in 2007. No COTS were recorded during SCUBA search surveys in 2007. *Drupella* were recorded at a density of 7/ha, and the number of coral colonies with white syndrome was rarely recorded.

Although abundances of fishes varied from year to year there was little tendency for prolonged increases or decreases in most taxa over the 14-year study period. One noteworthy pattern was a steady fall then rise in abundance of *Pomacentrus* spp. (driven by a wide range of species) and *Plectroglyphidodon* spp. (driven by *P. lacrymatus*). Abundances of a number of these species were the highest recorded for East Cay Reef in 2007, over the entire survey period. It is unclear what caused these patterns as hard coral cover was particularly stable throughout the study period. There may have been a long period characterised by minimal recruitment and associated population declines (through natural mortality) followed by a more successful recruitment period.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.146

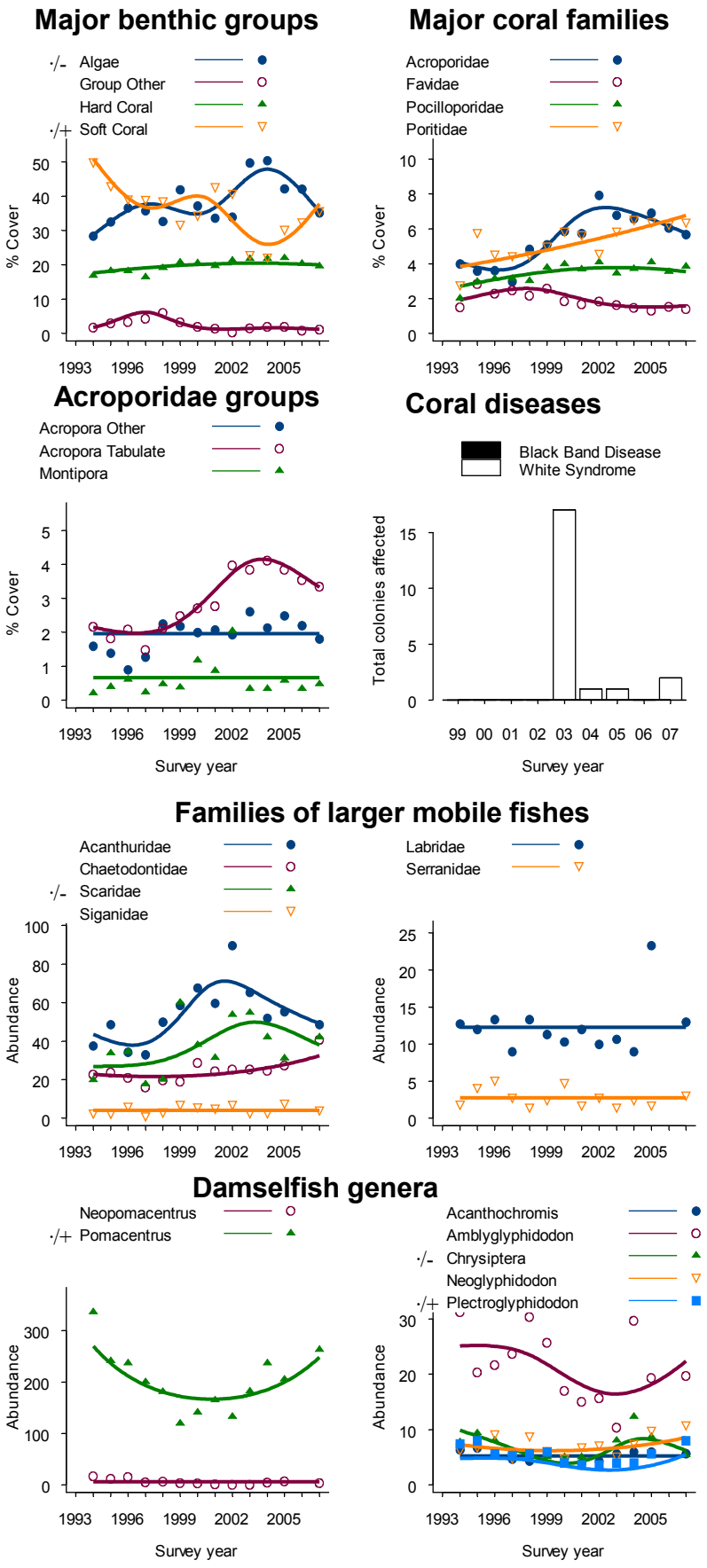




East Cay Reef (No. 21-305) is an outer shelf crescentic reef with an area of 6.3 sq.km.

Figure 5.146 (cont.)

East Cay Reef was last surveyed in November 2006.



GANNET CAY

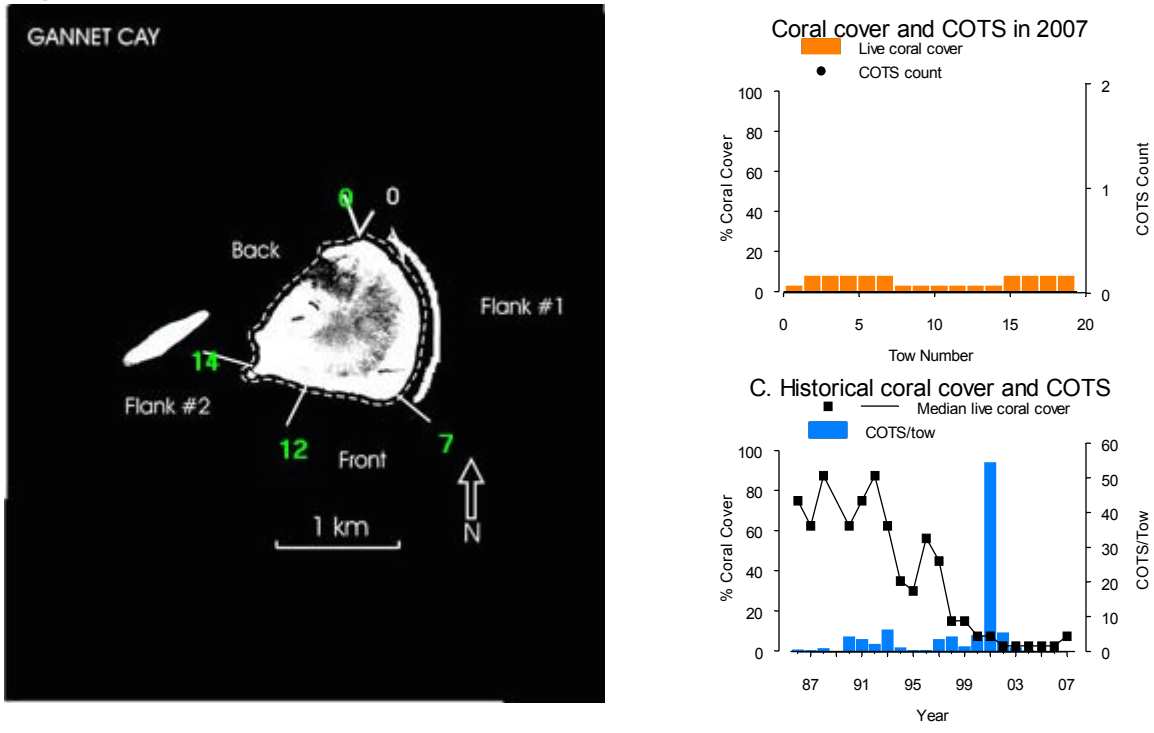
Gannet Cay is a Preservation Reef within the GBRMP and so has the highest protection status. Gannet Cay Reef has been surveyed numerous times using manta tow since 1986. COTS were present at Outbreak levels on nearly three quarters of all surveys. As a result, median reef-wide live coral cover declined dramatically from the extremely high levels (76-100%) first recorded in the 1980s to a very low level (1-5%) by 2002. This reef was classified as an Active Outbreak for some thirteen years, the longest period of outbreak recorded on the Great Barrier Reef. Surveys in 2004 showed COTS numbers had declined on Gannet Cay Reef (most likely due to the lack of hard coral to eat) and it was reclassified as Recovering. Reef-wide coral cover remained low (1-10%) in 2007 and no COTS were observed so Gannet Cay Reef remained classified as Recovering. No bleaching or signs of black band disease or white syndrome were recorded in 2007.

Surveys of the intensive study sites since 1993 show a steady decline in hard coral cover which due to COTS predation. Cover of hard corals was 60% in the first year of survey but declined consistently to a low of approximately 3% cover in 2002. This decline was mostly due to the loss of branching *Acropora* colonies. Cover of Pocilloporidae also decreased slightly. In 2007 recovery from COTS was noticeable with hard coral cover at 16%, which was double that of the last survey in 2005. Acroporidae was the most abundant family at 5% cover, with tabulate *Acropora* spp. being most common growth form. Algal cover in 2007 was 68%, mostly comprised of turfing algae (63%). Soft coral cover has been slowly increasing and in 2007 was at its highest abundance since surveys began (10%). The density of corallivorous snails *Drupella* spp. was 20/ha in 2007. No instances of coral disease were recorded.

The decline in hard coral from a very high to low percent cover during the study period certainly influenced some fish taxa, yet other taxa appear to have varied independently of the massive coral declines. In 2007, the moderate hard coral cover was high enough to mark the reversal of declining fortunes for a number of coral dependent taxa. Two Chaetodontidae species, *Chaetodon rainfordi* and *C. aureofasciatus*, and one Pomacentridae species (*Pomacentrus moluccensis*, whose trends did not reflect the genus as a whole) had greatly decreased in abundance over the first decade of surveys, but by 2007 numbers had considerably increased. Numbers of the commercially important coral trout (Serranidae; *Plectropomus leopardus*) had reached a 12-year low in 2003 but numbers had increased to a 13-year high in 2007. Large increases in *Chromis* spp. abundance in 2005 was due to *C. nitida*, a plankton feeding damselfish which often swarms in very large numbers. Numbers of this species were still comparably high in 2007.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

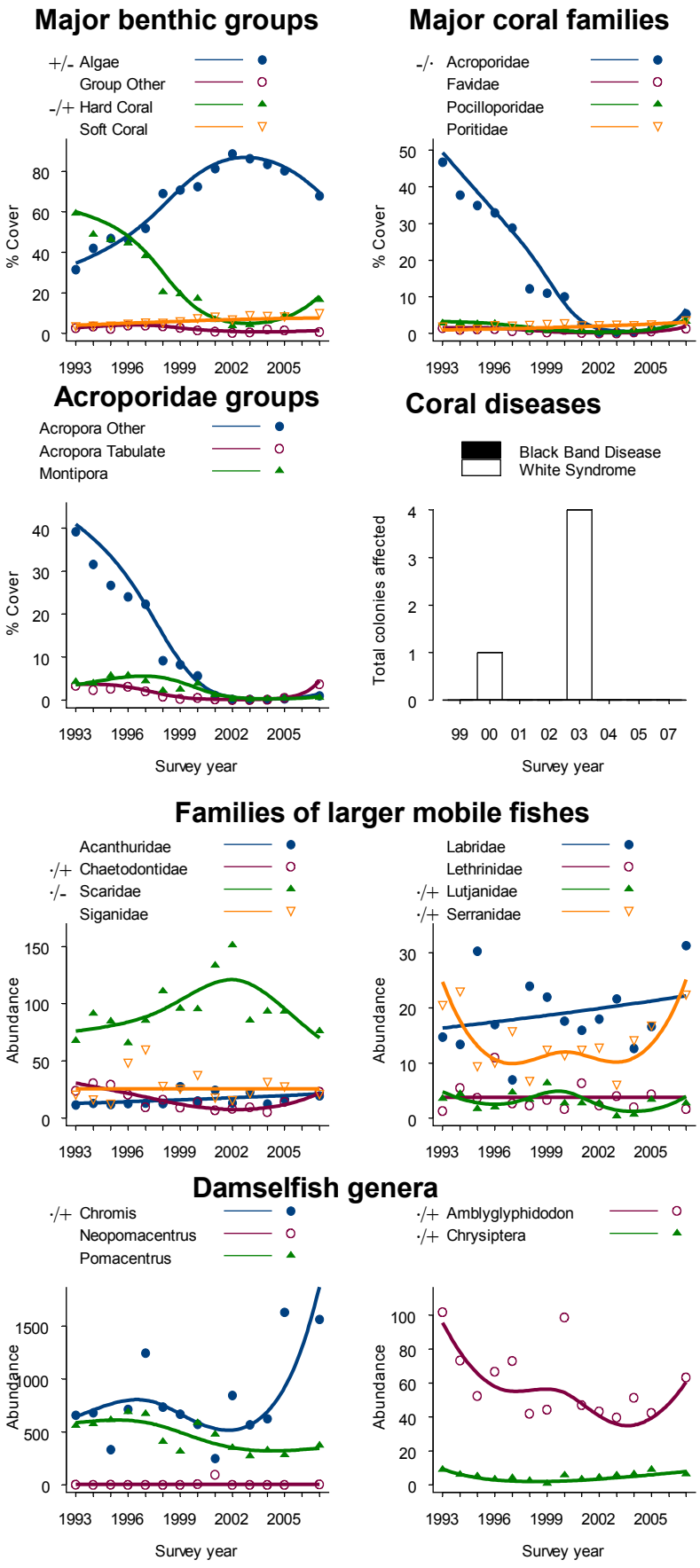
Figure 5.147



Gannet Cay Reef (No. 21-556) is a mid-shelf planar reef with an area of 1.2 sq.km.

Figure 5.147 (cont.)

Gannet Cay Reef was last surveyed in November 2006.



HORSESHOE

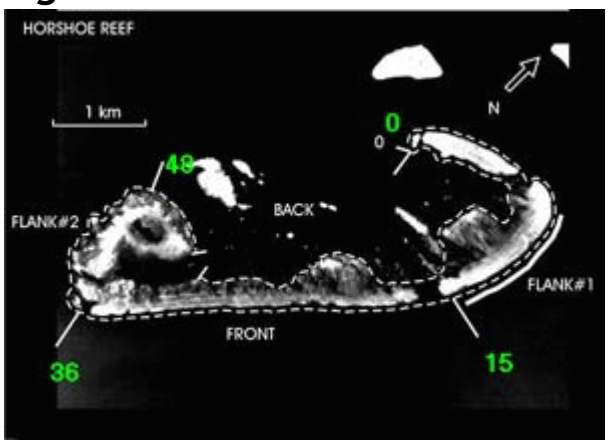
Horseshoe Reef has been surveyed using manta tow 16 times since 1986. There was an Incipient Outbreak of COTS in 1986 then COTS numbers dropped below outbreak levels until 1995. There was a small increase in median reef-wide live coral cover from moderate levels (11-30%) up until 1995 when a high level (31-40%) was recorded. COTS activity then increased, with a peak in numbers in 1998 and again in 2003 and a corresponding decline in median reef-wide live coral cover. From 2004 until 2007 reef-wide coral cover was the lowest (1-5%) recorded for Horseshoe Reef. Surveys in 2006 indicated COTS remained active on Horseshoe Reef and it remained classified as an Active Outbreak. Surveys in 2007 indicated COTS numbers had dropped well below outbreak levels on Horseshoe Reef and it was reclassified as Recovering. Reef-wide live coral cover remained very low. No bleaching or signs of disease were recorded during surveys in 2006 or 2007.

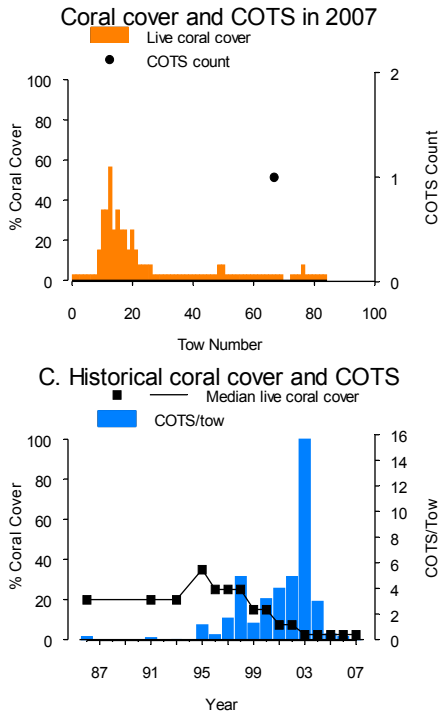
The intensive benthic surveys on Horseshoe Reef show that hard coral cover increased from an initial 36% until 1997 when hard coral cover was 52%. Coinciding with an active outbreak of COTS in 1998, coral cover then declined to 11% in 2003 and has been slowly increasing to reach 23% in 2007. Poritidae was the most abundant hard coral family in the early stages of recovery but in 2007 Acroporidae reached 9% (driven by the increase in size of tabulate *Acropora* spp. colonies) and is once again most abundant in terms of percent cover.The cover of soft corals remained reasonably stable, fluctuating around a mean of 5%. The cover of algae increased after 1997 and was 78% in 2005, which was comprised of 10% coralline algae, 67% turf algae and 1% other algae groups. The density of corallivorous snails *Drupella* spp. was 73/ha in 2007. No instances of coral disease were recorded.

The decline in coral cover from 1997 until 2003 almost certainly affected some fish taxa, yet numbers of other taxa appear to be varying independently of the major coral declines. The coral-associated species from family Chaetodontidae, mostly decreased in abundance as corals declined, but there was an indication of recovery in 2007 (driven largely by *C. rainfordi*) as coral cover began to increase. Numbers of Labridae increased over the 12 years of surveys, driven mainly by *Hemigymnus fasciatus* and *Choerodon fasciatus*. Acanthuridae also showed a general tendency to increase in abundance over the study period with numbers of *Ctenochaetus* spp. and *Zebrasoma scopas* being at a 15-year high in 2007. The damselfish, *Pomacentrus moluccensis* was initially abundant but had declined to very low numbers in 2005; this species lives among the small branching corals that were most affected during the COTS outbreak. Numbers of the previously abundant *Pomacentrus lepidogenys* were also at a 13-year low in 2005. Numbers of these two species and some others from the genus *Pomacentrus* had recovered slightly in 2007, following increases in hard coral cover. In contrast, *P. wardi* numbers were at a 13-year high in 2005 and had also slightly increased in 2007. Abundances of *Neopomacentrus* (driven by N. *azysron*) remained extremely low in 2007 after being relatively abundant between 1996 and 2002.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.148

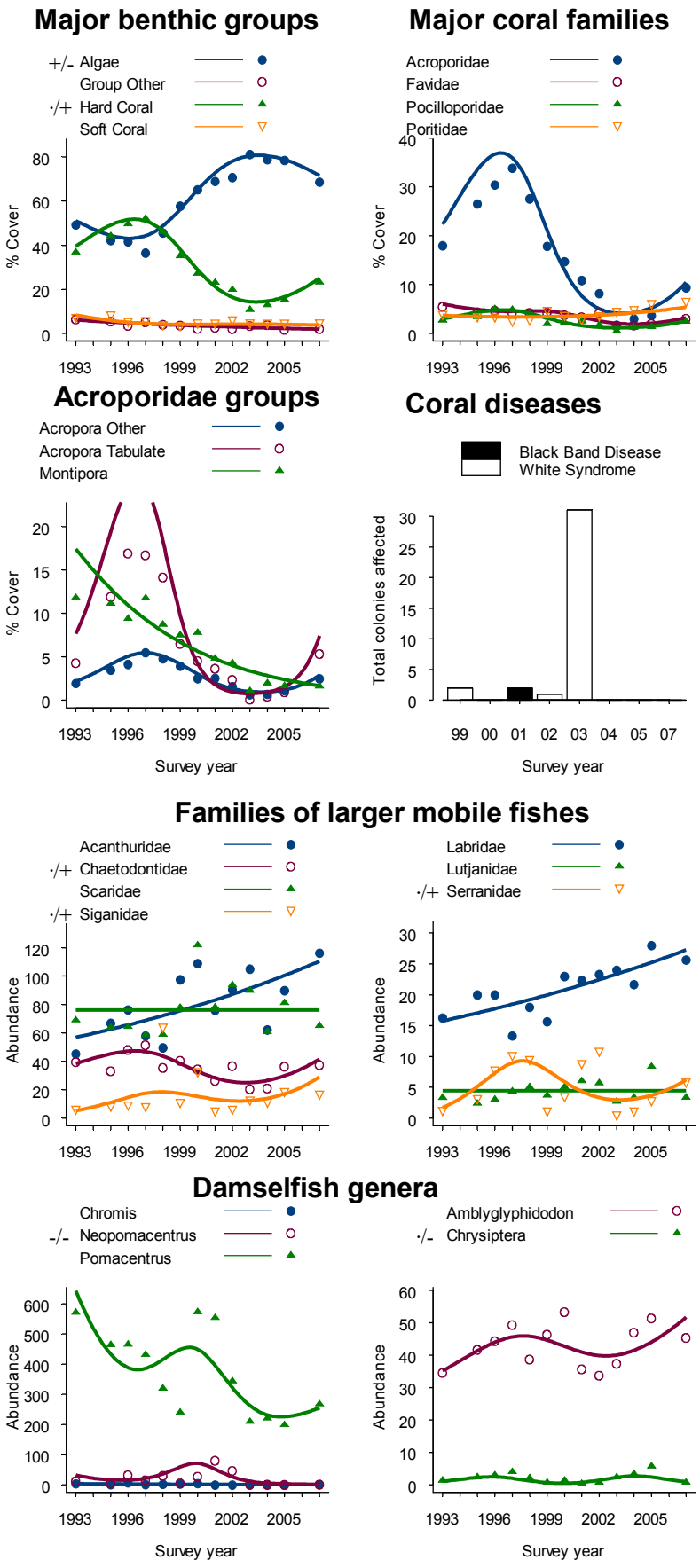




Horseshoe Reef (No. 22-104) is a mid-shelf crescentic reef with an area of 12.5 sq.km.

Figure 5.148 (cont.)

Horseshoe Reef was last surveyed in November 2006.



JENKINS

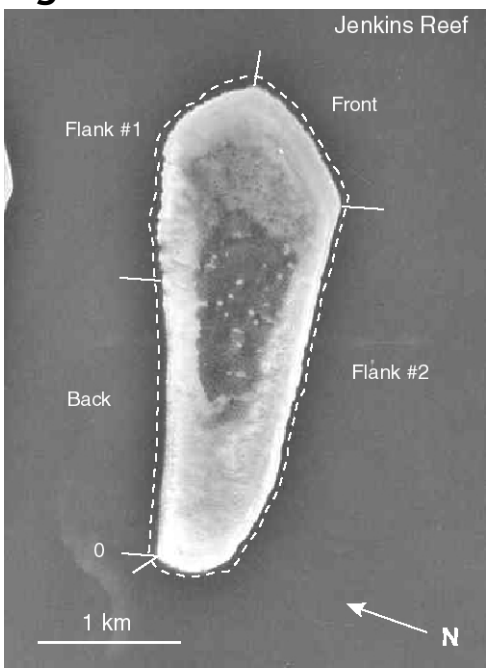
2006 was the first time that Jenkins Reef had been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was low (1-5%) and no COTS were observed. Since this reef is surrounded by reefs that have experienced COTS outbreaks in recent years, it is almost certain that the low coral cover is a result of a recent COTS outbreak on Jenkins Reef. Therefore Jenkins Reef was classified as Recovering. No coral bleaching or signs of coral disease were observed during surveys in 2006.

Intensive survey sites were set up in 2006. Hard coral cover in the first year of benthic surveys was low at 11%. *Porites* spp. was the most abundant genus with 6% cover, then *Echinopora* spp. at 1% cover. Encrusting and massive non-*Acropora* spp. corals were the most dominant hard coral growth forms. The cover of soft coral was low at 3%. Algae covered 83% of the substrate at the intensive survey sites. The low hard coral cover dominated by *Porites* spp. suggests that Jenkins Reef experienced a COTS outbreak in the recent past, as corallivorous COTS preferentially eat *Acropora* spp. over other coral genera. Skeletal eroding band disease was rarely observed during SCUBA search surveys. No corallivorous COTS or *Drupella* spp. were observed in 2006.

Acanthuridae and Scaridae dominated the large, mobile fish community. Acanthuridae abundances were particularly high, driven mainly by *Ctenochaetus* spp.. Abundances of Chaetodontidae and Lethrinidae were relatively low. Chaetodontidae are often highly coral dependent. Correspondingly, their abundances are often low when coral cover is around 10% or less as was the case for Jenkins Reef. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys* and to a lesser extent by *P. wardi*. Among other damselfish genera, *Chromis* abundances were very low, although this is not uncommon among Swain mid-shelf survey reefs.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.149



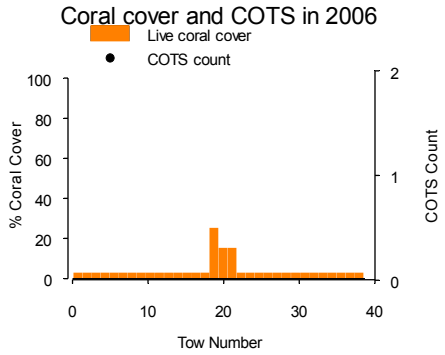
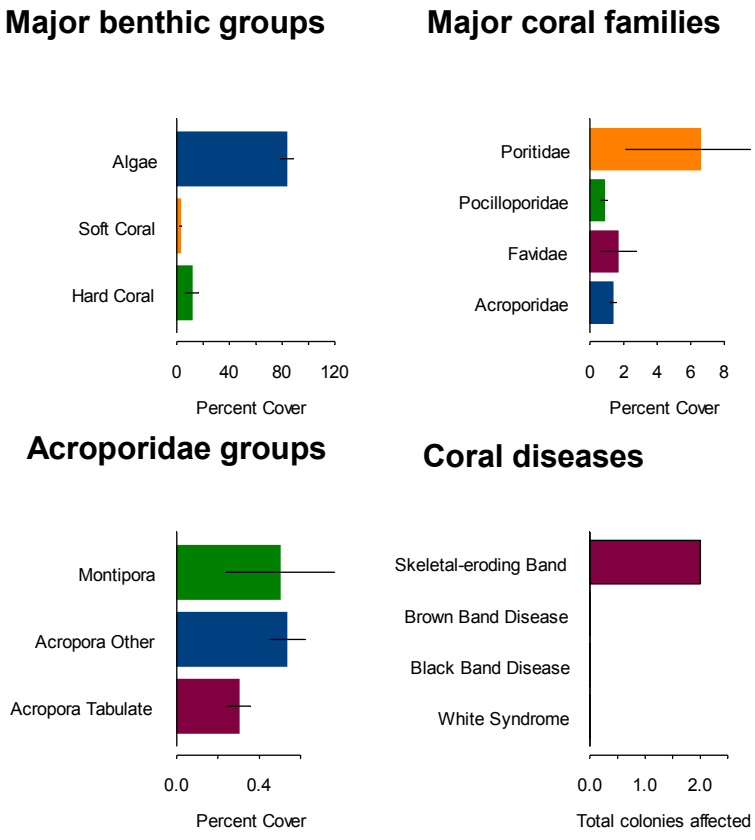
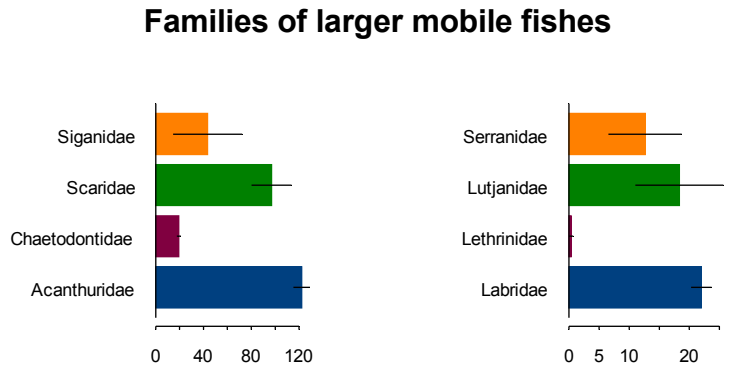
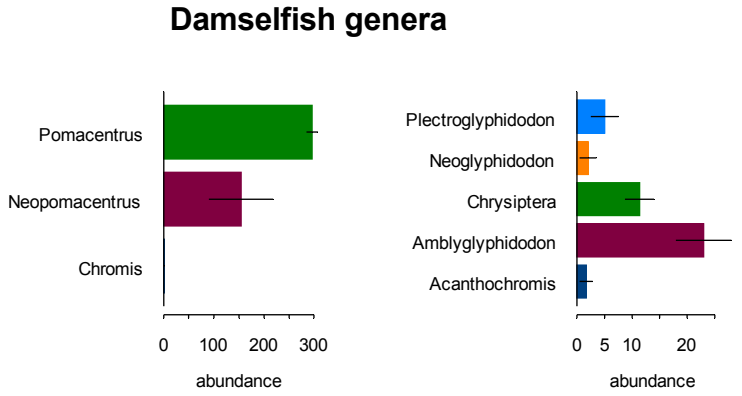


Figure 5.149 (cont.)
Jenkins Reef was last surveyed in January 2006.







SMALL LAGOON

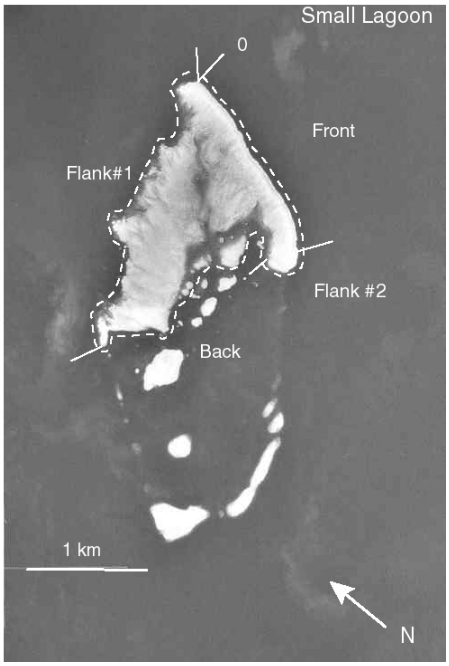
2006 was the first time that Small Lagoon Reef had been surveyed using manta tow by the LTMP. Median reef-wide live coral cover was low (1-5%). COTS were observed on Small Lagoon Reef at outbreak levels and it had been classified as Incipient Outbreak. However, since Small Lagoon Reef is close to reefs that have experienced COTS outbreaks in recent years, it is almost certain that the low coral cover is a result of a recent COTS outbreak and that COTS numbers were much higher in the recent past. No coral bleaching or signs of coral disease were observed during surveys in 2006.

The highest algae cover recorded in 2006 occurred at Small Lagoon Reef (92%) in the first intensive survey. The algal community was composed of turfing algae (81% cover) and coralline algae (10% cover). Hard coral cover was 6%, represented by 3% encrusting *Porites* spp. and the remaining percent was from very low cover of 13 genera. Soft coral cover was very low at 1%. While COTS were not found at the survey sites during intensive searches, they were observed in outbreaking numbers during broadscale surveys on Small Lagoon Reef. The very low hard coral cover dominated by *Porites* spp. suggests that COTS were present at Small Lagoon Reef in higher numbers in the recent past. No white syndrome or *Drupella* spp. were observed during SCUBA search surveys in 2006.

Acanthuridae and Scaridae dominated the large, mobile fish community. Acanthuridae abundances were particularly high, driven fairly equally by *Ctenochaetus* spp. and *Zebrasoma veliferum*. Abundances of Chaetodontidae were relatively low. Chaetodontidae are often highly coral dependent. Correspondingly, their abundances are often low when coral cover is around 10% or less, as was the case for Small Lagoon Reef in 2006. Amongst the damselfishes, *Pomacentrus* spp. were dominant, driven by *P. lepidogenys* and to a lesser extent by *P. wardi* and *P. moluccensis*. Among other damselfish genera, *Chromis* spp. abundances were very low (although this is not uncommon among Swain mid-shelf survey reefs) and abundances of *Amblyglyphidodon*spp. (driven by *A. curacao*) were relatively high.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.150



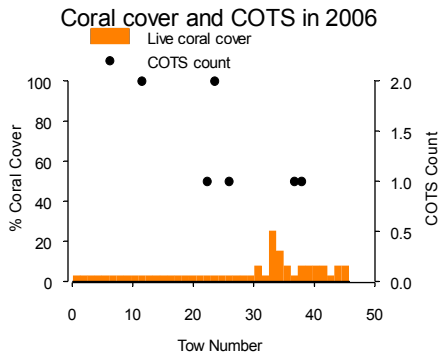
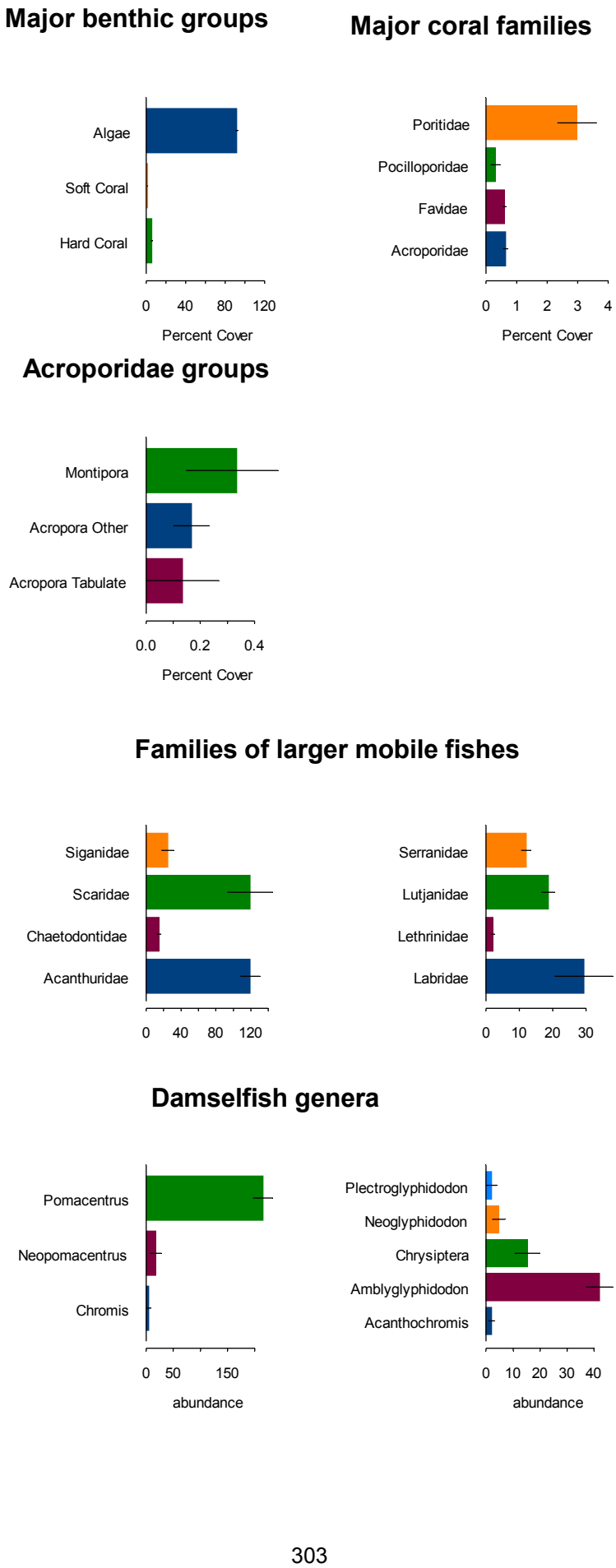


Figure 5.150 (cont.)
Small Lagoon Reef was last surveyed in January 2006.



SNAKE

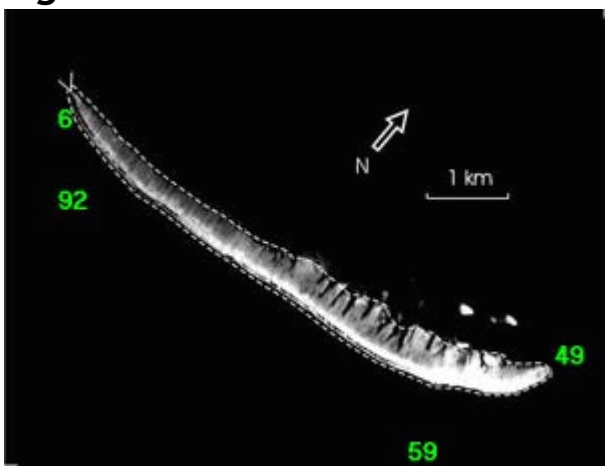
Snake Reef has been surveyed using manta tow 15 times since 1993 when COTS numbers were high. Snake Reef was classified as having an Incipient Outbreak until 1997 and median reef-wide live coral cover dropped from a high level (31-50%) in 1993 to a low level (1-10%) by 1997. Snake Reef was reclassified as Recovering in 1997. No COTS have been observed since 1997 and there has been a corresponding steady recovery in reef-wide live coral cover to moderate (11-30%) levels. Surveys in 2006 and 2007 showed reef-wide live coral cover remained moderate on Snake Reef and it continued to be classified as Recovering. No bleaching or signs of black band disease were recorded during broadscale surveys. Low levels of white syndrome, restricted to a few scattered coral colonies on the north and south flank and front of the reef (where coral cover was the highest) were observed during surveys in 2006 and 2007.

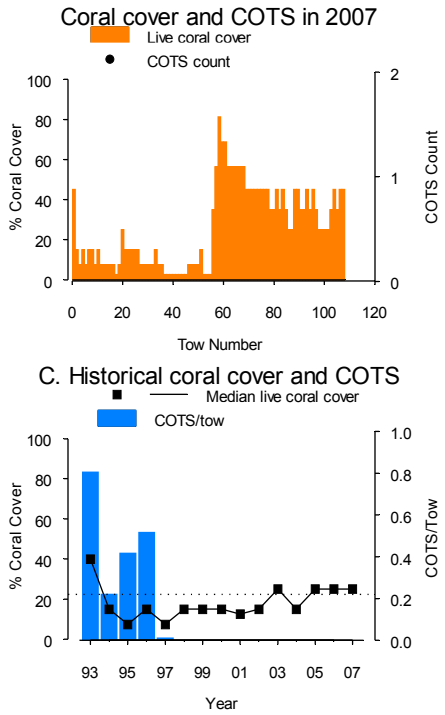
Intensive survey sites were set up on Snake Reef in 1993 and the initial hard coral cover was moderate at 33%. From 1994 the cover of hard corals decreased to a low of 17% in 1997, coinciding with an Incipient Outbreak of COTS. After 1998 hard coral cover increased until 2005, then reached 54% and was stable in 2007. Acroporidae was the most abundant hard coral family at 30% cover followed by Poritidae at 10%. The cover of algae was 37% in 2007. Soft coral reached a maximum abundance of 11% in 2002 and in 2007 was 7%. The density of corallivorous snails *Drupella* spp. was 20/ha in 2007. Coral diseases had been observed in moderate numbers since 2002 but only white syndrome was observed in 2007, although rare.

Although year-to-year variation in abundance has been common there has been little tendency for prolonged increases or decreases in most taxa. Many of the large mobile taxa seemed to increase in abundance in the last several surveys with all (except Scaridae) having abundances at, or near 15-year highs in 2007. The increase in numbers of Chaetodontidae reflected an influx of coral-associated species such as *Chaetodon rainfordi* and *C. aureofasciatus*. Inter-annual variation was very high in the Scaridae due to the clumped schooling nature of some species. However, a general decrease was evident due largely to declines in abundance of *Chlorurus sordidus* since 2003. Numbers of this species were at a 15-year low in 2007. Abundances of the genus *Pomacentrus*, have shown no long-term trends. However, numbers of the numerically dominant species *P. lepidogenys* increased dramatically from 1999 to 2000, most probably due to a particularly good recruitment season.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.151

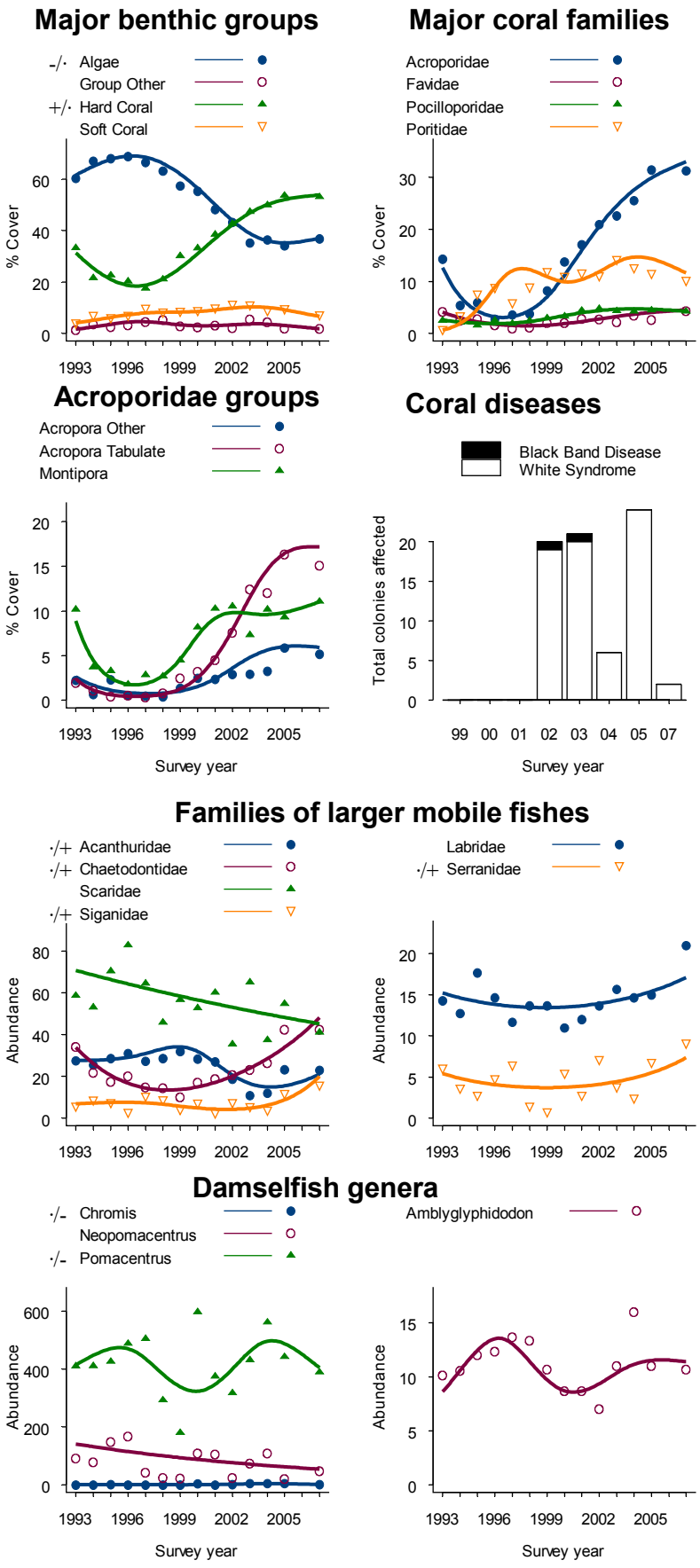




Snake Reef (No. 22-088) is an mid-shelf ribbon reef with an area of 14.4 sq.km.

Figure 5.151 (cont.)

Snake Reef was last surveyed in November 2006.



TURNER CAY

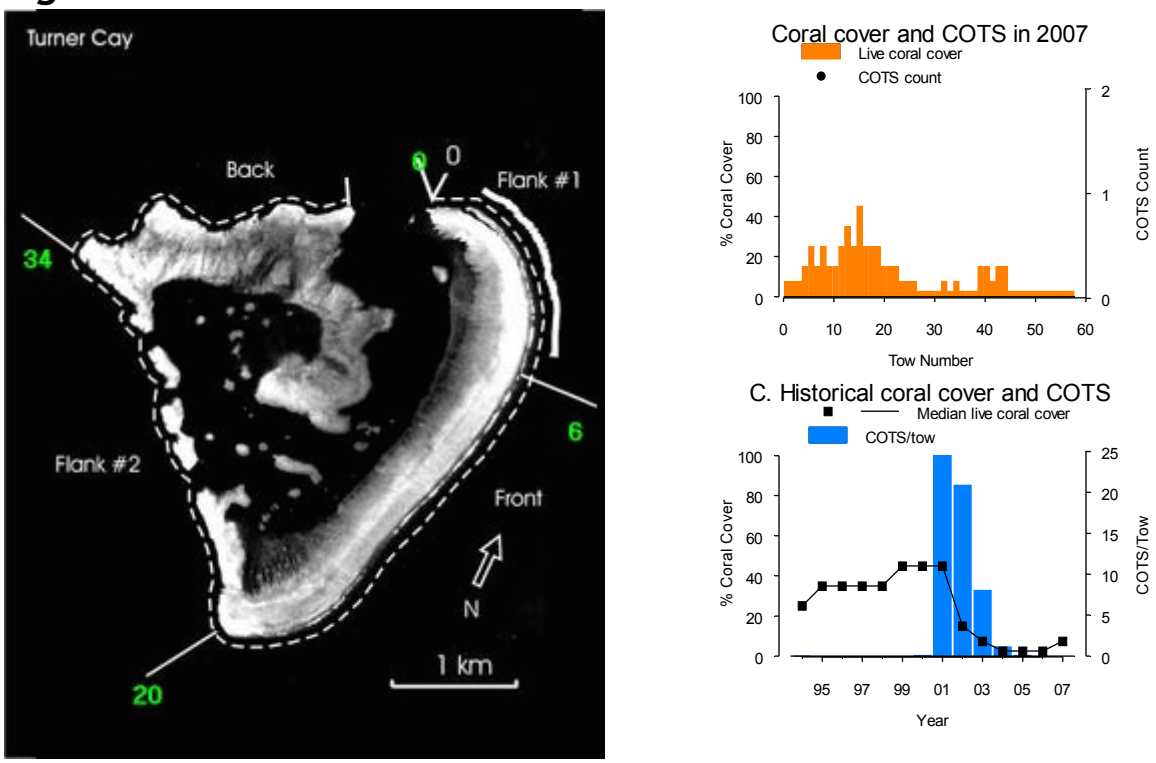
Turner Cay Reef has been surveyed using manta tow 14 times since 1994. Over this time, median reef-wide live coral cover gradually increased to high levels (31-50%), peaking in 1999. Reef-wide live coral cover remained high until 2001, when COTS numbers increased dramatically to very high levels and Turner Cay Reef was reclassified as an Active Outbreak. The Active Outbreak persisted until 2004, when there was corresponding decline in reef-wide live coral cover to a low level (1-10%). Surveys in 2005 indicated a large reduction in COTS numbers on Turner Cay Reef and it was reclassified as Recovering. Surveys in 2006 recorded no COTS for the first time since 2000. There were no COTS observed in surveys done in 2007 and the reef showed some sign of recovery in coral cover, although it remained low. Turner Cay Reef remained classified as Recovering. No bleaching or signs of coral disease were recorded during the surveys in 2007.

Cover of hard corals on the intensive survey sites exhibited an increasing trend from 1994, when surveys began, up until to 1999 when the cover reached 33%.From 2001 until 2002 hard coral cover dropped substantially from 31% to 20%, and by 2004, hard coral cover had decreased to 13%. This decline coincided with the outbreak of COTS (2001-2004) observed on broadscale surveys. By 2005, no COTS were observed during SCUBA searches and hard coral cover increased slightly and was 16% in 2007. There has been some recovery of digitate *Acropora* spp. and *Isopora* spp., however Poritidae was still the most abundant family in 2007 at 7%. The cover of soft corals has been fluctuating around 32% apart from a decline following 2002 which can probably be attributed to bleaching mortality of Xeniidae. In 2007, algal cover (mostly turf and coralline) was 45%. The density of corallivorous snails *Drupella* spp. was 67/ha in 2007 and no coral diseases were recorded.

Abundances of large mobile fish species on the intensive surveys sites were either fairly stable or tended to increase in abundance between 1993 and 2007, even though hard coral cover had considerably declined after 2001 surveys. In 2007, abundances of the families Acanthuridae, Scaridae, Siganidae and Labridae were relatively high or at 14-year maximums. Numbers of three coral-associated butterflyfishes, *Chaetodon rainfordi*, *C. melannotus* and *C. trifascialis*, decreased substantially after 2002, while the COTS reduced live hard coral cover dramatically to 20% . By 2005, numbers of *C. rainfordi*, and *C. melannotus* had reached previous levels when more hard coral was present and these had been maintained in 2007, while numbers of the tabulate *Acropora* spp. loving, *C. trifascialis*, were almost at a 14-year low. Numbers of damselfish taxa tended to be stable or had declined during the study period. Declining abundance patterns for *Pomacentrus* spp. were driven by the extremely abundant *P. lepidogenys*, although numbers seemed to increase in 2007. *P. wardi* also exhibited an increase in abundance in 2007 after declines to 2005. However, numbers of *P. moluccensis* and *P. coelestis* were at a 14-year low or were very low respectively in 2007. Abundances of the genus *Chromis* (driven by a number of species, not all of which were highly coral associated) were at record lows in 2007. *Neopomacentrus azysron* was relatively abundant prior to 2002 yet has not been recorded since. We suspect that successful recruitment events for small, site-attached damselfishes may occur sporadically in this region.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

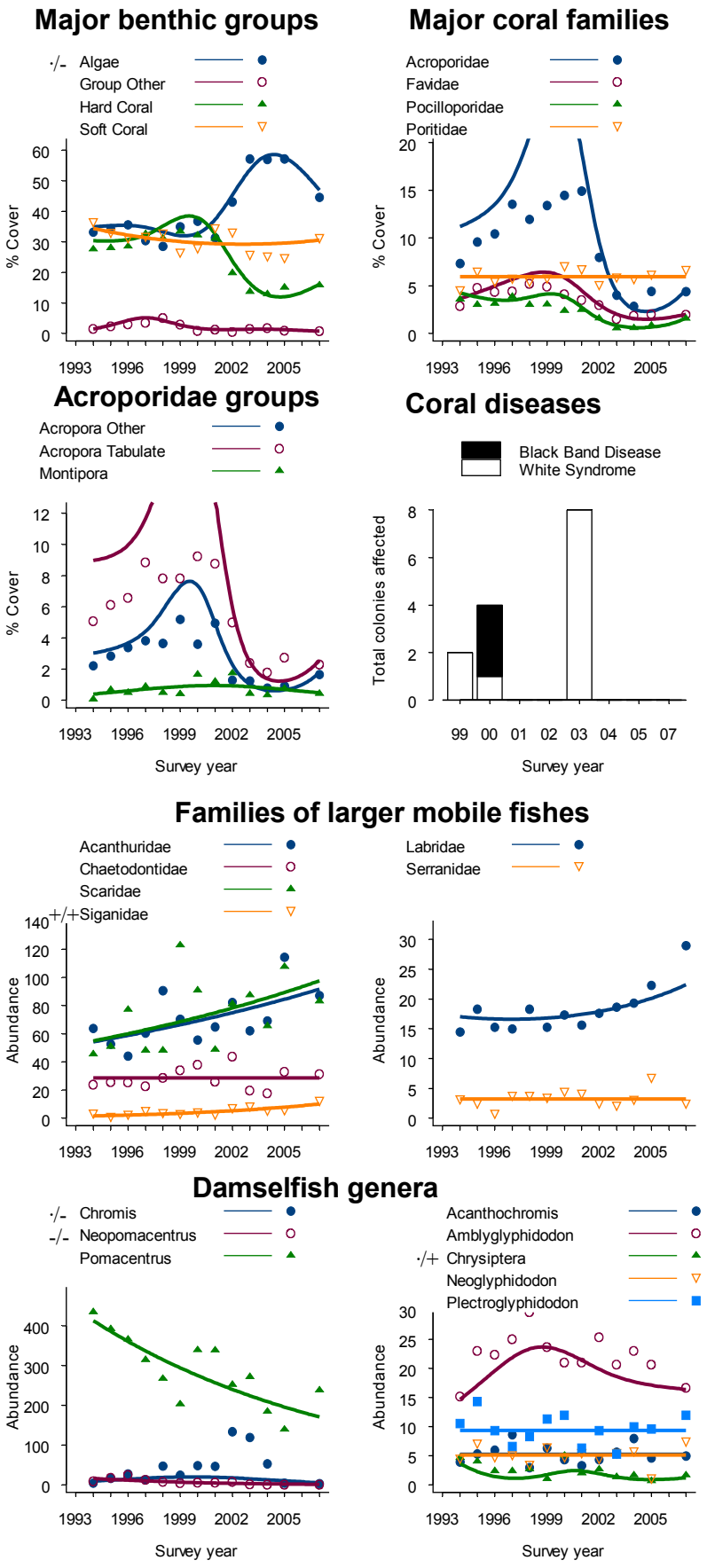
Figure 5.152



Turner Cay Reef (No. 21-562) is an outer shelf lagoonal reef with an area of 5 sq.km.

Figure 5.152 (cont.)

Turner Cay Reef was last surveyed in November 2006.



WADE

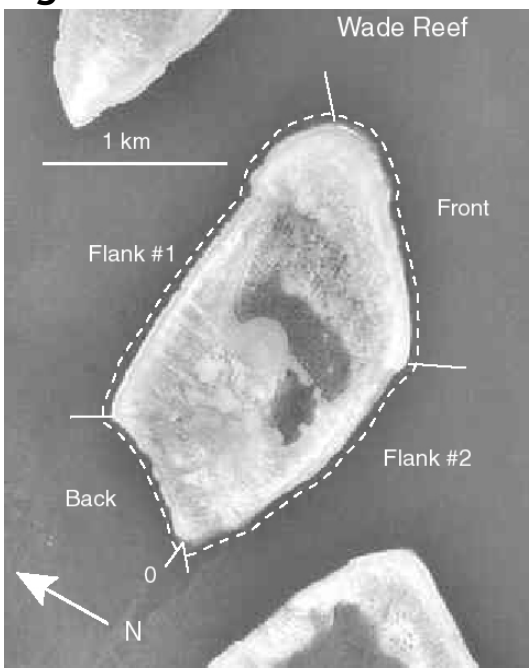
Wade Reef was surveyed for the first time in 2006 using manta tow. Median reef-wide live coral cover was low (6-10%). Small numbers of COTS were observed but in numbers generally considered to be too low to have an impact on reef-wide live coral cover. However since Wade Reef is surrounded by reefs that have experienced COTS outbreaks in recent years it is almost certain that the low reef-wide coral cover is a result of a recent COTS outbreak. Therefore Wade Reef was classified as Recovering. No coral bleaching or signs of coral disease were observed during surveys in 2006.

Wade reef was first surveyed in 2006. Hard coral cover was 19%. The main families of hard coral were Acroporidae with a cover of 9%, Poritidae with 4% and Pocilloporidae and Faviidae each with 2%. The genus *Acropora* had the highest cover with 6%, while 3% cover was recorded for both *Montipora* spp. and *Porites* spp.. Soft coral had a similar abundance to hard coral, with 17% recorded. Xeniidae covered 10% of the substrate, while alcyoniidae covered 2%. The cover of algae was 62% at Wade Reef.The most abundant algae was turfing algae at 45% cover, followed by coralline algae at 16% cover. The incidence of white syndrome recorded on SCUBA search surveys was rare and *Drupella* spp. were observed at a density of 20 snails/ha. COTS outbreaks have occurred on reefs surrounding Wade reef in the recent past. In 1998 and 2003 outbreaks occurred on some Swains reefs. The low cover of hard coral on this reef suggests that COTS outbreaks occurred in the recent past at Wade reef.

Acanthuridae and Scaridae dominated the large, mobile fish community. Scaridae abundances were particularly high, driven by *Scarus rivulatus*, *S. psittacus* and *Chlorurus sordidus*. Abundances of other families were moderate. Amongst the damselfishes, *Pomacentrus* species were dominant, driven strongly by *P. lepidogenys*. Among other damselfish genera, *Chromis* abundances were very low (although this is not uncommon among Swain mid-shelf survey reefs) and abundances of *Amblyglyphidodon* (driven by *A. curacao*) were relatively high.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.153



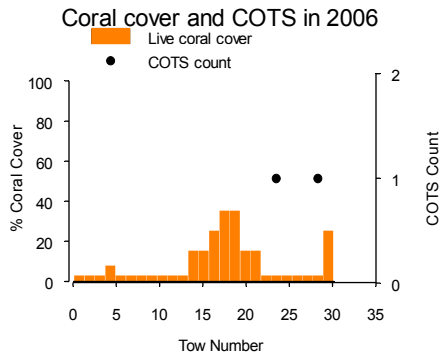
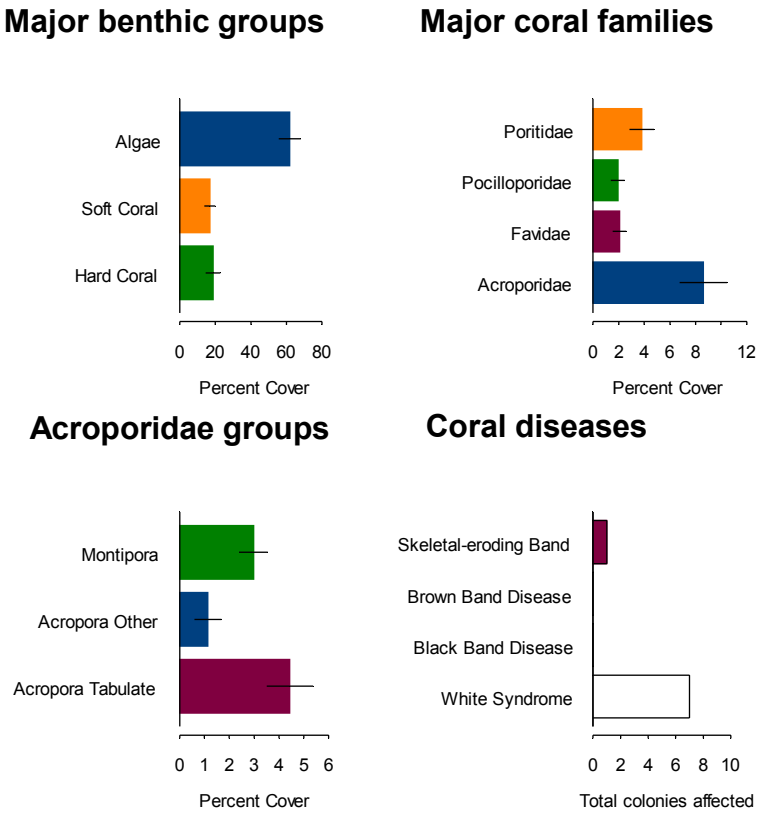
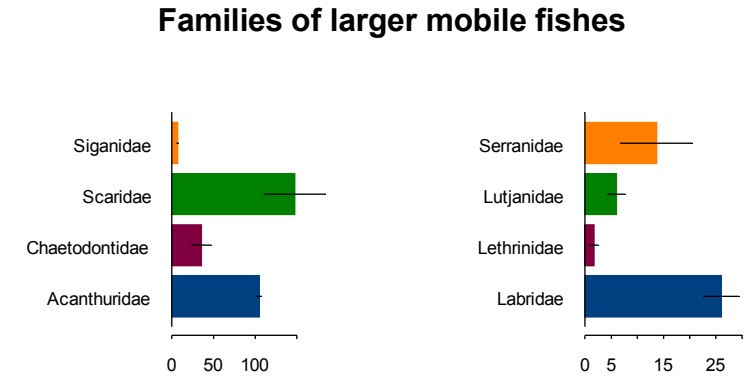
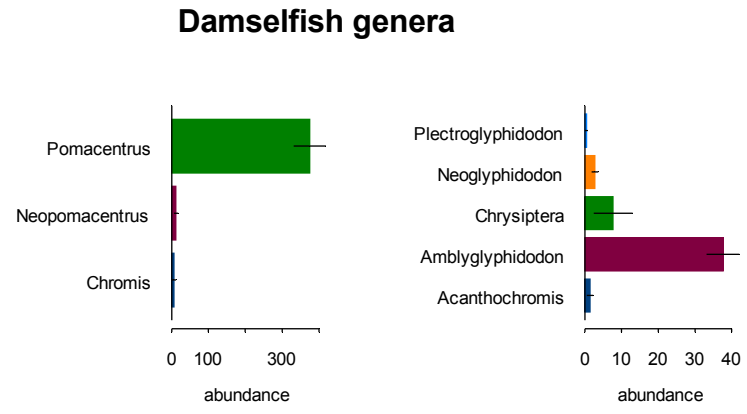


Figure 5.153 (cont.)
Wade Reef was last surveyed in January 2006.







Capricorn Bunker

Reef Pages

BOULT

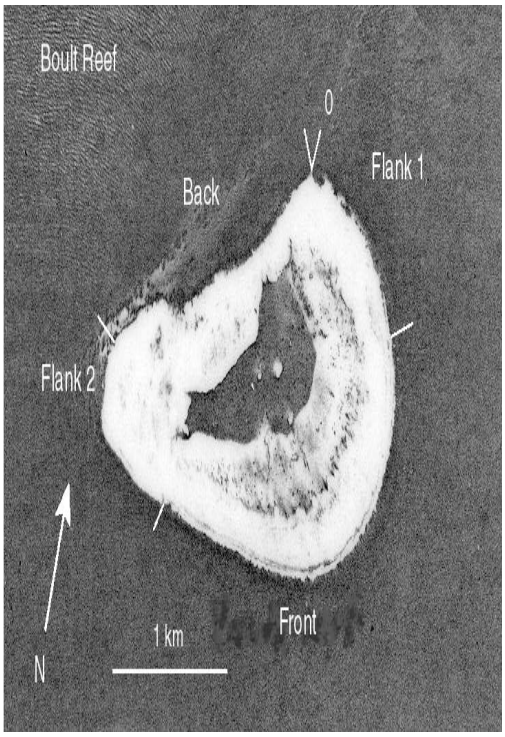
Boult Reef was first surveyed using manta tow in 1991, but it was not surveyed again until 2006. In 1991 median reef-wide live coral cover was moderate (11-30%). The relatively low coral cover recorded at this time was a result of a decline in hard coral cover between 1988 and 1990 in the Capricorn Bunker group. Storms during this time were responsible for damage to the live coral. Surveys in 2006 showed that reef-wide live coral cover was very high (51-63%). Signs of white syndrome were common on the front and flanks of Boult Reef during surveys in 2006. No bleaching or signs of black band disease were observed and no COTS recorded. Boult Reef was classified as No Outbreak.

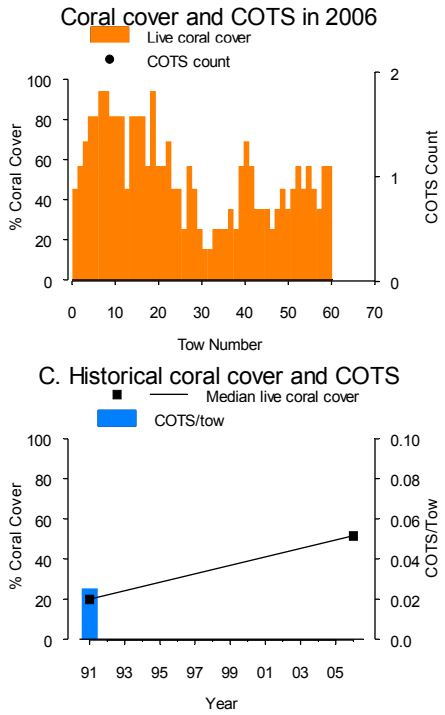
Intensive survey sites were set up on Boult Reef in 2006. Very high hard coral cover (71%) was observed in the initial survey in 2006. Acroporidae was the dominant family with 68% cover. Little cover was observed for the Faviidae, Pocilloporidae and Poritidae families.Tabulate *Acropora* spp. occupied the most of the benthos, with 57% cover and branching *Acropora* spp. covered 9% of the benthos. The cover of soft coral was very low at 1%. Algae cover was moderate at 27%, with the most abundant types being coralline algae (13% cover) and turf algae (12% cover). White syndrome was seen at moderate levels (between 16 and 45 affected colonies on the intensive survey sites). *Drupella* spp. were observed at a density of 127/ha in 2006.

The very high coral cover recorded during the benthic surveys was reflected in the composition of the fish community, both in the large mobile families and the damselfishes. There were high abundances of most large mobile families, including the surgeonfishes (Acanthuridae), butterflyfishes (Chaetodontidae), the parrotfishes (Scaridae) and the wrasses (Labridae). Large numbers of butterflyfishes were observed on all sites, including the coral feeding specialist, *Chaetodon trifascialis*, *C. trifasciatus* and *C. pelewensis*. Numbers of surgeonfishes were determined largely by the high abundance of two species, *Ctenochaetus* spp. and *Zebrasoma scopas*. The other major herbivorous family, Scaridae, was represented by a number of highly abundant species including *Scarus globiceps*, *S. niger* and *Chlorurus sordidus*. There were low numbers of the commercially important coral trout species. Among the damselfish community high numbers of a number of coral affiliated species were recorded, including *Pomacentrus moluccensis* and *Plectroglyphidodon dickii*. Other more generalist and planktivorous species were also recorded in high numbers during the latest surveys.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

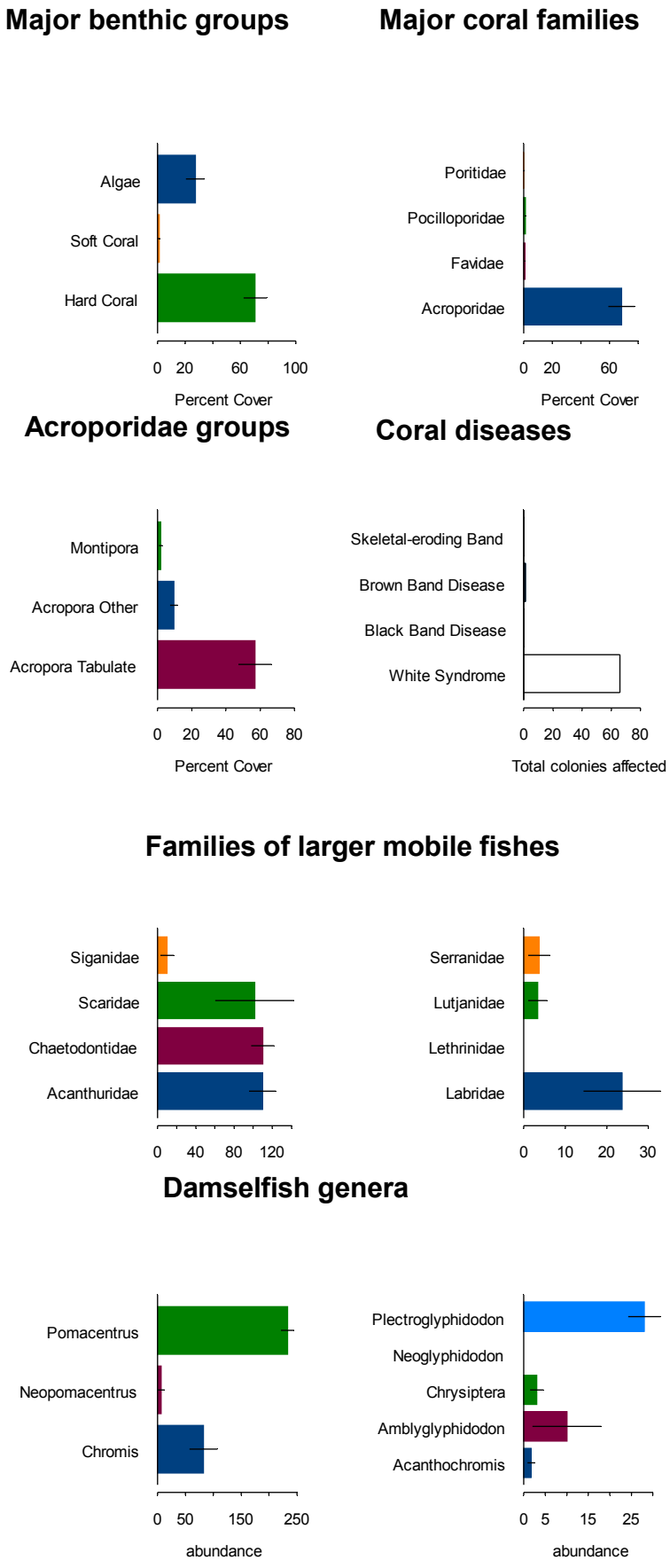
Figure 5.154





Boult Reef (No. 23-079) is an outer shelf lagoonal reef with an area of 6.3 sq.km.

Figure 5.154 (cont.)
Boult Reef was last surveyed in May 2006.



BROOMFIELD

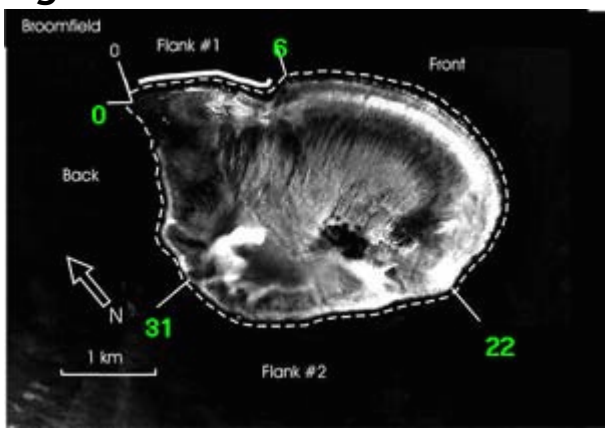
Broomfield Reef has been surveyed regularly using manta tow since 1986, when median reef-wide live coral cover was high (31-50%). Reef-wide live coral cover dropped dramatically between 1988 and 1990 to moderate levels (11-30%). Storms in the Capricorn Bunker group during this time probably contributed to this decline. From 1993 until 1999 reef-wide coral cover slowly increased to a high level (31-50%) and remained at this level until 2003. Surveys in 2004 and 2005 recorded a small drop in coral cover to moderate levels (21-30%). It is possible that coral disease played a role in the observed decline. The small rise in reef-wide coral cover in 2006 was reversed in 2007 when reef-wide coral dropped to moderate levels (11-20%). Storm damage and coral disease are responsible for the observed decline. No COTS have been recorded on Broomfield Reef and it remained classified as No Outbreak in 2007. No bleaching was observed and signs of black band disease only affected a few scattered coral colonies on the back reef. Signs of white syndrome were more widespread, around the entire reef perimeter, but again at a low level only affecting small numbers of scattered coral colonies.

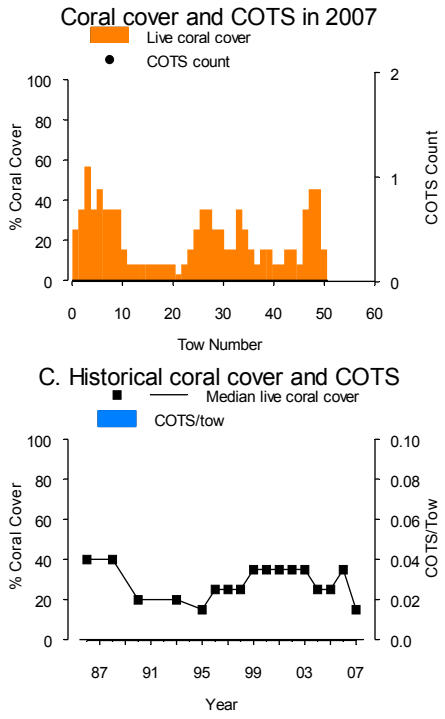
Intensive surveys on Broomfield Reef show a dramatic increase in hard coral cover from 10% in 1993 to 56% in 2002. Hard coral cover has been declining since 2002 and was 49 % in 2006, then 38% in 2007. The decline of Tabulate *Acropora* spp. since 2002 accounts for the decline in hard coral observed, with other coral groups being stable or increasing. High levels of white syndrome were recorded in 2003 with 315 colonies affected. Only 25 diseased colonies were recorded in 2007. Partial mortality of tabulate *Acropora* spp. was commonly seen in 2007. Tabulate *Acropora* spp. typically dominate reefs in the Capricorn Bunker group, while soft corals usually remain low in cover (<10%). The cover of algae has shown an inverse trend to hard coral, decreasing with the corresponding increase in hard coral. Cover of algae in 2006 was 43% but increased to 53% in 2007 and was composed of coralline and turf species. The density of corallivorous snails *Drupella* spp. was 146/ ha in 2006 and 27/ha in 2007.

Hard coral cover provides most of the topographic complexity on the gently sloping reefs characteristic of the exposed Capricorn Bunker sector. The removal of most hard coral during the late 1980s created a relatively featureless environment and fish abundance was low in early surveys. However the abundance of many species of large mobile fish from the families Acanthuridae, Scaridae, Chaetodontidae and Labridae, increased dramatically after 1994 as hard coral cover also began to increase. The number of Serranidae had also increased in 2005 and 2007, due largely to increases in the number of common trout *Plectropomus leopardus*. Generally, damselfishes have shown less dramatic changes than the large mobile fishes. The genus *Pomacentrus* declined in numbers from 1995 until 2001, when the then dominant *Pomacentrus coelestis* declined as hard coral cover increased. From this point onwards, another species, *P. lepidogenys* has accounted for the increase in numbers of this genera. Increases in another damselfish genera, *Plectroglyphidodon*, has been driven by two species *P. lacrymatus* and *P. dickii*.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.155

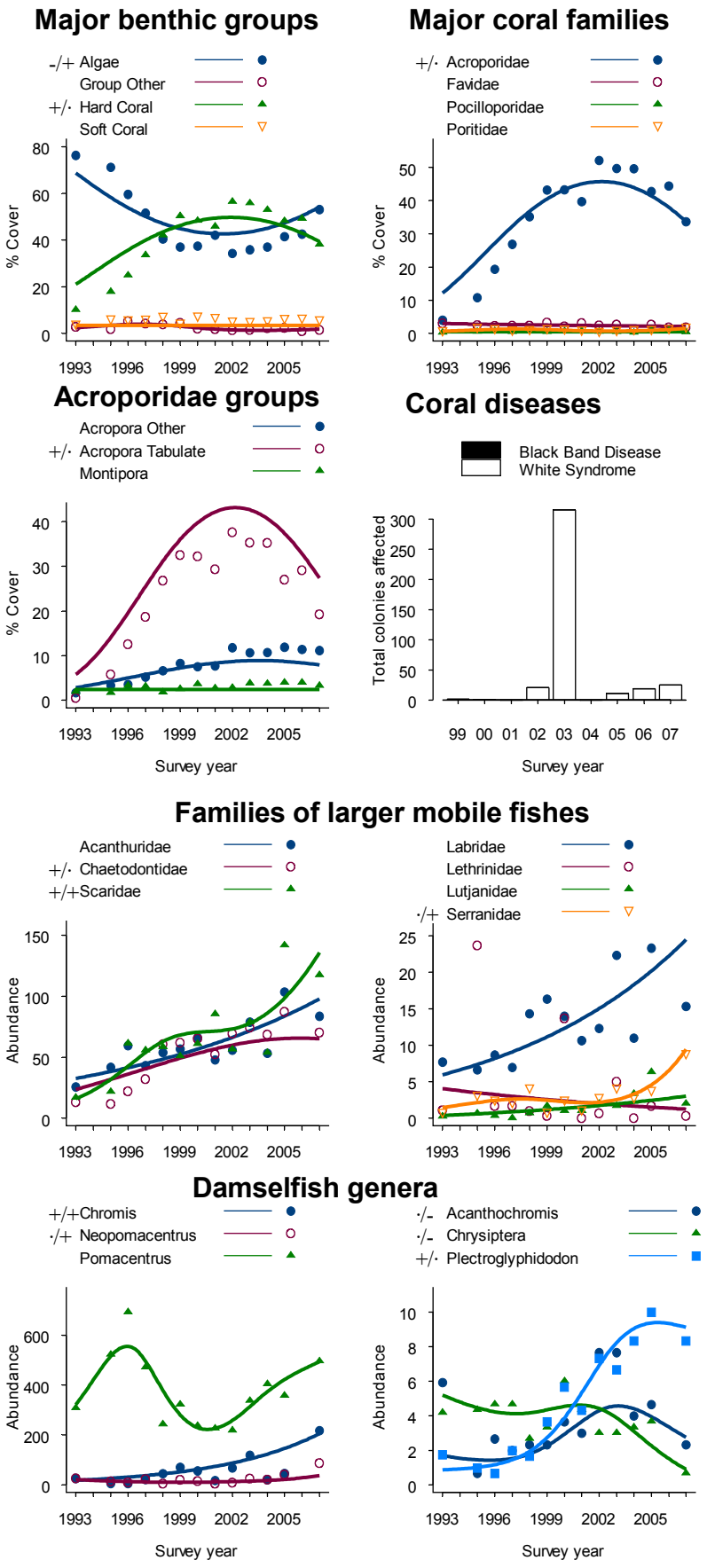




Broomfield Reef (No. 23-048) is an outer shelf planar reef with an area of 21.3 sq.km.

Figure 5.155 (cont.)

Broomfield Reef was last surveyed in November 2006.



ERSKINE IS

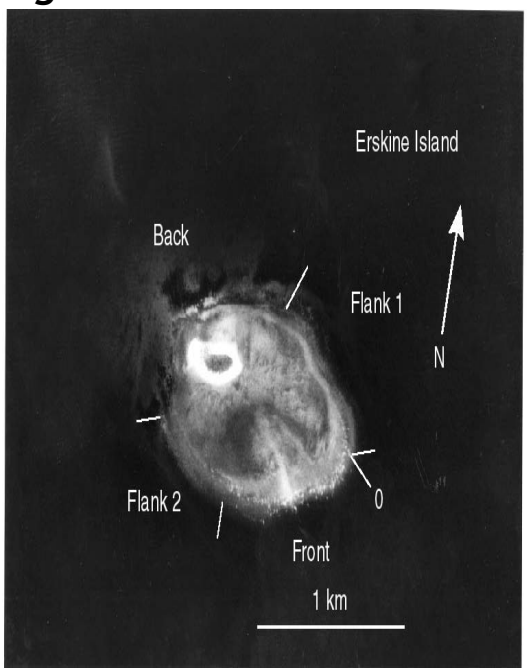
Erskine Island Reef was surveyed for the first time using manta tow in 2006. Median reef-wide live coral cover was moderate (21-30%). Widespread coral bleaching was observed in March 2006 with 50-75% of the total hard coral cover bleached on the reef front and flanks. No signs of disease or COTS were recorded from Erskine Island Reef in 2006 and it was classified as No Outbreak.

Erskine Island Reef was closed to fishing in 2004 and intensive surveys commenced in 2006. Hard coral cover and algal cover were high, at 39% and 44% respectively. Acroporidae was the dominant hard coral family, with tabulate *Acropora* spp. accounting for 21% of the benthic cover. Low cover of Faviidae, Pocilloporidae and Poritidae corals was observed. Soft coral cover averaged 7%. White syndrome was rarely encountered during SCUBA search surveys. Along the fixed transects bleaching affected 50% of Acroporidae colonies along with colonies from a variety of other families including Pocilloporidae, Faviidae, Poritidae, Merulinidae and Dendrophylliidae. Erskine Island Reef was the only reef within the Capricorn Bunker group for which high levels of bleaching were recorded in 2006. Surveys at this reef took place shortly after the austral summer (March 2006), while most of the other reefs in this group were surveyed in May 2006. No *Drupella* spp. were recorded at the survey sites.

Chaetodontidae and Scaridae dominated the large mobile, fish community. Abundances of Acanthuridae were relatively low but all other families were well represented. Amongst the damselfishes, the genus *Pomacentrus* was dominant, driven mainly by *Pomacentrus moluccensis* and *P. wardi*. *P. moluccensis* is a highly coral dependent species and therefore it is not surprising that numbers were high on this reef. Abundances of *Chromis* spp. and *Chrysiptera* spp. were particularly low while *Acanthochromis polyacanthus* was very abundant.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.156



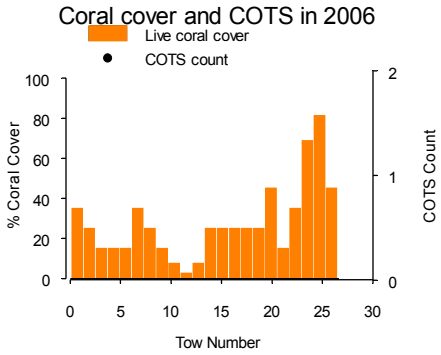
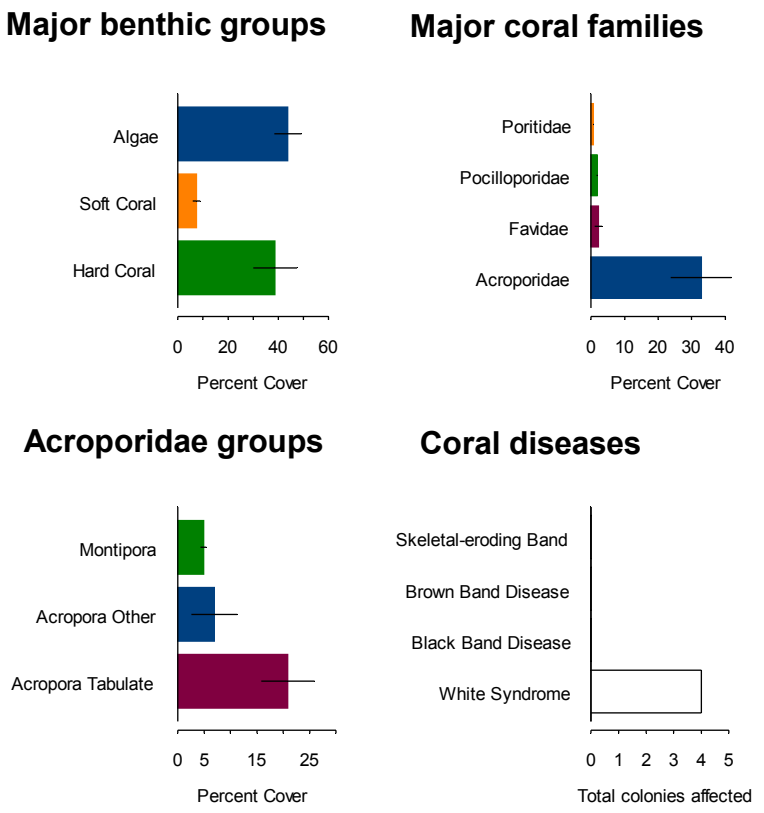
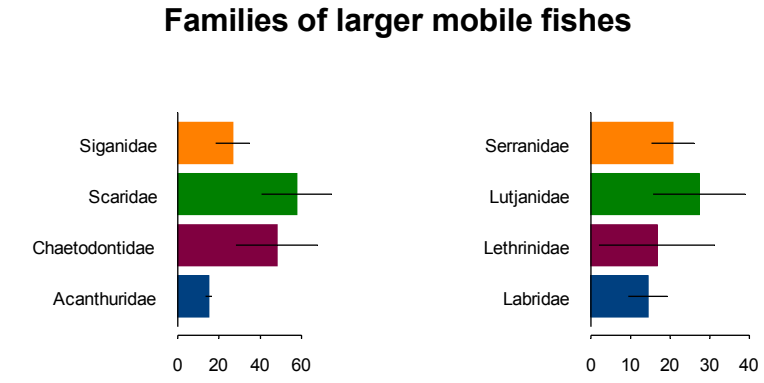
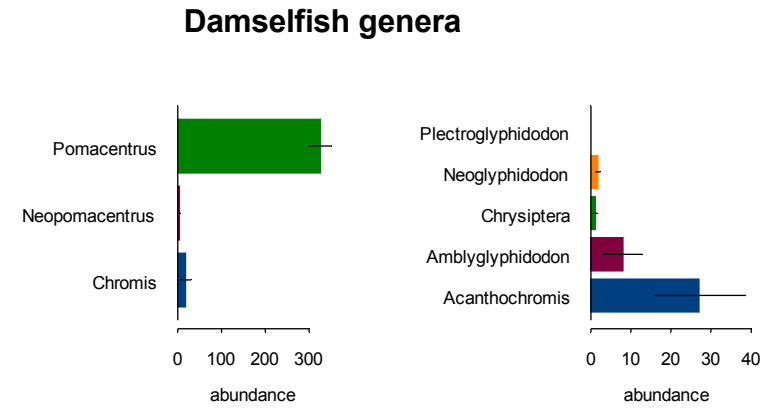


Figure 5.156 (cont.)
Erskine Is Reef was last surveyed in March 2006.







FAIRFAX IS

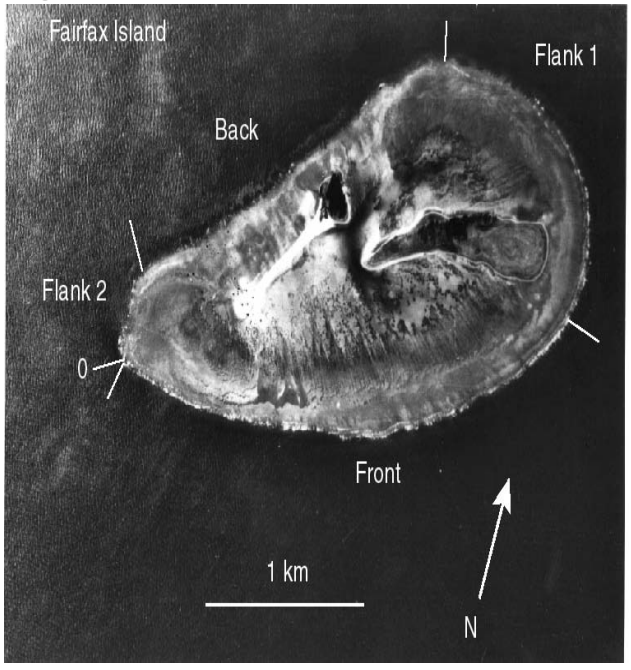
Fairfax Islands Reef was first surveyed using manta tow in 1991 and then fifteen years later in 2006. Median reef-wide live coral cover was high (31-50%) in 1991, despite a decline in reef-wide live coral cover on other reefs witihin the Capricorn Bunker group between 1988 and 1990. Storms during this time were responsible for the reduction in live coral. Surveys in 2006 showed that reef-wide live coral cover was very high (50-63%). Signs of white syndrome were restricted to small numbers of individual colonies around the reef perimeter during surveys in 2006. No bleaching or signs of black band disease were observed and no COTS recorded. Fairfax Islands Reef was classified as No Outbreak.

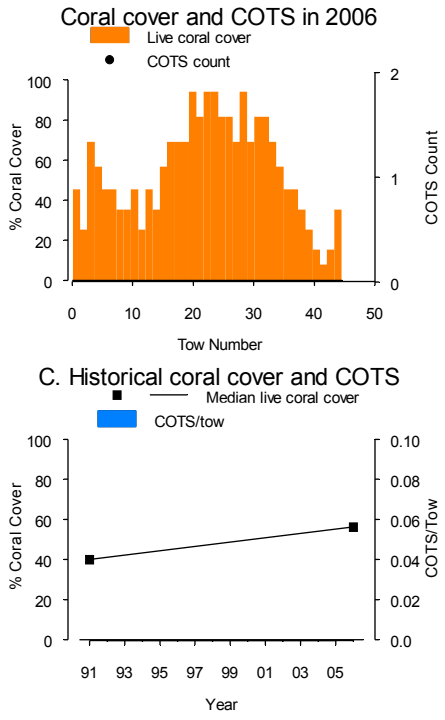
Fairfax Islands Reef changed from a reef open to fishing to a reef that was closed to fishing in 2004 and intensive survey sites were set up after the re-zoning in 2006. Hard coral cover was very high at 73% in 2006. Acroporidae accounted for 72% of the benthic cover. Tabulate and branching *Acropora* spp. were the dominant growth forms of hard coral with 38% and 32% cover respectively. Historically tabulate *Acropora* spp. was the most common lifeform on reefs within the Capricorn Bunker group. The relatively high abundance of branching coral in addition to tabulate lifeforms at Fairfax Islands Reef provides a more complex reef structure at this location. Soft coral cover was low in the initial survey. The algal community covered 25% of the benthos and was comprised of turf, coralline and macroalgae. A rare incidence of white syndrome was observed during SCUBA search surveys and no *Drupella* spp. were recorded along the fixed transects.

Acanthuridae and Scaridae dominated the large mobile, fish community. Abundances of Chaetodontidae were relatively high. This is unsurprising as many species within the family Chaetodontidae are coral dependent and their numbers probably reflect the extremely high coral cover (73%) at this reef. Amongst the damselfishes, the genus *Pomacentrus* was dominant, driven mainly by *Pomacentrus lepidogenys* and *P. moluccensis*. *Chromis atripectoralis* drove the moderate abundances in *Chromis*. Both *P. moluccensis* and *C. atripectoralis* are highly coral dependent species and therefore it is not surprising that their numbers were high on this reef. Abundances of *Chrysiptera* spp. were particularly low while *Plectroglyphidodon* spp. were extremely abundant, driven largely by the algal farming *P. lacrymatus* and the coral loving *P. johnstonianus*. Somewhat surprisingly, *Acanthochromis polyacanthus*, a very widespread species, was not recorded.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

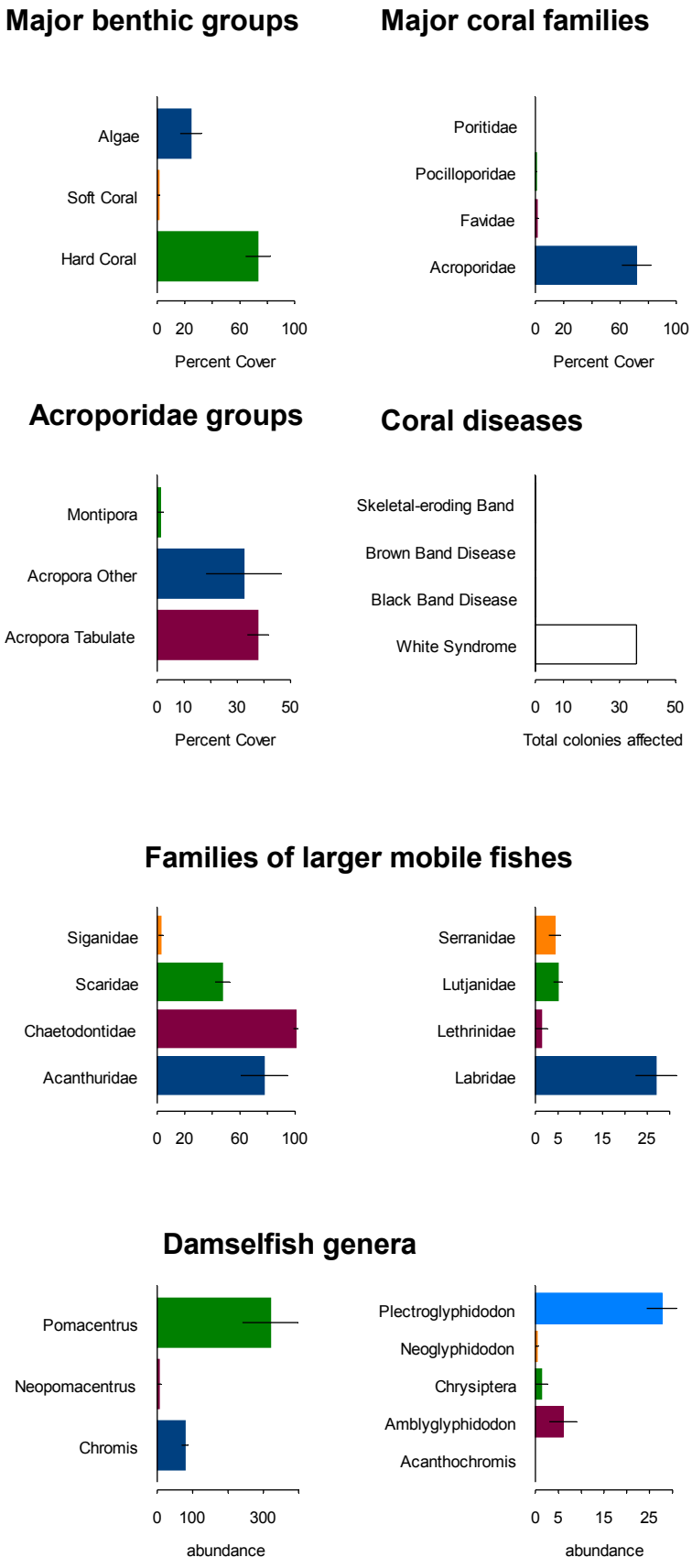
Figure 5.157





Fairfax Is Reef (No. 23-081) is an outer shelf planar reef with an area of 3.8 sq.km.

Figure 5.157 (cont.)
Fairfax Is Reef was last surveyed in May 2006.



HOSKYN IS

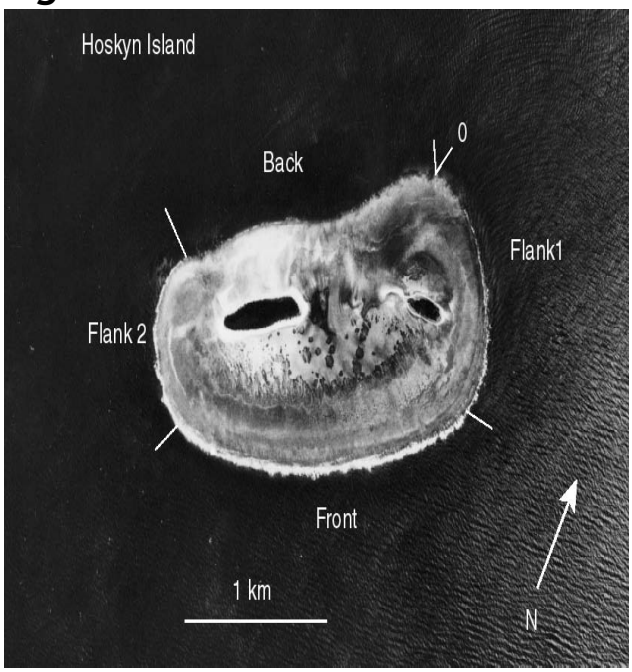
Hoskyn Islands Reef has been surveyed five times using manta tow since 1987. In the initial broadscale survey median reef-wide live coral cover was extremely high (76-100%), but it declined to very high levels (51-75%) by 1988, and continued to decline to moderate levels (11-30%) by 1990. This decline was also observed on other reefs in the region with storms held responsible. By 1992 median reef-wide live coral cover had increased to a high level (30-50%). After 1992 broadscale surveys at Hoskyn Islands Reef there was a fourteen year hiatus until the next survey in 2006. Very high levels (51-63%) of reef-wide live coral cover recorded in 2006. Signs of white syndrome were restricted to small numbers of individual colonies around the reef perimeter. No bleaching or signs of black band disease were observed and no COTS recorded. Hoskyn Island Reef was classified as No Outbreak.

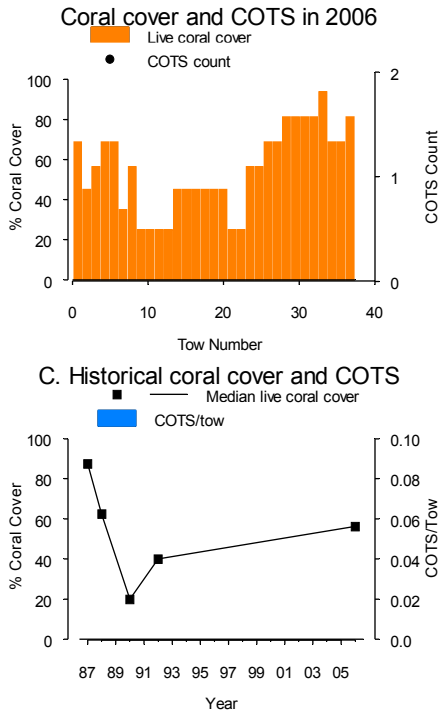
Intensive survey sites were set up at Hoskyn Islands Reef in 2006. Hard coral cover was very high at 74% in 2006 where tabulate and branching *Acropora* spp. cover was 55% and 9% respectively. Low cover of Faviidae was recorded (3%) while the other major hard coral families each had an average cover of less than 1%. The cover of soft coral was low in 2006. Historical records indicate tabulate *Acropora* spp. typically dominated reefs in this sector, while cover of soft corals was generally low (<1%). A moderate cover of algae was observed in 2006. The algal community was made up of turf algae (10%), coralline algae (9%) and macroalgae (3%). There was a low incidence of white syndrome recorded during SCUBA search surveys in 2006 and skeletal eroding band disease and brown band disease were rare. The corallivore *Drupella* spp. were observed at a density of 87/ha.

There were high abundances of most large mobile fish families, including the surgeonfishes (Acanthuridae), the butterflyfishes (Chaetodontidae), the parrotfishes (Scaridae) and the wrasses (Labridae) in 2006. Butterflyfishes were abundant at all sites, particularly the coral specialist, *Chaetodon trifascialis*, the numbers of which reflect the high cover of tabulate *Acropora* spp. colonies, upon which this species feeds. The commercially valuable coral trout species were moderately abundant and included not only the common trout, *Plectropomus leopardus* but also the coronation trout, *Variola louti*. The damselfish community contained large numbers of coral affiliated species, including *Pomacentrus moluccensis* and *Plectroglyphidodon dickii*, as well as more generalist/planktivorous species such as *Pomacentrus lepidogenys* and *Amblyglyphidodon* curacoa.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

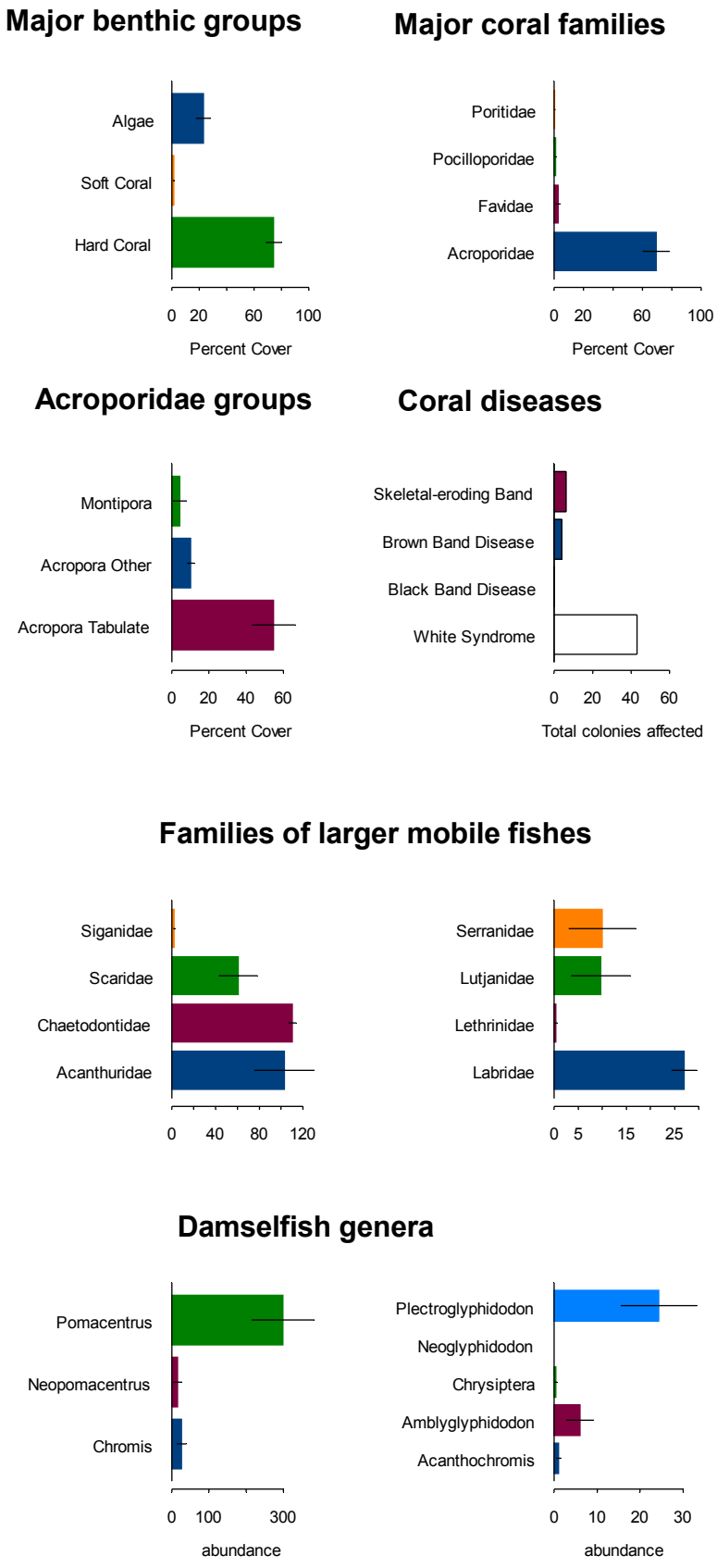
Figure 5.158





Hoskyn Is Reef (No. 23-080) is an outer shelf planar reef with an area of 3.8 sq.km.

Figure 5.158 (cont.)
Hoskyn Is Reef was last surveyed in May 2006.



LADY MUSGRAVE IS

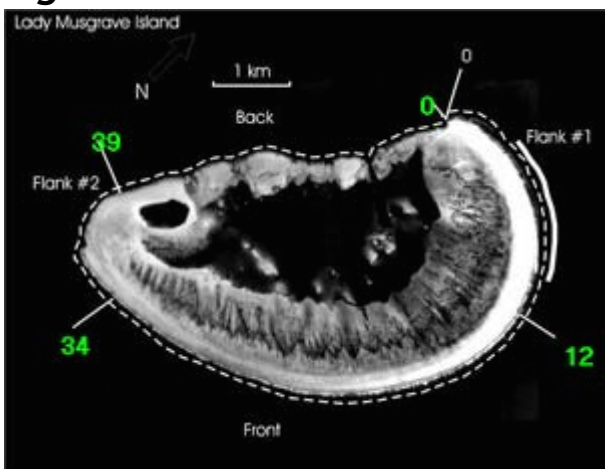
Lady Musgrave Island Reef has been surveyed regularly since 1986. Median reef-wide live coral cover was very high (51-75%) in 1996 and increased to extremely high levels (76-100%) in 1987 and remained at this level in 1988. Between broadscale surveys in 1988 and 1990 reef-wide live coral cover fell dramatically to moderate levels (11-30%) and this was due to storm damage. Coral cover continued to decline until 1993 before recovering. COTS had been recorded on several occasions, but in numbers too few to affect reef-wide live coral cover. Reef-wide live coral cover reached a very high (51-75%) level in 2002, before showing signs of decline once more, possibly due to white syndrome, which has been present or common On Lady Musgrave Island Reef since 2001. Reef-wide live coral cover was high (41-50%) in 2005 and remained so in 2006. In 2007 surveys indicated coral cover was very high (51-75%) on Lady Musgrave Island Reef and it remained classified as No Outbreak. No bleaching or signs of black band disease were observed in 2007. However, elevated signs of white syndrome disease were recorded. Particularly on the back of the reef where it was common (more than ten colonies per two minute manta tow).

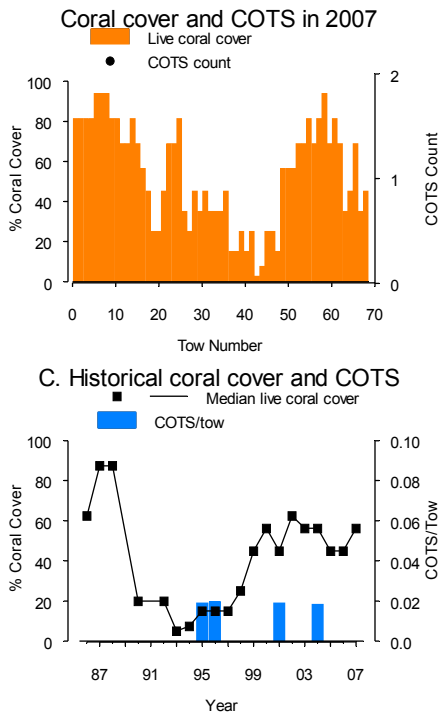
Intensive surveys on Lady Musgrave Island Reef show that hard coral cover increased dramatically from less than 5% in 1993 to a very high level of 75% in 2004. The increase in coral cover was due almost entirely to tabulate *Acropora* spp., which increased dramatically from 0% in 1993 to a maximum of 65% in 2006. Tabulate *Acropora* spp. cover was 60% in 2007. Branching *Acropora* spp. have been slowly increasing over the survey period, reaching 14% in 2007. Pocilloporidae, Faviidae, and Poritidae have remained steady over the survey period. Historical records indicate tabulate *Acropora* spp. typically dominate reefs in this region, while cover of soft corals was low (<1%). The cover of algae decreased from 94% in 1993 to 21% in 2007. White syndrome was recorded at low levels for 3 years before a dramatic increase in 2003, when SCUBA searches recorded 343 colonies affected by white syndrome. This is the highest incidence of white syndrome ever recorded in LTMP intensive surveys. In contrast, only 60 affected colonies were recorded in 2007. The density of corallivorous snails (*Drupella* spp.) was 100/ha.

Hard coral cover provides most of the topographic complexity on the gently sloping reefs characteristic of the exposed Capricorn Bunker sector. The removal of most hard coral during the late 1980s at Lady Musgrave Isalnd Reef created a relatively featureless environment and fish abundance was low in early surveys. Abundance of many species of large mobile fish from the families, Acanthuridae, Scaridae, Chaetodontidae, Labridae and Lutjanidae increased after 1994 as hard coral cover also increased. Patterns of Chaetodontidae abundance were largely driven by a single species *Chaetodon trifascialis*, a hard coral feeding specialist, which has increased in concert with hard coral cover. Patterns in Scaridae abundance were driven by numerous species, but two, *Scarus globiceps* and *S. psittacus* were particularly instrumental. Of the damselfishes, the genus *Pomacentrus* remained stable during the last eight years, after a sharp rise and fall, driven by *P. coelestis*, which dominated the community in the early years when coral cover was low. As coral cover increased, this species became a smaller and smaller component of the community. Recently the number of the coral associated planktivore *Chromis atripectoralis* have increased dramatically. Similarly, numbers of the coral dwelling *Plectroglyphidodon dickii* have increased dramatically, in concert with the increase in branching *Acropora* colonies in the benthic community.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.159

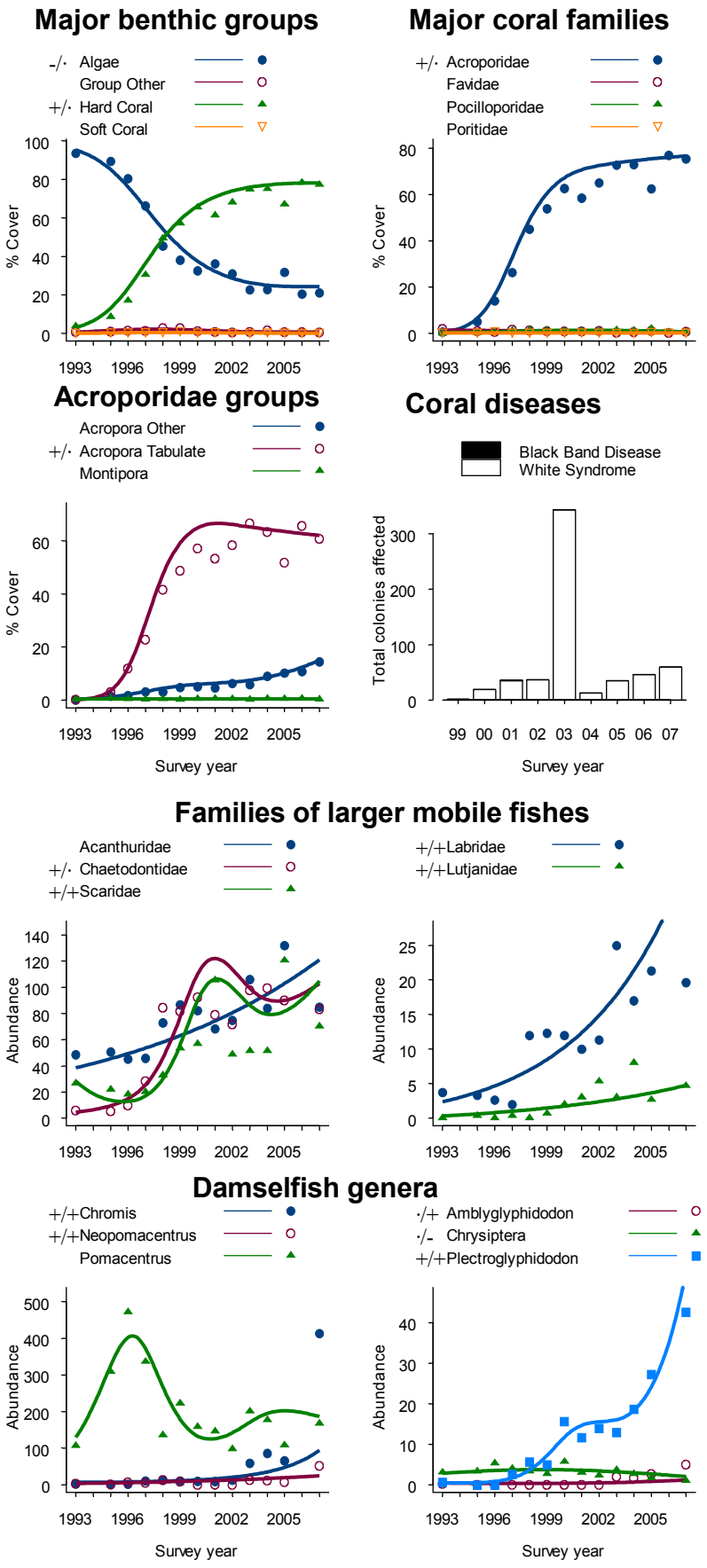




Lady Musgrave Is Reef (No. 23-082) is an outer shelf lagoonal reef with an area of 12.5 sq.km.

Figure 5.159 (cont.)

Lady Musgrave Is Reef was last surveyed in November 2006.



MASTHEAD IS

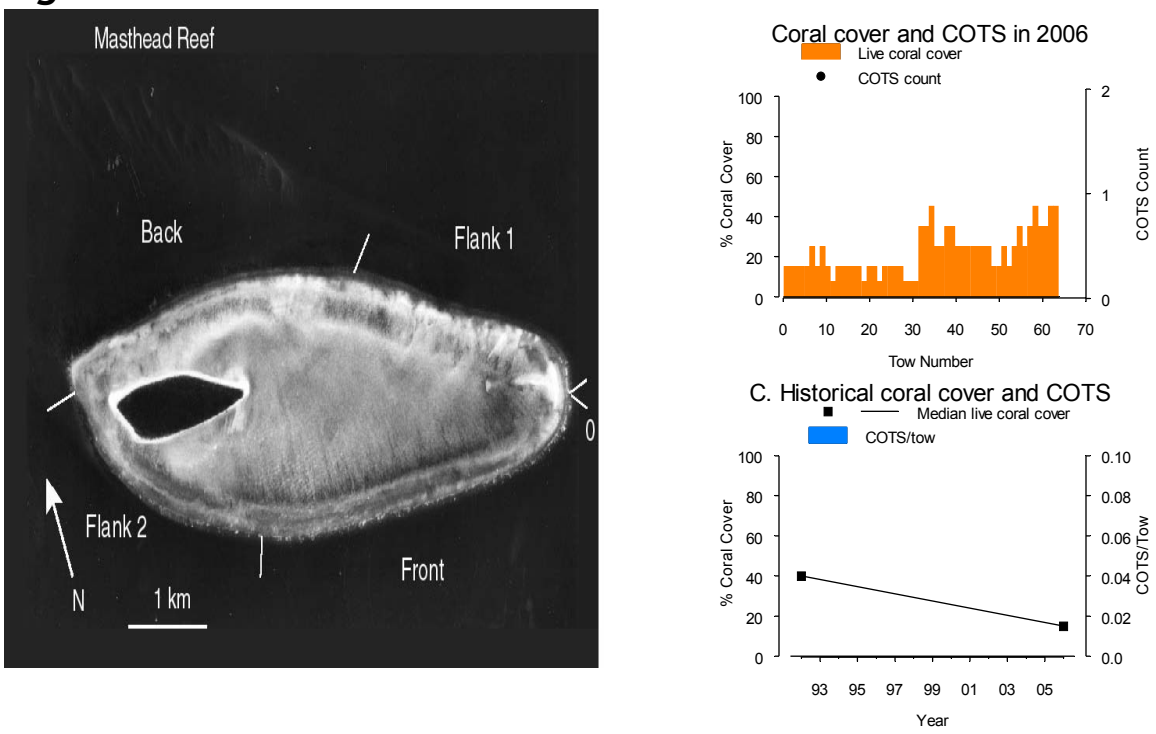
Masthead Island Reef had not been surveyed using manta tow since 1992. Broadscale surveys in 1992 indicated median reef-wide live coral cover was high (31-50%), despite a decline in coral cover on nearby reefs from storms that remained in the Capricorn Bunker group for some time between 1988 and 1990. Surveys in 2006 showed that reef-wide live coral cover was moderate (21-30%). Widespread coral bleaching was observed in May 2006 with approximately 10% of total hard coral cover bleached around the reef perimeter. Signs of white syndrome were also prevalent particularly on the front reef where they were common. No signs of black band disease or COTS were recorded from Masthead Island Reef in 2006 and it remained classified as No Outbreak.

Intensive surveys commenced at Masthead Reef in 2006, where sites were set up in a more protected position on the reef. The benthic community was made up of 54% algae, 22% sand, 17% hard coral, 5% soft coral and 2% sponge cover. As sand covered one fifth of the surveyed area, the proportion of the other benthic groups was lower. Turf algae dominated the intensive survey sites, covering 51% of the benthos. Tabulate *Acropora* spp. were the most common growth form (7% cover) within the Acroporidae, which covered 11% of the benthos. Pocilloporidae and Faviidae were the next most common families, each with a low average cover of 2%. Soft coral colonies of the family Alcyoniidae covered 3% of the substrate. White syndrome was rare on SCUBA search surveys and no *Drupella* spp, were found. Bleaching was observed on 1 to 5% of the coral community at the intensive survey sites.

Chaetodontidae and Scaridae dominated the large mobile, fish community. Abundances of Acanthuridae were relatively low but Chaetodontidae abundances were very high in 2006, driven mainly by *Chaetodon rainfordi*. Abundances of Lutjanidae were also relatively high at this reef, driven by *Lutjanus carponotatus*. Amongst the damselfishes, the genus *Pomacentrus* was dominant in 2006, driven mainly by *Pomacentrus wardi* and to a lesser extent by *P. moluccensis*. Abundances of other damselfish genera were quite low with the exception of *Acanthochromis polyacanthus*.

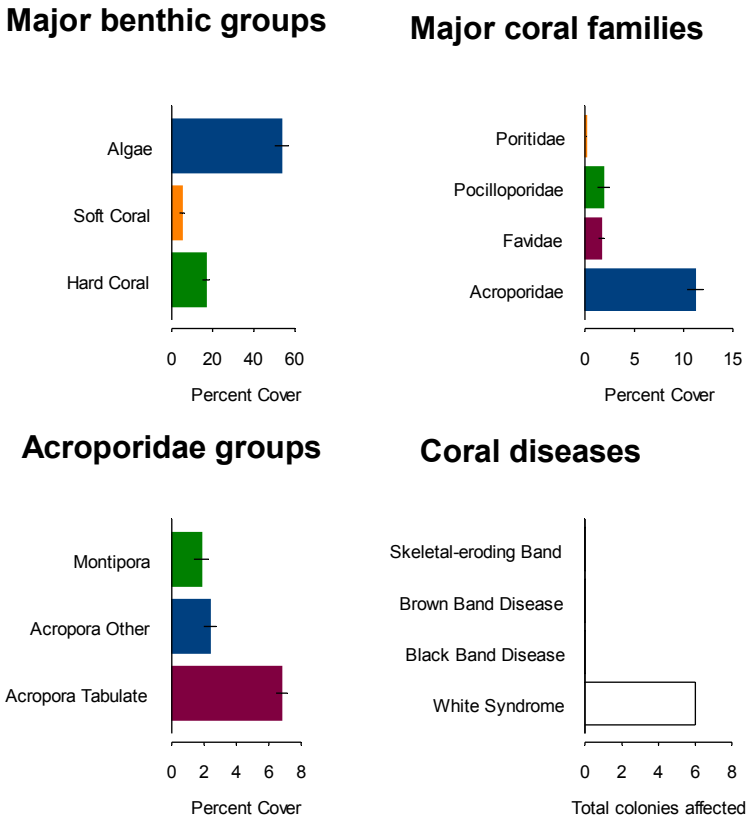
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.160



Masthead Is Reef (No. 23-069) is a mid-shelf planar reef with an area of 13.8 sq.km.

Figure 5.160 (cont.)
Masthead Is Reef was last surveyed in May 2006.



NORTH (A)

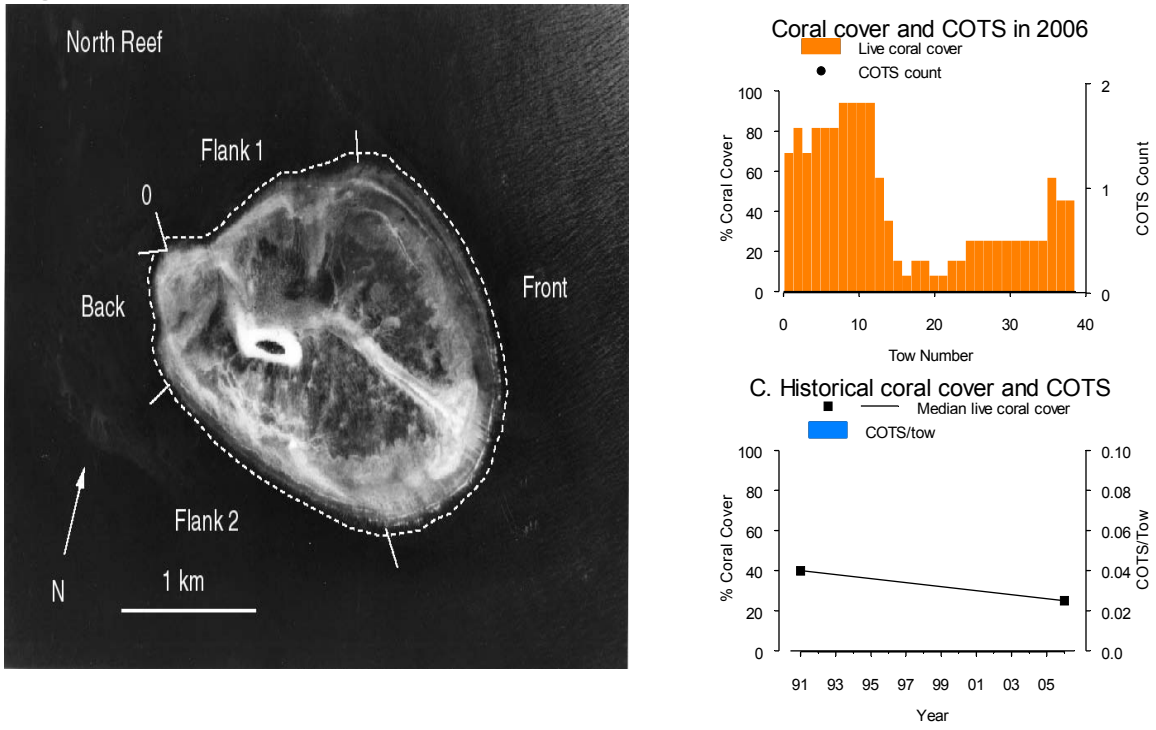
North (A) Reef was first surveyed using manta tow in 1991 and then fifteen years later in 2006. In 1991, median reef-wide live coral cover was high (31-50%), despite a decline in coral cover on nearby reefs in the Capricorn Bunker group between 1988 and 1990 that was attributed to storm damage. Surveys in 2006 showed that reef-wide live coral cover was moderate (21-30%). Widespread low levels of coral bleaching affected small numbers of individual coral colonies around the reef perimeter. Bleaching was highest on the southern flank where up to 5% of total hard coral cover was affected during surveys in March 2006. Signs of white syndrome disease were also observed but again restricted to small numbers of individual colonies on the back and flanks. White syndrome was not observed on the front reef where coral cover was generally low. No signs of black band disease or COTS were recorded on North (A) Reef in 2006 and it remains classified as No Outbreak.

Intensive surveys commenced on North (A) Reef in 2006. Hard coral cover was high (55%) in the first survey. Acroporidae were well represented, with branching and tabulate growth forms of *Acropora* spp. each occupying approximately 15% of the benthic community and *Montipora* spp. occupying 13%. The average cover of both the Faviidae and Poritidae families was low. Algal cover was 41% and the algal community was mainly composed of turf algae and coralline algae. Soft coral cover was low at 3%. Individual bleached colonies were seen along some sites during intensive surveys in March 2006. The incidence of white syndrome along the intensive survey sites was low and the corallivorous gastropod, *Drupella* spp. were observed at a density of 60/ha.

The high live coral cover recorded during the benthic surveys is reflected in the abundance and diversity of reef fish taxa recorded at North (A) Reef. Large mobile fish families were generally well represented, especially the coral associated butterflyfishes (Chaetodontidae). High numbers of coral feeding butterflyfish, including *Chaetodon trifascialis* and *C. rainfordi*, reflect the high abundance of their food source, tabulate *Acropora* spp. colonies. High numbers of herbivorous species from two families, Acanthuridae and Scaridae reflect the healthy nature of North (A) Reef. The commercially important coral trout species were also moderately abundant at North Reef and included not only the common trout *Plectropomus leopardus*, but also the coronation trout, *Variola louti*. The high coral cover was also reflected in the damselfish community, with high numbers of coral affiliated species such as *Pomacentrus moluccensis* and *Plectroglyphidodon dickii* recorded. Other more generalist and planktivorous species were also recorded in high numbers, e.g *Pomacentrus lepidogenys* and *Chromis atripectoralis*.

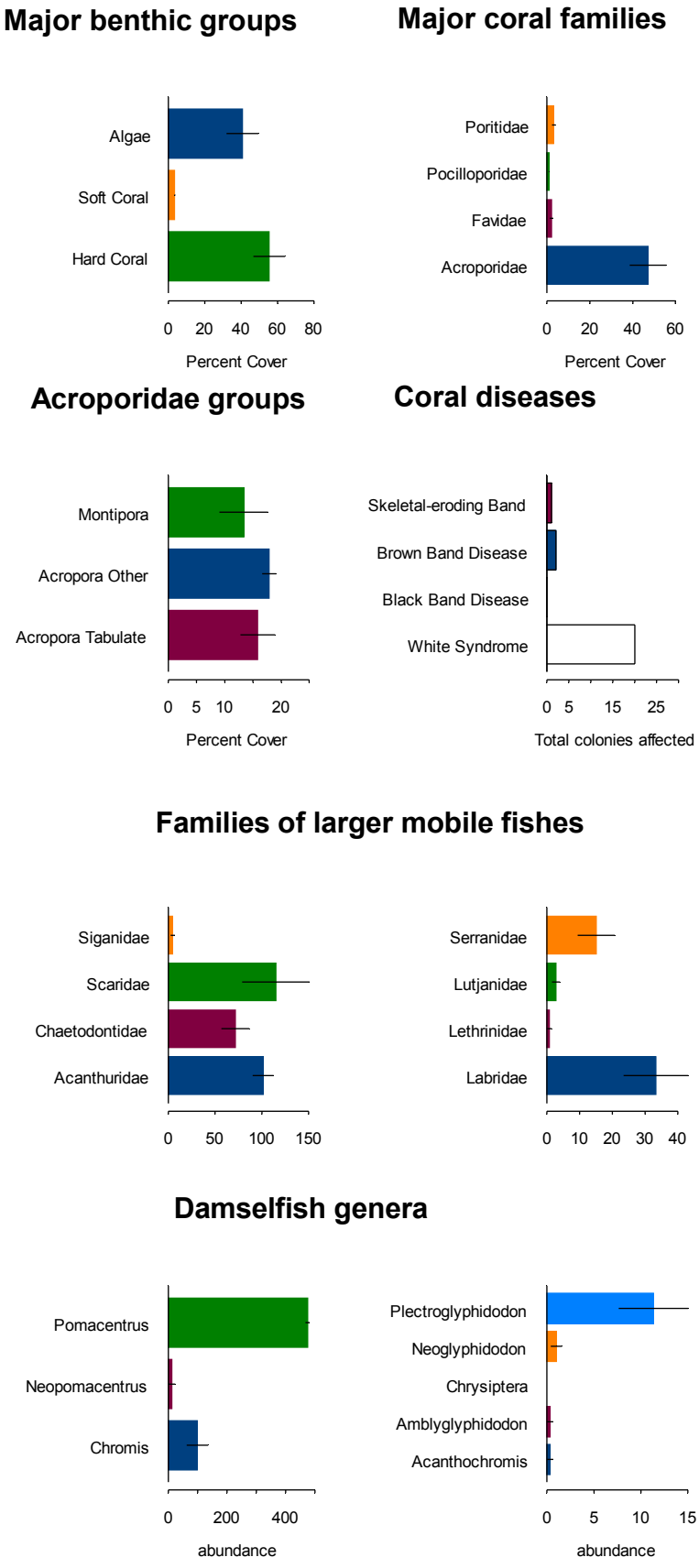
For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.161



North (A) Reef (No. 23-045) is an outer shelf planar reef with an area of 5.6 sq.km.

Figure 5.161 (cont.)
North (A) Reef was last surveyed in March 2006.



ONE TREE IS

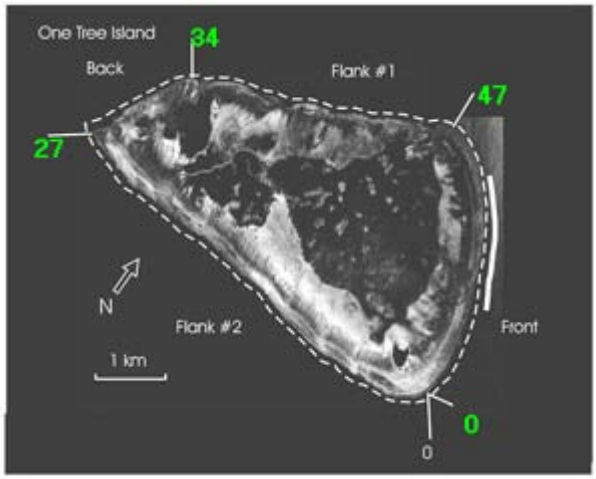
One Tree Island Reef has been surveyed extensively using manta tow since 1986. Median reef-wide live coral cover was very high (51-75%) before it dropped dramatically between broadscale surveys in 1988 and 1990. This decline was caused by severe storms in and around the Capricorn Bunker group. The moderate (11-30%) reef-wide live coral cover increased slowly after 1990 surveys to reach high levels (31-50%) by 1999 where it remained up to and including 2007. No COTS have been recorded on One Tree Island Reef and it remained classified as No Outbreak. No bleaching or signs of black band disease were recorded and white syndrome disease was restricted to a few scattered colonies on the second flank during surveys in 2007.

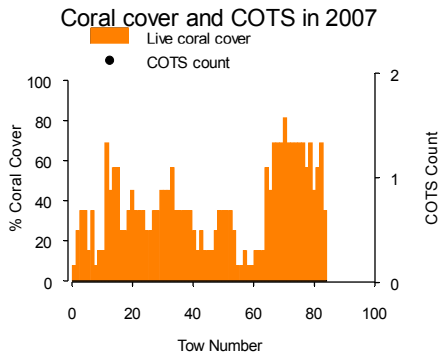
Intensive surveys on One Tree Island Reef showed that hard coral cover has increased from less than 5% in 1993 to a maximum 76% in 2003. Tabulate *Acropora* spp. made up 66% of that cover, a dramatic increase from 0% in 1993. In 2007 hard coral cover was 64%. Tabulate *Acropora* spp. cover has declined since 2003 but in 2007 was still high at 50%, while the cover of branching *Acropora* spp. had slowly increased since 1996 to 10% in 2007. The cover of algae peaked at 90% in 1993, and in 2007 was 31%. The cover of soft coral has remained low (1-2%) since surveys began. White syndrome increased dramatically from 17 affected colonies in 2002 to 336 affected colonies in 2003. In 2007 white syndrome affected 59 colonies. Corallivorous snails, *Drupella* spp., were present at an abundance level of 7/ha in 2007.

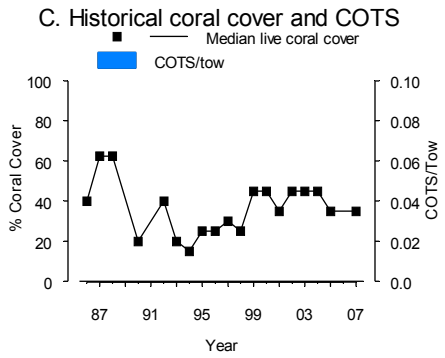
Hard coral cover provides most of the topographic complexity on the gently sloping reefs characteristic of the exposed Capricorn Bunker sector. The removal of most hard coral during the late 1980s created a relatively featureless environment and fish abundance was low in early surveys. Numbers of most large mobile fish taxa increased after 1994 and often tracked the increases in hard coral cover. Families Chaetodontidae, Acanthuridae, Lutjanidae and to a lesser extent, Scaridae, all increased during the last decade. Family Serranidae had been increasing slightly since the beginning of surveys, however in 2007 there was a large jump in numbers which was attributabed to a large increase in the abundance of the common coral trout *Plectropomus leopardus*. Numbers of Labridae had decreased slightly since 2005, when they reached their highest numbers yet recorded on One Tree Island Reef. Damselfishes have been relatively stable as a whole over the study period. A notable exception was the genus *Plectroglyphidodon*, which continued its trend of increasing abundance over the survey period. Other damselfish genera showed variable temporal trends, although *Chromis* spp. had increased slightly since the last surveys in 2005.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

Figure 5.162



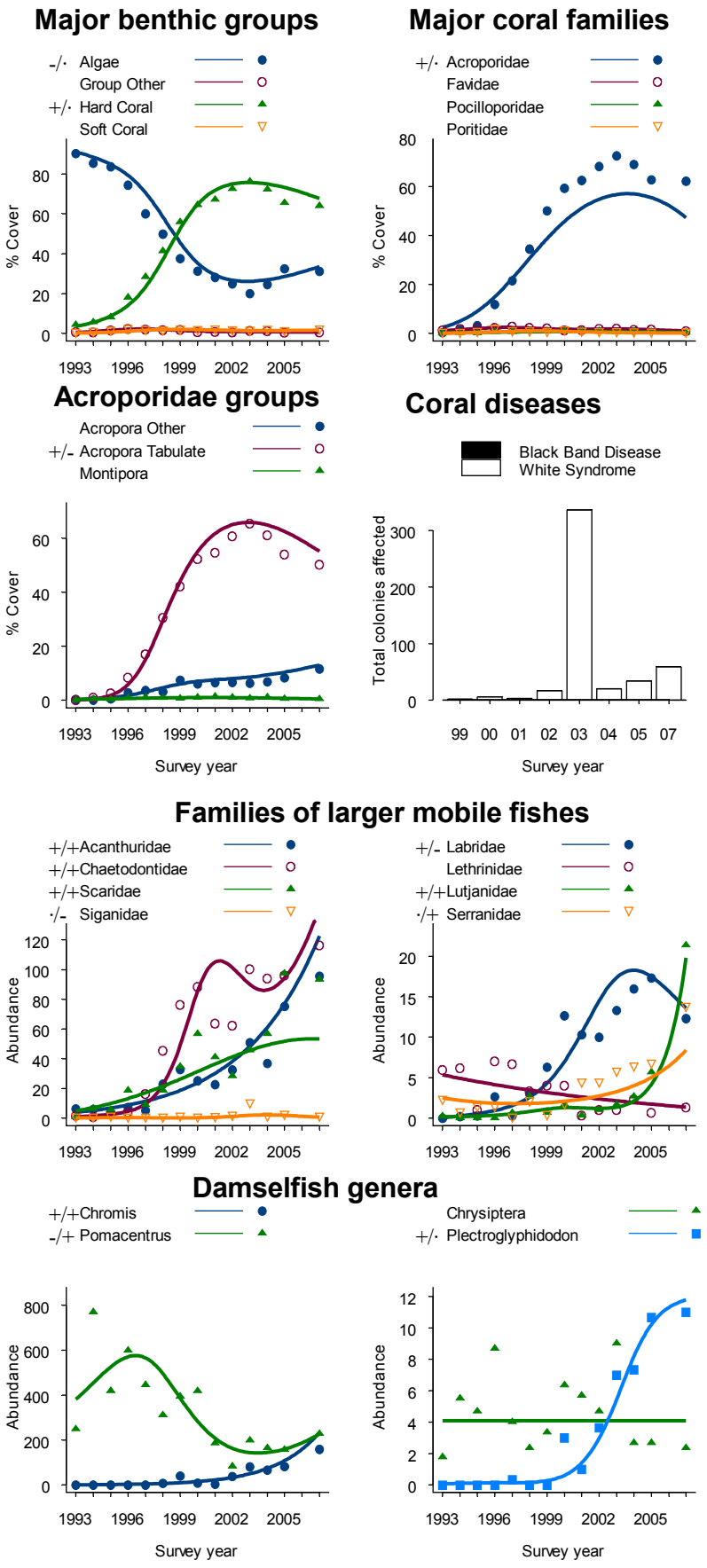




One Tree Is Reef (No. 23-055) is an outer shelf lagoonal reef with an area of 18.09 sq.km.

Figure 5.162 (cont.)

One Tree Is Reef was last surveyed in November 2006.



WRECK IS

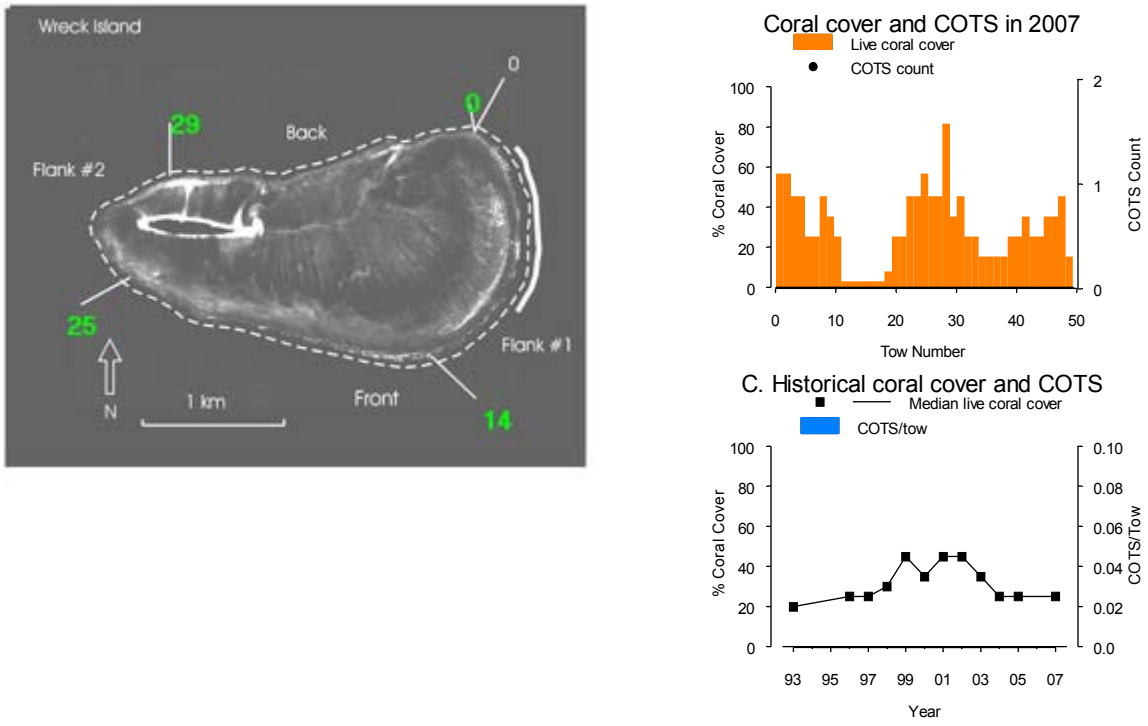
Wreck Island Reef has been surveyed 12 times using manta tow since 1993. During the initial period of survey median reef-wide live coral cover was generally moderate before increasing to a high level (31-50%) which was maintained between 1999 and 2002. Since broadscale surveys in 2003 reef-wide live coral cover declined to a moderate level (11-30%) by 2004 remained at this level up to and including 2007. The reason for this decline is unclear although white syndrome may be responsible, as it was present from 2001 but common around the reef perimeter in 2003. No COTS have been observed on Wreck Island Reef during surveys and it remained classified as No Outbreak. No bleaching or signs of black band disease were recorded and white syndrome was restricted to a few scattered colonies around the reef perimeter in 2007.

Intensive survey sites of Wreck Island Reef showed a dramatic increase in hard coral cover from 15% in 1993 to a maximum of 71% in 1999. Hard coral cover has been declining since 1999 and was 39% in 2007. Both the increase and subsequent decline were due to change in the dominant coral lifeform, tabulate *Acropora* spp. although branching *Acropora* spp. has increased slowly since intensive surveys began and was 14% in 2007. Historical records indicate that dominance by tabulate *Acropora* spp. is typical for reefs in this region, as is very low cover of soft corals (<1%). The cover of algae decreased with the corresponding increase in hard coral. In 2007 the cover of algae was 55%. The decrease in hard coral cover between 2002 and 2004 is possibly due to increasing levels of white syndrome. High numbers (221) of hard coral colonies were affected by white syndrome in 2003 while in 2007 white syndrome rarely affected colonies. In 2007 many tabulate *Acropora* spp. colonies were observed that had suffered partial or complete mortality. The density of corallivorous snails, *Drupella* spp., was 60/ha in 2007.

Hard coral cover provides most of the topographic complexity on the flat gently sloping reef bases characteristic of the exposed Capricorn Bunker reefs. Judging by the low numbers of fish present when surveys began in 1993, it is presumed that the removal of much hard coral during the late 1980s created a relatively featureless environment unsuitable for sustaining large fish populations. However, numbers of most large mobile fish taxa increased after 1994 and often tracked increases in hard coral cover. Most families of large mobile fishes have steadily increased since the hard coral cover increased from low levels in the early 1990s. Numbers of Acanthuridae increased dramatically in 2005 and 2007, due to the increase in *Naso tuberosus* and the *Ctenochaetus* spp.. Of the damselfishes three genera showed increases over the study period, *Pomacentrus*, *Acanthochromis* and *Plectroglyphidodon*. *Pomacentrus* spp. numbers have increased since 2000, due mainly to two species *P. lepidogenys* and *P. coelestis*. The drop in *Plectroglyphidodon* spp. reverses the trend of the previous four surveys, and is due to all three species in this genus acting in concert.

For an explanation of the plots please see "How to read a reef page" at the beginning of Section 5.

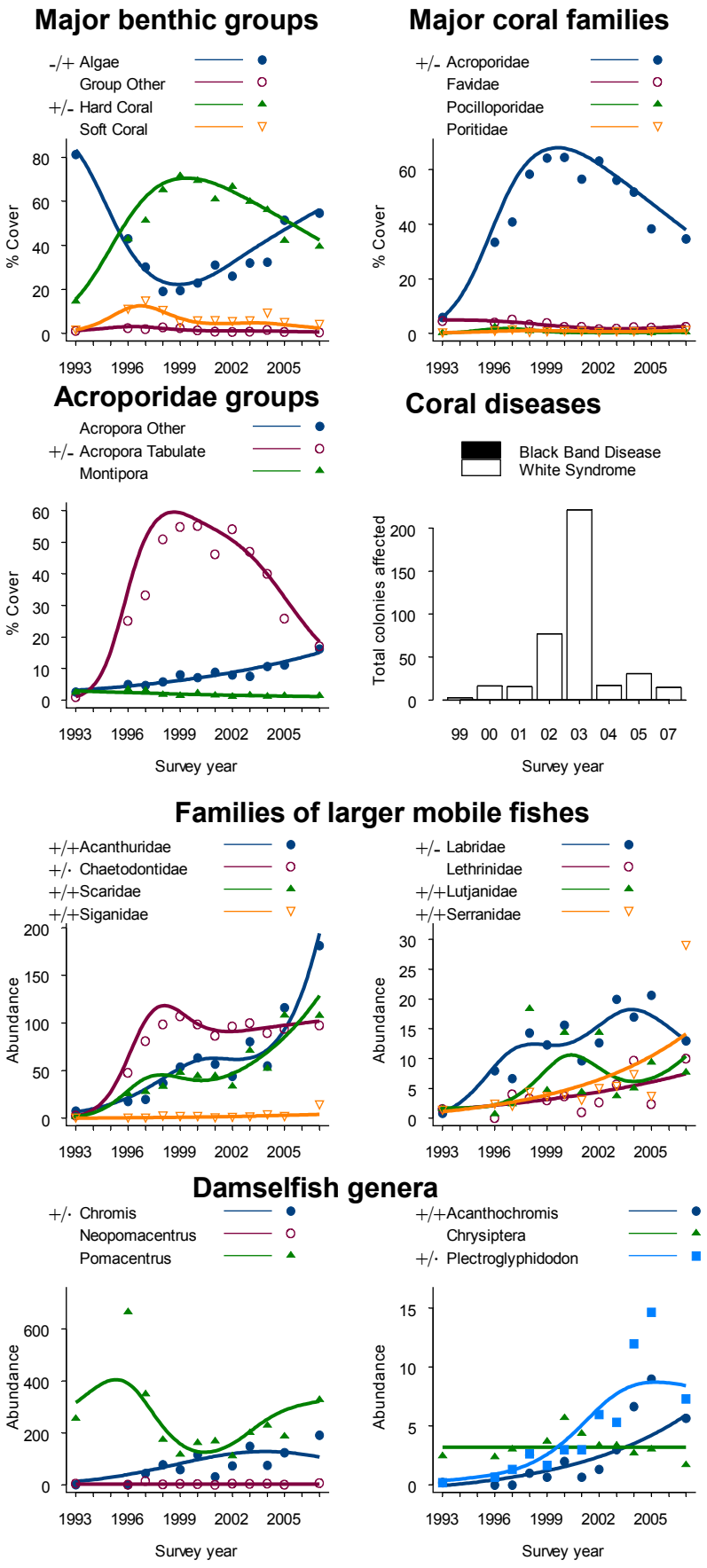
Figure 5.163



Wreck Is Reef (No. 23-051) is an outer shelf planar reef with an area of 6.3 sq.km.

Figure 5.163 (cont.)

Wreck Is Reef was last surveyed in November 2006.



6. Monitoring the effects of re-zoning the GBR Marine Park – preliminary results

Introduction

A new zoning plan for the GBR Marine Park came into effect on 1 July 2004. The new zoning plan involved protection of at least 20% of a number of bio-regions and increased the area of the Marine Park that was closed to fishing from 4.5% to >33%. Since livelihoods were affected the effects of this measure needed to be monitored. Changes in the fishing regime should affect the target species first, with later consequences for structure of fish communities and communities of other organisms within reserves caused by trophic cascades and, in the long term, fishery benefits beyond the reserves through spill-over effects. The survey design was described in Section 2. It involved multiple matched pairs of reefs in 5 regions of the GBRMP, with both reefs having been open to fishing prior to 2004, and one reef in each pair then rezoned as a no-take area in the new zoning plan. A figure of the survey design is available on the GBRMPA website. Standard LTMP methods were used to survey the paired reefs 1.5-2 years after the implementation of the new zoning plan.

Results

While the density of fishes varied among the 5 regions, the density of the primary target species for the reef line fishery, coral trout (*Plectropomus* spp.) increased on reefs that were closed to fishing by 31-64% (Figure 6.1) The difference was significant in all regions except the Cairns region (mean increase 54%) where numbers of coral trout were lowest. The numbers of coral trout on the individual reef pairs are shown in Figure 6.2

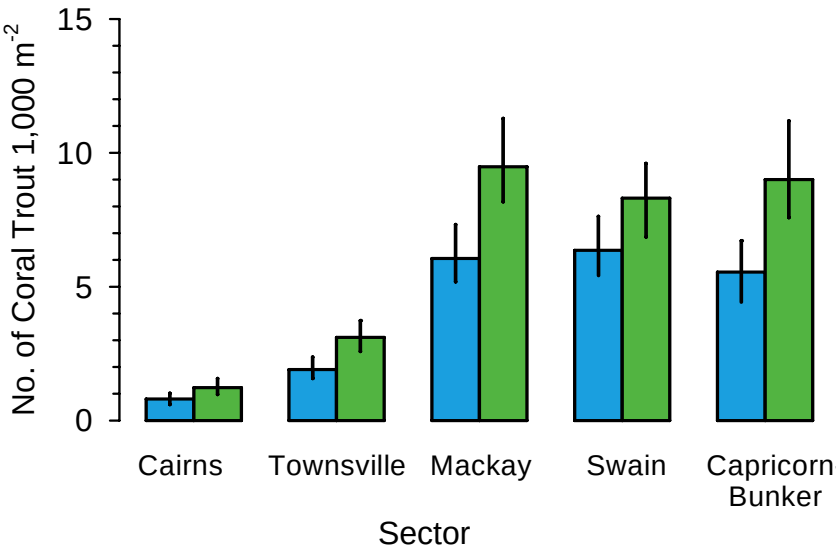


Figure 6.1 Numbers of coral trout (*Plectropomus* spp.) per 1,000 m^2 on No-take reefs (green bars) and Open reefs (blue bars) in five regions of the GBRMP in 2006. Values are geometric means (± 1 standard error) derived from mixed-effects models.

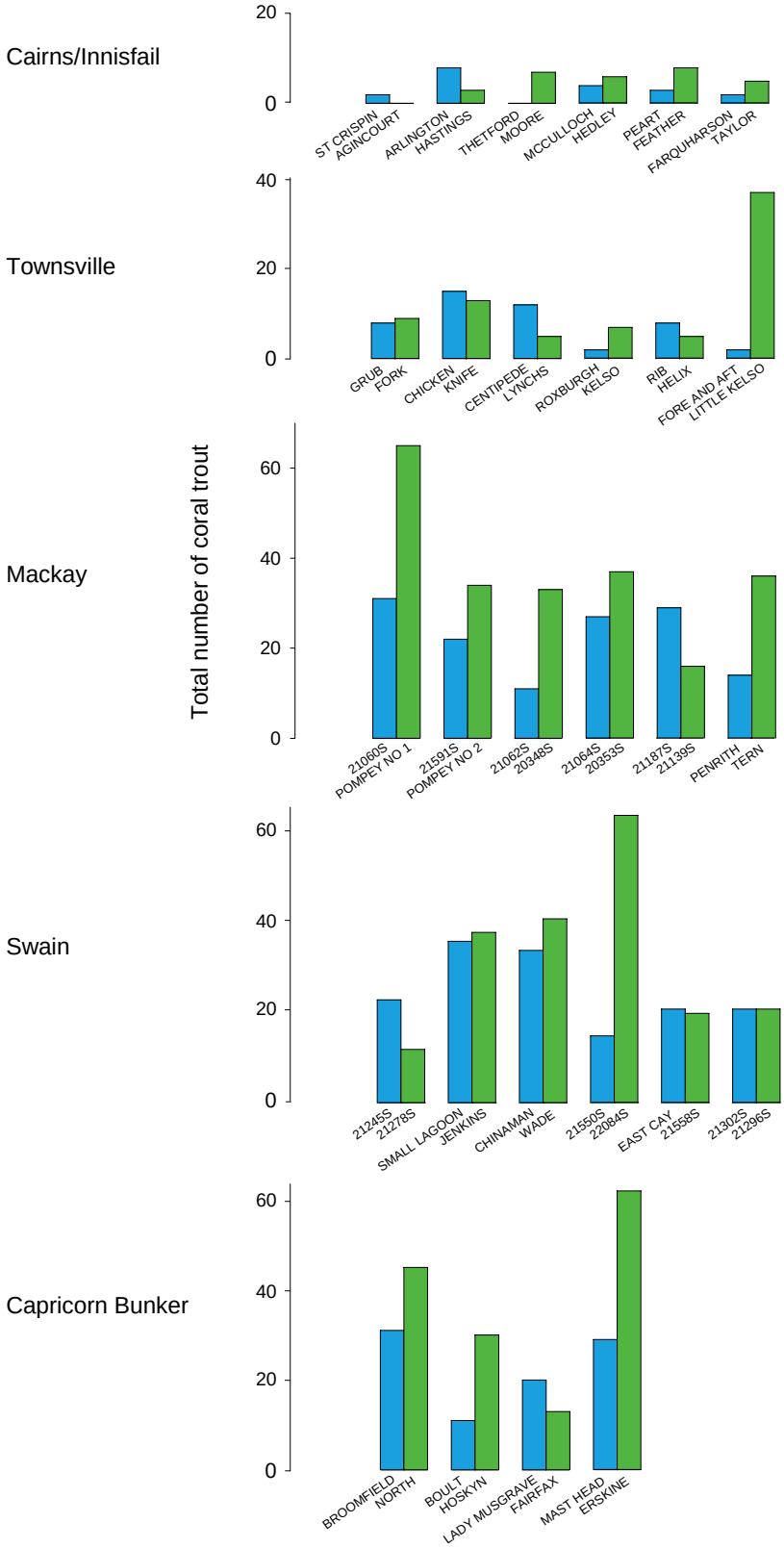


Figure 6.2 Total number of coral trout (*Plectropomus* spp.) recorded on matched pairs of survey reefs in five regions of the Great Barrier Reef in 2006. Blue bars refer to reefs that were open to fishing prior to 2004 and remained so; green bars refer to reefs that were rezoned as no-take areas in 2004 having previously been open to fishing.

Discussion

Finding higher numbers of coral trout in the no-take reefs so soon after the rezoning is encouraging and is presumably due to reduced fishing mortality on the no-take reefs. Most fishing pressure on these mid-shelf and outer shelf reefs is commercial rather than recreational and there was a large reduction in commercial fishing effort following a restructure of the line fishing industry and the introduction of a quota system in 2004. This makes it likely that fishing pressure did not increase substantially in the reduced area that remained open to fishing.

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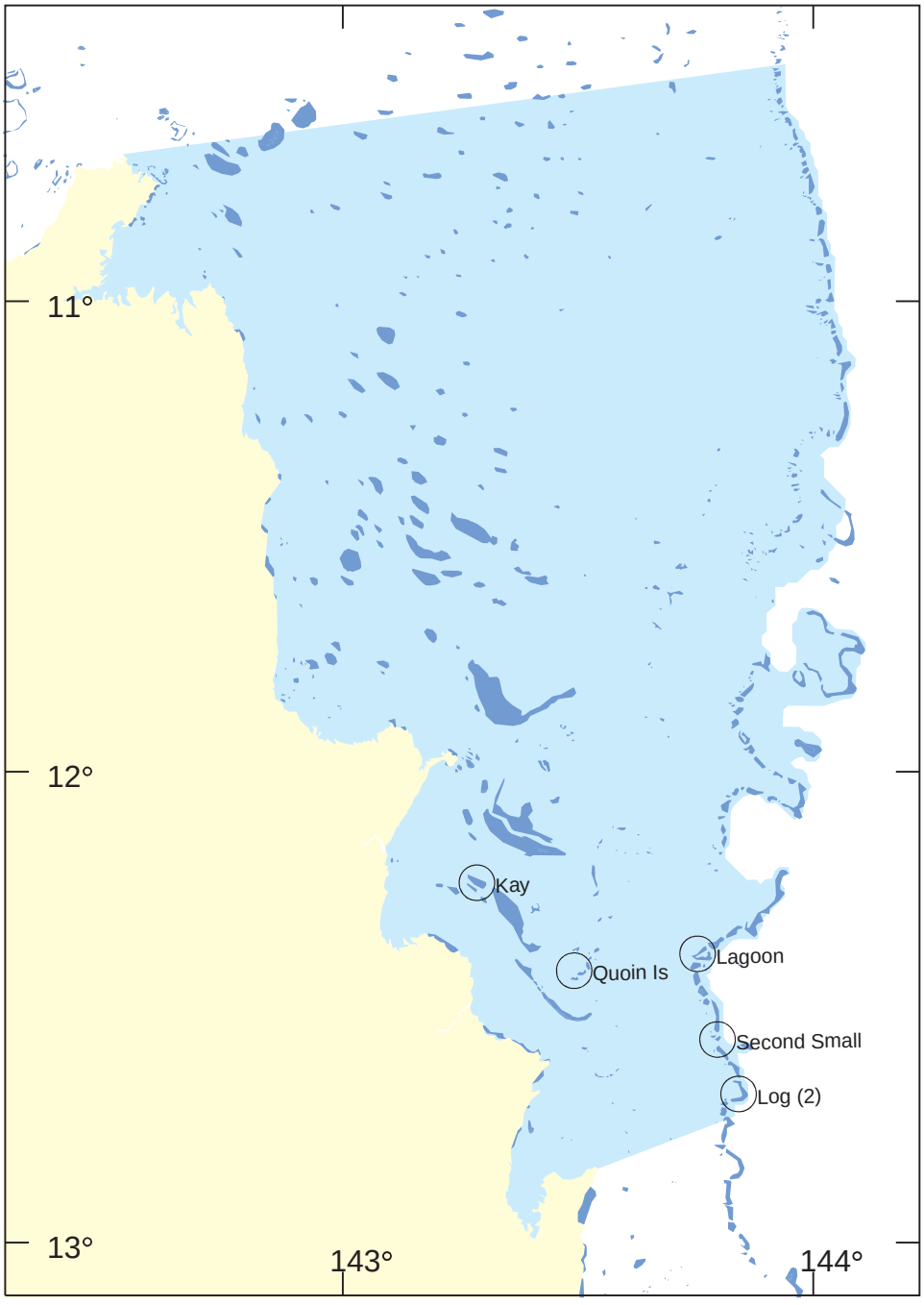
8. Appendices

Appendix A

Location of reefs surveyed in 2006 and 2007 and the types of surveys taken.

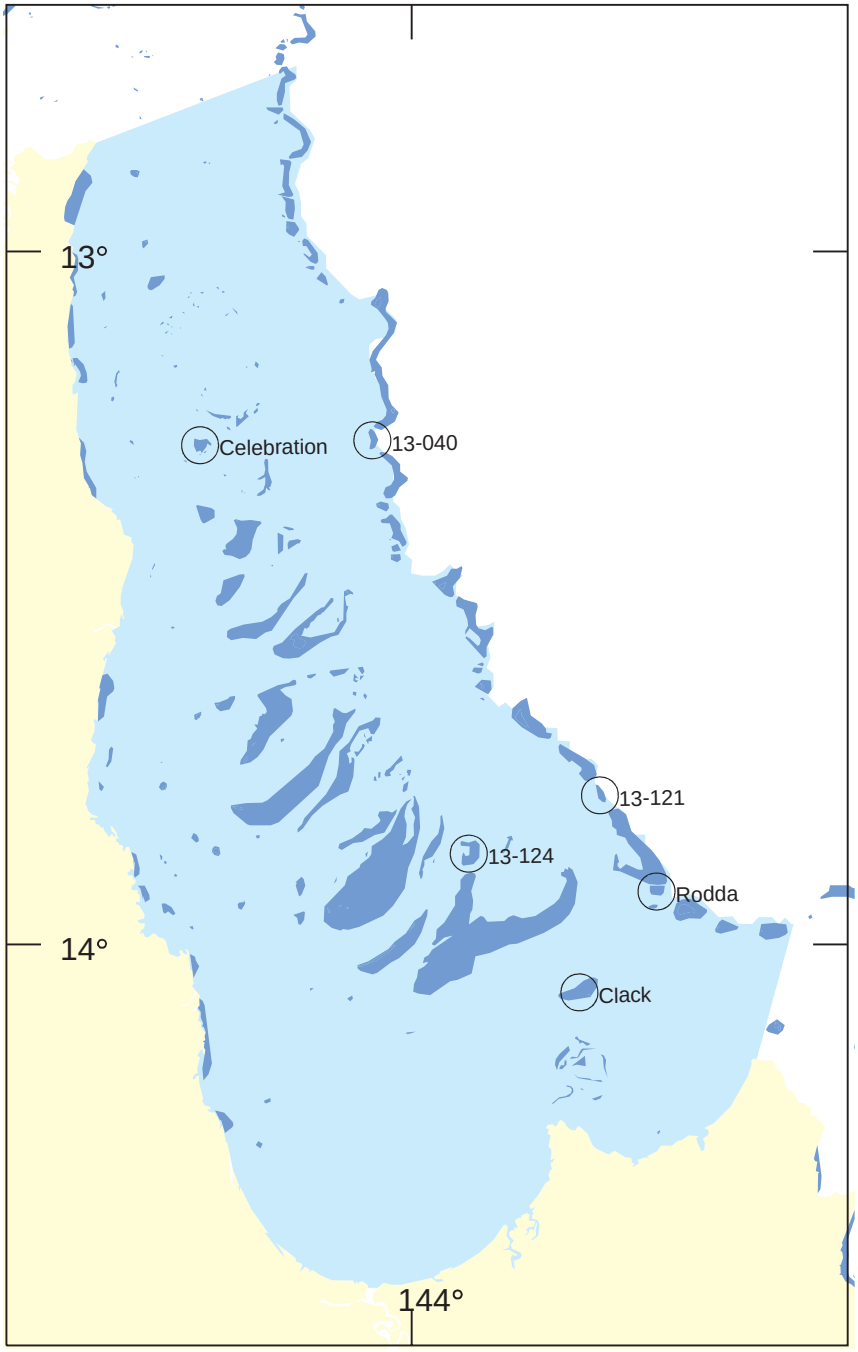
Cape Grenville Sector



- Fish and Benthos

○ Manta Tow

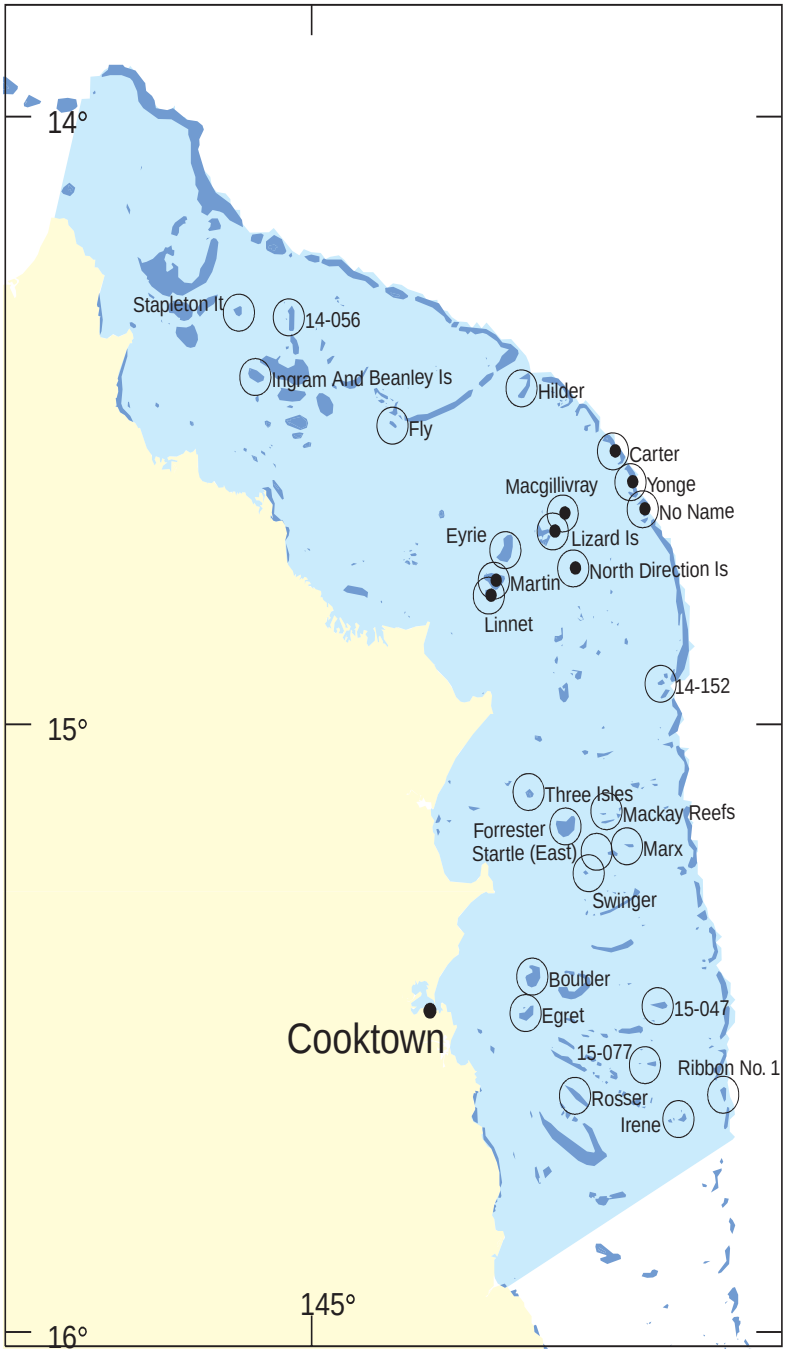
Princess Charlotte Bay Sector



- Fish and Benthos

○ Manta Tow

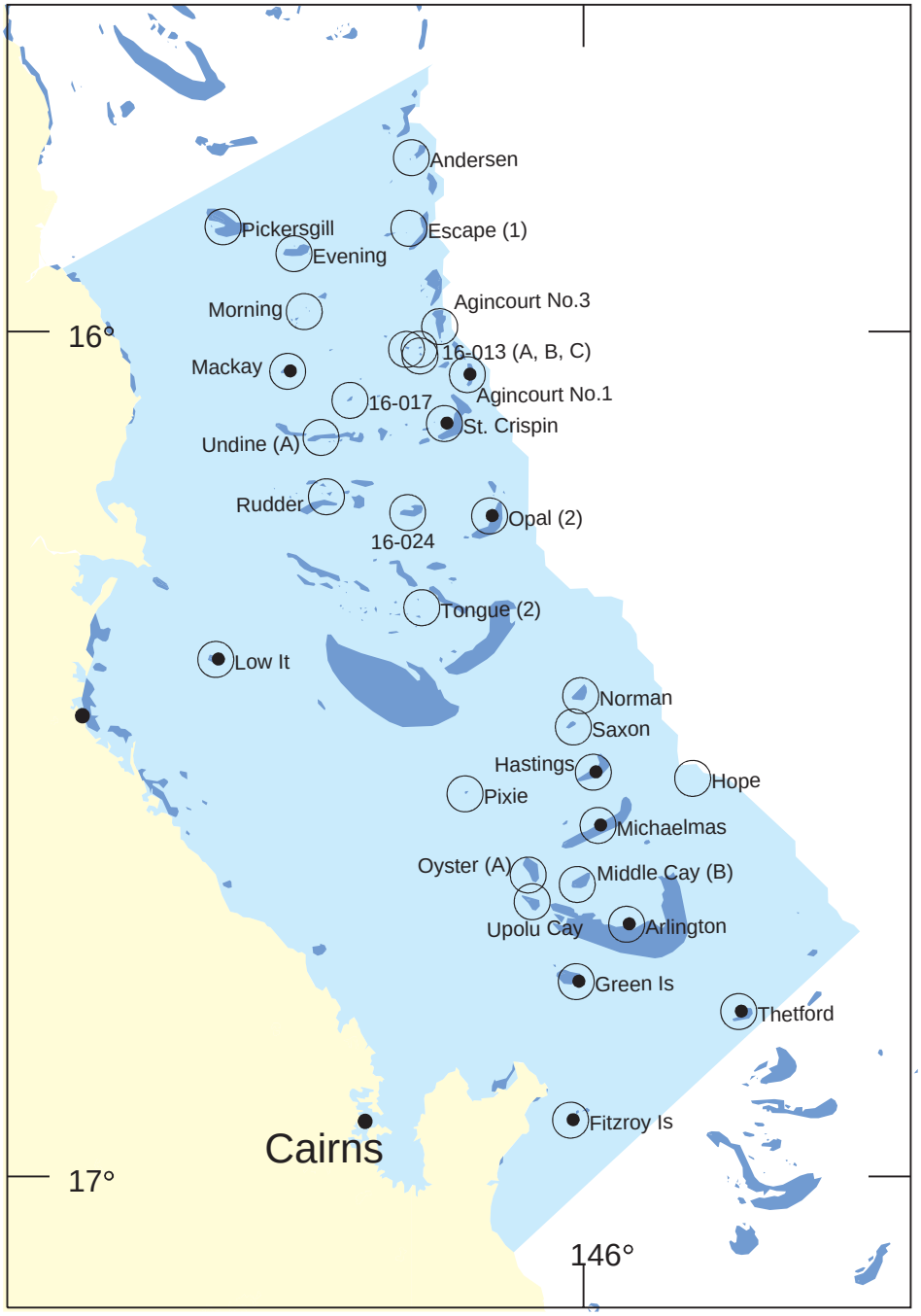
Cooktown / Lizard Island Sector



- Fish and Benthos

○ Manta Tow

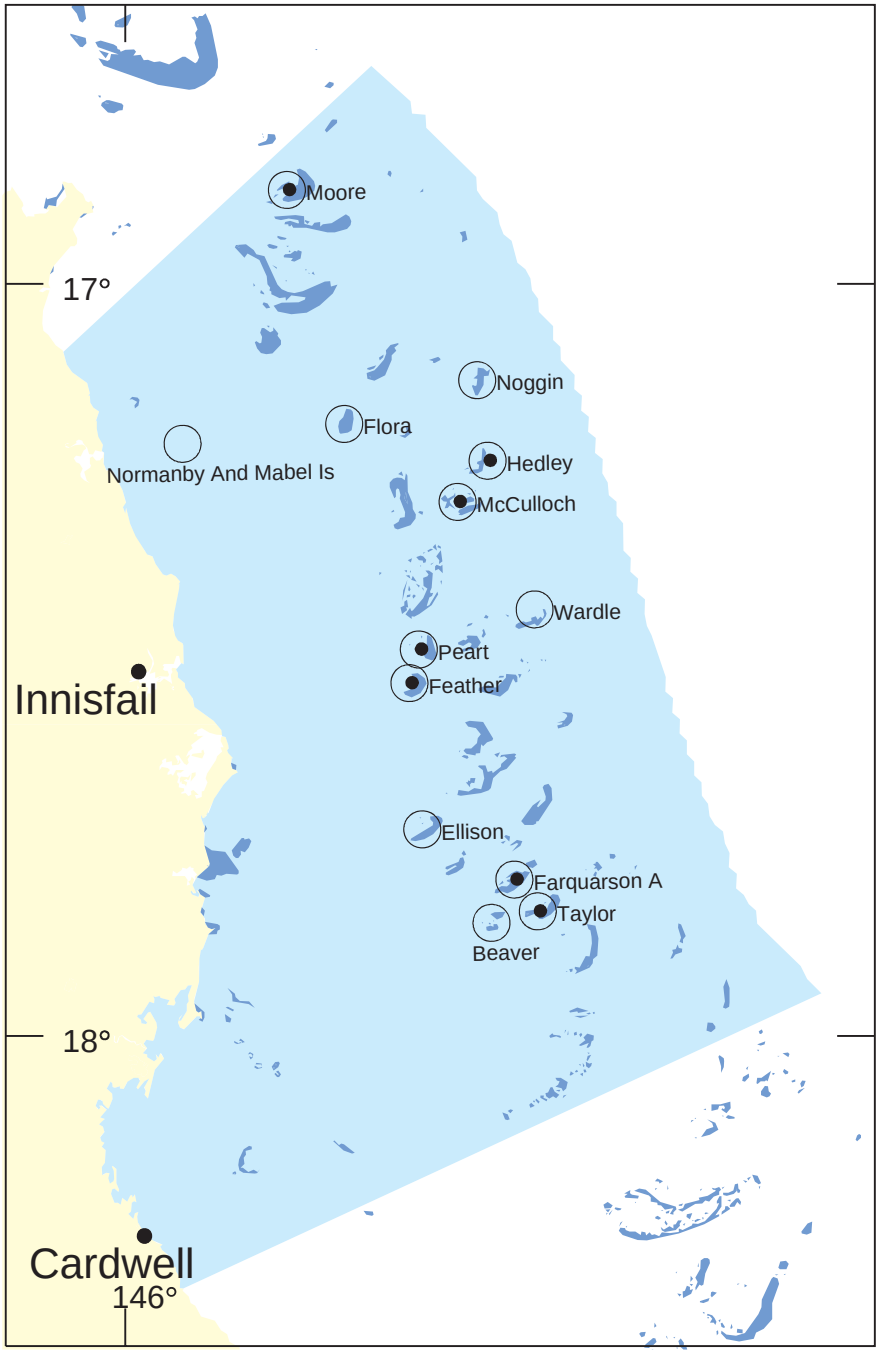
Cairns Sector



- Fish and Benthos

○ Manta Tow

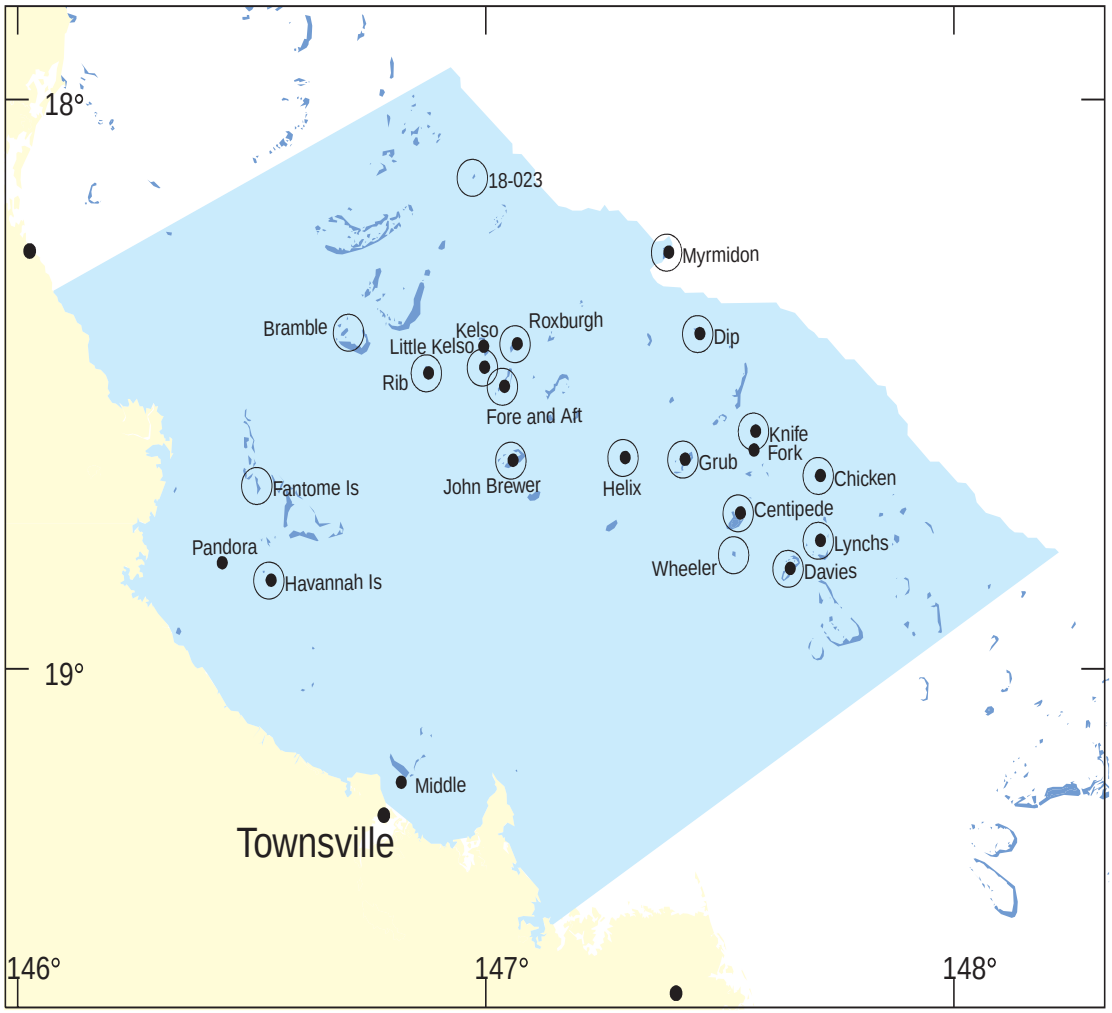
Innisfail Sector



- Fish and Benthos

○ Manta Tow

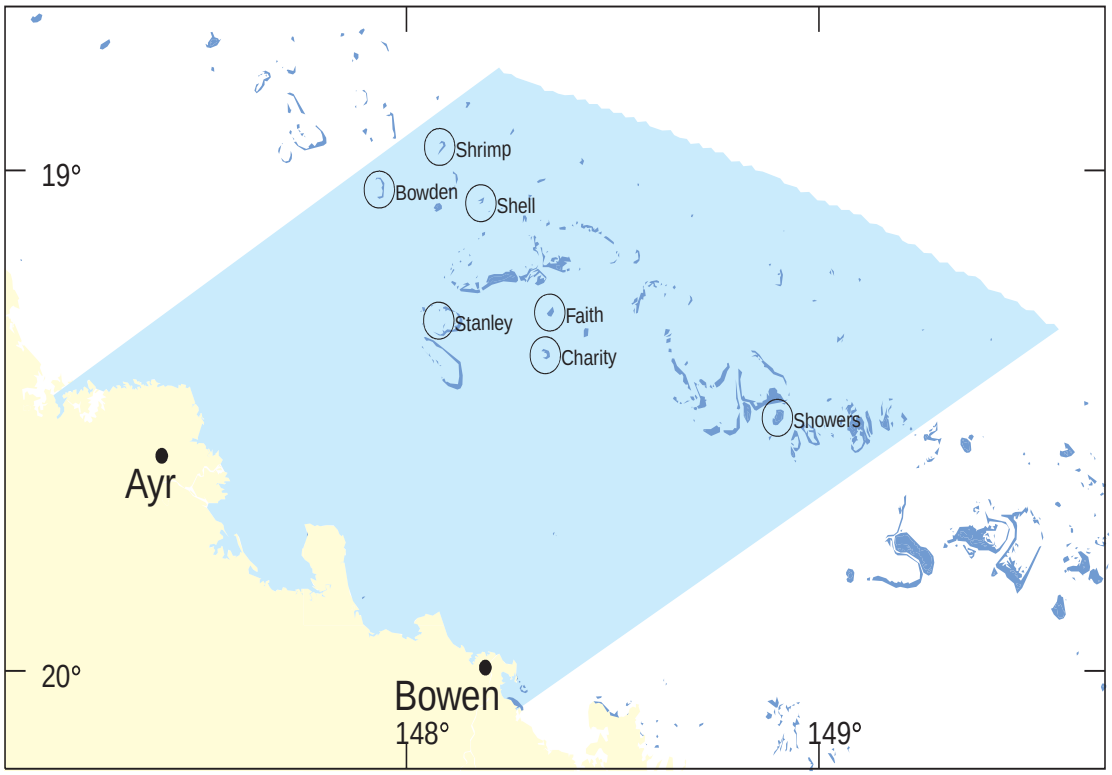
Townsville Sector



- Fish and Benthos

○ Manta Tow

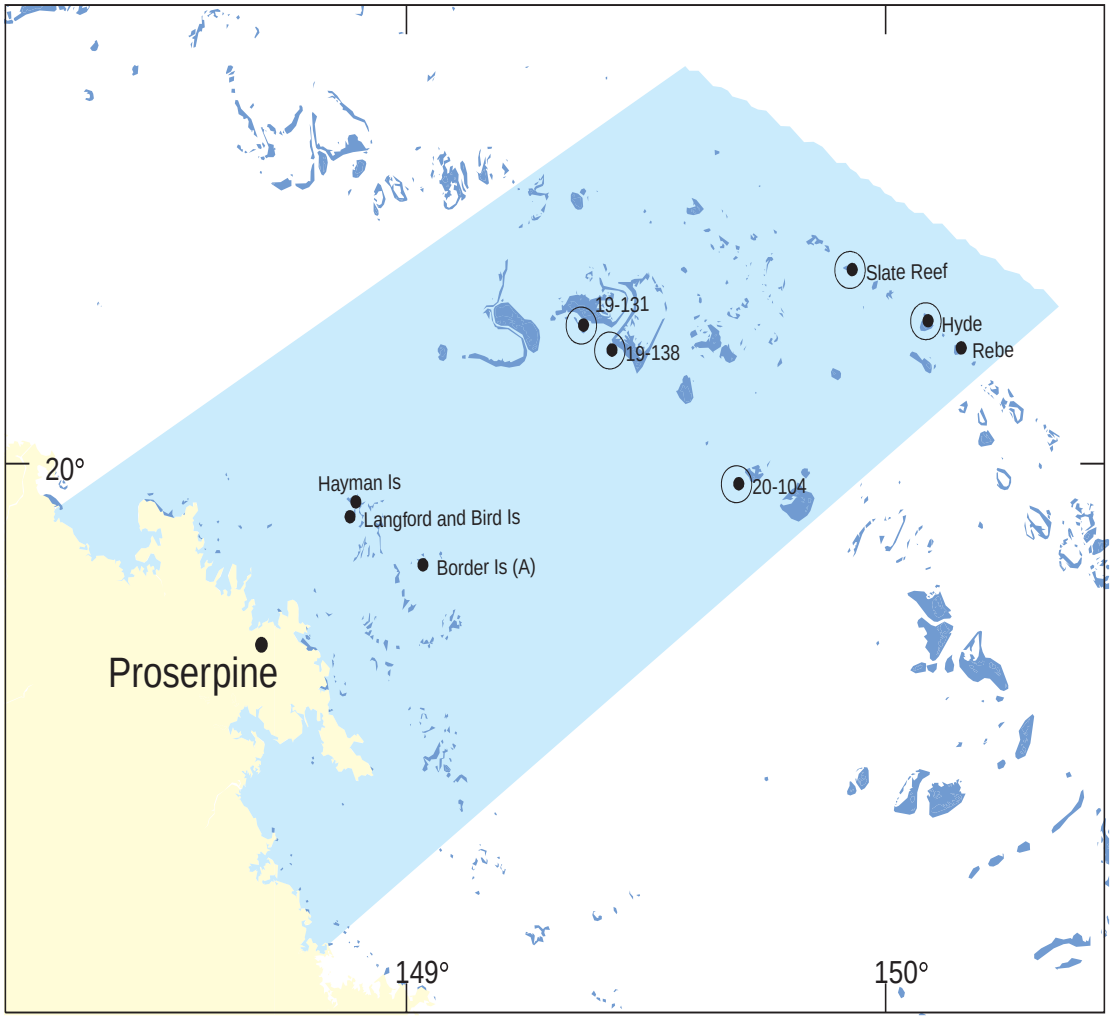
Cape Upstart Sector



- Fish and Benthos

○ Manta Tow

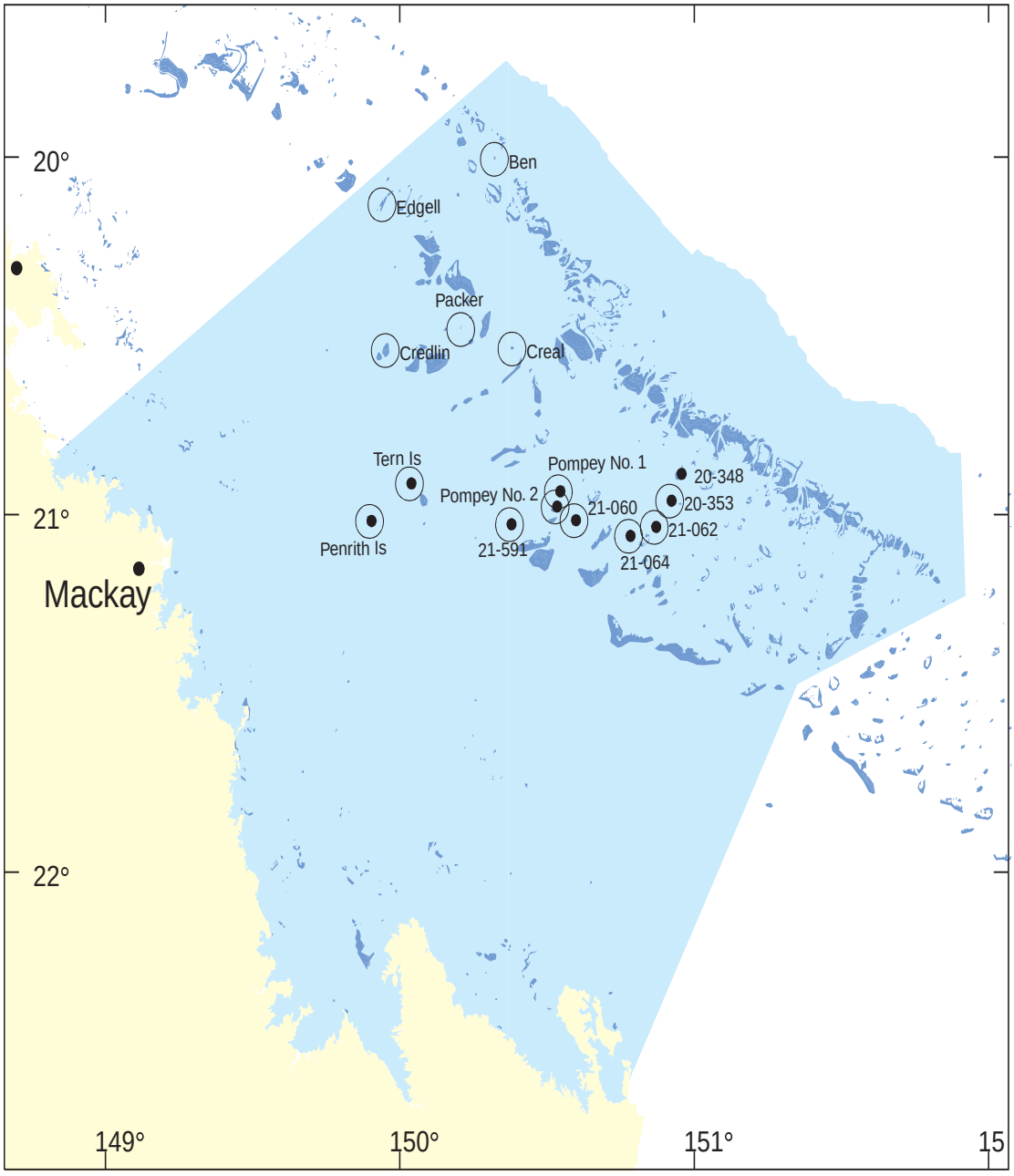
Whitsunday Sector



- Fish and Benthos

○ Manta Tow

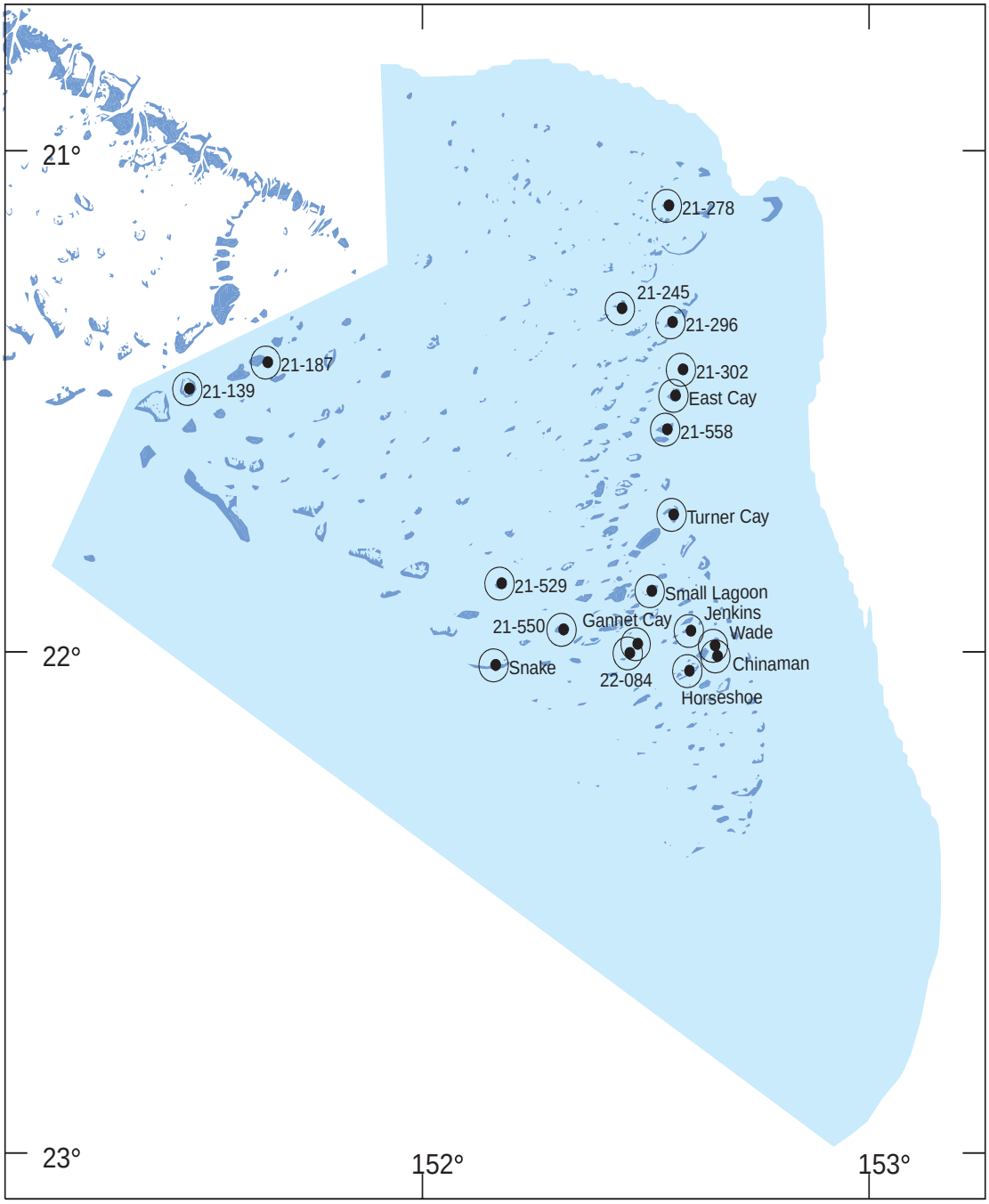
Pompey Sector



- Fish and Benthos

○ Manta Tow

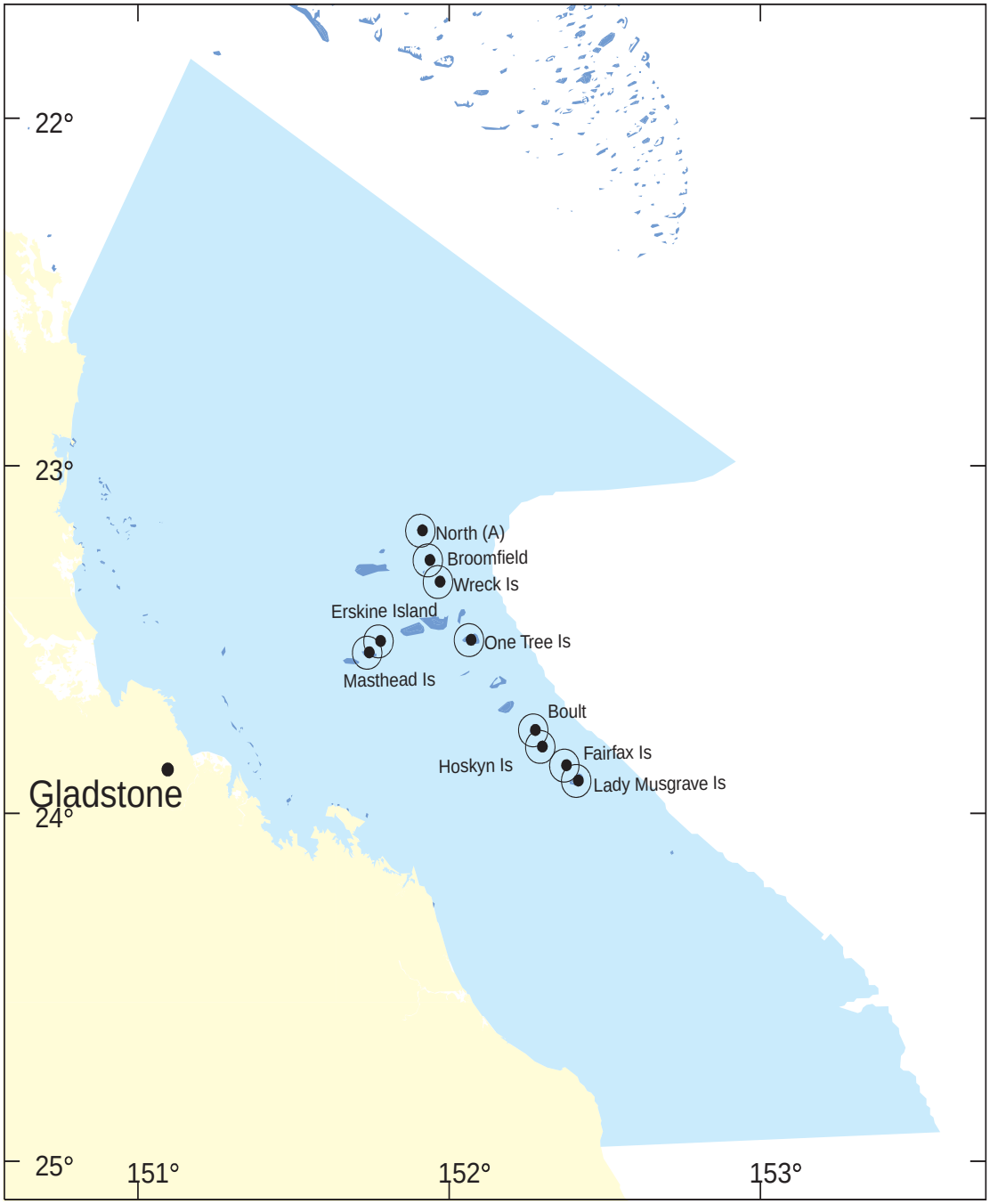
Swain Sector



- Fish and Benthos

○ Manta Tow

Capricorn Bunker Sector



- Fish and Benthos

○ Manta Tow

Appendix B

Summary of reefs surveyed in 2006 or 2007.
Reef ID refers to the GBRMPA Gazetteer. Sampling codes:
B = benthos, F = reef fishes, M = manta tow.

Sector	Shelf Position	Reef ID	Reef Name	Sampling Methods	
				2006	2007
Cape Grenville	Inshore	12010	Kay	M	
Cape Grenville	Mid-shelf	12027	Quoin Is	M	
Cape Grenville	Outer shelf	12061	Lagoon	M	
		12098	Second Small	M	
		12107	Log (2)	M	
Princess Charlotte Bay	Inshore	14017	Clack	M	
Princess Charlotte Bay	Mid-shelf	13041	Celebration	M	
		13124	13-124	M	
Princess Charlotte Bay	Outer shelf	13040	13-040	M	
		13121	13-121	M	
		13127	Rodda	M	
Cooktown / Lizard Is	Inshore	14123	Martin	M	MBF
		14126	Linnet	M	MBF
		15005	Three Isles	M	
		15012	Boulder	M	M
		15013	Egret		M
Cooktown / Lizard Is	Mid-shelf	14054	Stapleton It		M
		14056	14-056	M	
		14064	Ingram And Beanley Is	M	
		14109	Fly	M	
		14114	MacGillivray	M	MBF
		14116	Lizard Is	M	MBF
		14118	Eyrie		M
		14143	North Direction Is	M	MBF
		15009	Forrester	M	
		15024	Mackay Reefs		M
		15027	Marx	M	
		15028	Startle (East)		M
		15030	Swinger		M
		15047	15-047		M
		15077	15-077		M
		15081	Rosser		M
		15084	Irene	M	M
Cooktown / Lizard Is	Outer shelf	14085	Hilder	M	
		14137	Carter	M	MBF
		14138	Yonge	M	MBF
		14139	No Name	M	MBF
		14152	14-152	M	
		15080	Ribbon No.1		M

Sector	Shelf Position	Reef ID	Reef Name	Sampling Methods	
				2006	2007
Cairns	Inshore	16028	Low It	M	MBF
		16049	Green Is	M	MBF
		16054	Fitzroy Is	M	MBF
Cairns	Mid-shelf	15093	Pickersgill	M	M
		15095	Evening		M
		15098	Morning		M
		16013	16-013 (C)		M
		16013	16-013 (B)		M
		16013	16-013 (A)		M
		16015	Mackay	M	MBF
		16017	16-017		M
		16020	Undine (A)		M
		16023	Rudder		M
		16024	16-024		M
		16026	Tongue (2)		M
		16032	Saxon		M
		16040	Pixie		M
		16043	Oyster (A)		M
		16044	Middle Cay (B)	M	M
		16046	Upolu Cay		M
		16057	Hastings	MBF	MBF
		16060	Michaelmas	M	MBF
		16064	Arlington	MBF	
		16068	Thetford	MBF	MBF
Cairns	Outer shelf	15090	Andersen		M
		15094	Escape (1)		M
		15099	Agincourt No.1	MBF	MBF
		15099	Agincourt No.3		M
		16019	St. Crispin	MBF	MBF
		16025	Opal (2)	M	MBF
		16030	Norman		M
		16058	Hope	M	M
Innisfail	Inshore	17012	Normanby And Mabel I		M
Innisfail	Mid-shelf	16071	Moore	MBF	M
		17010	Flora		M
		17016	McCulloch	MBF	
		17024	Peart	MBF	
		17034	Feather	MBF	M
		17044	Ellison	M	M
		17051	Beaver	M	M
		17063	Farquharson A	MBF	
		17064	Taylor	MBF	
Innisfail	Outer shelf	17008	Noggin		M
		17014	Hedley	MBF	M
		17032	Wardle	M	M

Sector	Shelf Position	Reef ID	Reef Name	Sampling Methods	
				2006	2007
Townsville	Inshore	18051	Pandora		BF
		18053	Fantome Is		M
		18065	Havannah Is	M	MBF
		19011	Middle		BF
Townsville	Mid-shelf	18029	Bramble		M
		18030	Kelso	BF	
		18031	Little Kelso	MBF	
		18032	Rib	MBF	MBF
		18042	Roxburgh	MBF	
		18043	Fore And Aft	MBF	
		18075	John Brewer		MBF
		18076	Helix	MBF	
		18077	Grub	MBF	
		18088	Centipede	MBF	
		18091	Lynchs	MBF	
		18095	Wheeler		M
		18096	Davies		MBF
Townsville	Outer shelf	18023	18-023		M
		18034	Myrmidon		MBF
		18039	Dip		MBF
		18081	Knife	MBF	
		18083	Fork	BF	
		18086	Chicken	MBF	MBF
Cape Upstart	Mid-shelf	18118	Shrimp		M
		19019	Bowden		M
		19028	Shell		M
		19044	Faith		M
		19045	Stanley		M
		19047	Charity		M
		19076	Showers		M
Whitsunday	Inshore	20014	Hayman Is		BF
		20019	Langford And Bird Is		BF
		20067	Border Is (A)		BF
Whitsunday	Mid-shelf	19131	19-131	M	MBF
		19138	19-138	M	MBF
		20104	20-104		MBF
Whitsunday	Outer shelf	19159	19-159		MBF
		19207	Hyde		MBF
		19209	Rebe		BF

Sector	Shelf Position	Reef ID	Reef Name	Sampling Methods	
				2006	2007
Pompey	Mid-shelf	20112	Edgell		M
		20145	Packer		M
		20287	Credlin	M	M
		20297	Creal		M
		20309	Tern Is	MBF	
		20348	20-348	BF	
		20351	Pompey No. 1	MBF	
		20351	Pompey No. 2	MBF	
		20353	20-353	MBF	
		21025	Penrith Island	MBF	
		21060	21-060	MBF	
		21062	21-062	MBF	
		21064	21-064	MBF	
		21591	21-591	MBF	
Pompey	Outer shelf	20113	Ben	M	M
Swain	Mid-shelf	21139	21-139	MBF	
		21187	21-187	MBF	
		21245	21-245	MBF	
		21278	21-278	MBF	
		21529	21-529	M	MBF
		21550	21-550	MBF	
		21556	Gannet Cay	M	MBF
		21572	Small Lagoon	MBF	
		21584	Jenkins	MBF	
		21588	Wade	MBF	
		22084	22-084	MBF	
		22088	Snake	M	MBF
		22102	Chinaman	MBF	
		22104	Horseshoe	M	MBF
Swain	Outer shelf	21296	21-296	MBF	
		21302	21-302	MBF	
		21305	East Cay	MBF	MBF
		21558	21-558	MBF	
		21562	Turner Cay	M	MBF
Capricorn Bunker	Mid-shelf	23068	Erskine Is	MBF	
		23069	Masthead Is	MBF	
Capricorn Bunker	Outer shelf	23045	North (A)	MBF	
		23048	Broomfield	MBF	MBF
		23051	Wreck Is		MBF
		23055	One Tree Is		MBF
		23079	Boult	MBF	
		23080	Hoskyn Is	MBF	
		23081	Fairfax Is	MBF	
		23082	Lady Musgrave Is	MBF	MBF

Appendix C

C1. List of large, mobile fish species that would be counted on 5m wide transects

Acanthuridae

Acanthurus albipectoralis
Acanthurus auranticavus
Acanthurus Bariene
Acanthurus blochii
Acanthurus dussumieri
Acanthurus grammoptilus
Acanthurus lineatus
Acanthurus maculiceps
Acanthurus mata
Acanthurus nigricans
Acanthurus nigricauda
Acanthurus nigrofuscus
Acanthurus nigroris
Acanthurus olivaceus
Acanthurus pyroferus
Acanthurus spp.
Acanthurus thompsoni
Acanthurus triostegus
Acanthurus xanthopterus
Ctenochaetus (grouped)
Naso lituratus
Naso tuberosus
Naso unicornis
Paracanthurus hepatus
Zebrasoma scopas
Zebrasoma veliferum

Chaetodontidae

Chaetodon aureofasciatus
Chaetodon auriga
Chaetodon baronessa
Chaetodon bennetti
Chaetodon citrinellus
Chaetodon ephippium
Chaetodon flavirostris
Chaetodon kleinii
Chaetodon lineolatus
Chaetodon lunula
Chaetodon melannotus
Chaetodon mertensii
Chaetodon meyeri
Chaetodon ornatissimus
Chaetodon pelewensis
Chaetodon plebeius
Chaetodon punctatofasciatus
Chaetodon rafflesii
Chaetodon rainfordi
Chaetodon reticulatus
Chaetodon speculum
Chaetodon trifascialis
Chaetodon trifasciatus
Chaetodon ulietensis
Chaetodon unimaculatus
Chaetodon vagabundus
Chelmon rostratus
Forcipiger flavissimus
Forcipiger longirostris
Hemitaurichthys polylepis

Labridae

Cheilinus fasciatus
Cheilinus undulatus
Choerodon fasciatus
Coris gaimard
Epibulus insidiator
Gomphosus varius
Halichoeres hortulanus
Hemigymnus fasciatus
Hemigymnus melapterus

Lethrinidae

Lethrinus atkinsoni
Lethrinus erythracanthus
Lethrinus harak
Lethrinus laticaudis
Lethrinus lentjan
Lethrinus miniatus
Lethrinus nebulosus
Lethrinus obsoletus
Lethrinus olivaceus
Lethrinus ornatus
Lethrinus rubrioperculatus
Lethrinus semicinctus
Lethrinus xanthochilus
Monotaxis grandoculis

Lutjanidae

Lutjanus adetii
Lutjanus argentimaculatus
Lutjanus biguttatus
Lutjanus bohar
Lutjanus boutton
Lutjanus carponotatus
Lutjanus fulviflammus
Lutjanus fulvus
Lutjanus gibbus
Lutjanus kasmira
Lutjanus lemniscatus
Lutjanus lutjanus
Lutjanus monostigma
Lutjanus quinquelineatus
Lutjanus rivulatus
Lutjanus russellii
Lutjanus sebae
Lutjanus semicinctus
Lutjanus vitta
Macolor (grouped)

Scaridae

Bolbometopon muricatum
Calotomus carolinus
Cetoscarus bicolor
Chlorurus bleekeri
Chlorurus gibbus
Chlorurus japanensis
Chlorurus sordidus
Hipposcarus longiceps
Scarus altipinnis
Scarus chameleon
Scarus dimidiatus
Scarus flavipectoralis
Scarus forsteni
Scarus frenatus
Scarus ghobban
Scarus globiceps
Scarus longipinnis
Scarus niger
Scarus oviceps
Scarus psittacus
Scarus rivulatus
Scarus rubroviolaceus
Scarus schlegeli
Scarus spinus
Scarus spp.

Serranidae *

Plectropomus areolatus
Plectropomus laevis
Plectropomus leopardus
Plectropomus maculatus
Variola louti

Siganidae

Siganus argenteus
Siganus corallinus
Siganus doliatus
Siganus fuscescens
Siganus javus
Siganus lineatus
Siganus puellus
Siganus punctatissimus
Siganus punctatus
Siganus spinus
Siganus vulpinus

Zanclidae

Zanclus cornutus

* In 2006 all Serranidae species were counted.

C2. List of damselfish species that would be counted on 1m wide transects

Acanthochromis polyacanthus
Amblyglyphidodon aureus
Amblyglyphidodon curacao
Amblyglyphidodon leucogaster
Amphiprion akindynos
Amphiprion chrysopterus
Amphiprion clarkii
Amphiprion melanopus
Amphiprion percula
Amphiprion perideraion
Cheiloprion labiatus
Chromis acares
Chromis agilis
Chromis amboinensis
Chromis atripectoralis
Chromis atripes
Chromis chrysura
Chromis flavomaculata
Chromis iomelas
Chromis lepidolepis
Chromis lineata
Chromis margaritifer
Chromis nitida
Chromis retrofasciata
Chromis ternatensis
Chromis vanderbilti
Chromis viridis
Chromis weberi
Chromis xanthochira
Chromis xanthura
Chrysiptera flavipinnis
Chrysiptera rex
Chrysiptera rollandi
Chrysiptera talboti
Dascyllus aruanus
Dascyllus reticulatus
Dascyllus trimaculatus
Dischistodus melanotus
Dischistodus perspicillatus
Dischistodus prosopotaenia
Dischistodus pseudochrysopoecil
Hemiglyphidodon plagiometopon
Neoglyphidodon melas
Neoglyphidodon nigroris
Neoglyphidodon polyacanthus
Neopomacentrus azysron
Neopomacentrus bankieri
Neopomacentrus cyanomos
Plectroglyphidodon dickii
Plectroglyphidodon johnstonianu
Plectroglyphidodon lacrymatus
Pomacentrus adelus
Pomacentrus amboinensis
Pomacentrus australis
Pomacentrus bankanensis
Pomacentrus brachialis
Pomacentrus chrysurus
Pomacentrus coelestis
Pomacentrus grammorhynchus
Pomacentrus imitator
Pomacentrus lepidogenys
Pomacentrus moluccensis
Pomacentrus nagasakiensis
Pomacentrus philippinus
Pomacentrus tripunctatus
Pomacentrus vaiuli
Pomacentrus wardi
Pomachromis richardsoni
Premnas biaculeatus
Stegastes apicalis
Stegastes fasciolatus
Stegastes gascoynei
Stegastes nigricans

Appendix D

General status of crown-of-thorns starfish in each sector on the Great Barrier Reef for survey year 2007.

D1. Status of crown-of-thorns starfish (COTS) in each sector in 2007. AO = Active outbreak, IO = Incipient outbreak, RE = Recovering, NO = No outbreak.

Sector	No. of reefs	No. COTS/ tow	No. COTS	Number (%) of reefs with COTS	Median category (range) coral cover		Mean % Coral Cover ± SE	% AO or IO reefs	% RE reefs	% NO reefs
Cooktown / Lizard Island	20	0.008	8	5 (25)	2-	(1-/1+ to 3-)	20.29 ± 1.78	0	35	65
Cairns	31	0.001	1	1 (3)	2-	(1- to 3+)	17.43 ± 1.71	0	29.03	71
Innisfail	9	0.000	0	0 (0)	1+	(1- to 1+)	9.374 ± 1.59	0	77.78	22.2
Townsville	11	0.002	1	1 (9)	1+	(1- to 3+)	13.14 ± 3.59	0	63.64	36.4
Cape Upstart	7	0.367	133	4 (57)	1+	(1- to 2+)	13.04 ± 2.62	42.86	42.86	14.3
Whitsunday	5	0.068	12	1 (20)	2+	(2- to 3-)	30.04 ± 3.67	20	20	60
Pompey	5	0.016	3	1 (20)	2+	(1- to 4+)	32.47 ± 10.9	0	20	80
Swain	6	0.007	2	2 (33)	1+/2+	(1- to 4+)	22.37 ± 7.26	0	66.67	33.3
Capricorn Bunker	4	0.000	0	0 (0)	2+/3-	(2- to 4-)	35.23 ± 6.94	0	0	100

Appendix E

Percentage cover of selected groups of benthic organisms recorded from each subregion in 2007 Survey.
Figures are regional means.
CL = Cooktown / Lizard Is, CA = Cairns, TO = Townsville, WH = Whitsunday, SW = Swain, CB = Capricorn-Bunker. I= Inshore, M = Mid-shelf, O = Outer shelf

Sector	Shelf	Hard Coral	Soft Coral	Algae	Acroporidae	Favidae	Pocilloporidae	Poritidae	Acropora Tabulate	Acropora Other	Montipora
CL	I	40.4	4.9	41.5	14.2	7.0	6.4	5.9	3.7	7.7	2.6
CL	M	25.2	7.7	52.0	4.1	5.2	3.4	7.3	1.6	1.6	0.8
CL	O	26.5	3.6	65.4	16.2	2.0	4.9	1.8	5.1	8.4	2.6
CA	I	16.4	13.7	55.9	3.2	1.3	0.6	8.0	1.4	0.9	0.9
CA	M	22.3	14.6	58.3	8.9	3.6	3.4	2.3	5.2	2.9	0.7
CA	O	24.2	29.5	42.9	14.0	2.1	4.6	2.5	4.3	9.1	0.5
TO	I	34.0	7.9	47.1	6.8	2.3	0.2	14.1	1.2	2.8	2.8
TO	M	11.8	2.2	80.7	3.4	2.4	2.5	2.0	1.5	1.5	0.4
TO	O	18.9	8.6	69.0	5.3	5.1	2.5	3.5	0.9	2.7	1.6
WH	I	34.7	24.3	28.0	13.8	4.1	1.0	9.6	1.3	5.2	7.1
WH	M	45.6	1.7	47.7	27.5	7.5	3.0	3.3	15.1	4.6	7.7
WH	O	24.4	29.6	33.7	10.1	4.2	2.5	4.7	3.6	5.3	1.0
SW	M	34.6	5.4	57.5	19.5	2.8	3.3	6.2	6.9	7.7	4.8
SW	O	17.7	33.7	44.7	5.1	1.7	2.7	6.5	2.8	1.7	0.4
CB	O	54.6	2.9	41.1	51.5	1.5	0.4	0.8	36.8	13.4	1.3

Appendix F

Summary counts of the different fish taxa recorded from each subregion in 2007 Survey.
Figures are regional means for the sums of individuals on 15 transects (3 sites) on each survey reef.

F1. Number of larger more mobile fishes recorded in the regions in the 2007 survey

CL = Cooktown / Lizard Is, CA = Cairns, TO = Townsville, WH = Whitsunday, SW = Swain, CB = Capricorn-Bunker. I= Inshore, M = Mid-shelf, O = Outer shelf

Sector	Shelf	Acanthuridae	Chaetodontidae	Labridae	Lethrinidae	Lutjanidae	Scaridae	Serranidae	Siganidae	Zanclidae
CL	I	75	152	59	9	55	215	16	133	1
CL	M	132	129	62	16	38	182	23	64	1
CL	O	434	112	34	8	29	209	4	7	21
CA	I	45	64	37	3	89	107	5	35	0
CA	M	204	105	55	4	23	227	4	12	6
CA	O	324	124	44	11	9	347	1	5	7
TO	I	2	19	22	1	15	53	7	10	0
TO	M	130	63	60	2	6	440	12	35	0
TO	O	251	44	23	4	5	210	6	7	5
WH	I	2	70	29	0	23	53	11	25	0
WH	M	31	158	50	0	29	210	15	79	1
WH	O	227	116	29	4	2	187	20	24	10
SW	M	120	100	76	5	9	197	36	51	12
SW	O	205	108	63	4	3	188	8	24	15
CB	O	334	276	47	9	28	291	42	14	12

F2. Number of damselfishes recorded in the subregions in the 2007 survey

CL = Cooktown / Lizard Is, CA = Cairns, TO = Townsville, WH = Whitsunday, SW = Swain, CB = Capricorn Bunker. I= Inshore, M = Mid-shelf, O = Outer shelf

Sector	Shelf	*Acantho-chromis*	*Amblygly-phidodon*	*Amphip-rion*	*Chromis*	*Chrysip-tera*	*Dascyllus*	*Dischist-odus*	*Neogly-phidodon*	*Neopoma-centrus*	*Plectrogly-phidodon*	*Poma-centrus*	*Poma-chromis*	*Premnas*	*Stegastes*
CL	I	181	200	0	154	70	12	3	20	555	2	2007	0	1	1
CL	M	110	128	3	125	117	39	8	15	119	28	774	0	0	1
CL	O	68	2	0	880	34	3	0	0	0	92	355	1	0	2
CA	I	27	47	0	11	37	8	4	31	105	1	532	0	0	0
CA	M	42	46	2	118	25	27	6	21	106	168	598	0	0	24
CA	O	27	10	0	232	10	11	0	3	2	152	185	0	0	4
TO	I	96	3	0	0	1	0	0	12	951	0	189	0	0	2
TO	M	75	110	10	90	42	4	12	92	400	30	1198	0	0	9
TO	O	47	3	1	150	16	12	0	1	189	135	344	0	0	31
WH	I	217	93	0	581	101	0	1	6	486	0	998	0	0	0
WH	M	24	23	2	794	37	4	0	1	2269	1	1806	0	0	31
WH	O	27	51	2	156	32	8	2	34	61	50	595	0	0	7
SW	M	7	140	5	1292	20	1	1	6	40	2	1018	0	0	10
SW	O	16	55	4	6	11	0	0	27	6	30	751	0	0	29
CB	O	8	7	1	737	4	10	0	4	95	52	914	1	0	5

Appendix G

Mean Percentage cover of selected groups of benthic organisms recorded from each reef.

Sector	Reef	Shelf	Year	Algae	Hard Coral	Soft Coral	Acro-poridae	Favii-dae	Pocillo-poridae	Pori-tidae	*Acropora* Tabulate	*Acropora* Other	*Monti-pora*
CL	Martin	I	2007	41.8	31.8	4.7	9.7	4.2	6.6	6.1	3.5	4.7	1.2
CL	Linnet	I	2007	41.2	49.0	5.1	18.7	9.8	6.2	5.7	3.9	10.7	4.0
CL	MacGillivray	M	2007	45.6	26.5	5.7	2.1	5.5	1.3	14.0	1.0	0.5	0.5
CL	Lizard Is	M	2007	56.5	21.0	14.2	3.4	4.7	4.9	4.7	1.2	0.8	1.3
CL	North Direction I	M	2007	53.9	28.2	3.2	6.8	5.5	4.0	3.3	2.5	3.6	0.6
CL	Carter	O	2007	60.3	30.4	3.7	18.5	2.0	6.5	1.5	4.1	10.8	3.4
CL	Yonge	O	2007	70.4	24.2	1.9	15.6	2.1	4.0	1.5	6.2	7.5	1.8
CL	No Name	O	2007	65.5	24.0	5.9	13.7	1.9	3.7	2.8	5.1	6.1	2.4
CA	Low Islets	I	2007	60.9	18.2	8.3	2.0	1.3	0.2	10.2	0.9	0.7	0.4
CA	Green Is	I	2007	60.7	13.2	7.2	5.5	1.6	0.5	4.4	3.1	1.6	0.8
CA	Fitzroy Is	I	2007	46.1	17.8	25.5	2.1	0.9	1.0	9.5	0.2	0.4	1.5
CA	Mackay	M	2007	61.8	27.1	4.1	4.3	5.6	2.3	3.6	1.7	2.1	0.5
CA	Hastings	M	2006	63.1	23.6	9.1	12.0	3.2	4.6	1.2	4.8	6.0	0.9
CA	Hastings	M	2007	61.3	24.9	9.8	11.7	4.0	5.1	1.9	5.6	5.1	0.9
CA	Michaelmas	M	2007	45.7	21.3	27.7	10.8	3.6	3.2	1.6	6.4	3.3	1.0
CA	Arlington	M	2006	57.7	17.9	20.4	6.4	3.7	3.9	1.4	3.9	1.5	1.0
CA	Thetford	M	2006	69.7	11.1	15.5	4.2	1.1	2.6	1.7	3.3	0.7	0.2
CA	Thetford	M	2007	64.5	16.0	16.6	8.7	1.3	2.9	2.0	6.9	1.3	0.3
CA	Agincourt No.1	O	2006	45.1	29.3	22.9	16.5	2.1	7.8	1.1	5.2	10.7	0.5
CA	Agincourt No.1	O	2007	50.4	25.0	22.5	14.4	2.0	6.8	1.2	4.7	9.1	0.6
CA	St. Crispin	O	2006	38.2	24.5	32.4	14.3	1.8	3.9	3.0	6.5	7.2	0.6
CA	St. Crispin	O	2007	35.9	28.3	31.9	15.1	2.5	4.6	4.4	7.0	7.5	0.6
CA	Opal (2)	O	2007	42.6	19.2	34.1	12.5	2.0	2.3	2.0	1.3	10.8	0.4
IN	Moore	M	2006	45.3	28.6	23.4	15.9	4.9	3.1	1.4	8.0	6.5	1.4
IN	McCulloch	M	2006	58.0	16.9	22.7	8.4	1.8	3.9	1.3	6.8	1.1	0.5
IN	Peart	M	2006	73.2	12.9	8.8	6.3	1.1	1.2	2.2	5.1	0.9	0.3
IN	Feather	M	2006	61.1	21.5	14.5	8.6	2.2	3.6	2.6	6.8	1.0	0.8
IN	Farquarson A	M	2006	86.7	5.6	3.0	1.3	0.4	0.2	1.7	1.0	0.2	0.1
IN	Taylor	M	2006	73.2	5.9	16.8	2.1	0.5	0.9	0.9	1.4	0.5	0.2
IN	Hedley	O	2006	69.8	15.5	10.0	9.7	1.1	1.6	1.4	2.9	5.8	1.0
TO	Pandora	I	2007	30.8	49.8	13.2	4.0	3.6	0.3	24.0	1.1	2.3	0.5
TO	Havannah Is	I	2007	83.6	6.9	6.5	3.6	0.5	0.1	0.9	0.2	1.9	1.6
TO	Middle	I	2007	26.9	45.2	4.0	12.9	2.8	0.0	17.4	2.3	4.3	6.3
TO	Kelso	M	2006	76.8	5.4	6.9	0.6	2.4	0.3	1.2	0.2	0.2	0.2
TO	Little Kelso	M	2006	83.1	8.0	3.8	2.9	1.5	0.4	1.3	0.9	1.5	0.4
TO	Rib	M	2006	82.0	7.3	6.5	3.9	0.8	0.9	0.7	1.7	1.9	0.2
TO	Rib	M	2007	86.1	6.3	3.6	2.7	0.7	1.0	0.9	1.2	1.2	0.3
TO	Roxburgh	M	2006	78.6	12.8	5.4	4.3	2.0	1.1	4.3	1.6	1.4	1.2
TO	Fore And Aft	M	2006	79.2	4.9	3.0	0.2	0.7	1.0	1.9	0.0	0.0	0.1
TO	John Brewer	M	2007	90.2	1.1	1.7	0.1	0.3	0.6	0.0	0.1	0.0	0.0
TO	Helix	M	2006	70.3	23.3	2.7	15.6	1.8	3.3	1.3	6.5	7.5	1.5
TO	Grub	M	2006	61.6	15.5	2.0	3.2	5.6	1.4	2.7	1.3	1.3	0.6
TO	Centipede	M	2006	81.0	12.2	1.9	1.4	2.2	2.6	4.2	0.4	0.4	0.4
TO	Lynchs	M	2006	88.1	2.3	4.0	0.2	0.4	1.1	0.3	0.1	0.1	0.0
TO	Davies	M	2007	65.9	27.9	1.4	7.5	6.2	5.8	5.0	3.3	3.3	0.8
TO	Myrmidon	O	2007	63.4	24.2	7.3	5.6	8.6	1.8	4.0	0.9	1.9	2.5
TO	Dip	O	2007	71.7	18.7	6.2	8.1	3.6	2.9	2.8	1.2	5.0	1.6
TO	Knife	O	2006	63.3	26.1	7.5	9.6	5.3	5.1	4.1	4.4	4.3	0.8
TO	Fork	O	2006	55.2	17.1	6.6	6.6	3.3	2.6	1.9	2.4	2.5	1.6

Sector	Reef	Shelf	Year	Algae	Hard Coral	Soft Coral	Acro-poridae	Favii-dae	Pocillo-poridae	Pori-tidae	*Acropora* Tabulate	*Acropora* Other	*Monti-pora*
TO	Chicken	O	2006	75.7	12.3	10.3	1.4	3.7	1.6	3.9	0.2	0.9	0.2
TO	Chicken	O	2007	71.9	13.9	12.3	2.1	3.2	2.8	3.8	0.5	1.0	0.6
WH	Hayman Is	I	2007	28.8	50.7	12.8	31.3	4.8	2.0	2.9	2.0	9.5	19.7
WH	Langford & Bird	I	2007	29.7	27.8	21.7	7.4	4.4	0.6	9.9	1.1	5.2	0.8
WH	Border Is (A)	I	2007	25.4	25.8	38.4	2.7	3.2	0.5	16.1	0.7	1.0	1.0
WH	19-131	M	2007	49.4	41.3	1.4	20.1	11.8	1.9	3.3	9.1	2.7	8.1
WH	19-138	M	2007	47.9	47.2	2.1	31.1	5.7	4.1	3.2	21.2	5.6	4.1
WH	20-104	M	2007	45.8	48.4	1.5	31.4	5.1	3.0	3.6	14.9	5.6	10.9
WH	19-159	O	2007	39.9	37.9	13.4	22.2	5.7	2.9	2.5	6.6	12.9	2.6
WH	Hyde	O	2007	29.7	17.4	39.8	4.2	4.2	1.5	5.4	2.6	1.3	0.2
WH	Rebe	O	2007	31.5	17.9	35.6	4.1	2.7	3.0	6.2	1.8	1.8	0.4
PO	Tern Is	M	2006	42.9	44.6	6.2	29.8	5.6	0.7	3.1	5.2	17.6	6.9
PO	20-348	M	2006	59.3	22.1	1.1	6.5	7.9	1.1	2.4	0.8	2.6	1.7
PO	Pompey No. 2	M	2006	65.1	25.9	6.1	14.6	2.1	2.6	3.5	3.7	6.2	4.6
PO	Pompey No. 1	M	2006	42.8	51.4	2.0	22.6	6.6	2.2	10.3	3.3	11.5	7.7
PO	20-353	M	2006	56.9	38.2	1.6	15.6	6.6	2.2	5.0	3.1	3.9	8.4
PO	Penrith Is	M	2006	36.0	28.3	20.6	14.6	2.1	0.5	5.2	1.1	9.5	3.7
PO	21-060	M	2006	47.6	45.2	3.3	30.4	2.5	3.4	4.0	4.3	17.2	8.9
PO	21-062	M	2006	62.4	32.7	1.5	9.5	13.1	0.5	1.8	0.5	2.9	5.4
PO	21-064	M	2006	55.1	39.7	2.9	17.9	5.8	1.5	5.6	2.7	10.4	4.6
PO	21-591	M	2006	52.1	29.2	12.6	18.6	1.8	1.6	3.4	4.3	12.7	1.5
SW	21-139	M	2006	57.1	22.1	2.3	6.2	3.6	0.8	9.3	0.9	3.1	1.9
SW	21-187	M	2006	53.9	34.7	4.4	14.8	5.5	3.8	5.0	7.5	5.1	2.1
SW	21-245	M	2006	60.5	34.5	2.6	17.9	3.8	4.1	5.6	7.6	6.0	4.3
SW	21-278	M	2006	59.3	26.5	9.1	7.8	3.8	4.0	7.1	3.8	2.4	1.5
SW	21-529	M	2007	50.1	45.6	0.8	31.7	2.4	3.4	5.0	3.7	21.9	6.0
SW	21-550	M	2006	42.2	56.1	0.9	41.3	4.4	3.2	2.1	5.2	15.3	20.9
SW	Gannet Cay	M	2007	72.2	16.7	9.8	5.4	1.4	3.2	3.4	3.7	1.1	0.5
SW	Small Lagoon	M	2006	91.7	5.6	1.3	0.6	0.6	0.3	3.0	0.1	0.2	0.3
SW	Jenkins	M	2006	83.5	11.5	2.8	1.4	1.7	0.8	6.6	0.3	0.5	0.5
SW	Wade	M	2006	61.9	18.7	17.0	8.6	2.1	1.9	3.8	4.4	1.1	3.0
SW	22-084	M	2006	84.3	8.3	5.0	2.6	0.4	2.3	1.2	1.7	0.5	0.4
SW	Snake	M	2007	37.8	53.0	6.8	31.3	4.3	4.2	10.0	15.1	5.2	11.1
SW	Chinaman	M	2006	35.8	37.6	25.8	16.0	5.6	3.1	8.7	12.3	1.7	2.0
SW	Horseshoe	M	2007	70.0	23.1	4.3	9.4	3.0	2.4	6.3	5.3	2.5	1.6
SW	21-296	O	2006	67.3	24.7	3.7	17.0	2.2	0.9	3.6	7.0	9.0	1.0
SW	21-302	O	2006	45.0	31.4	21.9	17.6	1.8	3.1	7.9	8.8	8.6	0.2
SW	East Cay	O	2006	42.9	20.3	32.2	6.1	1.5	3.5	6.2	3.5	2.2	0.3
SW	East Cay	O	2007	39.2	19.6	36.3	5.7	1.4	3.8	6.3	3.3	1.8	0.5
SW	21-558	O	2006	38.8	18.2	25.9	7.3	2.1	2.7	4.5	3.0	3.9	0.4
SW	Turner Cay	O	2007	50.1	15.8	31.2	4.4	2.0	1.5	6.6	2.3	1.7	0.4
CB	Erskine Is	M	2006	43.8	38.7	7.4	32.9	2.2	1.8	0.7	20.9	6.9	4.9
CB	Masthead Is	M	2006	53.6	16.7	5.1	11.2	1.6	1.9	0.1	6.8	2.4	1.8
CB	North (A)	O	2006	40.7	55.5	3.3	47.1	2.1	0.9	3.0	15.9	17.9	13.4
CB	Broomfield	O	2006	42.7	49.2	6.1	44.4	1.8	0.9	1.1	29.1	11.4	3.9
CB	Broomfield	O	2007	53.4	38.1	5.4	33.7	1.7	0.4	1.6	19.2	11.2	3.2
CB	Wreck Is	O	2007	55.2	39.4	4.3	34.7	2.4	0.4	1.1	17.1	16.2	1.4
CB	One Tree Is	O	2007	33.7	63.8	1.7	62.2	0.9	0.3	0.1	50.3	11.6	0.3
CB	Boult	O	2006	27.4	70.6	1.1	68.4	0.6	1.0	0.0	57.0	9.6	1.8
CB	Hoskyn Is	O	2006	23.0	74.4	1.3	69.3	2.5	0.9	0.1	54.8	10.2	4.3
CB	Fairfax Is	O	2006	24.6	73.2	1.1	71.5	1.1	0.5	0.0	37.8	32.4	1.2
CB	Lady Musgrave	O	2006	20.7	78.3	0.1	77.1	0.3	0.6	0.1	65.6	10.9	0.6
CB	Lady Musgrave	O	2007	22.0	77.2	0.1	75.5	0.8	0.5	0.2	60.8	14.5	0.3

Appendix H

Summary counts of the different fish taxa recorded from each reef.
Figures are the sums of individuals on 15 transects (3 sites) on each sur

H1. Number of larger more mobile fishes recorded.

Sector	Reef	Shelf	Year	Acanthuridae	Chaetodontida	Labridae	Lethrinidae	Lutjanida	Scaridae	Serranidae	Siganidae	Zanclidae
CL	Martin	I	2007	87	132	47	17	65	257	9	60	0
CL	Linnet	I	2007	62	172	70	0	44	172	23	206	2
CL	MacGillivray	M	2007	139	110	62	20	41	163	21	44	1
CL	Lizard Is	M	2007	178	137	61	12	45	220	33	68	2
CL	North Direction I	M	2007	80	139	63	17	29	164	16	79	0
CL	Carter	O	2007	447	118	36	7	50	198	6	9	26
CL	Yonge	O	2007	596	145	47	8	8	222	3	2	24
CL	No Name	O	2007	260	73	18	10	29	208	3	10	12
CA	Low It	I	2007	22	68	26	4	129	81	5	29	0
CA	Green Is	I	2007	108	78	34	5	34	203	9	42	0
CA	Fitzroy Is	I	2007	4	46	50	1	104	36	2	34	0
CA	Mackay	M	2007	32	110	35	7	20	149	5	14	5
CA	Hastings	M	2006	280	110	57	3	13	105	3	14	4
CA	Hastings	M	2007	290	107	65	3	7	99	1	8	11
CA	Michaelmas	M	2007	228	144	56	2	49	199	4	19	5
CA	Arlington	M	2006	287	98	65	3	16	202	8	14	4
CA	Thetford	M	2006	265	43	50	1	19	262	0	13	4
CA	Thetford	M	2007	265	58	65	2	15	459	5	6	2
CA	Agincourt No.1	O	2006	271	130	43	27	15	150	0	5	5
CA	Agincourt No.1	O	2007	325	126	63	14	11	232	0	0	10
CA	St. Crispin	O	2006	195	138	52	15	1	305	2	8	3
CA	St. Crispin	O	2007	202	148	42	3	2	634	0	10	6
CA	Opal (2)	O	2007	445	99	28	16	14	176	2	5	5
IN	Moore	M	2006	111	120	41	3	27	157	7	20	1
IN	McCulloch	M	2006	298	82	85	6	21	283	4	29	1
IN	Peart	M	2006	138	49	81	1	67	159	3	22	0
IN	Feather	M	2006	81	53	76	0	134	646	8	11	0
IN	Farquharson A	M	2006	53	16	46	0	5	111	2	13	0
IN	Taylor	M	2006	254	33	139	2	110	216	5	43	1
IN	Hedley	O	2006	102	47	36	11	4	112	6	10	4
TO	Pandora	I	2007	2	39	19	2	37	28	8	8	0
TO	Havannah Is	I	2007	3	17	46	0	7	132	12	23	0
TO	Kelso	M	2006	130	71	54	2	0	261	7	35	0
TO	Little Kelso	M	2006	276	49	49	10	53	369	37	40	3
TO	Rib	M	2007	195	57	56	3	3	371	7	40	1
TO	Rib	M	2006	122	65	53	7	4	408	8	56	3
TO	Roxburgh	M	2006	136	67	48	7	6	218	2	22	2
TO	Fore And Aft	M	2006	153	28	56	1	2	165	2	22	0
TO	John Brewer	M	2007	104	30	72	0	2	526	8	31	0
TO	Helix	M	2006	189	114	69	1	2	387	5	41	4
TO	Grub	M	2006	32	24	42	2	1	116	8	54	1
TO	Centipede	M	2006	92	38	42	3	3	188	12	29	0
TO	Lynchs	M	2006	217	29	69	7	6	198	5	35	0
TO	Davies	M	2007	91	101	52	3	14	422	20	34	0
TO	Myrmidon	O	2007	218	53	15	0	4	206	7	1	9
TO	Dip	O	2007	270	32	26	5	7	164	3	2	3
TO	Knife	O	2006	263	92	41	2	9	439	13	13	2

Sector	Reef	Shelf	Year	Acanthuridae	Chaetodontida	Labridae	Lethrinidae	Lutjanida	Scaridae	Serranidae	Siganidae	Zanclidae
TO	Fork	O	2006	273	61	49	2	21	256	9	12	3
TO	Chicken	O	2007	265	46	27	7	4	261	8	18	4
TO	Chicken	O	2006	306	60	39	12	3	367	15	18	2
WH	Hayman Is	I	2007	2	57	48	0	14	61	6	14	0
WH	Langford & Bird	I	2007	3	68	16	0	15	69	4	41	0
WH	Border Is (A)	I	2007	1	85	22	0	41	29	24	19	0
WH	19-131	M	2007	23	127	40	0	17	180	19	35	0
WH	19-138	M	2007	29	204	77	1	31	297	13	146	0
WH	20-104	M	2007	41	144	32	0	40	153	13	56	2
WH	19-159	O	2007	173	163	27	4	3	179	25	53	6
WH	Hyde	O	2007	219	71	28	5	0	248	9	8	11
WH	Rebe	O	2007	288	115	33	4	4	135	25	12	14
PO	Tern Is	M	2006	30	102	28	1	44	347	36	126	0
PO	20-348	M	2006	24	88	67	3	36	124	33	31	0
PO	Pompey No. 2	M	2006	17	117	79	2	35	283	34	53	0
PO	Pompey No. 1	M	2006	30	95	44	3	22	236	65	34	0
PO	20-353	M	2006	35	87	82	2	40	255	37	14	0
PO	Penrith Is	M	2006	16	56	42	0	2	310	14	37	0
PO	21-060	M	2006	22	117	54	1	41	252	31	43	0
PO	21-062	M	2006	19	178	123	1	51	268	11	12	0
PO	21-064	M	2006	37	144	69	5	31	320	27	95	0
PO	21-591	M	2006	3	90	83	1	34	371	22	22	0
SW	21-139	M	2006	4	95	100	11	10	312	16	41	0
SW	21-187	M	2006	2	112	93	7	36	188	29	40	0
SW	21-245	M	2006	166	75	82	11	12	379	23	77	7
SW	21-278	M	2006	258	197	54	5	2	254	12	37	15
SW	21-529	M	2007	1	91	71	13	13	241	31	47	1
SW	21-550	M	2006	43	85	53	10	32	346	15	125	5
SW	Gannet Cay	M	2007	59	69	94	5	8	228	67	62	9
SW	Small Lagoon	M	2006	358	44	88	6	56	358	36	74	2
SW	Jenkins	M	2006	367	58	66	1	55	291	38	130	8
SW	Wade	M	2006	314	106	78	5	18	442	41	21	8
SW	22-084	M	2006	83	62	87	6	24	312	64	97	6
SW	Snake	M	2007	69	127	63	2	6	123	28	46	5
SW	Chinaman	M	2006	158	135	64	5	20	164	34	20	3
SW	Horseshoe	M	2007	349	112	77	0	10	195	17	49	31
SW	21-296	O	2006	361	63	50	2	0	342	21	11	14
SW	21-302	O	2006	239	63	27	5	1	188	21	7	5
SW	East Cay	O	2006	172	135	47	1	3	137	21	19	15
SW	East Cay	O	2007	146	122	39	3	0	126	9	11	16
SW	21-558	O	2006	195	69	50	2	2	168	20	18	6
SW	Turner Cay	O	2007	263	94	87	4	5	249	7	36	14
CB	Erskine Is	M	2006	45	144	43	50	82	173	62	80	10
CB	Masthead Is	M	2006	88	162	58	4	53	373	29	20	5
CB	North (A)	O	2006	304	215	100	2	8	345	45	14	17
CB	Broomfield	O	2007	251	211	46	1	6	352	26	6	2
CB	Broomfield	O	2006	338	239	44	2	11	276	31	16	13
CB	Wreck Is	O	2007	543	292	42	30	27	322	89	42	6
CB	One Tree Is	O	2007	287	349	39	4	64	280	42	2	24
CB	Boult	O	2006	329	330	71	0	10	305	11	30	20
CB	Hoskyn Is	O	2006	309	331	81	1	29	182	30	6	26
CB	Fairfax Is	O	2006	233	302	81	4	15	142	13	8	18
CB	Lady Musgrave	O	2007	255	250	59	2	14	210	10	5	17
CB	Lady Musgrave	O	2006	388	312	64	2	15	192	20	7	34

H2. Number of damselfishes recorded.

Sector	Reef	Shelf	Year	*Acanthochromis*	*Amblyglyphidodon*	***Chromis***	*Chrysiptera*	*Neoglyphidodon*	*Neopomacentrus*	*Plectroglyphidodon*	*Pomacentrus*
CL	Martin	I	2007	103	137	160	89	10	553	0	1635
CL	Linnet	I	2007	258	263	148	51	30	557	3	2378
CL	MacGillivray	M	2007	165	75	54	91	12	70	29	547
CL	Lizard Is	M	2007	98	121	179	81	17	229	28	1119
CL	North Direction I	M	2007	68	187	142	179	15	59	27	657
CL	Carter	O	2007	64	5	1336	29	0	0	96	450
CL	Yonge	O	2007	66	0	794	41	0	0	135	279
CL	No Name	O	2007	74	1	510	31	0	0	46	335
CA	Low Islets	I	2007	43	19	0	40	34	194	0	759
CA	Green Is	I	2007	28	81	30	58	10	58	3	488
CA	Fitzroy Is	I	2007	11	41	2	12	49	62	0	349
CA	Mackay	M	2007	65	166	30	81	83	12	1	758
CA	Hastings	M	2006	16	4	62	8	0	96	155	462
CA	Hastings	M	2007	62	11	92	6	0	19	240	486
CA	Michaelmas	M	2007	7	5	268	4	0	379	211	551
CA	Arlington	M	2006	18	5	203	7	0	518	107	885
CA	Thetford	M	2006	44	6	22	7	4	25	131	538
CA	Thetford	M	2007	32	3	82	9	0	15	219	596
CA	Agincourt No.1	O	2006	37	0	113	8	0	3	188	208
CA	Agincourt No.1	O	2007	29	0	206	12	0	0	201	169
CA	St. Crispin	O	2006	42	20	252	9	6	0	95	516
CA	St. Crispin	O	2007	35	30	423	4	7	5	118	252
CA	Opal (2)	O	2007	17	1	68	15	2	0	136	134
IN	Moore	M	2006	57	22	540	4	5	718	109	718
IN	McCulloch	M	2006	37	7	70	2	13	246	158	400
IN	Peart	M	2006	85	261	10	6	107	359	12	717
IN	Feather	M	2006	56	78	89	2	48	449	2	746
IN	Farquharson A	M	2006	100	87	0	25	90	120	0	401
IN	Taylor	M	2006	41	119	23	5	114	114	42	503
IN	Hedley	O	2006	43	61	43	8	136	0	65	221
TO	Pandora	I	2007	65	5	0	2	18	2373	0	195
TO	Havannah Is	I	2007	190	5	0	0	16	88	0	306
TO	Middle	I	2007	32	0	0	0	3	391	0	66
TO	Kelso	M	2006	37	55	42	40	38	37	70	741
TO	Little Kelso	M	2006	52	104	101	100	99	268	53	1121
TO	Rib	M	2006	87	127	189	19	95	457	46	764
TO	Rib	M	2007	57	82	34	28	75	67	45	1161
TO	Roxburgh	M	2006	102	21	0	2	51	7	85	291
TO	Fore And Aft	M	2006	41	16	1	4	45	62	23	476
TO	John Brewer	M	2007	102	48	2	64	86	331	16	942
TO	Helix	M	2006	57	48	996	4	42	491	93	644
TO	Grub	M	2006	13	11	0	24	19	0	6	279
TO	Centipede	M	2006	73	41	6	12	54	946	41	904
TO	Lynchs	M	2006	78	27	6	19	41	74	45	373
TO	Davies	M	2007	67	199	233	35	116	802	28	1492
TO	Myrmidon	O	2007	56	10	321	3	0	7	183	168
TO	Dip	O	2007	50	0	93	13	0	8	100	256
TO	Knife	O	2006	11	3	104	1	2	454	228	674
TO	Fork	O	2006	23	10	34	26	17	927	42	829
TO	Chicken	O	2006	37	0	23	22	2	985	165	640
TO	Chicken	O	2007	35	0	36	32	2	553	122	608
WH	Hayman Is	I	2007	238	138	11	24	5	161	0	898
WH	Langford & Bird	I	2007	241	52	140	47	4	207	0	706

Sector	Reef	Shelf	Year	*Acanthochromis*	*Amblyglyphidodon*	***Chromis***	*Chrysiptera*	*Neoglyphidodon*	*Neopomacentrus*	*Plectroglyphidodon*	*Pomacentrus*
WH	Border Is (A)	I	2007	173	90	1593	233	8	1089	0	1389
WH	19-131	M	2007	23	9	116	26	0	4239	2	1971
WH	19-138	M	2007	28	48	957	30	2	1008	0	1817
WH	20-104	M	2007	21	12	1310	56	2	1560	1	1629
WH	19-159	O	2007	28	88	392	29	54	95	60	506
WH	Hyde	O	2007	34	31	20	27	30	11	47	709
WH	Rebe	O	2007	19	34	56	41	17	77	43	569
PO	Tern Is	M	2006	155	88	633	13	6	356	0	1089
PO	20-348	M	2006	0	156	116	428	4	2	0	730
PO	Pompey No. 1	M	2006	1	155	230	52	6	266	0	1546
PO	Pompey No. 2	M	2006	18	107	0	241	7	104	0	1404
PO	20-353	M	2006	0	154	112	209	5	0	0	1351
PO	Penrith Is	M	2006	61	37	71	38	5	483	0	865
PO	21-060	M	2006	12	266	40	38	7	129	0	1300
PO	21-062	M	2006	0	199	43	388	5	0	0	617
PO	21-064	M	2006	1	289	324	323	18	4	0	2093
PO	21-591	M	2006	30	117	420	94	15	136	0	838
SW	21-139	M	2006	36	127	25	126	2	20	0	1098
SW	21-187	M	2006	17	73	1669	124	6	0	0	1342
SW	21-245	M	2006	16	105	55	31	55	17	48	1100
SW	21-278	M	2006	19	123	28	18	1	0	37	900
SW	21-529	M	2007	7	202	435	51	3	0	2	996
SW	21-550	M	2006	4	216	78	46	1	483	2	1014
SW	Gannet Cay	M	2007	12	190	4726	19	10	15	2	1111
SW	Small Lagoon	M	2006	6	126	14	46	14	53	6	646
SW	Jenkins	M	2006	5	69	4	34	6	463	15	888
SW	Wade	M	2006	4	113	18	23	8	34	1	1127
SW	22-084	M	2006	27	153	651	74	3	594	1	961
SW	Snake	M	2007	8	32	4	6	8	142	0	1164
SW	Chinaman	M	2006	13	116	241	2	28	111	36	1026
SW	Horseshoe	M	2007	2	136	4	2	4	3	4	801
SW	21-296	O	2006	102	3	157	47	1	16	23	590
SW	21-302	O	2006	27	3	46	44	9	42	17	672
SW	East Cay	O	2006	22	45	0	19	34	39	15	789
SW	East Cay	O	2007	17	59	0	16	32	11	24	788
SW	21-558	O	2006	35	39	0	34	17	0	15	560
SW	Turner Cay	O	2007	15	50	11	5	22	1	36	713
CB	Erskine Is	M	2006	81	24	54	3	5	10	0	978
CB	Masthead Is	M	2006	39	2	118	1	3	10	0	692
CB	North (A)	O	2006	1	1	297	0	3	35	34	1425
CB	Broomfield	O	2006	10	0	224	4	6	185	29	1372
CB	Broomfield	O	2007	7	0	655	2	6	262	25	1485
CB	Wreck Is	O	2007	17	14	577	5	8	21	22	980
CB	One Tree Is	O	2007	7	0	476	7	1	10	33	679
CB	Boult	O	2006	5	30	247	9	0	19	84	699
CB	Hoskyn Is	O	2006	3	18	78	1	0	46	73	896
CB	Fairfax Is	O	2006	0	18	236	4	1	17	83	959
CB	Lady Musgrave	O	2006	0	19	539	10	0	108	110	493
CB	Lady Musgrave	O	2007	1	15	1241	3	0	86	128	513

Appendix I

Statistical Analysis of the Survey Data

Analysis of reef trends [Section 5]

Temporal trends in percent cover of benthic groups and families and abundance of fish families were examined at each reef within each Sector/Shelf region using linear mixed-effects models. Estimated trends and observed means for each measure were plotted against survey year to provide a visual presentation of temporal patterns.

Benthic cover analyses

Estimates of percent cover for the benthic groups are obtained by point sampling a 50 m transect recorded on videotape. The response at each site (average percent cover of 5 transects) is transformed using the empirical logit:

$$log\left(\frac{p+cf}{100-p+cf}\right)$$

where p was the average percentage cover for a given benthic group and cf represented the correction factor for zero $\left(cf = \frac{1}{2} * \frac{1}{200} * \frac{1}{15} * 100\right)$ where $\frac{1}{2}$ is the correction factor suggested by McCullagh and Nelder (1989), $\frac{1}{200}$ averages this single point over the number of points sampled for a video transect (200), $\frac{1}{15}$ average this number over the 15 transects and 100 puts this on a percentage scale).

Fish abundance analyses

Counts of fish abundance are obtained from 50 m transects adjacent to the benthic video surveys. The response at each site (summed counts over 5 transects) is transformed to the natural logarithm of the observed count ($log(y + 1)$).

Mixed-effects models

Linear mixed-effects models (Laird and Ware 1982, Pinheiro and Bates 2000), which extend the linear model to include random effects to account for correlation among observations on the same sampling unit, were used to examine the relationship between the response and time (i.e. survey year). The response, y_i, for the i^{th} sampling unit is expressed as:

$$y_i = X_i\beta + Z_i b_i + \varepsilon_i, \quad i = 1,...,M,$$
$$b_i \sim N(0,\Sigma), \quad \varepsilon_i \sim N(0,\sigma^2 I)$$

where X_i and Z_i are known fixed-effect and random-effect regressor matrices, β are the fixed-effects, b_i are the random-effects, and ε_i is the within-sampling-unit error with a spherical Gaussian distribution, $N(0,\sigma^2 I)$. The random-effects and within-sampling-unit errors are assumed independent between sampling units and within sampling units. The distribution of the random-effects is characterised by the variance-covariance matrix, Σ.

The model chosen to describe the response (y_{ijklm}) represents the empirical logit of percent cover of a particular benthic group, or the log of abundance of a particular fish family, recorded on site *l* for the k^{th} reef in the ij^{th} region at time (*m*) as:

$$y_{ijklm} = f(x_{ijklm}) + b_{ijkl} + \varepsilon_{ijklm}$$

where $f(x_{ijklm})$ represents the fixed-effects as some function of the response for the l^{th} site at the k^{th} reef in the ij^{th} region at survey time *m*, b_{ijkl} represents the random-effects (i.e. random intercepts) for individual reefs and ε_{ijklm} is the within-sampling unit error. The random intercepts form for the random-effects in the model results in a scalar variance estimate for between sampling unit variation. The assumption that the variance of the ε_i is equal to $\sigma^2 I$ can be relaxed to allow within-sampling unit correlation structures. The errors were assumed to conform to a multivariate normal distribution with mean = 0 and covariance structure = Σ. To account for temporal correlation within sampling units, models were fitted with and without a continuous autoregressive covariance structure (Pinheiro and Bates 2000). The structure was assumed to be homogeneous for all reefs.

Form of the fixed-effects component

The following forms for the fixed-effects relationship between the response and survey year were examined:

Constant - $y_{ijklm} = \beta_{0ijk} + \varepsilon_{ijklm}$,

Linear - $y_{ijklm} = \beta_{0ijk} + \beta_{1ijk} x_{ijklm} + \varepsilon_{ijklm}$,

Quadratic - $y_{ijklm} = \beta_{0ijk} + \beta_{1ijk} x_{ijklm} + \beta_{2ijk} x^2_{ijklm} + \varepsilon_{ijklm}$,

Natural spline - $y_{ijklm} = s_{ijk}(x_{ijklm}) + \varepsilon_{ijklm}$,

where

β_{0ijk} represents the response at $x_{ijklm} = 0$ for the k^{th} reef in the ij^{th} region,

β_{1ijk} represents the instantaneous rate of change of the response at $x_{ijklm} = 0$ for the k^{th} reef in the ij^{th} region,

β_{2ijk} represents the curvature of the response for the k^{th} reef in the ij^{th} region,

s_{ijk} represents a natural spline, with specified degrees of freedom, in the response for the k^{th} reef in the ij^{th} region,

x_{ijklm} is the survey number for the l^{th} site, k^{th} reef in the ij^{th} region at time *m*, and

ε_{ijklm} is the error term.

Natural splines are flexible, smooth and nonlinear functions of the explanatory variables which represent the relationship with the response. Natural splines 'smooth' the relationship by dividing the data along the *x*-axis into regions separated at user-defined breakpoints and fitting polynomial regressions to each group constrained to be continuous (i.e. 'smooth') at the breakpoints. The degree of flexibility (i.e. the smoothness) is determined by the number of breakpoints as defined by the degrees of freedom of the spline.

Models containing each of the fixed effects structures described were defined *a priori* as candidate models. This candidate set included models with natural splines with either three or four degrees of freedom. The set of models accounted for temporal correlation within sampling units by fitting models for each fixed effects structure both with and without a continuous autoregressive correlation structure.

Model selection

The 'best' approximating model among the set of candidate models outlined above was determined using Akaike's Information Criteria (AIC) (Akaike 1973, Burnham and Anderson 1998). The criterion is defined as:

$$AIC = -2\log(L(\hat{\theta} \mid y)) + 2K$$

where $L(\hat{\theta} \mid y)$ represents the likelihood of the model parameters, $\hat{\theta}$, given the data, y, and *K* represents the number of parameters in the model. The AIC value is then a measure of the goodness-of-fit of the model to the data, penalised by the number of parameters in the model. This is equivalent to the trade-off between bias and variance that is implicit in the principle of parsimony: selecting a model with the smallest number of parameters which adequately represents the data.

From the set of candidate models, the model that minimised AIC was subsequently used for inference.

Coding of the survey year

To estimate average and current trends in the response the data were analysed using the survey year coded both as:

$$x_{ijklm} = (survey\ year - 1999.5)$$

and

$$x_{ijklm} = (survey\ year - 2007)$$

to allow direct estimation of β_{0ijk} and β_{1ijk} at two different times during the survey period. When the survey year is centred around 1999.5, the parameters β_{0ijk} and β_{1ijk} represent the average value of the response over the last 15 years for reef *ijk* and the linear change in the response over the period of the surveys for reef *ijk*, respectively. When the survey year is centred around 2007, the parameters β_{0ijk} and β_{1ijk} represent the estimated average value of

the response for reef *ijk* in the last survey year and the instantaneous linear change in the response for reef *ijk* in the last survey year, respectively. These estimates were then used to summarise the average and current changes in the response at the Sector level for GBR-wide summaries.

Statistical computing

The S-Plus (2000) statistical software (Insightful Corp., Seattle, WA) was used for all analyses. The **`lme`** function was used to fit the linear mixed-effects models described for the benthic cover and fish abundance analyses.