Australian Government
Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility Milestone Report, 31 March 2009

Program 1: **Status and Trends of Species and Ecosystems in the Great Barrier Reef**

Project 1.1.2: **Condition and trend of the Great Barrier Reef ecosystem: Indicators, thresholds of potential concern, and ecological influence of the Great Barrier Reef Zoning Plan on mid and outer shelf reefs**

Project Leader: **Dr Hugh Sweatman, Australian Institute of Marine Science (AIMS)**

NB: A report on the components of Project 1.1.2 accorded to Reef Check Australia has been submitted separately for this reporting period. See: Project 1.1.2 RCA Schläppy, M-L (2009) March Milestone Report (http://www.rrrc.org.au/mtsrf/theme_1/project_1_1_2.html)

Summary

This project has several components divided between the Australian Institute of Marine Science (AIMS) and Reef Check Australia (RCA). The AIMS monitoring program makes surveys of different sets of reefs in alternating years. Surveys of the long-term monitoring sites in the current years are on track though surveys of reefs in the Cairns sector were limited by unfavourable weather. Two more survey cruises are scheduled. Initial results of surveys completed so far found an increase in the number of reefs where crown-of-thorns starfish (COTS) were sighted north of Cairns, but to the north of the putative 'initiation zone' for the waves of outbreaks. Only single starfish were sighted on the majority of the reefs and no reef had outbreak densities, but similar surveys next year may be necessary. Secondly, some reefs in the Capricorn-Bunker group have lost coral cover, most probably due to storm events. The forthcoming surveys may provide some assessment of the effects of Tropical Cyclone *Hamish*.

Analysis of results from the second set of surveys to assess the effects of rezoning the Great Barrier Reef (GBR) in 2004 found that the early increase in coral trout numbers and biomass in no-take zones compared with zones that were open to fishing has been maintained, but the differences have not increased significantly over the ensuing two years. There is no evidence of trophic cascades where the higher numbers of predatory fishes affect the numbers of prey after three to four years.

Project Outputs / Milestones

Targeted Activity	Due Date
• Progress report on Objective (a) fieldwork: Sites visited, schedules for sites still to survey (with appropriate attribution of MTSRF funding) [AIMS] • Report on evidence of effects of rezoning of the Great Barrier Reef Marine Park in 2004 on patterns of biodiversity on survey reefs after three to four years [AIMS] • Reports describing outputs of workshops / individual meetings with operator managers to acquire feedback on communication / interpretation materials [RCA – This has been submitted separately – see above]	31 March 2009

Project Results

Description of the results achieved for this milestone

Progress: 2008/2009 Field Surveys

AIMS long-term monitoring team surveys of AIMS' Long-term Monitoring Reef Sites and Surveys to assess the ecological influence of the GBR Zoning Plan on mid and outer shelf reefs in alternate years. This year's surveys concern the Long-term Monitoring sites. As of mid-March, reefs in the Cooktown-Lizard Island sector (eight core survey reefs, plus twenty reefs surveyed by manta tow), Cairns sector (seven core survey reefs, plus three reefs surveyed by manta tow), Swains sector (seven core survey reefs) and Capricorn-Bunker sector (four core survey reefs) have been surveyed. Surveys in the Cairns sector were restricted by unfavourable weather. Preliminary analysis of the results of manta tow surveys prior to Tropical Cyclone *Hamish* suggest that reef-wide coral cover had changed little in three of the sectors, but two reefs in the Capricorn-Bunker sector (Broomfield and Lady Musgrave Reefs), which previously had high coral cover had lost much of it in the past year to storms. There was no marked change in reef-wide coral cover at One Tree Island Reef or Wreck Island Reef in that sector.

Two more survey cruises are scheduled – one to Whitsunday sector reefs from 23 March to 9 April and another to Townsville sector reefs between 27 April and 17 May. Reefs in the Whitsunday sector were close to the path of Tropical Cyclone *Hamish* when the storm was most intense, so considerable damage is anticipated.

Crown-of-thorns Starfish Early Warning Surveys

Waves of outbreaks of *Acanthaster planci* start north of Cairns and progress southward through the central Great Barrier Reef. Brodie *et al.* (2005) specifically identified the region between Cape Grafton and Cape Tribulation as the 'initiation region'. Surveys between Lizard Island and Cairns did not find any reefs with outbreak densities (though seven starfish were seen at Startle Reef which was just less than outbreak densities). While the numbers of starfish seen at each reef was low (usually single individuals), the number of reefs where at least one starfish was seen has increased in the north, notably in the region 15° to 16°S (Figure 1). This area is north of the presumed initiation zone.

The objective of the early warning surveys is to give advance warning of increases in starfish numbers that might initiate a new wave of outbreaks, and so allow tourism operators,

particularly in the Cairns region, to prepare for outbreaks at their sites. Primary outbreaks of *A. planci* have never been recorded on the GBR, so the critical densities are unknown. While the evidence for a substantial recent increase in starfish densities is limited, the proportion of reefs with low densities of starfish appears to have increased, suggesting at least a need for continued vigilance.

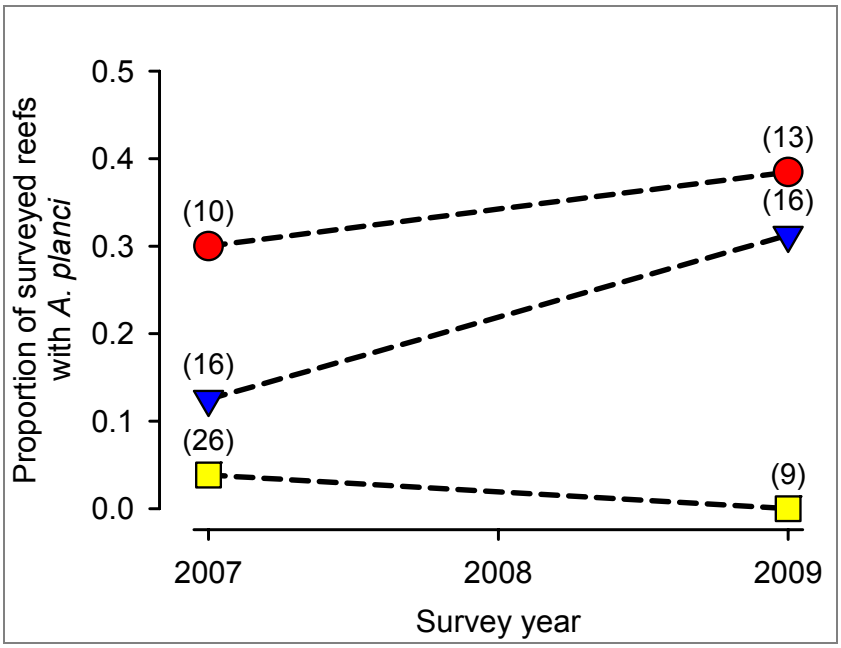

Figure 1: Proportion of reefs surveyed by manta tow which had *Acanthaster planci* present in 2007 and 2009 survey years. Red circles represent reefs 14° to 15°S; blue triangles represent reefs 15° to 16°S; yellow squares represent reefs 16° to 17°S (the putative initiation zone for outbreaks); figures in parentheses are the numbers of reefs.

Effects of rezoning of the Great Barrier Reef Marine Park in 2004 on patterns of biodiversity

Primary effects of the rezoning: While marine protected areas potentially have wide-ranging effects on biodiversity, the principal change with the implementation of the new zoning plan in 2004 was to close a much larger area of the GBR to fishing. For this reason, the most immediate effects would be on target species of fishes, with subsequent effects on their prey and possibly other components of the ecosystem.

Russ *et al.* (2008) described the differences in density and biomass of coral trout (*Plectopomus* spp.) between reefs that were open or closed to fishing that were evident only two years after the new zoning plan took effect. A second set of surveys of sets of matched pairs of midshelf and offshore reefs in five regions suggested that the differences in numbers and biomass of coral trout was maintained, but not amplified, 3½ to four years after the rezoning (Figures 2-5). There remain clear regional differences in the numbers of coral trout, with relatively fewer in the northern regions, as well as in the patterns of change. Overall, there are still on average about fifty percent more trout in the no-take zones.

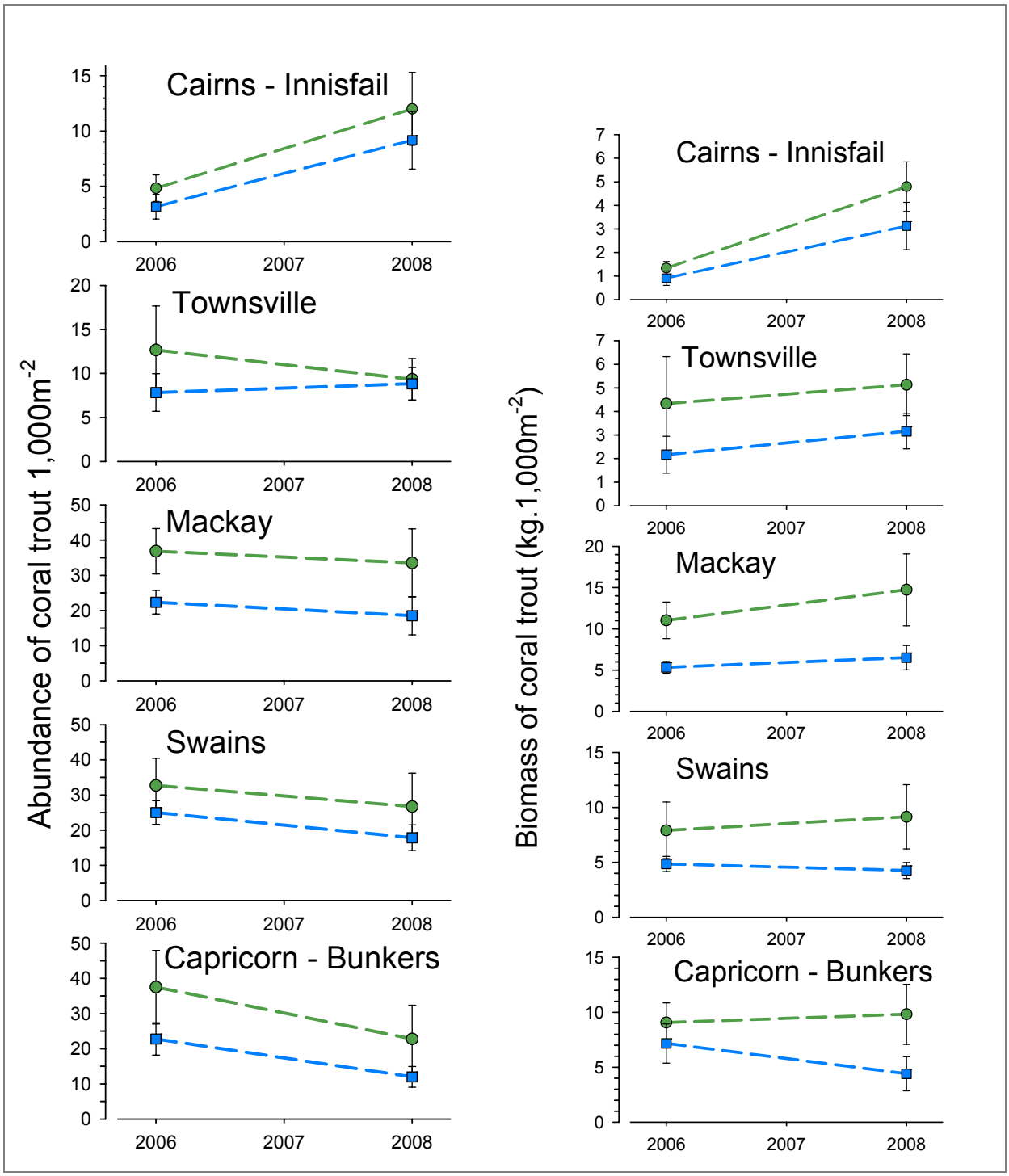

Figure 2 (*above left*): Mean abundance of coral trout (*Plectropomus* spp.) on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

Figure 3 (*above right*): Mean biomass of coral trout (*Plectropomus* spp.) on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

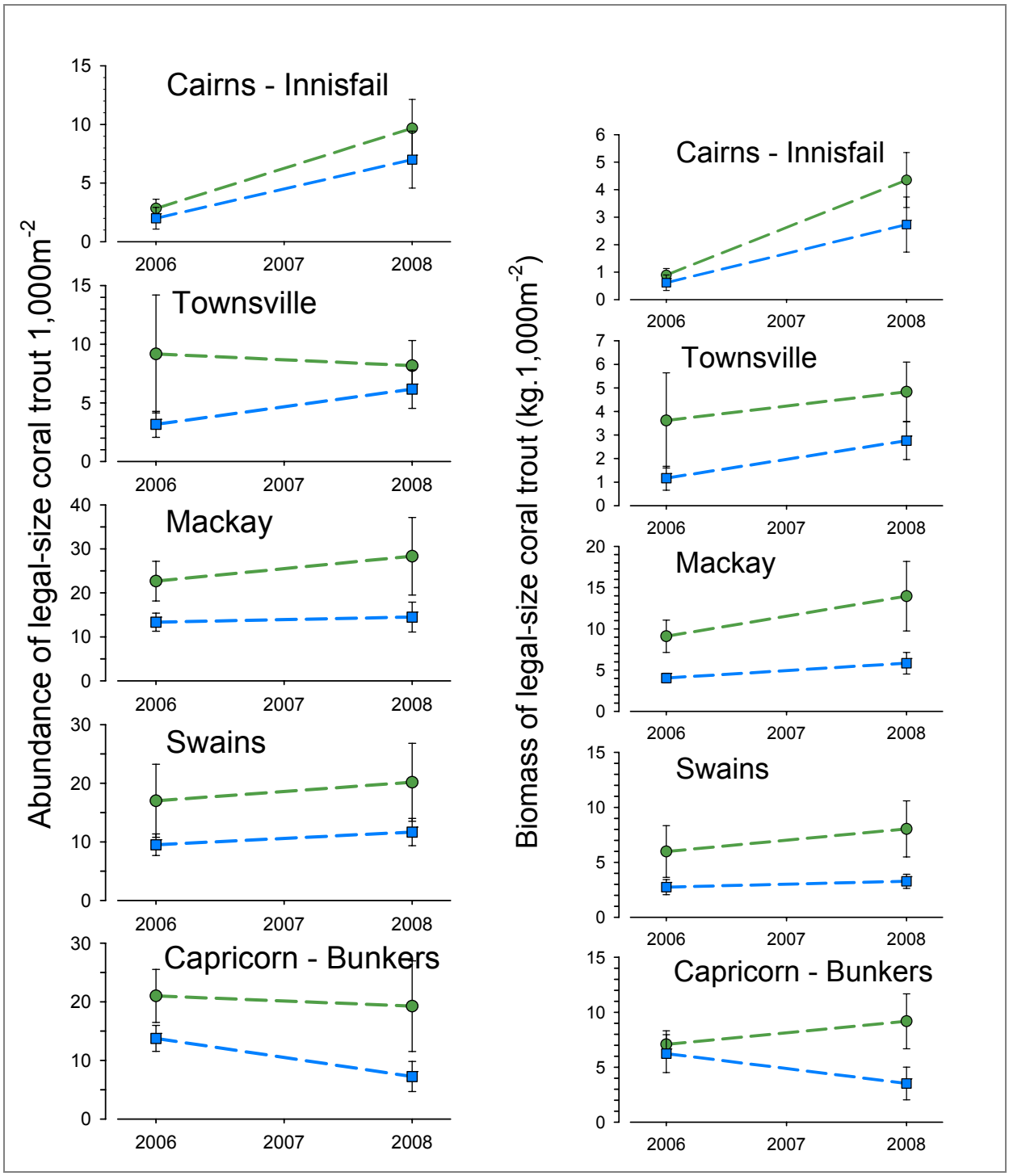

Figure 4 (*above left*): Mean abundance of coral trout (*Plectropomus* spp.) of legal size on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

Figure 5 (*above right*): Mean biomass of coral trout (*Plectropomus* spp.) of legal size on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

Secondary effects of the rezoning: Given that the most recent surveys were made 3½ to four years after the new zoning plan came into effect and the average numbers of some large piscivorous fishes is substantially higher in the no-take zones, secondary effects such as changes in the relative numbers of prey species might be expected. Most simply, more predators could result in lower densities of prey species in no-take zones compared with those on reefs that are subject to fishing. Further, the expected differences should be greater on reefs where there are more predators. Two lines of evidence point to which fishes might be affected. Firstly, there have been several studies of the diet of coral trout based on analysis of gut contents (Goeden 1978, St John *et al.* 2001; Kingsford 1992) which suggest that parrotfishes and the damselfish *Acanthochromis polyacanthus* are common prey. Secondly, Graham *et al.* (2003) recorded higher numbers of coral trout and lower numbers of several likely prey species in no-take zones compared with numbers in areas that were open to fishing on some inshore reefs of the GBR. AIMS surveys mid-shelf and offshore reefs, so not all inshore species are encountered. Among the taxa that Graham *et al.* (2003) found did differ in numbers among zones that do occur on the survey reefs are *A. polyacanthus* and another damselfish, *Amblyglyphidodon curacao*, as well as some other planktivorous damselfishes and small parrotfishes. We examined *A. polyacanthus* and *Amblyglyphidodon curacao*, all small parrotfishes, all damselfishes and planktivorous damselfishes (both with and excluding the abundant schooling *Neopomacentrus* spp) (Figures 6-11). None of these taxa showed consistent differences in mean abundance between no-take reefs and open reefs that were compatible with a trophic cascade, even in the regions with the greatest densities of coral trout. For most taxa, the relative values of means were contrary to expectation in many regions. Besides their inshore location, an obvious difference between these reefs and the sites studied by Graham *et al.* (2003) is the time since closure to fishing. However, the average biomass of coral trout in the no-take inshore sites in Graham and others' (2003) study was two to three times that in the open sites, which was also the case here (Figure 3). Trophic cascades may yet become evident with more time, but there is no evidence so far.

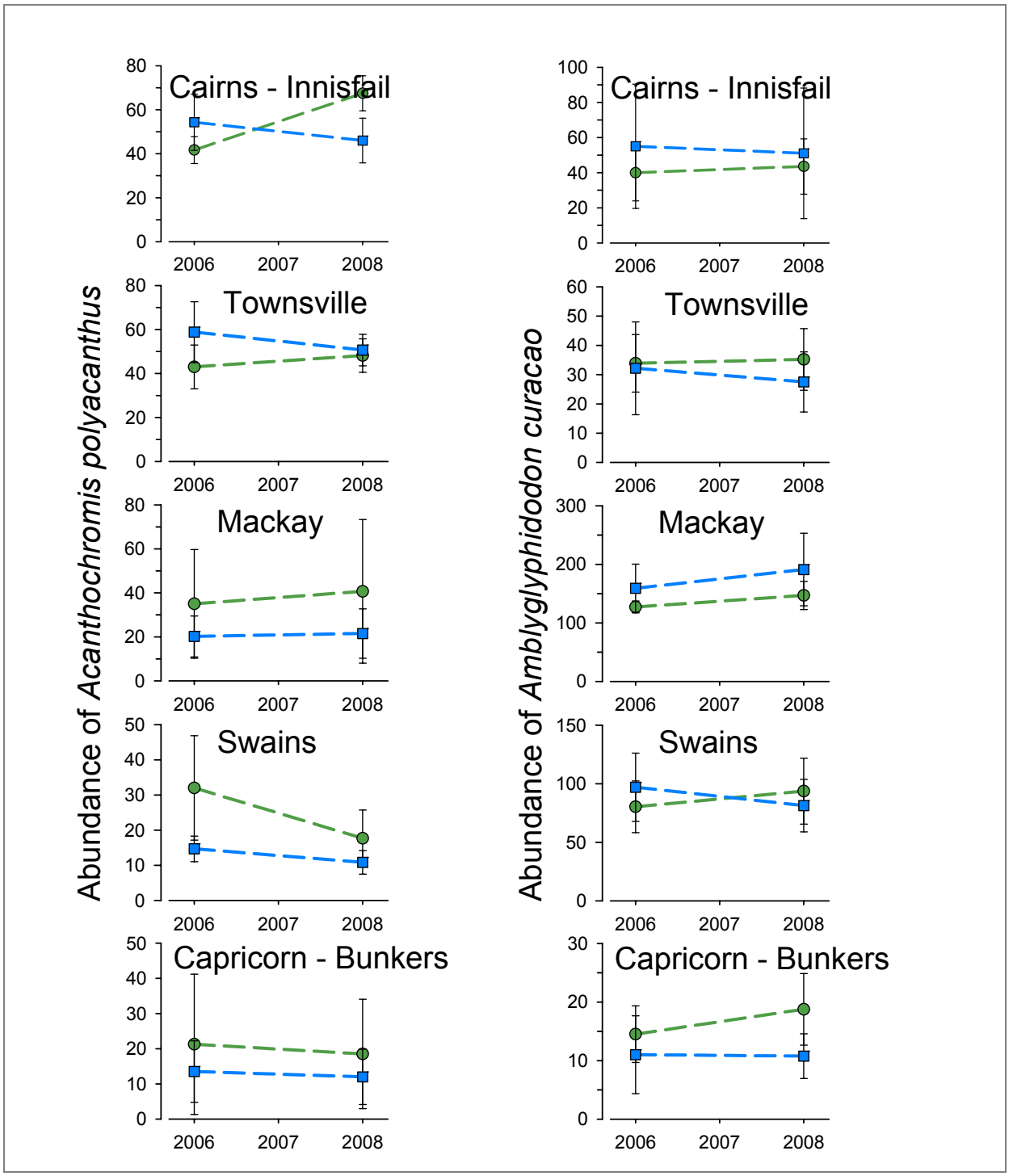

Figure 6 (*above left*): Mean abundance of the potential prey fish, *Acanthochromis polyacanthus* on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

Figure 7 (*above right*): Mean abundance of the potential prey fish, *Amblyglyphidodon curacao* on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

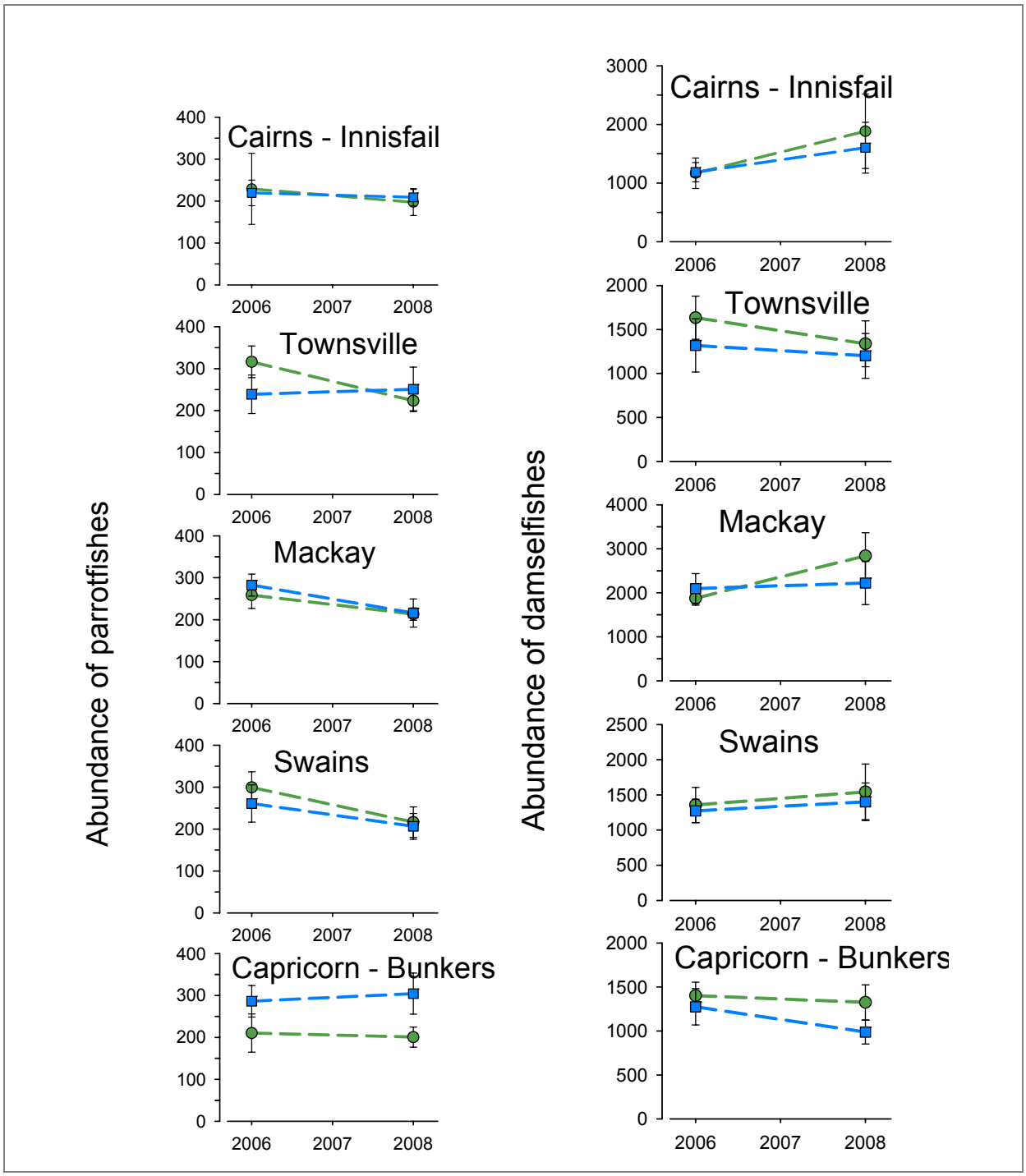

Figure 8 (*above left*): Mean abundance of the potential prey fishes, small parrotfishes on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors.
Figure 9 (*above right*): Mean abundance of the potential prey fishes, all damselfishes, on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes

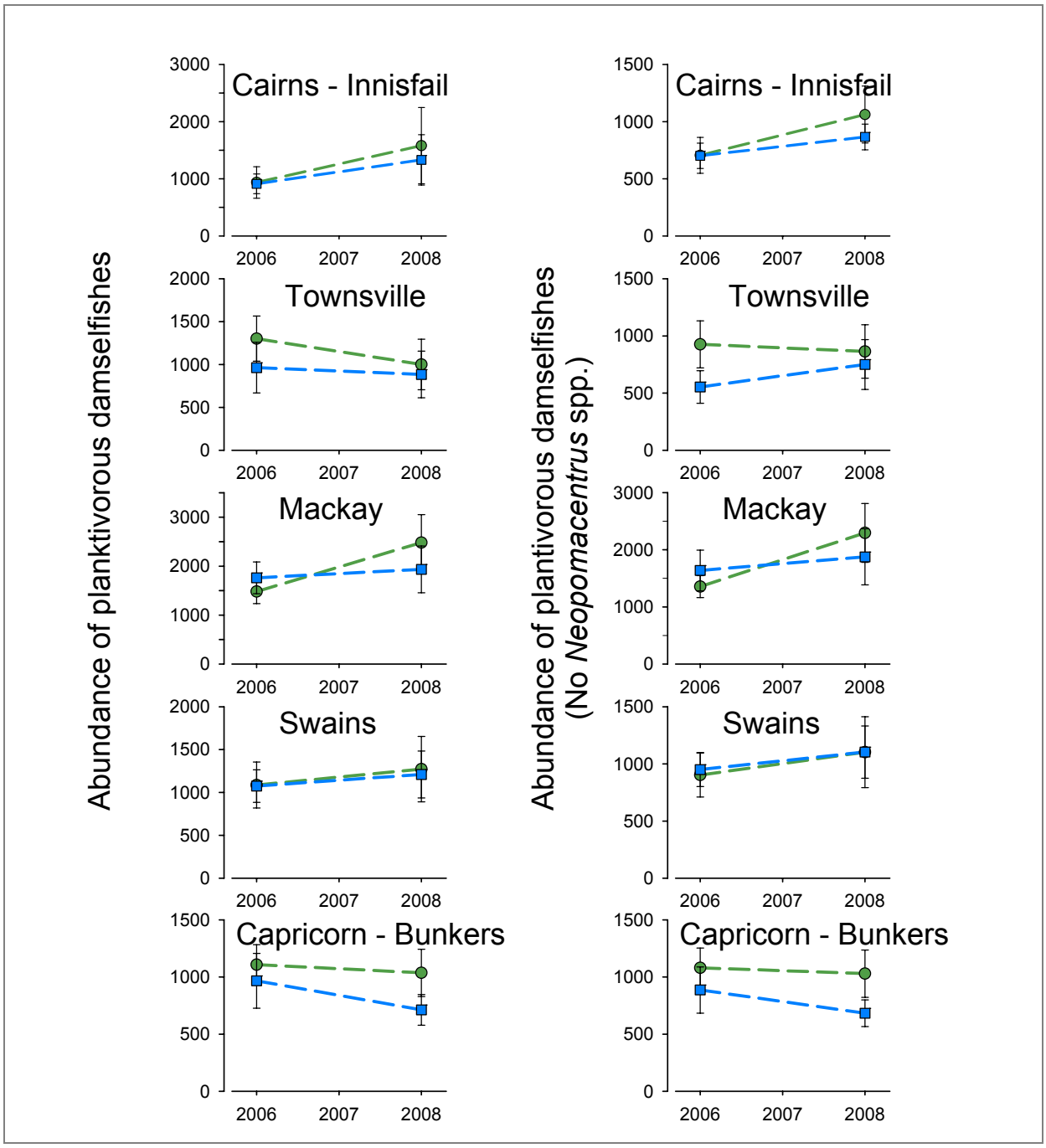

Figure 10 (*above left*): Mean abundance of the potential prey fishes, all planktivorous damselfishes, on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.
Figure 11 (*above right*): Mean abundance of the potential prey fishes, all planktivorous damselfishes but excluding *Neopomacentrus* spp., on matched pairs of survey reefs in five regions in 2006 and 2008. Green circles represent reefs that were open to fishing but were rezoned as no-take areas in July 2004; blue squares represent reefs that were open to fishing prior to July 2004 and remained so; error bars are sample standard errors. **Note** differences in scales of X-axes.

References

Brodie JE, Fabricius KE, De'ath AG and Okaji K (2005) Are increased nutrient inputs responsible for more outbreaks of crown-of-thorns starfish? An appraisal of the evidence. *Marine Pollution Bulletin* 51:266-278.

Goeden GB (1978) A monograph of the coral trout *Plectropomus leopardus*. *Queensland Fisheries Service Research Bulletin* 1:1-42.

Kingsford MJ (1992) Spatial and temporal variation in predation on reef fishes by coral trout (*Plectropomus leopardus*, Serranidae). *Coral Reefs* 11:193-198.

Russ GR, Cheal AJ, Dolman A, Emslie MJ, Evans RD, Miller IR, Sweatman H and Williamson DH (2008) Rapid increase in fish numbers follows creation of world's largest marine reserve network. *Current Biology* 18: R514-R515.

St John J, Russ GR, Brown I and Squire L (2001) The diet of the large coral reef serranid *Plectropomus leopardus* in two fishing zones on the Great Barrier Reef, Australia. *Fishery Bulletin* 99: 180-192.

Explanation of Activity Changes

The only change from the project's original plan is that some reefs in the Cairns sector could not be surveyed due to bad weather.

Communications, major activities or events – during next milestone reporting period

The survey trip in late March 2009, and to a lesser extent, the survey trip to reefs in the Townsville region will report damage caused by Tropical Cyclone *Hamish*, which may generate media activity.