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Kimberley marine biota. Historical data: scleractinian corals

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ABSTRACT – Limited information is publicly available about the coral fauna of the Kimberley region, particularly of the inshore coastal communities, and this greatly inhibits species conservation efforts. Nevertheless, sporadic coral collection events have occurred in the Kimberley over the last century, so it is important that these historical data are consolidated and made accessible. Biodiversity loss among reef corals poses a significant threat to the function and dynamics of coral reef ecosystems and to the global economy. To maximise the likelihood that coral diversity can be protected in the long term it is imperative that regional biodiversity baselines are established. Here we synthesise the existing records of shallow water (<30 m) scleractinian coral species in the Kimberley region, which are verified by specimens lodged in Australian museum collections (1880s–2009). Based on 2,420 specimen based records, collected from 70 locations, a total of 338 species of hard corals belonging to 17 families and 71 genera has been identified from Kimberley material. There are pronounced cross shelf differences in species composition with 27 species (8%) recorded only from inshore locations and 111 species (33%) recorded only at offshore locations. The inshore Kimberley coral communities are of great regional and national significance for numerous reasons, including their high diversity, inherent tolerance of harsh environmental conditions, and the opportunities they present for examining the biology and ecology of corals in the absence of anthropogenic disturbance.

KEYWORDS: baseline data, biodiversity, hard coral, natural history collections, north west Australia, species inventory

INTRODUCTION

Protected by virtue of its isolation from urban centres and agricultural influences, the Kimberley Project Area (see Methods for boundary explanation) features one of the least impacted marine ecosystems in the world (Halpern et al. 2008). As a result, the Kimberley Project Area is likely to be a significant repository of marine biodiversity. However, to date, restricted information about the coral fauna of the region is publicly available. While substantial baseline information is available about some of the offshore atolls (e.g. Scott and Ashmore Reefs), fauna inhabiting the inshore fringing reefs and coastal habitats, as well as many of the offshore shelf reefs, shoals and banks, remain largely unexplored. The current lack of understanding about the marine fauna in this region precludes targeted conservation effort and further baseline data are needed to fill these knowledge gaps (Waples 2007).

Reefs in the Project Area fall into two distinct groups – the large atolls, platform reefs, banks and shoals that occur in the offshore bioregion, and the fringing and submerged patch reefs that occur in the inshore bioregion (Wilson 2013, 2014). There are 13 atolls in the offshore bioregion (including Scott Reef, Rowley Shoals and Ashmore Reef). The oceanographic setting of the offshore reefs is unique because they occur in a transition zone, receiving low to moderately productive oceanic water of mixed Pacific and Indian Ocean origins. Opposed to this, the inshore communities are uniquely characterised by large tide oscillations (>11 m), strong currents and high levels of turbidity (Wilson 2006). As a result, inshore reef habitats are extremely dynamic and over spring tides, intertidal coral communities can be directly exposed to harsh temperature and light conditions for up to three hours at a time (Rosser and Veron 2011).

Despite limited information being publicly available concerning the diversity of reef building hard corals in the Kimberley Project Area, sporadic collections have occurred in the region dating back to 1893, when a small collection was obtained from Troughton Island by the British Admiralty (described by Bassett-Smith 1899). Admiralty collections, together with specimens collected by W. Saville-Kent from King Sound, the Lacepede Islands and Roebuck Bay, were included in early monographs by Brook (1893), Bernard (1897, 1903, 1905) and Matthai (1928), but these specimens are not deposited in Australian museums.

Substantial collections have been obtained from offshore locations including Mermaid and Clerke Reefs (Rowley Shoals) in 1983 and 2006 (Berry 1986; McKinney 2009), Scott and Seringapatam Reefs in 1984 and 2006 (Veron 1986; McKinney 2009), and Ashmore Reef and Cartier Island in 1986 and 1997 (Veron 1993; Griffith 1997). These coral collections are supplemented by long term coral monitoring projects undertaken by the Australian Institute of Marine Science (AIMS), commissioned by the Australian Government and, in some cases, supported by industry, e.g. Scott Reef (Berry 1986; Smith et al. 2003, 2004, 2006; Gilmour et al. 2008); Rowley Shoals (Berry 1986; McLoughlin et al. 1988; Bryce 2009) and Ashmore Reef and Cartier Island (Berry 1993, 2005; Rees et al. 2003; Smith et al. 2004; Kospartov et al. 2006; Richards et al. 2009).

Collections and publications relating to the coral communities of the inshore coastal bioregion are far fewer in number. Veron and Marsh (1988) recorded 102 species of 45 genera from the Kimberley coast and islands, from material collected from Prince Frederick Harbour, Bigge Island, Admiralty Gulf and Cassini Island. Loisette Marsh collected hard corals at Camden Harbour in 1990 (Marsh 2011) and at various islands and reefs between Broome and Wydham in 1991 (Marsh 1992), and David Blakeway collected corals along the central Kimberley coast in 1996 (Blakeway 1997).

Considering there are over 2,500 islands with well developed fringing reefs along the Kimberley coast (Wilson 2013), the existing collections from this inshore bioregion are comparatively small. Nevertheless, consolidating the existing baseline information is imperative to developing targeted collection and research programs and optimising biodiversity conservation efforts in the future.

AIMS

To synthesise the existing records of shallow water (<30 m) hard coral species in the Kimberley Project Area, which are verified by specimens lodged in museum collections (1880s – 2009); and to provide commentary on diversity, regional trends and collection gaps.

METHODS

The Kimberley Project Area extends west and north of the Kimberley coastline (south of Broome to the Western Australia-Northern Territory border), beyond the 1000 m bathymetric contour (see Sampey et al. 2014 for map, coordinates and full explanation of the study area).

Skeleton based museum records of shallow water (<30 m) scleractinian corals belonging to the phylum Cnidaria (class Anthozoa; subclass Hexacorallia) that have been historically collected from the Project Area were collated in this study. Data were sourced from the collection databases of the Western Australian Museum (WAM), the Museum and Art Gallery of the Northern Territory (MAGNT) and the Australian Museum (AM), as well as the species (and locations) documented on five WAM survey expeditions in the Kimberley Project Area in 1982 and 1984 (Veron 1986), 1986 (Veron 1993), 1991 (Marsh 1992), 1996 (Blakeway 1997) and 2006 (McKinney 2009).

The species names were cross checked using Veron and Wallace (1984), Veron (2000), Wallace (1999), Hoeksema (1989) and Cairns (1998) and the classification system reflects Veron (2000), and Wallace (1999) for Acroporidae. The specimens were not re-examined for this study (see Sampey et al. 2014).

Scleractinian coral data from all sources were collated into a single database. Location and collecting details were checked and verified. The location of the specimen records were visualised using ARCGIS v9, ArcMap v9.3. Maps of species richness and sampling effort were generated for each main location. The full list of locations, latitude and longitude and other relevant collection information is provided in Table 2 in Sampey et al. (2014).

BIOGEOGRAPHIC AND HABITAT CODING

Species were coded for their known biogeographic range and habitat; see Sampey et al. (2014) for a full description of these codes:

- Indo-Australian (IA). From Australian and Indonesian waters, may extend to the Philippines and for some species Japan.
- South East Asia (SE). Restricted to South East Asia.
- Indian Ocean (IO). Restricted to the Indian Ocean.
- Indo-West Pacific (IWP). Found throughout the Red Sea, Indian and W. Pacific Oceans.
- Western Pacific (WP). Found on the East Coast of Australia and Melanesia.
- Indo-Pacific (IP). Found in the Red Sea, Indian Ocean and throughout the Pacific Ocean, in some cases may only extend to the Central Pacific Ocean.

- Circumglobal (C). Found throughout tropical and temperate waters of the Indian and Pacific Oceans.
- Intertidal (i). Species is found in the intertidal zone.
- Subtidal (s). Species is found in the subtidal zone.
- Hard Substrate (H). Species is found associated with hard substrates (e.g. rock, coral, rubble).
- Soft Substrate (S). Species is found associated with soft substrates (e.g. sand, mud).

In some instances, the species in question does not occur in certain parts of the broad biogeographic zones denoted and these exceptions are described where relevant (i.e. IP, not Australia/PNG).

RESULTS

Records from Australian museums indicate a total of 2,700 scleractinian coral specimens were collected from the Project Area between 1889–2009. Two hundred and eighty specimen-based records were excluded from the analysis because they were either obtained from deep reef locations, which are beyond the scope of this project, or because the voucher specimen could not be located. Thus, this study synthesises 2,420 specimen-based records.

Scleractinian skeletal material has been collected from 70 locations in the Project Area originating from six offshore and 65 coastal locations (Figure 1). This material was collected by over 30 people with the most comprehensive collections obtained by L.M. Marsh, J.E.N. Veron, D. McKinney and J.K. Griffith. These four scientists also completed the majority of species identifications, with taxonomic input provided by B. Hoeksema, C.C. Wallace, S.D. Cairns, M. Pichon, P. Alderslade, J. Wells, Z. Dinesen, J. Wolstenholme and L. Thomas.

Over 99% of the Project Area coral specimens are held at WAM, with small collections held at the AM and the MAGNT. The oldest record from Australian museums for a hard coral collected in the Project Area was *Polyphyllia talpina* collected from Yampi Sound in 1959.

A total of 338 species of hard corals, belonging to 71 genera and 17 families, has been identified from material collected in the Kimberley Project Area (see Appendix 1). Corals from the families Acroporidae (748 specimens) and Faviidae (560 specimens) are best represented in the collections. There are also substantial collections of corals from the families Poritidae, Fungiidae and Agariciidae (294, 218 and 106 specimens, respectively). To date, 67 species of *Acropora*, 29 species of *Montipora* and 15 species of *Favia* have been identified from the existing collections (Table 1).

The Kimberley Project Area is the type locality of two species (*Australomussa rowleyensis* and *Echinopora ashmorensis*) and an additional three species of *Acropora* were described using specimens collected from within the Project Area, i.e. *Acropora loisetteae*, *Acropora russelli* and *Acropora indiana*, which was subsequently synonymised to *A. papillare* (Wallace, 1999).

Twenty species included in this dataset are denoted with cf. meaning 'compare with'. It is not our intention here to validate or revise the identifications of other taxonomists. However, a number of these records, if deemed correct, would represent important range extensions (e.g. *Acropora batunai; Acropora indonesia; Astreopora incrustans*). Thus, it will be important in the future to re-examine these specimens in order to validate the occurrence of these species in the Kimberley Project Area.

Excluding those species currently classified as cf., based upon the collection records, five species have been recorded for the first time in Australia (*Acropora pichoni, Acanthastrea brevis, Goniopora burgosi, Leptastrea aequalis* and *Pavona frondifera*). The known ranges of an additional seven species have been extended to Western Australia (*Acropora echinata, Ctenactis albitentaculata, Cycloseris somervillei, Goniopora palmensis, Halomitra pileus, Porites monticulosa* and *Scolymia vitiensis*).

Collection records suggest at least 310 species are present in the offshore bioregion and at least 225 species occur in the inshore bioregion. Twenty six species (8%) are recorded from inshore sites only and 111 species (33%) are recorded from the offshore region only (Appendix 2). The overwhelming majority of *Acropora* were collected from offshore locations (62 species compared to 39 species inshore: Table 2).

Of all the Project Area locations sampled so far, the most comprehensive collection is from Scott Reef, where 268 species have been identified belonging to 14 families (Figure 2). Two hundred and fourteen species from 14 families have been identified from Mermaid Reef and 209 species from 14 families have been collected from Ashmore Reef. Among the inshore locations sampled to date, important but not comprehensive collections have been obtained from One Arm Point (73 species), Scorpion Island (62 species), Cassini Island (61 species), Augustus Island (55 species), Montgomery Reef (53 species) and Churchill Reef (51 species).

At the family level, no locations had all 17 families represented. The greatest family level representation is Scorpion Island, where 15 of the 17 families present in the Project Area are represented in the museum collections. Representatives from a single family have been collected from 13 inshore locations (such as Beagle Bay, Steep Island, Cambridge Gulf, Collier Bay and White Island),

TABLE 1 Number of species recorded from each genus in the Kimberley Project Area.

Genus	No. species	Genus	No. species
Acropora	67	*Lithophyllon*	2
Acanthastrea	5	*Lobophyllia*	3
Alveopora	6	*Merulina*	2
Anacropora	1	*Montastrea*	4
Astreopora	7	*Montipora*	29
Australomussa	1	*Moseleya*	1
Barabattoia	1	*Mycedium*	3
Catalaphyllia	1	*Oulastrea*	1
Caulastrea	3	*Oulophyllia*	2
Coeloseris	1	*Oxypora*	2
Coscinaraea	3	*Pachyseris*	2
Ctenactis	3	*Pavona*	10
Cycloseris	6	*Pectinia*	4
Cynarina	1	*Physogyra*	1
Cyphastrea	4	*Platygyra*	7
Diploastrea	1	*Plerogyra*	1
Duncanopsammia	1	*Plesiastrea*	1
Echinophyllia	4	*Pocillopora*	6
Echinopora	6	*Podabacia*	1
Euphyllia	3	*Polyphyllia*	1
Favia	15	*Porites*	14
Favites	8	*Psammocora*	8
Fungia	11	*Pseudosiderastrea*	1
Galaxea	4	*Rhizopsammia*	1
Gardinoseris	1	*Sandalolitha*	1
Goniastrea	7	*Scapophyllia*	1
Goniopora	14	*Scolymia*	1
Halomitra	1	*Seriatopora*	2
Heliofungia	1	*Stylocoeniella*	2
Herpolitha	1	*Stylophora*	1
Heterocyathus	1	*Symphyllia*	4
Hydnophora	4	*Trachyphyllia*	1
Isopora	2	*Truncatoflabellum*	1
Leptastrea	5	*Tubastrea*	2
Leptoria	1	*Turbinaria*	8
Leptoseris	8		

suggesting they have only been superficially sampled.

All the species recorded from the Project Area have a broad distribution and none are endemic or restricted to the region. The majority of species (74%) occur in tropical Indo-Pacific locations extending from the Red Sea to the central Pacific Ocean, and an additional 2% of species are found in both tropical and temperate waters across the Indian and Pacific Oceans. Eighteen percent of species occur in the Indo-West Pacific, 5% are restricted to South East Asia and 1% are restricted to the Indo-Australian region. The proportion of globally restricted (IA-SE-WP) species occurring at offshore versus inshore locations is consistent (5% and 4% respectively).

Forty one species are recorded from only one site and 30 species are recorded only at a single offshore location. Fifteen species are known only from Scott Reef (*Ctenactis albitentaculata, Favia danae, Acropora papillare, Pavona frondifera, Leptoseris glabra, Acropora pichoni, Psammocora obtusangulta, Anacropora puertogalerae, Mycedium manacoi, Galaxea longisepta, Hydnophora pileus, Fungia moluccensis, Cycloseris somervillei, Leptoseris solida and Acropora turaki*), six species are recorded only at Ashmore Reef (*Tubastrea micranthus, Cycloseris sinensis, Fungia gravis, Acanthastrea bowerbanki, Porites eridani, Porites* cf. *australiensis*), four species are recorded only at Clerke Reef (*Euphyllia cristata, Fungia klunzingeri, Alveopora tizardi, Montipora turtlensis*), two species are known only from Cartier Reef (*Acropora russelli* and *Echinopora gemmacea*) and a single species is known from each of Mermaid Reef (*Symphyllia radians*) and Seringapatam Reef (*Acropora* cf. *batunai*).

Twelve species are recorded at only a single inshore location: *Acropora bushyensis* (One Arm Point), *Acropora dendrum* (Powerful Island), *Acropora* cf. *sarmentosa* (Scorpion Island), *Acropora verweyi* (Lord Island), *Turbinaria patula* (Broome), *Favia veroni* (Colbert Island), *Truncatoflabellum aculeatum* (Broome), *Echinophyllia echinoporoides* (Yankawingarri Island), *Goniopora eclipsensis* (George Water) and *Goniopora* cf. *norfolkensis* (Montgomery Reef).

Seven species have been collected from over 20 locations in the Project Area, indicating they are locally widespread (*Fungia fungites, Platygyra sinensis, Platygyra daedalea, Goniastrea retiformis, Goniastrea aspera, Favites abdita* and *Euphyllia glabrescens*). Other species that are well represented in the Project Area collections are *Seriatopora hystrix, Galaxea fascicularis, Stylophora pistillata, Lobophyllia hemprichii, Merulina ampliata, Polyphyllia talpina, Herpolitha limax, Porites cylindrica, Goniastrea pectinata, Turbinaria frondens, Pavona decussata* and *Cyphastrea serailia.* While a diversity of species from the genus *Acropora* have been collected in the Project Area, the existing collections may under-represent their spatial extent.

TABLE 2 Number of species recorded from each genus in the Kimberley Project Area.

Offshore only	Inshore only
Acropora (28 spp.)	*Acanthastrea* cf. *lordhowensis*
Acanthastrea (2 spp.)	*Acanthastrea hillae*
Alveopora (5 spp.)	*Acropora bushyensis*
Anacropora puertogalerae	*Acropora* cf. *dendrum*
Astreopora (4 spp.)	*Acropora* cf. *sarmentosa*
Coscinarea cf. *wellsi*	*Acropora verweyi*
Ctenactis albitentaculata	*Cynarina lacrymalis*
Cycloseris (4 spp.)	*Duncanopsammia axifuga*
Cyphastrea cf. *agassizi*	*Echinophyllia* cf. *echinoporoides*
Echinophyllia echinata	*Favia* cf. *maritima*
Echinopora (3 spp.)	*Favia veroni*
Euphyllia cristata	*Goniastrea australiensis*
Favia (5 spp.)	*Goniopora* cf. *norfolkensis*
Favites (2 spp.)	*Goniopora eclipsensis*
Fungia (5 spp.)	*Goniopora stokesi*
Galaxea (2 spp.)	*Heterocyathus aequicostatus*
Goniopora (2 spp.)	*Montipora* cf. *australiensis*
Leptastrea (2 spp.)	*Moseleya latistellata*
Leptoseris (5 spp.)	*Oulastrea crispata*
Lithophyllon mokai	*Pseudosiderastrea tayami*
Lobophyllia hataii	*Scolymia vitiensis*
Merulina scabricula	*Trachyphyllia geoffroyi*
Montastrea annuligera	*Truncatoflabellum aculeatum*
Montipora (6 spp.)	*Tubastrea coccinea*
Mycedium (2 spp.)	*Turbinaria bifrons*
Pavona (5 spp.)	*Turbinaria conspicua*
Pectinia teres	*Turbinaria mesenterina*
Physogyra lichtensteini	*Turbinaria patula*
Platygyra ryukyuensis	
Pocillopora (3 spp.)	
Porites (7 spp.)	
Psammocora (2 spp.)	
Stylocoeniella armata	
Symphyllia (2 spp.)	
Tubastrea micranthus	
Turbinaria frondens	

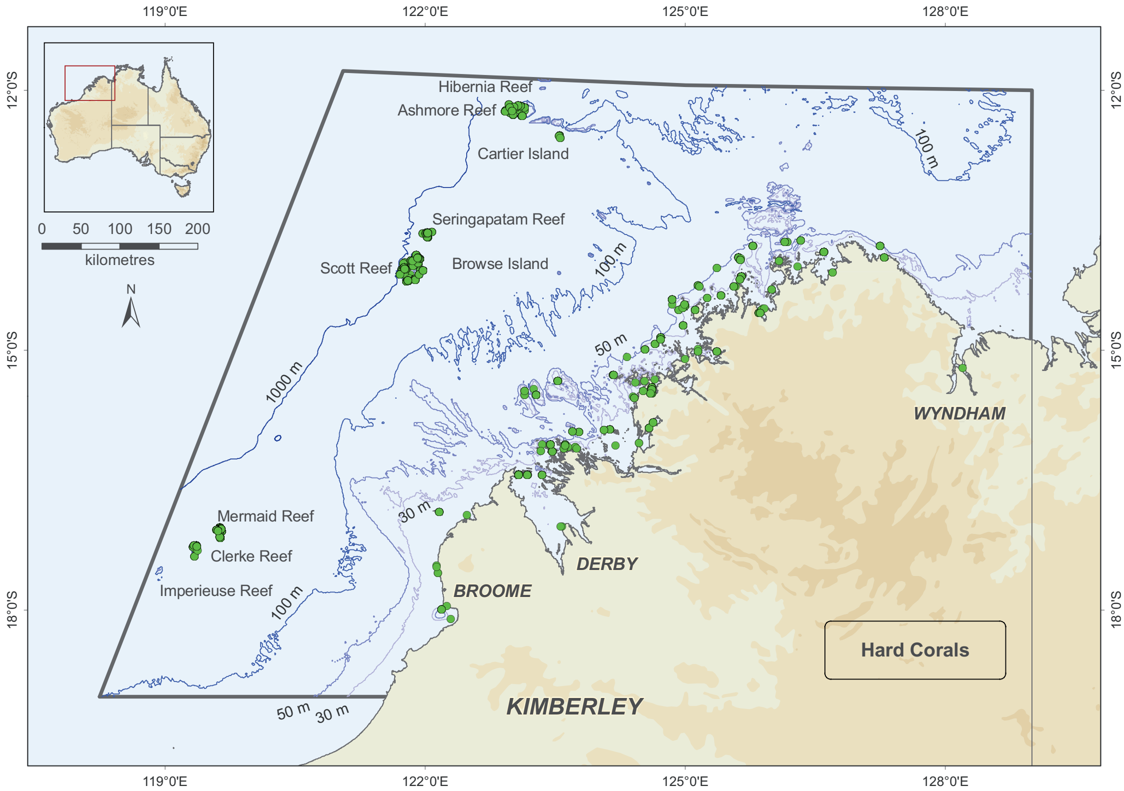

FIGURE 1 Map of the locations where hard corals have been collected historically in the Kimberley Project Area. The Project Area boundary is marked in grey. Map projection: GDA94, Scale: 1:6, 250,000.

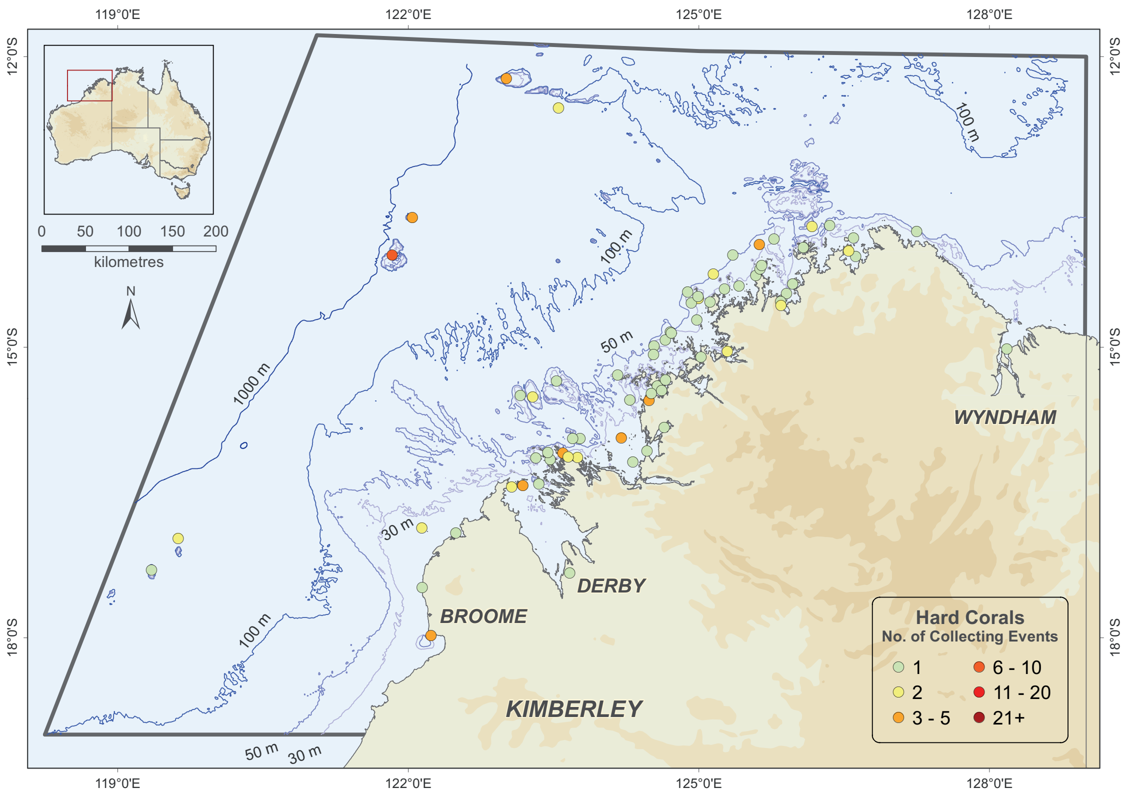

FIGURE 2 The number of collecting events conducted at each sampling location providing a level of sampling effort in the Project Area from 1889–2009. Map projection: GDA94, Scale: 1:6, 250,000.

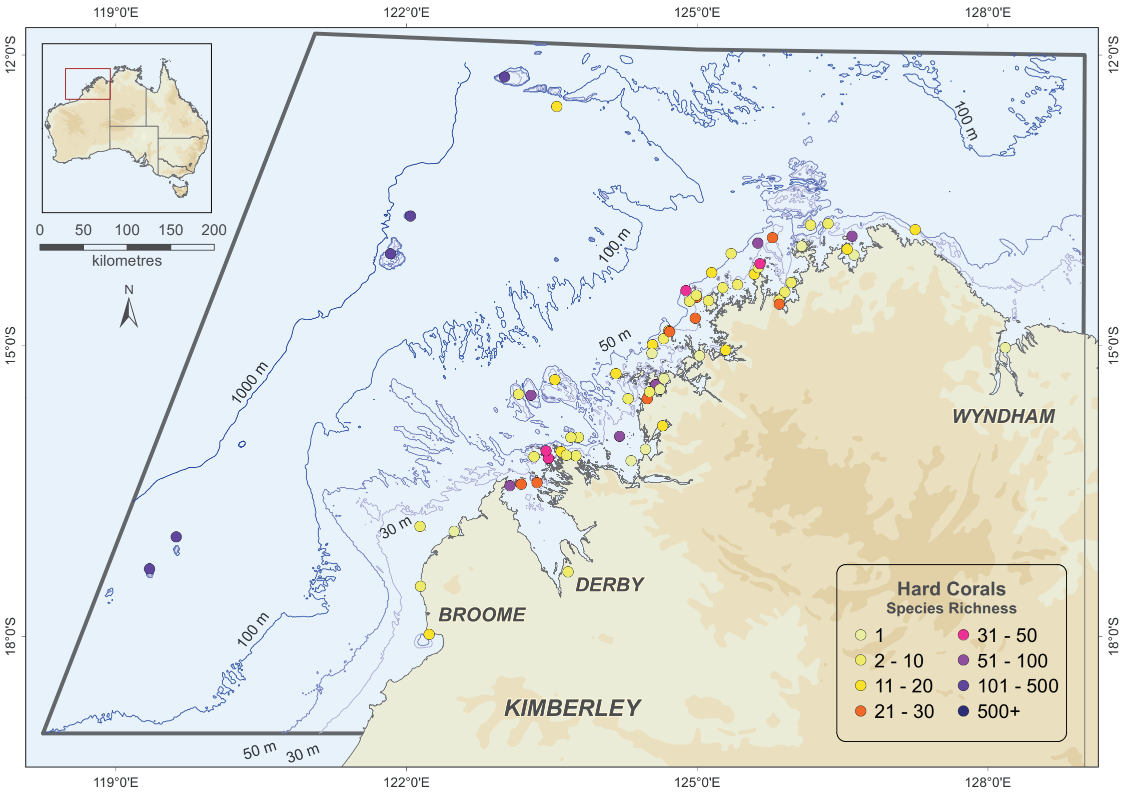

FIGURE 3 The species richness of hard corals in the Project Area based on museum collection records. Map projection: GDA94, Scale: 1:6, 250,000.

DISCUSSION

This synthesis of the skeleton-based records available for the Kimberley Project Area hard coral fauna indicates at least 338 species of scleractinian corals from 71 genera occur in the Project Area. This level of diversity is the highest recorded in Western Australia and similar to that recorded at the same latitude on the Great Barrier Reef (Devantier et al. 1998, 2006; Wakeford et al. 2008). To date, eight genera present on the Great Barrier Reef are not recorded in collection records from the Project Area (*Paulastrea, Madracis, Diaseris, Cantharellus, Heteropsammia, Blastomussa, Australogyra* and *Stylaraea*) and one genus (*Australomussa*) recorded in the Project Area has not been recorded on the Great Barrier Reef. Among the six offshore atolls and 64 coastal locations sampled to date, Scott Reef has been the most comprehensively studied. Based on current records, almost 79% of the species known to occur across the Kimberley have been recorded from Scott Reef. Sixteen of the 267 species recorded from Scott Reef (from 14 different genera) have not been recorded at any other location in the Project Area (Figure 3). Furthermore, some of these regionally restricted species have not been recorded anywhere else in Australia to date (e.g. *Acropora pichoni* and *Pavona frondifera*). Scott Reef may be a regional diversity hotspot and, as such, a critical part of the region's coral reef ecosystem. However, this remains to be verified after further targeted biodiversity research is conducted across the wider Kimberley region.

There appears to be pronounced differences in species composition between the inshore and offshore communities of the Project Area, similar to that described from the Great Barrier Reef (Done 1982). Species richness declines from offshore to inshore (309 species offshore versus 225 species inshore). There is only a small area of reef offshore (1,500 km^2) and at least three times more reef area inshore, yet the inshore communities support only a subset of the offshore species complement and there is a substantial level of species replacement moving inshore. One hundred and eleven species are recorded only at offshore locations, while 27 species are recorded only at inshore locations (Table 2). Assemblage transitions are particularly evident in the families Acroporidae and Agariciidae. Forty five percent of agaricid species (10 of 22 species) are restricted to offshore locations, whilst 43% of *Acropora* species (28 of 67 species) and five of six *Alveopora* species are only recorded offshore. Regional differences in community composition are to be expected, given the offshore and inshore ecosystems are classified within different bioregions and form separate coral reef provinces with very different habitats (Wilson and Allen 1987; Thackway and Cresswell 1998; Wilson et al. 2011; Wilson 2013). The Inshore Coastal Bioregion is defined by its macro-tidal conditions, fringing reefs and muddy rocky shores, while the Oceanic Shoals Bioregion is made up of shelf edge atolls, offshore banks and platform reef with clear water. The offshore reefs are thought to have persisted during glacial maxima and acted as refuges when sea levels were more than 100 m below present levels. Contrary to this, inshore reefs only date back ~ 10,000 years to the Holocene, after the sea level began rising to its present level (Brooke 1997). There is no evidence of Pleistocene reef development (2.5 my–12,000 yBP) in the inshore bioregion and this distinguishes these reefs from those of the Western Pilbara and West Coast Bioregions, where raised Pleistocene limestone benches and fossil reefs are well developed (Brooke 1995; Wilson 2013, 2014).

Differences in the assemblages of coral communities offshore versus inshore are also likely to be driven by physical processes and water clarity (Fabricius et al. 2005). On the east coast of Australia, the species richness of hard corals declines in association with increasing turbidity and chlorophyll (De'ath and Fabricius 2010). In the Kimberley, large diurnal tides, strong currents and the shallow bathymetry of the inshore habitats lead to high water movement and variable levels of turbidity. As the tide cycles, particulate matter is deposited and re-suspended as it is slowly transported westwards by the surface flowing South Equatorial Current, which introduces low salinity water from the Pacific into the Indian Ocean via the Timor Sea (Wyrtki 1987). Furthermore, the inshore communities must withstand additional abiotic stressors, including low tide emersion, fluctuating temperature, sun and wind conditions, physical damage from storm-generated waves and freshwater inundation (Glynn 1976; Dunne and Browne 1991).

Dynamic environmental conditions can be stressful for scleractinian corals (Philipp and Fabricius 2003). Hence, it is expected that in the Kimberley a particular suite of inshore species would be found, which are adapted to these dynamic conditions. Indeed, the collection records indicate species that are hardy and sediment/nutrient or thermo-tolerant, such as species within the genus *Turbinaria* (Done 1982; Stafford-Smith and Ormond 1992; Philipp and Fabricius 2003), reach their highest diversity inshore. In addition, other solitary and/or free-living species such as *Trachyphyllia geoffreyi*, *Truncatoflabellum aculeatum, Heterocyathus aequicostatus, Moseleya latistellata, Cynarina lacrymalis* and *Scolymia vitiensis*, which often live on soft substrata, are also only recorded inshore. The comparatively low diversity of *Acropora* in the inshore bioregion may be a reflection that *Acropora* do not survive well under these harsh environmental conditions. However, additional surveys are required to confirm this.

While corals were traditionally thought to prefer clear water because light penetration benefits photosynthesis (i.e. autotrophy by their symbiotic dinoflagellates), it is now understood that at high particle loads, some corals gain energy by increasing their heterotrophic feeding, i.e. using their tentacles to capture food from the water column (Anthony and Fabricius 2000). Hence, corals growing in the Kimberley inshore bioregion may offset the stress and low photosynthetic output accompanying high turbidity by changing their trophic mode and this sustains a positive energy balance in turbid conditions. However, while adult corals can potentially adapt to the turbid conditions (Stafford-Smith and Ormond 1992), early life stages are particularly sensitive and both coral settlement and juvenile survival are inhibited by sedimentation, especially where sediments are organically enriched (Fabricius et al. 2003).

The data presented here expand our knowledge of the range of coral biodiversity present in the Kimberley Project Area and will help support species conservation in the region. It is important to note that the historical collection records presented here may not accurately reflect the composition of contemporary assemblages. For example, a rapid visual assessment of scleractinian species richness at Mermaid, Scott and Seringapatam Reefs (McKinney 2009) reported lower numbers of species at these locations than implied by the historical records. Similarly, the most recent quantification of coral biodiversity at Ashmore and Cartier Reefs (Richards et al. 2009) reported a lower number of coral species than historical records indicate. Taxonomic inconsistency may help explain some of the differences in the contemporary and historical datasets. However, it is also probable that some species turnover has occurred throughout the region and it is rare for the entire species assemblage to be detected on a single survey.

In natural communities, species turnover occurs as a result of natural stochasticity and patch dynamics (Wu and Loucks 1995; Levin 2002), both are influenced by disturbance (Wakeford et al. 2008). Reefs in the Project Area offshore region experienced severe bleaching in 1998 and 2003. At Scott Reef, bleaching led to approximately 80% of coral cover being lost and after six years of recovery, an obvious shift in community structure had taken place (Smith et al. 2008). Most notably, there was a decline in the relative abundance of the previously dominant reef building coral family Acroporidae and relative increases of massive corals within the families Poritidae and Faviidae (Smith et al. 2008). After 12 years, coral cover, recruitment, generic diversity and community structure were similar to those observed pre-bleaching (Gilmour et al. 2013). Similarly, at Ashmore Reef changes in community structure have been documented over the last decade (Ceccarelli et al. 2011).

In order to better understand how the coral communities within the Kimberley Project Area are structured and to detect temporal changes, empirical ecological data are needed. For this reason, from 2009–2013 standardised and replicated quantitative abundance data on coral biodiversity have been collected on belt transects at over 140 stations spanning inshore, midshelf and offshore Kimberley locations (including Adele Island, Ashmore Reef, Browse Island, Champagney Islands, Cassini Island, Hibernia Reef, Long Reef, Montalivet Island, Montgomery Reef, Robroy Reefs, White Island and Wildcat Reefs) and various mid-shelf shoals, as part of the WAM Kimberley Woodside Collection Project (Richards in preparation). Preliminary results from these surveys indicate a large amount of spatial variability in species richness across the inshore coral communities, but that certain locations have exceptionally high coral diversity (e.g. Cassini Island). Further taxonomic studies, coupled with ecological analyses will provide important insights into how these communities are structured and give a clearer picture of how coral diversity varies spatially in the Kimberley Project Area.

A number of the species in this study require further examination in conjunction with the new material collected in the WAM Kimberley Woodside Collection Project. As a consequence the total species number from the region will be higher than that reported here. Furthermore, hundreds of locations in the Project Area have not been surveyed previously, including Imperieuse Reef and Holothuria Banks, and other inshore locations such as Beagle Bay, Steep Island, Cambridge Gulf, Collier Bay and Scorpion Island, which have been only superficially surveyed. It will also be important to survey the coral communities living in the nearshore and mangrove habitats, inter-reefal areas and coastal soft bottom habitats, which have received comparatively little collection effort.

The coral community within the Project Area is of great national and international significance for three important reasons. Firstly, our compilation of historical data suggests there is a high level of coral diversity in this region. Secondly, the hardy Kimberley coastal coral communities may be indicative of those species and genotypes best suited to future conditions on coral reefs (including increasing water temperature and turbidity). Lastly, the Project Area provides some of the least impacted coral reef habitat in the world. With this comes an opportunity to examine how communities are structured across environmental gradients in the absence of anthropogenic disturbance. Continuing to develop and expand research programs concerning corals within the Project Area is of profound interest to coral science and coral reef conservation.

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APPENDIX 1 Species collected from the Kimberley Project Area (1959–2009) based on voucher specimens deposited in Australian museums.

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Family: Acroporidae				
Acropora abrolhosensis Veron, 1985	H^s	IWP		•
Acropora abrotanoides (Lamarck, 1816)	H^s	IP		•
Acropora aculeus (Dana, 1846)	H^s	IP	•	•
Acropora acuminata (Verrill, 1864)	H^s	IP		•
Acropora anthocercis (Brook, 1893)	H^s	IP	•	•
Acropora aspera (Dana, 1846)	H^s	IP	•	•
Acropora austera (Dana, 1846)	H^s	IP	•	•
Acropora cf. *batunai* Wallace, 1997	H^s	SE		•
Acropora cf. *bushyensis* Veron & Wallace, 1984	H^s	IA	•	
Acropora carduus (Dana, 1846)	H^s	IP		•
Acropora caroliniana Nemenzo, 1976	H^s	IWP		•
Acropora cerealis (Dana, 1846)	H^s	IP	•	•
Acropora clathrata (Brook, 1891)	H^s	IP	•	•
Acropora cytherea (Dana, 1846)	H^s	IP	•	•
Acropora cf. *dendrum* (Bassett-Smith, 1890)	H^s	IWP	•	
Acropora cf. *desalwii* Wallace, 1994	H^s	SE		•
Acropora digitifera (Dana, 1846)	H^s	IP	•	•
Acropora divaricata (Dana, 1846)	H^s	IP	•	•
Acropora donei Veron & Wallace, 1984	H^s	IP		•
Acropora echinata (Dana, 1846)	H^s	IP		•
Acropora elseyi (Brook, 1892)	H^s	IP		•
Acropora exquisita Nemenzo, 1971	H^s	IWP		•
Acropora florida (Dana, 1846)	H^s	IP	•	•
Acropora gemmifera (Brook, 1892)	H^s	IP	•	•
Acropora glauca (Brook, 1893)	H^s	IP		•
Acropora grandis (Brook, 1892)	H^s	IP		•
Acropora granulosa (Milne Edwards & Haime, 1860)	H^s	IP		•
Acropora horrida (Dana, 1846)	H^s	IP	•	•
Acropora humilis (Dana, 1846)	H^s	IP	•	•
Acropora hyacinthus (Dana, 1846)	H^s	IP	•	•
Acropora cf. *indonesia* Wallace, 1997	H^s	SE		•
Acropora intermedia (Brook, 1891)	H^s	IP	•	•
Acropora latistella (Brook, 1891)	H^s	IP	•	•
Acropora listeri (Brook, 1893)	H^s	IP		•
Acropora loisetteae Wallace, 1994	H^s	IWP		•
Acropora longicyathus (Milne Edwards & Haime, 1860)	H^s	IP		•
Acropora loripes (Brook, 1892)	H^s	IP		•
Acropora lutkeni Crossland, 1952	H^s	IP	•	•
Acropora microclados (Ehrenberg, 1834)	H^s	IP	•	•
Acropora microphthalma (Verrill, 1869)	H^s	IP	•	•
Acropora millepora (Ehrenberg, 1834)	H^s	IP	•	•
Acropora monticulosa (Brüggemann, 1879)	H^s	IP		•
Acropora muricata (Linnaeus, 1758)	H^s	IP	•	•
Acropora nana (Studer, 1878)	H^s	IP	•	•
Acropora nasuta (Dana, 1846)	H^s	IP		•

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Acropora paniculata Verrill, 1902	H^s	IP	●	●
Acropora papillare Latypov, 1992	H^s	IWP		●
Acropora pichoni Wallace, 1999	H^s	IWP		●
Acropora polystoma (Brook, 1891)	H^s	IP		●
Acropora pulchra (Brook, 1891)	H^s	IP	●	●
Acropora robusta (Dana, 1846)	H^s	IP	●	●
Acropora russelli Wallace, 1994	H^s	IA		●
Acropora samoensis (Brook, 1891)	H^s	IP	●	●
Acropora cf. *sarmentosa* (Brook, 1892)	H^s	IP	●	
Acropora secale (Studer, 1878)	H^s	IP		●
Acropora selago (Studer, 1878)	H^s	IP	●	●
Acropora solitaryensis Veron & Wallace, 1984	H^s	IP	●	●
Acropora spicifera (Dana, 1846)	H^s	IP	●	●
Acropora subglabra (Brook, 1891)	H^s	IWP		●
Acropora subulata (Dana, 1846)	H^s	IP	●	●
Acropora tenuis (Dana, 1846)	H^s	IP	●	●
Acropora turaki Wallace, 1994	H^s	IWP		●
Acropora valenciennesi (Milne Edwards & Haime, 1860)	H^s	IP	●	●
Acropora valida (Dana, 1846)	H^s	IP	●	●
Acropora vaughani Wells, 1954	H^s	IP	●	●
Acropora verweyi Veron & Wallace, 1984	H^s	IP	●	
Acropora yongei Veron & Wallace, 1984	H^s	IP	●	●
Anacropora puertogalerae Nemenzo, 1964	H^s	IWP		●
Astreopora cf. *cucullata* Lamberts, 1980	H^s	IP		●
Astreopora expansa Brüggemann, 1877	H^s	IP		●
Astreopora gracilis Bernard, 1896	H^s	IP	●	●
Astreopora cf. *incrustans* Bernard, 1896	H^s	IWP		●
Astreopora cf. *listeri* Bernard, 1896	H^s	IP		●
Astreopora myriophthalma (Lamarck, 1816)	H^s	IP	●	●
Astreopora ocellata Bernard, 1896	H^s	IP	●	●
Isopora brueggemanni (Brook, 1893)	H^s	IP	●	●
Isopora palifera (Lamarck, 1816)	H^s	IP	●	●
Montipora aequituberculata Bernard, 1897	H^s	IP	●	●
Montipora angulata (Lamarck, 1816)	H^s	IP	●	●
Montipora cf. *australiensis* Bernard, 1897	H^s	IP	●	
Montipora caliculata (Dana, 1846)	H^s	IP	●	●
Montipora crassituberculata Bernard, 1897	H^s	IP	●	●
Montipora danae (Milne Edwards & Haime, 1851)	H^s	IP	●	●
Montipora digitata (Dana, 1846)	H^s	IP	●	●
Montipora efflorescens Bernard, 1897	H^s	IP	●	●
Montipora floweri Wells, 1954	H^s	IP		●
Montipora foliosa (Pallas, 1766)	H^s	IP		●
Montipora foveolata (Dana, 1846)	H^s	IP	●	●
Montipora grisea Bernard, 1897	H^s	IP	●	●
Montipora hispida (Dana, 1846)	H^s	IP	●	●
Montipora hoffmeisteri Wells, 1954	H^s	IP		●
Montipora incrassata (Dana, 1846)	H^s	IP		●
Montipora informis Bernard, 1897	H^s	IP	●	●

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Montipora millepora Crossland, 1952	H^s	IP	●	●
Montipora mollis Bernard, 1897	H^s	IP	●	●
Montipora monasteriata (Forsskål, 1775)	H^s	IP	●	●
Montipora nodosa (Dana, 1846)	H^s	IP	●	●
Montipora peltiformis Bernard, 1897	H^s	IP	●	●
Montipora spongodes Bernard, 1897	H^s	IP	●	●
Montipora spumosa (Lamarck, 1816)	H^s	IP	●	●
Montipora tuberculosa (Lamarck, 1816)	H^s	IP	●	●
Montipora turgescens Bernard, 1897	H^s	IP	●	●
Montipora turtlensis Veron & Wallace, 1984	H^s	IWP		●
Montipora undata Bernard, 1897	H^s	IP	●	●
Montipora venosa (Ehrenberg, 1834)	H^s	IP		●
Montipora verrucosa (Lamarck, 1816)	H^s	IP	●	●
Family: Agariciidae				
Coeloseris mayeri Vaughan, 1918	H^s	IP	●	●
Gardineroseris planulata (Dana, 1846)	H^s	IP	●	●
Leptoseris explanata Yabe & Sugiyama, 1941	H^s	IP	●	●
Leptoseris foliosa Dinesen, 1980	H^s	IWP		●
Leptoseris hawaiiensis Vaughan, 1907	H^s	IP		●
Leptoseris incrustans (Quelch, 1886)	H^s	IP		●
Leptoseris mycetoseroides Wells, 1954	H^s	IP	●	●
Leptoseris papyracea (Dana, 1846)	H^s	IP		●
Leptoseris scabra Vaughan, 1907	H^s	IP		●
Leptoseris yabei (Pillai & Scheer, 1976)	H^s	IP	●	●
Pachyseris rugosa (Lamarck, 1801)	H^s	IP	●	●
Pachyseris speciosa (Dana, 1846)	H^s	IP	●	●
Pavona cactus (Forsskål, 1775)	H^s	IP		●
Pavona clavus (Dana, 1846)	H^s	IP		●
Pavona decussata (Dana, 1846)	H^s	IP	●	●
Pavona duerdeni Vaughan, 1907	H^s	IP		●
Pavona explanulata (Lamarck, 1816)	H^s	IP	●	●
Pavona frondifera (Lamarck, 1816)	H^s	IP-not Aus/PNG		●
Pavona maldivensis (Gardiner, 1905)	H^s	IP		●
Pavona minuta Wells, 1954	H^s	IWP	●	●
Pavona varians Verrill, 1864	H^s	IP	●	●
Pavona venosa (Ehrenberg, 1834)	H^s	IP	●	●
Family: Astrocoeniidae				
Stylocoeniella armata (Ehrenberg, 1834)	H^s	IP		●
Stylocoeniella guentheri Bassett-Smith, 1890	H^s	IP	●	●
Family: Caryophylliidae				
Heterocyathus aequicostatus Milne Edwards & Haime, 1848	S^S	IP	●	
Family: Dendrophylliidae				
Duncanopsammia axifuga (Milne Edwards & Haime, 1848)	H^s/S^S	IWP	●	
Rhizopsammia verrilli van der Horst, 1922	H^s		●	●
Tubastrea coccinea Lesson, 1829	H^s		●	
Tubastrea micranthus (Ehrenberg, 1834)	H^s			●
Turbinaria bifrons Brüggemann, 1877	H^s	IWP	●	

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Turbinaria conspicua Bernard, 1896	H^s	IA	•	
Turbinaria frondens (Dana, 1846)	H^s	C	•	•
Turbinaria mesenterina (Lamarck, 1816)	H^s	C	•	
Turbinaria patula (Dana, 1846)	H^s	IP	•	
Turbinaria peltata (Esper, 1794)	H^s	C	•	•
Turbinaria reniformis Bernard, 1896	H^s	C	•	•
Turbinaria stellulata (Lamarck, 1816)	H^s	IP	•	•
Family: Euphyllidae				
Catalaphyllia jardinei (Saville-Kent, 1893)	H^s	IP	•	•
Euphyllia ancora Veron & Pichon, 1980	H^s	IWP	•	•
Euphyllia cristata Chevalier, 1971	H^s	IWP		•
Euphyllia glabrescens (Chamisso & Eysenhardt, 1821)	H^s	IP	•	•
Physogyra lichtensteini (Milne Edwards & Haime, 1851)	H^s	IP		•
Plerogyra sinuosa (Dana, 1846)	H^s	IP	•	•
Family: Faviidae				
Barabattoia amicorum (Milne Edwards & Haime, 1850)	H^s	IWP-not west IO	•	•
Caulastrea curvata Wijsman-Best, 1972	H^s	IWP	•	•
Caulastrea furcata Dana, 1846	H^s	IP	•	•
Caulastrea tumida Matthai, 1928	H^s	IWP	•	
Cyphastrea cf. *agassizi* (Vaughan, 1907)	H^s	IP		•
Cyphastrea chalcidicum (Forsskål, 1775)	H^s	IP	•	•
Cyphastrea microphthalma (Lamarck, 1816)	H^s	IP	•	•
Cyphastrea serailia (Forsskål, 1775)	H^s	C	•	•
Diploastrea heliopora (Lamarck, 1816)	H^s	IP	•	•
Echinopora ashmorensis Veron, 1990	H^s	SE-WA		•
Echinopora gemmacea Lamarck, 1816	H^s	IP		•
Echinopora hirsutissima Milne Edwards & Haime, 1849	H^s	IWP	•	•
Echinopora horrida Dana, 1846	H^s	IWP	•	•
Echinopora lamellosa (Esper, 1795)	H^s	IP	•	•
Echinopora mammiformis (Nemenzo, 1959)	H^s	IWP		•
Favia cf. *danae* Verrill, 1872	H^s	IWP		•
Favia favus (Forsskål, 1775)	H^s	IP	•	•
Favia helianthoides Wells, 1954	H^s	IP		•
Favia laxa (Klunzinger, 1879)	H^s	IWP		•
Favia lizardensis Veron, Pichon & Wijsman-Best, 1977	H^s	IP		•
Favia cf. *maritima* (Nemenzo, 1971)	H^s	IP- not WA	•	
Favia matthaii Vaughan, 1918	H^s	IP	•	•
Favia maxima Veron, Pichon & Wijsman-Best, 1977	H^s	IWP	•	•
Favia pallida (Dana, 1846)	H^s	IP	•	•
Favia rotumana (Gardiner, 1899)	H^s	IP		•
Favia rotundata (Veron, Pichon & Wijsman-Best, 1977)	H^s	IWP	•	•
Favia speciosa Dana, 1846	H^s	IP	•	•
Favia stelligera (Dana, 1846)	H^s	IP	•	•
Favia truncata Veron, 2000	H^s	IWP		•
Favia veroni Moll & Borel-Best, 1984	H^s	IP	•	
Favites abdita (Ellis & Solander, 1786)	H^s	IP	•	•
Favites chinensis (Verrill, 1866)	H^s	IP	•	•

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Favites complanata (Ehrenberg, 1834)	H^s	IP	●	●
Favites flexuosa (Dana, 1846)	H^s	IP	●	●
Favites halicora (Ehrenberg, 1834)	H^s	IP	●	●
Favites pentagona (Esper, 1794)	H^s	IP	●	●
Favites russelli (Wells, 1954)	H^s	IP		●
Favites stylifera (Yabe & Sugiyama, 1937)	H^s	SE-WA		●
Goniastrea aspera Verrill, 1865	H^s	IP	●	●
Goniastrea australensis (Milne Edwards & Haime, 1857)	H^s	C	●	
Goniastrea edwardsi Chevalier, 1971	H^s	IP	●	●
Goniastrea favulus (Dana, 1846)	H^s	WP	●	●
Goniastrea palauensis (Yabe, Sugiyama & Eguchi, 1936)	H^s	IP	●	●
Goniastrea pectinata (Ehrenberg, 1834)	H^s	IP	●	●
Goniastrea retiformis (Lamarck, 1816)	H^s	IP	●	●
Leptastrea aequalis Veron, 2000	H^s	SE-IO not WA		●
Leptastrea inaequalis Klunzinger, 1879	H^s	IP- not central IO or CP		●
Leptastrea pruinosa Crossland, 1952	H^s	IP	●	●
Leptastrea purpurea (Dana, 1846)	H^s	IP	●	●
Leptastrea transversa Klunzinger, 1879	H^s	IP	●	●
Leptoria phrygia (Ellis & Solander, 1786)	H^s	IP	●	●
Montastrea annuligera (Milne Edwards & Haime, 1849)	H^s	IP		●
Montastrea curta (Dana, 1846)	H^s	IP	●	●
Montastrea magnistellata Chevalier, 1971	H^s	IWP	●	●
Montastrea valenciennesi (Milne Edwards & Haime, 1848)	H^s	IWP	●	●
Moseleya latistellata Quelch, 1884	H^s	SE-IA	●	
Oulastrea crispata (Lamarck, 1816)	H^s	IWP	●	
Oulophyllia bennettae (Veron, Pichon & Wijsman-Best, 1977)	H^s	IWP	●	●
Oulophyllia crispa (Lamarck, 1816)	H^s	IP	●	●
Platygyra daedalea (Ellis & Solander, 1786)	H^s	IP	●	●
Platygyra lamellina (Ehrenberg, 1834)	H^s	IP	●	●
Platygyra pini Chevalier, 1975	H^s	IP	●	●
Platygyra ryukyuensis Yabe & Sugiyama, 1936	H^s	IWP		●
Platygyra sinensis (Milne Edwards & Haime, 1849)	H^s	IP	●	●
Platygyra verweyi Wijsman-Best, 1976	H^s	SE-IA	●	●
Plesiastrea versipora (Lamarck, 1816)	H^s	C	●	●
Family: Flabellidae				
Truncatoflabellum aculeatum (Milne Edwards & Haime, 1848)	H^s	IWP	●	
Family: Fungiidae				
Ctenactis albitentaculata Hoeksema, 1989	H^s	IWP		●
Ctenactis crassa (Dana, 1846)	H^s	IP	●	●
Ctenactis echinata (Pallas, 1766)	H^s	IP	●	●
Cycloseris costulata (Ortmann, 1889)	S^S	IWP		●
Cycloseris cyclolites (Lamarck, 1801)	S^S	IWP	●	●
Cycloseris sinensis Milne Edwards & Haime, 1851	S^S	IP		●
Cycloseris somervillei (Gardiner, 1909)	S^S	IWP		●
Cycloseris tenuis (Dana, 1846)	S^S	IP	●	●
Cycloseris vaughani (Boschma, 1923)	S^S	IP		●
Fungia concinna Verrill, 1864	S^S	IP	●	●

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Fungia fungites (Linnaeus, 1758)	S^S	IP	●	●
Fungia granulosa Klunzinger, 1879	S^S	IP		●
Fungia gravis Nemenzo, 1955	S^S			●
Fungia horrida Dana, 1846	S^S	IP	●	●
Fungia klunzingeri Döderlein, 1901	S^S	IWP		●
Fungia cf. *moluccensis.* Horst, 1919	S^S	IP		●
Fungia paumotensis Stutchbury, 1833	S^S	IP		●
Fungia repanda Dana, 1846	S^S	IP	●	●
Fungia scruposa Klunzinger, 1879	S^S	IP	●	●
Fungia scutaria Lamarck, 1801	S^S	IP	●	●
Halomitra pileus (Linnaeus, 1758)	S^S	IP		●
Heliofungia actiniformis (Quoy & Gaimard, 1833)	S^S		●	●
Herpolitha limax (Esper, 1797)	S^S	IP	●	●
Lithophyllon mokai Hoeksema, 1989	H^s	IP		●
Lithophyllon undulatum Rehberg, 1892	H^s	IWP	●	●
Podabacia crustacea (Pallas, 1766)	H^s	IP	●	●
Polyphyllia talpina (Lamarck, 1801)	H^s	IP	●	●
Sandalolitha robusta Quelch, 1886	H^s	IWP-not west IO	●	●
Family: Merulinidae				
Hydnophora exesa (Pallas, 1766)	H^s	IP	●	●
Hydnophora microconos (Lamarck, 1816)	H^s	IP	●	●
Hydnophora pilosa Veron, 1985	H^s	IP	●	●
Hydnophora rigida (Dana, 1846)	H^s	IP	●	●
Merulina ampliata (Ellis & Solander, 1786)	H^s	IP	●	●
Merulina scabricula Dana, 1846	H^s	IP		●
Scapophyllia cylindrica Milne Edwards & Haime, 1848	H^s	IP	●	●
Family: Mussidae				
Acanthastrea bowerbanki Milne Edwards & Haime, 1851	H^s	IWP		●
Acanthastrea brevis Milne Edwards & Haime, 1849	H^s	IWP		●
Acanthastrea echinata (Dana, 1846)	H^s	IP	●	●
Acanthastrea hillae Wells, 1955	H^s	IWP	●	
Acanthastrea lordhowensis Veron & Pichon, 1982	H^s	IWP	●	
Australomussa rowleyensis Veron, 1985	H^s	IWP	●	●
Cynarina lacrymalis (Milne Edwards & Haime, 1848)	H^s	IP	●	
Lobophyllia corymbosa (Forsskål, 1775)	H^s	IP	●	●
Lobophyllia hataii Yabe, Sugiyama & Eguchi, 1936	H^s	IP		●
Lobophyllia hemprichii (Ehrenberg, 1834)	H^s	IP	●	●
Scolymia vitiensis Brüggemann, 1877	H^s	IP- not WA	●	
Symphyllia agaricia Milne Edwards & Haime, 1849	H^s	IP		●
Symphyllia radians Milne Edwards & Haime, 1849	H^s	IP	●	●
Symphyllia recta (Dana, 1846)	H^s	IP	●	●
Symphyllia valenciennesii Milne Edwards & Haime, 1849	H^s	IP		●
Family: Oculinidae				
Galaxea astreata (Lamarck, 1816)	H^s	IP	●	●
Galaxea fascicularis (Linnaeus, 1767)	H^s	IP	●	●
Galaxea horrescens (Dana, 1846)	H^s	IP		●
Galaxea cf. *longisepta* Fenner & Veron, 2000	H^s	IWP		●

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Family: Pectiniidae				
Echinophyllia aspera (Ellis & Solander, 1786)	H^s	IP	●	●
Echinophyllia echinata (Saville-Kent, 1871)	H^s	IP		●
Echinophyllia echinoporoides cf. Veron & Pichon, 1980	H^s	IA	●	
Echinophyllia orpheensis Veron & Pichon, 1980	H^s	IP	●	●
Mycedium elephantotus (Pallas, 1766)	H^s	IP	●	●
Mycedium cf. *mancaoi* Nemenzo, 1979	H^s	IP		●
Mycedium cf. *robokaki* Moll & Borel-Best, 1984	H^s	SE		●
Oxypora glabra Nemenzo, 1959	H^s	IWP	●	●
Oxypora lacera (Verrill, 1864)	H^s	IP	●	●
Pectinia alcicornis (Saville-Kent, 1871)	H^s	IWP-not west IO	●	●
Pectinia lactuca (Pallas, 1766)	H^s	IP	●	●
Pectinia paeonia (Dana, 1846)	H^s	IWP-not west IO	●	●
Pectinia teres Nemenzo & Montecillo, 1981	H^s	IWP		●
Family: Pocilloporidae				
Pocillopora damicornis (Linnaeus, 1758)	H^s	IP	●	●
Pocillopora eydouxi Milne Edwards & Haime, 1860	H^s	IP		●
Pocillopora meandrina Dana, 1846	H^s	IP		●
Pocillopora verrucosa (Ellis & Solander, 1786)	H^s	IP	●	●
Pocillopora woodjonesi Vaughan, 1918	H^s	IP		●
Seriatopora caliendrum Ehrenberg, 1834	H^s	IP	●	●
Seriatopora hystrix Dana, 1846	H^s	IP	●	●
Stylophora pistillata Esper, 1797	H^s	IP	●	●
Family: Poritidae				
Alveopora allingi Hoffmeister, 1925	H^s	IP	●	●
Alveopora catalai Wells, 1968	H^s	IWP-not west IO		●
Alveopora fenestrata (Lamarck, 1816)	H^s	IP		●
Alveopora spongiosa Dana, 1846	H^s	IP		●
Alveopora tizardi Bassett-Smith, 1890	H^s	IP		●
Alveopora verrilliana Dana, 1872	H^s	IWP-not west IO		●
Goniopora burgosi Nemenzo, 1955	H^s	SE-IO		●
Goniopora columna Dana, 1846	H^s	IP	●	●
Goniopora djiboutiensis Vaughan, 1907	H^s	IP	●	●
Goniopora eclipsensis Veron & Pichon, 1982	H^s	SE-IA	●	
Goniopora lobata Milne Edwards & Haime, 1860	H^s	IP	●	●
Goniopora minor Crossland, 1952	H^s	IP	●	●
Goniopora cf. *norfolkensis* Veron & Pichon, 1982	H^s	SE-IA	●	
Goniopora palmensis Veron & Pichon, 1982	H^s	SE-IA	●	●
Goniopora pandoraensis Veron & Pichon, 1982	H^s	IWP/IA-not west IO	●	●
Goniopora pendulus Veron, 1985	H^s	SE-IA		●
Goniopora somaliensis Vaughan, 1907	H^s	IP	●	●
Goniopora stokesi Milne Edwards & Haime, 1851	H^s	IP	●	
Goniopora stutchburyi Wells, 1955	H^s	IWP-not west IO	●	●
Goniopora tenuidens (Quelch, 1886)	H^s	IP	●	●
Porites annae Crossland, 1952	H^s	IWP		●
Porites cf. *australiensis* Vaughan, 1918	H^s	IP		●
Porites cylindrica Dana, 1846	H^s	IP	●	●

Taxa	Habitat code	Biogeographic code	Inshore	Offshore
Porites eridani Umbgrove, 1940	H^s	SE		•
Porites lichen Dana, 1846	H^s	IP	•	•
Porites lobata Dana, 1846	H^s	IP	•	•
Porites lutea Milne Edwards & Haime, 1851	H^s	IP	•	•
Porites monticulosa Dana, 1846	H^s	IP-not WA or CP		•
Porites murrayensis Vaughan, 1918	H^s	IP		•
Porites nigrescens Dana, 1846	H^s	IP	•	•
Porites rus (Forsskål, 1775)	H^s	IP	•	•
Porites solida (Forsskål, 1775)	H^s	IP		•
Porites stephensoni Crossland, 1952	H^s	IP	•	•
Porites vaughani Crossland, 1952	H^s	IWP-not west IO		•
Family: Siderasteridae				
Coscinaraea columna (Dana, 1846)	H^s	IP	•	•
Coscinaraea exesa (Dana, 1846)	H^s	IP	•	•
Coscinaraea cf. *wellsi* Veron & Pichon, 1980	H^s	IP		•
Psammocora contigua (Esper, 1797)	H^s	IP	•	•
Psammocora digitata Milne Edwards & Haime, 1851	H^s	IP	•	•
Psammocora explanulata Horst, 1922	H^s	IP	•	•
Psammocora haimeana Milne Edwards & Haime, 1851	H^s	IP	•	•
Psammocora nierstraszi Horst, 1921	H^s	IP		•
Psammocora cf. *obtusangula* (Lamarck, 1816)	H^s	IP		•
Psammocora profundacella Gardiner, 1898	H^s	IP	•	•
Psammocora superficialis Gardiner, 1898	H^s	IP	•	•
Pseudosiderastrea tayami Yabe & Sugiyama, 1935	H^s	IP	•	
Family: Trachyphylliidae				
Trachyphyllia geoffroyi (Audouin, 1826)	H^s	IWP	•	

APPENDIX 2 Details of Project Area collections by location from 1959–2009. [OA] Offshore Atolls.

Location	Collecting year range	Species richness	No. collection events	No. families	Acroporidae	Agariciidae	Astrocoeniidae	Caryophylliidae	Dendrophylliidae	Euphyllidae	Faviidae	Flabellidae	Fungiidae	Merulinidae	Mussidae	Oculinidae	Pectiniidae	Pocilloporidae	Poritidae	Siderastreidae	Trachyphylliidae
Adele Island	1990	7	1	5	•						•		•					•	•		
Ashmore Reef[OA]	1986–1997	209	3	14	•	•	•		•	•	•		•	•	•	•	•	•	•	•	
Augustus Island	1990	55	1	14	•	•	•		•	•	•		•	•	•	•	•	•	•	•	
Beagle Bay	1988	1	1	1				•													
Beagle Reef	1991	19	1	10	•	•			•	•	•			•			•	•	•	•	
Bedford Island	1989	2	1	1									•								
Berthier Island	1996–2007	26	2	9	•					•	•		•	•			•	•	•	•	
Boomerang Bay	1987	7	1	4						•	•								•		•
Broome	1929–2002	16	4	8	•			•	•		•	•	•	•						•	
Cambridge Gulf	1995	1	1	1	•																
Camden Sound	1987–1990	21	3	8	•					•	•		•		•				•	•	•
Cape Voltaire	1976	11	1	6	•					•	•		•		•						•
Careening Bay	1987	1	1	1							•										
Cartier Island[OA]	1986–1992	19	2	8	•	•	•				•		•					•	•	•	
Cassini Island	1976–1996	51	3	13	•	•			•	•	•		•	•	•	•	•	•	•	•	
Churchill Reef	1991–1996	61	2	14	•	•	•		•	•	•		•	•	•	•	•	•	•	•	
Clerke Reef[OA]	1982	127	1	13	•	•	•		•	•	•		•	•	•		•	•	•	•	
Cockatoo Island	1963–1968	17	3	12	•	•			•	•	•		•	•	•		•	•		•	•
Colbert Island	1996	15	1	8	•	•			•		•				•	•		•	•		
Collier Bay	1998	1	1	1													•				
De Freycinet Island	1996	20	1	8	•	•					•		•		•		•		•	•	
Derby	1975	2	1	2							•					•					

Location	Collecting year range	Species richness	No. collection events	No. families	Acroporidae	Agariciidae	Astrocoeniidae	Caryophylliidae	Dendrophylliidae	Euphylliidae	Faviidae	Flabellidae	Fungiidae	Merulinidae	Mussidae	Oculinidae	Pectiniidae	Pocilloporidae	Poritidae	Siderastreidae	Trachyphylliidae
George Water	1990	20	1	6	•					•	•								•	•	•
Gibbings Reefs	1996	9	1	6	•						•		•					•	•	•	
Hale Island	1991	9	1	5	•		•		•					•				•			
Hedley Island	1996	7	1	5	•						•				•			•		•	
Heritage Reef	1991–1996	15	2	8	•	•			•		•		•	•	•		•				
James Price Point	1988	2	1	2					•		•										
Jamieson Reef	1996	2	1	2		•														•	
Jones Island	1991	6	1	5	•	•				•	•								•		
Jussieu Island	1996	23	1	5	•	•			•		•								•		
Koolan Island	1972–1986	3	2	3							•		•					•			
Kuri Bay	1991	2	1	2							•										•
Lacepede Islands	1982	10	2	7	•					•	•		•						•	•	•
Lesueur Island	1991	11	1	5	•						•		•					•	•		
Long Reef	1991	22	1	11	•	•			•	•	•		•		•	•	•	•			•
Lord Island	1991	35	1	12	•	•			•	•	•		•	•	•	•			•	•	•
Macleay Island	1996	8	1	5	•	•					•		•		•						
Malcolm Island	1976	2	1	2									•			•					
Mermaid Island	1991	23	1	7	•					•	•		•	•					•		•
Mermaid Reef[OA]	1982–2006	213	2	14	•	•	•		•	•	•		•	•	•	•	•	•	•	•	
Montgomery Reef	1987–1996	53	3	13	•				•	•	•		•	•	•	•	•	•	•	•	•
Napier Broome Bay	1991	1	1	1																	•
One Arm Point	1988	78	2	13	•	•			•	•	•		•	•	•	•	•	•	•		•
Osborne Islands	1976	2	1	1							•										
Parry Harbour	1991	1	1	1															•		

Location	Collecting year range	Species richness	No. collection events	No. families	Acroporidae	Agariciidae	Astrocoeniidae	Caryophylliidae	Dendrophylliidae	Euphylliidae	Faviidae	Flabellidae	Fungiidae	Merulinidae	Mussidae	Oculinidae	Pectiniidae	Pocilloporidae	Poritidae	Siderastreidae	Trachyphylliidae
Port George IV	1988	1	1	1																	●
Port Warrender	1976	3	1	3						●	●										●
Powerful Island	1991	43	1	11	●				●	●	●		●	●	●	●		●	●		●
Prince Frederick Harbour	1987–1997	18	2	6					●		●		●			●			●		●
Prudhoe Islands	1996	3	1	2	●															●	
Robroy Reefs	1991	39	1	12	●	●	●		●		●		●	●	●	●		●	●	●	
Rogers Strait	1990	1	1	1												●					
Scorpion Island	1991	62	1	15	●	●	●		●	●	●		●	●	●	●	●	●	●	●	●
Scott Reef[OA]	1984–2007	267	7	14	●	●	●		●	●	●		●	●	●	●	●	●	●	●	
Seringapatam Reef[OA]	1978–2007	166	4	14	●	●	●		●	●	●		●	●	●	●	●	●	●	●	
Solem Islands	1991	5	1	3					●				●				●				
Steep Island	1986	1	1	1														●			
Suffern Island	2007	4	1	2	●														●		
Sunday Island	1991–1996	29	3	10	●				●	●	●		●	●	●	●			●		●
Troughton Island	1960	8	2	4	●						●		●					●			
Turbin Island	2007	4	1	2	●						●										
Vansittart Bay	1970–1991	11	2	5	●						●		●			●			●		
Wailgwin Island	1990	2	1	1							●										
Walsh Point	1976	25	2	7					●	●	●		●			●			●		●
White Island	1996	1	1	1	●																
Wildcat Reefs	1996	20	1	7	●	●				●	●				●		●		●		
Woodward Island	1991	29	1	11	●	●				●	●		●	●	●	●		●	●	●	
Yampi Sound	1959–1981	5	2	5					●	●	●		●								●
Yankawingarri Island	1991	40	1	13	●	●	●		●	●	●		●	●	●		●	●	●	●	