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Source: A Rapid Marine Biodiversity Assessment of the Northeastern Lagoon from Touho to Ponérihouen, Province Nord, New Caledonia: 194

Published By: Conservation International

URL: https://doi.org/10.1896/054.062.0106

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Chapter 5

Reef Condition: Touho, Poindimie, and Ponérihouen

Sheila A. McKenna

SUMMARY

- Reef condition is a term pertaining to the general "health" of a particular site as determined by assessment of key variables including natural and human-induced damage or stress and biodiversity based on focal species or indicator groups (corals and fishes) and approximate count of targeted fish for the 46 reef sites assessed. These variables were summed by reef site and comparatively ranked from high to low and rated accordingly as: excellent 13%, good to very good 28.3% , fair 45.6% and poor 13%.
- The most frequently observed disturbance was from symptoms indicative of disease mainly for hard corals. Coral disease was observed at 46.8% of the sites surveyed. Other symptoms indicative of diseases were noted at 27.2% of the sites surveyed on several other invertebrates including soft coral, sponges and crustose coralline algae. The incidence of bleaching was very low and minor with one to two colonies with pale tissue coloration observed at three sites.
- Sedimentation stress was observed at 42.5 % of the sites surveyed and varied in extent of observable impact. The fringing reef sites as expected were the reef type where sedimentation stress appeared to be most severe.
- Predation by *Acanthaster plancii*, or Crown of Thorns Starfish (COTS) can be mainly characterized as light and localized with the exception of one site, Ilot Ague where evidence of a past population outbreak was observed with 12 individuals seen at the time of the assessment.
- Several types of debris were noted on 19.4% of the reef sites surveyed. The most frequently observed debris was from fishing activity. Evidence of marine resource extraction as noted by fishing debris or by the presence of actual fishers on the reef was observed at 21.3% of the reef sites surveyed.
- Red listed species were spotted on 55.3% (26 sites) of the reef sites we assessed. For these species only one or two individuals were seen when present at a site with one exception. The coral trout, *Plectropomus leopardus* was seen occasionally in small schools at 47.8% (or 22 reef sites).

INTRODUCTION

The reefs of New Caledonia have been impacted by land -based activities mainly from mining, deforestation and coastal development. Other sources of damage that have been documented include bleaching, crown of thorns starfish (COTS), disease and cyclone events. The most recent major disturbance was from Cyclone Erica (category 5) that struck the west coast of New Caledonia in March 2003 resulting in a reduction in live coral coverage in some areas and altering habitats (Lovell et al. 2004, Guillemot et al. 2010). Sulu et al. (2002) reported low live coral coverage for South Noumea due to either large numbers of COTS, coral bleaching or coral disease. Unfortunately, a gap in monitoring for 1999 precluded confirmation of the exact cause.

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Assessments of the state or threats to the coral reefs of New Caledonia are available at the coarse (Bryant et al. 1998, Burke et al. 2011) to site-specific scale. Assessments, workshops and information on the biodiversity and threats of New Caledonia's coral reefs have increased considerably at the national level since the 2004 Mont Panié Marine RAP Survey (e.g. Payri and Forges 2006, Gabrie et al. 2007, Andrefouet and Wantiez 2010). This was spurred in part from the preparation of data and information in support of the World Heritage Nomination and from the Coral Reef Initiative for the South Pacific. Most notably, a special issue of Marine Pollution Bulletin reporting on various multidisciplinary investigations from the lagoons of New Caledonia was published in 2010 (Grenz and Le Borgne 2010). At the site scale, studies on the status of coral reefs in New Caledonia have focused mainly in the Province Sud where the majority of the population lives and where the major marine associated institutions can be found (e.g. Institut de recherche pour le dévloppement (IRD) and Université de Nouvelle-Calédonie). Hence most reports of stressors or disturbances (e.g. bleaching, crown of thorns feeding aggregations and sedimentation) to the reefs are reported from the south.

In 2003 as part of IFRECOR (French Initiative for Coral Reefs), sampling sites were extended to include Province Nord and Isle Province. Within Province Nord, three sites were monitored at Hienghène, Népoui, and Pouembout. The stations sampled within Hienghène are on the east coast in the vicinity of the previous rapid assessment survey of the Mount Panié area (McKenna et al. 200and included Koulnoué, Hiengabat, and Donga Hienga (Wantiez et al 2004). The other two sites, Népoui, and Pouembout, are located off the west coast of Province Nord and lie further south than the area covered during this survey (see main map xx). Other site specific studies within Province Nord include the region of Koné where studies are being and have been conducted to monitor and assess the coral reefs in preparation of a mining project (e.g. Pascale et al. 2006). In the Diahot-Balabio region, just north of the Mont Panié area, an assessment of the reefs and the use of their resources was conducted in 2006 (Gabrie et al. 2007).

Here, the condition of the 47 reef sites in the northeast lagoon off the coast of the three communes, Touho, Poindimié and Ponérihouen is described to provide a snapshot of reef "health" as observed during the period of the survey. Information is presented on the benthic community structure of the reefs surveyed and on incidence or evidence of stress or threats to those sites. Based on a comparative rank of these parameters with the number of species of coral and fish as well as targeted fish counts for the reef sites surveyed, the reef sites can be approximated into three "health or state" categories: excellent, very good to good, and average. This information is meant to serve as an initial snapshot of the health of the reefs surveyed and to provide an indication of what factors appear to be influencing the reef that suggest further research, monitoring, management and subsequent mitigation activities may be needed.

MATERIALS AND METHODS

At each survey site substrata/biota data of the benthos were collected. Transects were used to sample the benthos as described in English et al. (2000). The following is a brief description of the transects: a 100 meter transect tape was placed along the bottom of the reef as close as possible to the biota/substrata., two 100m transects were placed at two out of three possible depth zones depending on the reef structure and topography. The three depth zones included <7 m (shallow), 7–10m (medium) or ≥12m (deep). At some sites it was not possible to place and sample transects along two different depth zones either due to weather conditions or limited reef topography. In those cases, one depth zone was sampled. The biota/substrata were sampled at selected 0.5 m intervals (for 40 sample points) along 20 m segments of the 100 m transect. Below each sampling point, the type of substrata/biota is identified or characterized as follows: hard coral (hc), soft coral (sc), sponge (sp), macro algae (ma), calcareous algae (ca), turf algae (ta), cyano-bacteria (cyano) rubble (rb), other, mud/silt, dead coral (dc) and bare substrata (bs). The category turf algae included filamentous and turf algae. Given that cyano-bacteria was observed to be widespread on some reefs, it was kept as a distinct type although it is a turf algae. The "other" category includes invertebrates such as tunicates, sea stars, sea cucumbers, etc. After the first 20 of the 100 m was sampled, the diver would skip 5 m and then continue sampling another 20 m (40 points) along the transect. This allowed for replication during sampling, with four 20 m segments of each transect sampled at half-meter intervals per depth.

Any visible signs of damage, threats, or disturbance at each reef site were noted. Evidence of disturbance, damage, or threat was rated according to the relative amount or level of impact/frequency (none, light, moderate, and excessive). The divers looked for evidence of damage from fishing (nets, spear guns, lines,), boating activities (anchor damage, grounding scars, fin marks from snorkelers), and storms or cyclones. Damage from the coral predators *Acanthaster plancii* and *Drupella cornus* on the reef was detected by the presence and number of individuals seen or by feeding scars on the coral. Breakage to coral colonies as a result of grazing activity by the bump-head parrotfish, *Bolbometapon muricatum* was also noted. Other divers of the RAP team supplemented observations on reef condition after the site survey dive had been completed. Charismatic marine fauna and other marine related red-listed species were also noted at each reef site. These include sharks, manta rays, clams turtles, dugongs, etc.

Bleaching refers to the discoloration of coral tissue color—the more discolored the coral tissue, the more severe the bleaching. Light (or early stages of) bleaching is indicated by a slight discoloration of the coral tissue. Moderate or extreme bleaching is usually indicated by the coral tissue being transparent, opaque, or clear in color with the coral skeleton visible. The number of colonies showing signs of bleaching

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and the level of tissue discoloration indicates the extent of the bleaching on the reef.

In addition to bleaching, coral pathogens or diseases may be observed on the reef and have been identified to occur on hard and soft coral. Some diseases are identifiable by a distinctive banding or pattern of discoloration on the surface of hard and soft coral. For example, black band disease on hard corals is evident by an obvious black band across the coral head—behind the band the coral skeleton is visible and the coral tissue is dead and gone. On the other side of the band the coral surface looks normal. The incidence of diseases and other pathogens has been more frequently observed and studied in the Caribbean than in the Indo-Pacific (Sutherland et al. 2004). Given the proximity of New Caledonia to the Great Barrier Reef and the need for further etiological studies on coral disease in the Indo –Pacific, any symptoms of disease or pathogens observed during the survey were classified according to the nomenclature used by Australian Institute of Marine Science (http://www.aims.gov.au/pages/research/reef-monitoring/coral-diseases/hcd-gbr-01.html) and in Willis et al 2004.

The presence of red-listed species observed on the reef by all survey participants was also compiled. This presence/absence data is used as a semi-quantitative indicator of reef health. In-situ long-term assessments of the red-listed species noted would be needed to determine the state and viability of these populations. In order to be consistent for comparison to past rap surveys in New Caledonia, the coral species that were recently assessed in 2008 and appear on the IUCN red-list were not included in this analysis. Details on the red-listed IUCN coral species observed during the survey can be found in chapter 1.

Evidence suggesting threat or pressure from pollution/eutrophication, fishing pressure, siltation, and freshwater runoff may be taking place on the reef can be observed, however further testing, monitoring, or experimentation is needed for quantitative data. In some cases, freshwater run-off or siltation may be a "natural" occurrence for a reef site because of its location next to a river mouth where the watershed has not been altered. In other cases theses occurrence are not "natural" and have been altered due to human activities. For example, the source of the damage (e.g., sewage outfall pipe, deforested area along the shoreline, mining activities coastal development, and river outfall) can be seen from the reef site, thereby providing qualitative evidence. An abundance of algae with low coral cover can be an anecdotal indicator of pollution/eutrophication on reefs. However, the population of herbivores and type of algae (macro-algae, turf or filamentous, or calcareous) need to be considered. The presence of fishers actively fishing or a low abundance of target biota (e.g., sea cucumbers or groupers) on the reef site indicates extractive pressure from fishers, but the frequency and extent of marine resource use and abundance of stocks need to be further investigated and monitored to obtain quantitative data. High percent cover of mud or silt on the reef benthos indicates siltation.

These types of threats or disturbance need to be characterized further by direct measurements of specific parameters (e.g., nutrients in the water column, stock abundance and fishers activity, sediments, and percent cover of biota/substrata) over a long sampling period of at least one year or more. The nature of the rapid assessment only allows for initial observations that suggest eutrophication/pollution, fishing pressure, siltation, or runoff is taking place and the relative extent of its impact on the reef site. This provides an important first step in determining stress or threat presence on the reefs sites and what follow up is needed in terms of further study, threat mitigation, monitoring and effective management. Sites where evidence of these threats is noted are indicated in the text and summarized in Table 5.3. The summary table synthesizes the key indicators for state or health of the reef based on biodiversity of the fish and coral species, average percent coral cover and consideration of presence or absence and extent of human impact. The observed values for these key indicators are summed and then ranked according to highest to lowest. The four categories of excellent, good to very good, average and poor are determined by the natural breaks in the determined values. Due to the high variability in targeted fish counts the sites were analyzed a second time with the approximate count of target fish included in the summation for ranking. In cases where percent coral cover and fish counts were obtained from more than one depth for the reef site assessed, the average of the values was used for calculating the sum. Only sites where a complete set of data for fish diversity, coral diversity, percent live coral cover and counts of targeted fish were included in this analysis. Complete data sets were available for 46 sites with the two sites excluded, the mangrove site (14) and site (48) where targeted fish counts were not taken.

RESULTS

Sea grass and mangroves were observed to be within the site or in close proximity. One site assessed, site 14 was a mangrove. At seven sites, sea grass was documented (sites 13, 14, 15, 22, 23, 40, and 48). Among the genus of sea grasses observed were *Halophila* and *Thalassia*. In addition to the mangrove at site 14, sites 13 and 16 had mangroves next to the reef.

Benthic cover

Percent coverage by hard coral was spatially variable. Mean percentage of hard coral cover in depths less than 7m ranged from 0 at site 30 to 65.6% at site 41 (Figure 5.1a). At depths greater than 7 m and less than 10m, mean percentage of live coral coverage ranged from 21% at sites 25 to 71% at site 37 (Figure 5.1b) while depths greater that 12m ranged from 6% at site 25 to 74% at site 36 (Figure 5.1c). The mean percent of biota/substrata for all categories cover by site is presented in Appendix 4. No hard coral was observed at site 14, the one mangrove habitat assessed. Five reef sites (one fringing 12, one intermediate 5, two back reef 7 and 18, and

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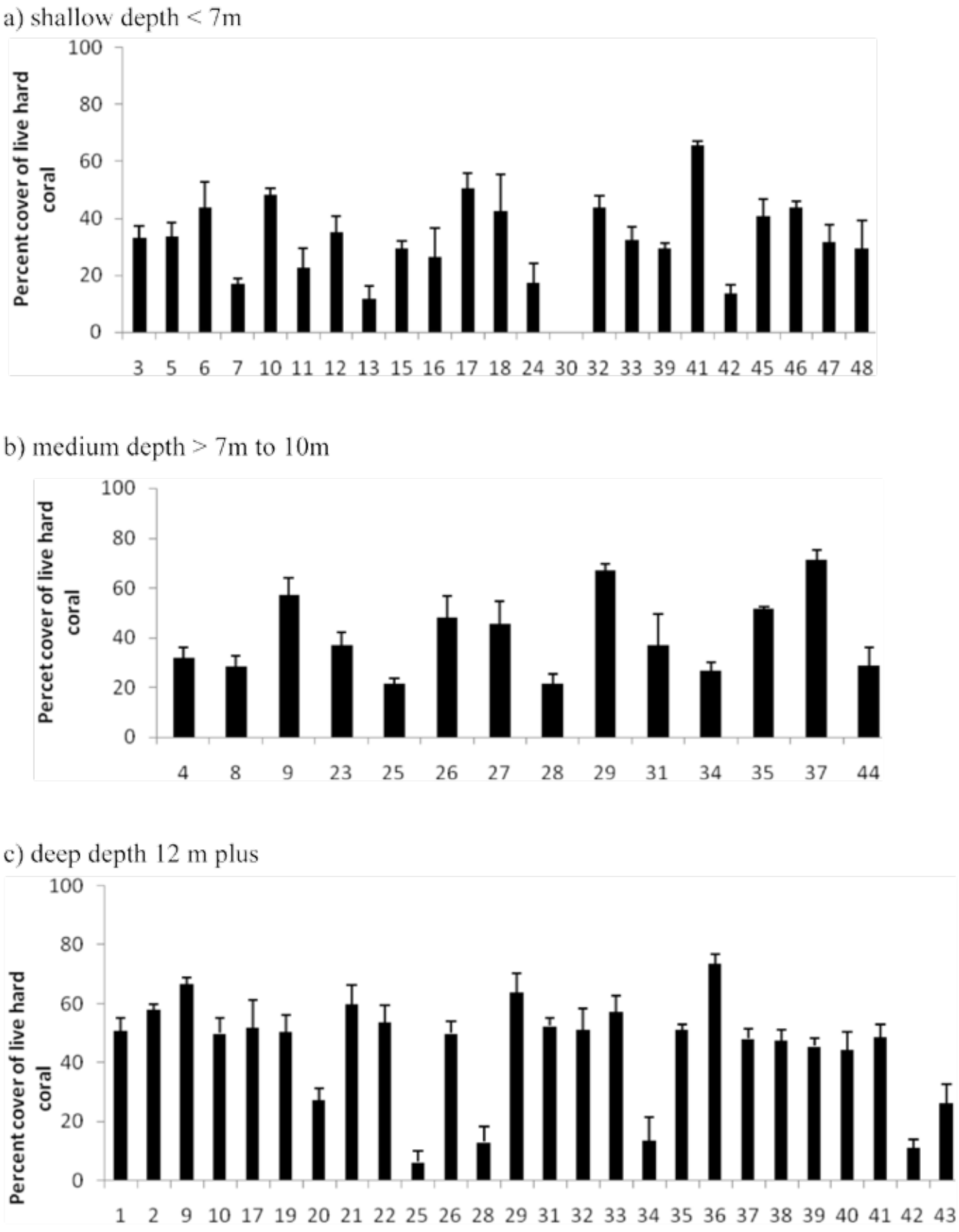

Figure 5.1. (a, b, c) Percent cover of live hard coral for sites as numbered at depths of (a) < 7m (b) > 7m to 10m and (c) 12 m plus as determined by the point intercept transect method. For each site, four 20m length transects were sampled (n = 4) except (a) where n = 7 for site 4, (b) n = 3 for sites 2, 28, 34, and 35: (c) where n = 3 for site 1.

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one outer barrier 37) were observed to have parts of their benthos dominated by cyano-bacteria, especially on the two back reef sites where blooms were noted.

Coral bleaching and pathogens

Minor bleaching, that is one to two colonies with pale tissue coloration, was observed at three sites, two intermediate reef sites (5, 34) and one back reef site (7). Coral disease was observed at 22 or 46.8% of the sites surveyed. Approximately 1 to 5 colonies of the table *Acropora* sp were observed to have white syndrome at 22 sites (1, 2, 7, 8, 9, 10, 11, 21, 22, 25, 27, 28, 29, 32, 33, 34, 37, 39, 40, 41, 44, and 45 (Willis et al. 2004). Calcioblastic neoplasms or coral tumors (Peters et al. 1986) were observed at eight sites (11, 24, 26, 38, 39, 44, 46, 47) on one to two colonies at most. Pink pigmentation response of one to two massive *Porites* coral colonies in total per site was observed at eight sites (10, 16, 19, 41, 42, 45, 47, and 48) (Aeby 1991; Willis et al 2004).

Other symptoms indicative of diseases were noted on several other invertebrates including soft coral, sponges and crustose coralline algae at thirteen or 27.2% of the sites. Growth anomalies or tumors were seen on the soft coral (*Sacrophyton*) at four sites (11, 21, 23, and 34). Discoloration of the sponge, *Cliona* sp. was seen at site 11. Coralline Lethal Orange Disease (CLOD) was seen on crustose coralline algae at ten sites (1, 10, 19, 28, 31, 34, 37, 39, 41, and 43).

CORAL PREDATORS AND DAMAGE FROM FISH GRAZING ACTIVITY

The presence or evidence of predation by Crown of Thorns (COTS) or *Acanthaster plancii* was observed at a total of 7 sites (2, 4, 11, 16, 17, 37, and 42) or 15.2% of the sites surveyed. The majority of sightings were of one to two individuals, with the exception of one site (42) where 12 individuals were seen. Feeding scars were noted on the coral species, *Acropora* sp, *Acropora humulis*, *Pocillopora* sp. and *Stylophora mordax*. No major aggregations of *Drupella cornus* were noted. Grazing activity by the bumphead parrot fish *Bolbometapon muricatum* was not observed although scars on some corals consistent with such activity were noted at two sites (9, 34).

Debris

Several types of debris were noted on 9 sites or 19.4% of the reef sites surveyed. The most frequently observed debris was from fishing activity. This included fishing line at four sites (20, 28, 36, 40), a spear gun at four sites (10, 19, 32, 36) and a fishing lure (36). Other evidence consistent with boating activity and potentially fishing included an anchor at one site (36) and a rope at one site (12). Other debris included one plastic bag (10).

Fishing and reef gleaning activity

Evidence of marine resource extraction as noted by fishing debris on the reef (as reported in the previous section or) by the presence of actual fishers on the reef was observed at 10 sites (7, 10, 11, 13, 19, 20, 28, 36, 40 and 41) or 21.3% of the sites surveyed.

Sedimentation

Sedimentation stress was observed at sites (3, 6,7, 8, 9, 12, 13, 15, 16, 17, 23, 30, 34, 35, 39, 43, 46, 47, 48 , 49) or 42.5 % of the sites surveyed and varied in extent of observable impact (i.e. turbidity and amount of silt covering reef organisms or substrata). Sedimentation stress was observed to have its highest impact on four fringing reefs sites (6, 12, 13, 30, 46), one intermediate reef site (16) and one pass site (43). Evidence of medium impact from sediment was seen on three fringing reef sites (15, 35, 48) and four intermediate reef sites 17, 39, 47, and 49. Six reef sites consisting of three back reefs (3, 7, and 23) and three intermediate 8, 9, and 34 had low sedimentation stress observed. At several sites a coating or layer of sediment was seen blanketing the turf algae or hard corals. As a result, when examining the average benthic coverage percentage for these sites, the percent value for the sediment category does not necessarily appear to be high value or in some cases is zero. The organism observed to be covering the substrata (itself covered with a layer of sediment or silt) was what was recorded with notation of the presence of sediment or silt.

Red-listed species sightings

Red listed species were spotted on 55.3% (26 sites) of the reef sites we assessed. These included such species as southern giant clam, Maori Wrasses, sharks, rays, sea turtles, coral trout and other groupers Information on these species is presented in Table 5.1. It is important to note that when red-listed species were observed on a reef site, only a total of one or two individuals were seen. The only exception was the species, *Plectropomus leopardus*, the coral trout that was seen occasionally in small schools at 22 reef sites. For more details on the red-listed species observed, please refer to chapter 2 and 4 for fishes, chapter 3 for invertebrates and chapter 6 for a historical review of marine mammals and sea turtles. During the survey no dugongs were observed during the field period, although they are reported from this region (chapter 6).

Other red-listed species not observed during the survey, but reported from New Caledonia are species of whales, great white sharks, other shark species, dugongs and sea horses. For more background on the red list and an up-to-date list of species evaluated from New Caledonia the reader is referred to their website, http://www.iucnredlist.org.

Synthesis of factors

Based on the number of fish and coral species observed with percent coral cover and consideration of presence or absence of human use at reef sites assessed (n = 47), most

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sites (42.5%) were comparatively ranked as fair (Table 5.2). When the approximate count of target fish was included for the (n = 46) sites having those data, the ranking predominately remained as fair (45.6%) as well.

DISCUSSION AND CONSERVATION RECOMMENDATIONS

Coral reef ecosystems are inherently variable. This study represents a snap shot of select reef sites (n = 47) along the communes of Touho, Poindimie, and Ponérihouen during the survey period. Multi-synergetic factors influence the parameters (benthic community, coral and fish diversity, targeted fish numbers quantified, evidence of disturbance) chosen as indicators of reef health on the sites assessed. The possible effects of these factors (e.g. turbidity, currents) on that particular parameter or indicator are discussed in their respective chapters (e.g. chapter 1for coral reef diversity). It is important to note that the coral reef system off this coastline varies considerably in terms of distance from shoreline (e.g. see Grand Récif Mengalia) and number and types of habitat present (e.g. there are more intermediate reefs found off of Ponérihouen). Therefore, comparisons among the number and type of sites sampled off each commune are limited due to low replication as well as temporal variability (e.g. the same habitat type, such as a reef pass being sampled at a different time of day would affect the number and diversity of fish present). Nevertheless, the likely impact of certain factors, possible trends (e.g. sedimentation, resource use) and symptoms indicative of disturbance (e.g. coral disease) can be examined with recommendations suggested for follow up monitoring and research to improve the management and conservations of the reefs surveyed.

Based on coral and fish diversity, percent live coral cover and relative impact of observed stress or disturbance, 42.5% or the majority of the reef sites surveyed (n = 47 sites with complete data sets available) were in fair condition. When the approximate count of targeted fish was added to each site (n = 46 with complete data sets available), the majority of reefs remained in fair condition.

The assessed reef sites ranked to be in poor condition, regardless of whether approximate fish counts were included (13%) or not (12.8%), were six sites (four fringing, one intermediate and one back reef site). This is not surprising as fringing reef sites, especially those closest to river mouths, coastal developments and ship channels are subject to terrigenous sediment influx and potentially the input of other substances depending on activities found along the watershed (e.g. mines, agricultural fields). Erosion along the coastline can also impact sediment loading in areas subject to high wave energy especially during storms or subject to anthropogenic activity (e.g. road construction or extraction of sand and dead coral for building materials).

The majority of reef sites found to be in good to very good and excellent condition were the exterior barrier reef and reef pass sites. This is expected as theses sites are farthest away from the influence of anthropogenic activity on the coast, are less accessible by humans and have habitat characteristics that promote high values for particular parameters measured as indicators (e.g. coral diversity higher with increase in depth). Additionally, some intermediate reef sites ranked in the two categories of good to very good and excellent condition. These sites tended to be the ones located in the lagoon closer to the barrier reefs and passes. Notably, one fringing reef site off of Cap Bayes (site 35) was assessed to be in good to very good condition (with targeted fish counts

Table 5.1. IUCN red listed species observed during the survey with their red list category and sites where observed during survey.

Species	Red List Category	Site
Bolbometopon muricatum (Bumphead parrotfish)	Vulnerable	28
Carcharhinus albimarginatus (Silvertip shark)	Near threatened	1
Carcharhinus amblyrhynchos (Grey reef shark)	Near threatened	1, 2, 9, 21, 29, 33, 37, 38
Cheilinus undulatus (Maori Wrasse)	Endangered	1, 2, 10, 26, 28
Chelonia mydas (Green turtle)	Endangered	10, 32
Epinephelus malabar (Malabar Grouper)	Near threatened	17, 37
Epinephelus polyphekadion (Camouflage grouper)	Near threatened	31, 42
Eretmochelys imbricata (Hawksbill turtle)	Critically endangered	11, 33
Manta birostris (Giant manta)	Near –threatened	43
Plectropomus leopardus (Coral trout)	Near- threatened	1, 3, 4, 5, 8, 9, 12, 16, 17, 20, 22, 23, 32, 34, 37, 39, 40, 41,42, 43, 45, 47
Taeniura meyeni (Black spotted stingray)	Vulnerable	5
Triaenodon obesus (Whitetip reef shark)	Near- threatened	11, 18, 20, 22, 26, 37, 38, 44, 47
Tridacna derase (Southern giant clam)	Vulnerable	9, 27, 33, 41, 42

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not included). Despite the deposition of sediment on many surfaces, the coverage of soft and hard coral was high.

Symptoms of disease were observed on more reef sites than the number of reefs sites affected by sedimentation stress. However, the impact of disease on the overall state of the reef was not as extensive as that observed from sedimentation. Coral disease occurs at a finer scale and was only seen affecting one to five colonies at a time when a reef site was sampled. Obviously, more research and monitoring are needed on the cause and incidence of diseases on invertebrates on coral reefs in addition to what currently exists not only in New Caledonia, but globally as well. This is especially true as coral disease outbreaks have been linked to increases in thermal temperature (Bruno et al 2007) that is projected to increase further with climate change.

Although scientists from IRD reported a bleaching event on the east coast of Province Nord, north of Poindimé in February 2008 (Spaggiari pers comun.), bleaching observed during this survey was of very low frequency (one or two colonies on three sites) and minor in level of tissue discoloration. The observed evidence of fishing related activity and debris on the reef sites assessed was not surprising, given that the reefs surveyed are used for various activities including recreational, subsistence and commercial fishers (see Chapter 6).

Comparisons can be made from this survey to the two past RAP surveys in New Caledonia. In summary, the reef sites assessed here are observed to have more evidence of stress or to be more impacted than what was observed in 2004 during the Mount Panié survey. However these reefs are observed to have less evidence of stress or to be less impacted than what was observed in 2007 during the Yandé to Koumac survey. It is important to keep in mind that the surveys were conducted at different times, had different participants and are only snap shots so caution is advised as these comparisons are limited. The reef sites surveyed here were not as impacted by sedimentation stress as was found on the west coast during the Yandé to Koumac survey, but were more impacted by sedimentation than what was observed during the Mt Panié survey. This is not surprising given the west coast has more mining activity than the east coast. Further, the reefs assessed during this survey are located farther south from those of Mt Panié and are closer to the mining activity that occurs on the east coast. In the most southerly commune of this survey, Ponérihouen, nickel mining activity occurs in Monéo and the neighboring commune of Houaïlou. More coral disease was seen on the reef sites assessed in this region compared to the other two surveys. The higher incidence of disease observed among all invertebrates on the reef sites in this region requires further research and monitoring as previously mentioned.

During this survey, the percent of reef sites (55.3%) where red listed species observed is less than what was observed on the two previous surveys, (76.2% Mount Panié survey, McKenna et al 2006 and 66% Yandé to Koumac survey, McKenna et al 2009). The number of reefs where red-listed species were sighted was for the most part low, however the presence of coral trout raised the number of sites where red-listed species were observed. Only one or two individuals of the various other red-listed species were seen at any given time if at all on the reef sites assessed. In comparison to past surveys conducted closer to and within the renowned coral triangle in the Pacific Ocean by Conservation International using similar methods (e.g. Raja Ampat, Togean Bangaii and Calamianes, Werner and Allen 1998, Allen et al. 2002, McKenna et al. 2002,), the sightings of red listed species in New Caledonia are presently the highest observed. As these percentages are observational and based on limited spatial and temporal scale, it is important that quantitative study and monitoring occur over extended periods of time. This will contribute to ensuring the viability of these populations and recovery of the threatened red-listed species in the future.

Based on the condition of the reef sites assessed, it is recommended that every effort be made to reduce the amount of sedimentation stress on the reefs by restoring the watershed (e.g. re-vegetating the denuded areas of the watershed with native plants). In cases where road work or other construction along the coastline is needed, sedimentation barriers or screens can be used to curtail the amount of sediment loading. As suggested in the previous two marine rap surveys, sedimentation rates need to be monitored.

Table 5.2. Comparative categories for the state of reef sites (n = 47)[a] surveyed based on rank cumulative total of number of fish species observed (FS), number of coral species observed (CS), and average percent live coral cover recorded (PLC) and consideration of presence or absence of human use. The second column lists the sites with approximate count of target fish (TFC) included in the summation for the comparison. The percentage of sites within that rating appears in parentheses.

Rating	FS + CS + PLC	FS + CS + PC + TFC
Excellent	2, 17, 32, 36, 38, 41 (12.8%)	17, 26, 37, 38, 40, 43 (13%)
Very good to good	1, 9, 10, 19, 22, 26, 29, 31, 33, 34, 35, 37, 39, 40, 45 (31.9%)	1, 2, 9, 19, 23, 27, 29, 31, 32, 33, 41, 44, 45 (28.3%)
Fair	3, 4, 5, 7, 8, 11, 12, 13, 16, 18, 20, 21, 23, 25, 27, 28, 42, 43, 44, 47 (42.5%)	3, 4, 5, 7, 8, 10, 11, 13, 18, 20, 21, 22, 24, 25, 28, 34, 35, 36, 39, 42, 47 (45.6%)
Poor	6, 15, 24, 30, 46, 48 (12.8%)	6, 12, 15, 16, 30, 46 (13%)

[a] the one mangrove site (14) was excluded from above analysis

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Table 5.3. Summary of reef condition. The reef condition table provides the syntheses of species diversity, percents of hard coral cover and damage and threat observations for each reef site surveyed. Threat or level of damage observed by site is noted: for Crown-of-Thorns and marine resource extraction with a "x"; for disease with the syndrome observed (Ws = white syndrome); for debris with the item observed (fl = fishing line and sg = spear gun);. for sedimentation with an L = light, M = moderate, and E = excessive according to extent or level of observed impact. If no threat or damage was observed the corresponding cell for that site is empty. The approximate counts of targeted fish have been omitted from the table intentionally.

Site #	Biodiversity of focal groups		Abundance	Percent mean hard coral coverage by depth			Presence of COTS	Marine resource extraction	Disease	Debris	Sedimentation
	# of coral species	Fish species	Number count of targeted fishes present	Deep (>12m)	Medium (7-10m)	Shallow (<7m)					
1	30	128		50.8					Ws		
2	75	143		58.1			yes		Ws		
3	60	96				33.1					L
4	72	73			31.9		yes				
5	79	79				33.6					
6	52	41				43.7					H
7	51	80				16.9		yes	Ws		
8	59	76			28.1				Ws		L
9	75	96		66.9	56.9				Ws		
10	83	97		50.0		48.1		yes	Ws, pink pigmentation response	Fl,	
11	49	94				22.5	yes	yes	Ws, tumors	Fl	
12	77	49				35.0		possible		Rope	H
13	64	52				11.9		yes		fl	M
14	1	7						gleaners			
15	33	39				29.4					M
16	81	80				26.2	yes		pink pigmentation response		H
17	78	130		51.9		50.6	yes				L
18	47	74				42.5					
19	85	107		50.6				yes	pink pigmentation response	sg	
20	83	81		27.5				yes		fl	
21	-	106		60.0					Ws		
22	80	108		53.7					Ws		
23	70	84			36.9						L
24	27	66				17.5			Tumors		
25	58	92		6.2	21.2				Ws		
26	78	92		50.0	48.1				Tumors		
27	84	71			45.6				Ws		
28	65	76		13.1	21.7			yes	Ws	Fl	
29	96	83		63.7	66.9				Ws		
30	0	40				0					H
31	96	96		52.5	36.9						
32	100	108		51.2		43.7		Yes	Ws	sg	

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Site #	Biodiversity of focal groups		Abundance	Percent mean hard coral coverage by depth			Presence of COTS	Marine resource extraction	Disease	Debris	Sedimentation
	# of coral species	Fish species	Number count of targeted fishes present	Deep (>12m)	Medium (7-10m)	Shallow (<7m)					
33	105	93		57.5		32.5			Ws		
34	89	96		13.7	26.7				Ws		L
35	79	88		51.2	51.7						M
36	85	99		73.7				yes		Fl, sg, anchor	
37	76	105		48.1	71.2		yes		Ws		
38	94	125		47.5					Tumors		
39	87	94		45.6		29.4			Ws, tumors		M
40	109	85		44.4				yes	Ws	Fl	
41	124	83		48.7		65.6		Yes	Ws, pink pigmentation response	lure	
42	71	71		11.2		13.7	yes		pink pigmentation response		
43	52	87		26.2							H
44	87	98			28.7				Ws, tumors		
45	105	92		30.0		40.6			Ws, pink pigmentation response		H
46	63	43				43.7			Tumors, pink pigmentation response		
47	85	67		28.7		31.9			Tumors, pink pigmentation response		
48	45	51				29.4			pink pigmentation response		

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Within New Caledonia, monitoring and research activities on the coral reefs are already in place, it is suggested that the locations currently being studied are assessed to ensure adequate representation of the coral reefs around all three provinces. As funding is usually limited for such activity, a way to increase coverage of the reefs given limited resources is to enlist the help of stakeholders who frequent the reef (e.g. SCUBA diving clubs, tribes with traditional marine areas, fishers etc.). An awareness and education campaign on what to look for in terms of signs of stress on the reef (e.g. coral diseases, bleaching, Crown-of-Thorns outbreaks) can be launched that would include a way to report such sightings for further examination by scientists, managers and the marine regulatory/protection entities in the region. Monitoring sediment loading on the reefs through some type of low tech method may also prove helpful as part of this campaign.

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