FINAL DRAFT

Report on a rapid ecological assessment of the Raja Ampat Islands, Papua, Eastern Indonesia held October 30 – November 22, 2002

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RAJA AMPAT

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Final Draft

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Chapter 1

Executive Summary

1.1 Introduction

The Raja Ampat Islands, situated adjacent to the northwest coast of Papua, Indonesia is an area of outstanding biological diversity and stunning marine and terrestrial habitats. Raja Ampat is located near the heart of the 'Coral Triangle', an area encompassing northern Australia, the Philippines, Indonesia and Papua New Guinea, which has the highest coral diversity on Earth. The archipelago has one of the world's richest coral reef fish faunas, consisting of at least 1,074 species and contains large rookeries of endangered turtles. It is also an area of astounding beauty above the water, including eerie limestone pinnacles, sandy palm fringed islets and unusual ridges to reefs ecosystems.

The Raja Ampat Islands encompass over four million hectares of land and sea. This area includes the four large islands of Waigeo, Batanta, Salawati, and Misool and hundreds of smaller islands (Figure 1). Oceanographically and bio-geographically, the Raja Ampat islands lie in a region that is on the western border of the equatorial Pacific Ocean and at the northeastern 'entrance' of the Indonesian Throughflow from the Pacific to the Indian Ocean. The vast majority of the archipelago rests on one of two continental shelf areas separated by the narrow Sagewin Strait. The presence of the continental shelf edge creates a strong gradient from clear water, to wave-washed open oceanic conditions, to sheltered and turbid bays (Erdmann & Pet 2002).

These remote and sparsely populated islands contain a wealth of natural resources. Depletion of similar wealth elsewhere in Indonesia and in the Philippines has resulted in fishing vessels from outside the archipelago, and the sphere of local custom ownership, visiting the area to exploit resources for the lucrative markets that deal in live reef food-fish, turtle shell and shark fin. Non-residents have introduced destructive fishing techniques, including the use of explosives and cyanide.

Whilst the majority of the population live within subsistence economies, integration into the cash economy is a rapidly growing phenomenon. Villagers feel powerless and disenfranchised by outsiders depleting the natural capital held within customary estates. This has lead to some local people becoming involved in the illegal activities in a desperate bid to gain from the exploitation of 'their' resources. Recent devolution of central government power to the regions has seen the establishment of the Raja Ampat Regency. This is seen as an opportunity for the remote communities of the archipelago to have representation that will exhibit greater custodial responsibility for natural resource management. This also offers a unique opportunity to assist the new administration to include conservation in its development planning.

This report stems from a three-week voyage through the Raja Ampat archipelago. It describes an integrated rapid biodiversity assessment for the eastern and southern areas of the Raja Ampat Islands. The survey was conducted from 31st October to 22nd November 2002 and involved a partnership that included The Nature Conservancy and WWF Sahul. Focal areas of the research were marine species biodiversity and ecosystems quality, terrestrial ecosystems and threats, and socio-economic studies of local communities utilizing natural resources. Information gathered will be used in developing conservation actions under the Ecoregions of New Guinea program being developed by multiple partners in Papua (Indonesia) and Papua New Guinea. The survey built upon similar surveys in the northern areas of Raja Ampat by Conservation International in collaboration with the University of Cenderawasih and LIPI-Oseanologi (McKenna et al. (2002) and by TNC in collaboration with the Henry Foundation and NRM/EPIQ (Erdmann and Pet, 2002).

The goal of the REA was to identify potential conservation targets, sites, and to recommended strategies by building on previous studies and assessments and indigenous knowledge. To achieve this goal, the REA team sought the objectives listed in Table 1.

Table 1. Objectives of the Rapid EcologicalAssessment in Raja Ampat

OBJECTIVE	ACTION
Complement and complete existing data on marine biodiversity and ecosystem condition.	• Implement assessments around Salawati, southwestern Fam, and south and west Kawe Islands • Implement comprehensive assessments at Misool (particularly the southeastern area) and eastern Wayag Islands • Generate data on sea turtles and dugongs, including species occurrence, distribution, status, threats and uses through direct observation and community consultations • Record seabird and cetacean occurrence and activities, especially evidence of seabird nesting • Document coral bleaching and identify resistant sites and correlation with resistance factors if relevant.
Determine and map vegetation types and condition, including biodiversity indicators and species of special interest.	• Collect quantitative and qualitative data on forest type and species • Implement general assessment of forest condition and frequency assessments of species of interest • Identify specific conservation assets • Determine uses of and threats to forest communities • Determine forest conservation needs, opportunities, and possible approaches.
Implement socio-economic assessments, including:	• Uses and degree of dependence on different resources, marine and terrestrial • Extent of immigrant (non-Papuan) activities and their impacts on coral reefs and other marine resources • Traditional user rights, customary land/sea tenure and participatory mapping of areas of perceived traditional ownership • Customary laws and practices governing resource use and control mechanisms (e.g., sasi gereja).
Recommend priority conservation actions.	• Assess value, condition, and conservation needs of existing MPAs and include or exclude from recommended network of sites • Identify potential new conservation sites • Identify conservation targets based on conservation value, measures of viability (including prospects for long-term survival, threat status and opportunities) • Identify priority conservation strategies and actions for follow-up, including activities to: ➢ Strengthen management of existing sites ➢ Establish new conservation areas ➢ Engage communities and local government in conservation planning and action ➢ Approach and process the establishment of a cluster of resilient and mutually replenishing MPA sites.

1.2 Methodology

Site selection for the REA involved a pre-survey analysis of nautical charts, existing literature and satellite images (cf. Appendix 7) to give a broad cross-section of marine habitats (fringing reefs, drop-offs, lagoon reefs, etc.) and to complement rather than duplicate existing studies. Logistical considerations, including landing the terrestrial, socio-economic and turtle teams were also factors that determined site selection. Local dive operators were consulted, including Edi Frommeweiler who runs the live-aboard dive boat Pindito, which served as a floating survey station. Detailed site selection was decided upon arrival at the general area for survey and was dependent on weather and sea conditions. Teams were serviced by three Zodiac tenders plus a 9m speedboat tender made available by WWF Sahul, Sorong Office.

The marine survey team visited a total of 59 sites (**Table 2**). Coral, mangrove, seagrass, other marine habitats, and turtle nesting beaches were plotted and surveyed. A list of fishes was compiled for 50 sites. The survey involved about 70 hours of scuba diving to a maximum depth of 52m and relied on the experience and depth of knowledge of the specialist. Each dive included a representative sample of all major bottom types and habitat situations, for example rocky intertidal, reef flat, steep drop-offs, caves, rubble and sand patches. A formula for predicting the total reef fish fauna was employed, based on the number of species in six key indicator families.

Coral reefs at 51 locations were characterized. At 43 of the locations, sites were surveyed at two depths and, at each site, the reef was assessed through an inventory of coral species, health, and habitat characteristics over sections of reef from 100 to 300m in length. At the end of each swim, the inventory was reviewed and each taxon was categorized in terms of its relative abundance in the community.

The terrestrial survey team identified areas of natural habitat, disturbed habitat, unusual vegetation types, cleared areas, and identified through observation key floral and faunal groups. Based on analyses of natural vegetation types, values were assigned to islands with regard to area, shape, topography, geology, vegetation types, natural habitats, and disturbance factors. Using a weighted ranking system, these values were used to identify areas of high biodiversity/conservation value, and which represent the diversity of terrestrial habitats in the islands.

The turtle nesting component focused on scouring beaches for nesting evidence and the incidence of disturbance and predation. A member of the dive team recorded underwater sightings and village interviews sought local knowledge on patterns of seasonality and exploitation.

The socio-economic team conducted interviews with local communities to gain information on economic activities (subsistence, artisanal, commercial), the roles of external and local players, and scale of threats to livelihood. Discussions were held with a range of stakeholders to assess local capacity for protected area and/or natural resource management. Focus group discussions were organised in major centres to hear the range of issues confronting natural resource management in the remote communities. Later, interviews were conducted with officials in Sorong from Fisheries, Forestry and Conservation departments.

Figure 1. Raja Ampat archipelago indicating the route of the Pindito during the REA.

Table 2. Sites surveyed during the REA.

REF #	DATE	*SITE NAME*	LATITUDE	LONGITUDE
D1	01/11/02	Salawati: Pulau Senapan/Jef Doif	0°53.089'S	131°01.677'E
D2	01/11/02	Salawati: Pulau Senapan/Jef Doif	0°54.002'S	131°01.835'E
D3	02/11/02	NE Batanta: long inlet	0°47.900'S	130°51.977'E
D4	02/11/02	N Central Batanta: divided bay E of Warai Bay	0°48.856'S	130°38.861'E
D5	03/11/02	Batanta: Tanjung Mabo	0°55.428'S	130°23.279'E
D6	03/11/02	Batanta: Bulbous headland E of Tg Mabo	0°55.283'S	130°28.606'E
D7	04/11/02	Misool: N Wagmab (island chain)	2°00.149'S	130°37.893'E
D8	04/11/02	Misool: N Farondi (island chain E)	2°00.306'S	130°38.630'E
D9	04/11/02	Misool: S Wagmab (island chain E)	2°00.518'S	130°37.943'E
D10	05/11/02	Misool: E Bajampop	1°59.212'S	130°29.545'E
D11	05/11/02	Misool: Mesemta	1°57.163'S	130°29.500'E
D12	05/11/02	Misool: Bajampop	1°58.814'S	130°28.927'E
D13	06/11/02	Misool: Papas Tip Pale	1°57.179'S	130°21.495'E
D14	06/11/02	Misool: Papas Tip Pale	1°56.642'S	130°22.499'E
D15	07/11/02	Misool: N Djam	2°07.253'S	130°32.758'E
D16	07/11/02	Misool: SW Kalig	2°13.802'S	130°30.076'E
D17	07/11/02	Misool: SW Mate	2°07.542'S	130°22.372'E
D18a	08/11/02	Misool: Los	2°06.970'S	130°18.454'E
D18b	08/11/02	Misool: Los	2°06.970'S	130°18.454'E
D19	08/11/02	Misool: Jef Pelee (inner W bay)	2°11.423'S	130°14.961'E
D20	08/11/02	Misool: Watjoke (W of Jef Pelee)	2°11.600'E	130°11.600'E
D21	08/11/02	Misool: Jef Pele (outer W bay)	2°11.500'S	130°13.600'E
D22	09/11/02	Misool: Pulau Tiga (SW side middle island)	2°01.949'S	130°00.587'E
D23	09/11/02	Misool: opposite middle P. Tiga	2°01.446'S	130°01.128'E
D24	09/11/02	Misool: Jef Bi	2°00.968'S	130°00.918'E
D25	10/11/02	Misool: Cot Malankari	1°49.184'S	129°38.380'E
D26	10/11/02	Misool: Nampale NW	1°46.539'S	129°36.937'E
D27	10/11/02	Misool: channel between Kanari & Kamet	1°48.306'S	129°38.978'E
D28	12/11/02	Kofiau: S Walo	1°16.549'S	129°39.622'E
D29	12/11/02	Kofiau: Anjoean	1°15.299'S	129°44.452'E
D30	12/11/02	Kofiau: S Miatkari Island	1°13.886'S	129°48.195'E
D31	13/11/02	Kofiau: Wambong Bay	1°12.370'S	129°55.385'E
D32	13/11/02	Kofiau: Tg Sool	1°10.053'S	129°57.638'E
D33	13/11/02	Kofiau: Deer island	1°08.894'S	129°51.058'E
D34	14/11/02	Waigeo: Selpele	0°12.030'S	130°14.278'E
D35	14/11/02	Waigeo: N of pearl farm	0°10.784'S	130°15.157'E
D36	14/11/02	Waigeo: E of pearl farm	0°11.384'S	130°15.935'E
D37	15/11/02	Sayang: N-center	0°19.465'N	129°52.806'E
D38	15/11/02	Sayang: small island W	0°17.332'N	129°52.299'E
D39	15/11/02	Sayang: Ai Island S	0°20.248'N	129°51.556'E
D40	15/11/02	Sayang: bommies W	0°17.756'N	129°51.680'E
D41	16/11/02	Wayag: small island W	0°10.715'N	129°59.686'E
D42	16/11/02	Wayag: large bay W	0°10.068'N	130°01.402'E
D43	17/11/02	Wayag: center-east	0°08.594'N	130°03.817'E
D44	17/11/02	Quoy: islets to south	0°07.491'N	130°07.580'E
D45	17/11/02	Bag: southeast	0°05.707'N	130°14.267'E
D46	17/11/02	Uranie: east	0°06.095'N	130°16.290'E
D47	17/11/02	Uranie: west bay	0°06.297'N	130°15.102'E
D48	18/11/02	Kawe: middle E bay, S side	0°01.997'S	130°07.886'E
D49	18/11/02	Kawe: southern peninsula E bay	0°02.153'S	130°09.280'E
D50	18/11/02	Kawe: inner E bay, S side	0°2.419'S	130°7.886'E
D51	19/11/02	Waigeo: rocks at mouth of Tl Fofak	0°1.183'S	130°44.193'E
D52	19/11/02	Waigeo: island S Tl Fofak opposite mouth	0°2.806'S	130°43.917'E
D53	19/11/02	Waigeo: reef W of Delphine Is, E Fofak Bay	0°2.720'S	130°46.056'E
D54	20/11/02	Waigeo: Boni island, N reef	0°0.646'S	131°03.510'E
D55	20/11/02	Waigeo: bay W of Boni Island	0°3.516'S	131°2.961'E
D56	20/11/02	Waigeo: Boni island, S reef	0°3.787'S	131°4.506'E
D57	21/11/02	Waigeo: Wayam island S side	0°23.938'S	131°15.358'E
D58	21/11/02	Waigeo: Wayam island N side	0°23.534'S	131°15.529'E

1.3 Results

Detailed presentation of findings from the individual components of the REA is contained within the chapters that follow. The key findings of the research in each component is as follows:

1.3.1 Socio-economic Conditions

Soon after the completion of the REA, the administrative structure of Raja Ampat changed significantly. The central government of Indonesia is in the process of devolving power to the regions. In so doing, fourteen new Regencies (*Kabupatens*) have been created in Papua, including Kabupaten Raja Ampat, whose Regency seat will be located at Waisai on Waigeo Island. The new government will be required to implement certain basic activities, including mapping of land-use plans for the area. This offers a unique opportunity to assist the new administration to include conservation in its development planning.

Speakers of indigenous Raja Ampat languages number just 10% of the population. Descendent communities of migrants from Ceram, Biak and elsewhere – known collectively as old migrants – also claim access rights, beyond subsistence use, to customarily held resources. In general, old migrant communities tend to be more integrated into the cash economy and are, consequently, more market oriented. The majority of the population of Raja Ampat, however, live within subsistence economies, supplemented when possible by small-scale trade in marine invertebrates. Growing cash dependence, in combination with increased prices of basic commodities and a decline in the price of copra, severely impact villager's livelihood. This has caused an increase in the dependence on marine resources as a commercial commodity, which has prompted some to adopt illegal fishing practices, including the use of explosives and cyanide, in order to meet cash needs. In some cases, village leadership has sold access to forestry resources in designated conservation areas that fall within areas of customary ownership as a means of easing the cash burden.

Claim to traditional ownership of resources and adherence to custom law is relatively strong among villagers. However, the archipelago is a very large and sparsely populated area. Consequently, vigilance against resource exploitation from non-residents is limited. The prevalence of destructive fishing, practiced primarily by outsiders and often endorsed by figures of authority, leave villagers feeling powerless to act in the face of depletion of their natural capital. Some young people feel disenfranchised by outsiders exploiting customarily held marine resources and so choose to participate in destructive fishing activities because they see no alternative. However, whilst there exists some erosion of regard for customary resource management, traditional councils and church and youth groups provide useful vehicles for implementing some conservation initiatives at the community level.

The establishment of *Kabupaten* Raja Ampat is an opportunity for government to develop social services and infrastructure in remote communities that were not apparent under the wider governance of Sorong. Opportunity exists to integrate long-term conservation planning into this process and to focus administrative and enforcement capacity to deliver sustainable community development that does not deplete the natural resources that underpin the way of life enjoyed by village communities.

1.3.2 Coral Reef Fishes

The Raja Ampat islands have one of the world's richest coral reef fish faunas, consisting of at least 1,074 species of which 899 (84%) were observed or collected during the present survey. Allen (2002) previously reported 970 species from this area. The present REA resulted in 104 new records for the Raja Ampats, including four new records for Indonesia. This is the third highest count for any similar-sized location, being surpassed only by Milne Bay Province, PNG (1,109 species) and Maumere Bay, Flores, Indonesia (1,111 species). However, the Milne Bay and Maumere data is based on long-term surveys, featuring more intense collecting activity. The Raja Ampat total is the world's highest for a survey based mainly on visual observations.

The dominant fish families of the Raja Ampat islands are typically well represented on coral reefs throughout the vast Indo-west and central Pacific region. The most speciose families are gobies (Gobiidae; 137 species), damselfishes (Pomacentridae; 114 species), wrasses (Labridae; 109 species), cardinalfishes (Apogonidae; 73 species), groupers (Serranidae; 58 species), butterflyfishes (Chaetodontidae; 40 species), blennies (Blenniidae; 35 species), surgeonfishes (Acanthuridae; 34 species), snappers (Lutjanidae; 32 species), and parrotfishes (Scaridae: 28 species). These 10 families collectively account for 660 species or 62.5 percent of the total reef fauna.

Regression statistics based on the number of species in the families Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae indicates that the total projected reef fish fauna of the Raja Ampat islands consists of approximately 1,149 species. Therefore, at least another 75, mainly cryptic species could be expected from the area.

Four of the six richest sites were located at Kofiau. Moreover, the highest count recorded by Gerry Allen for a single dive, 284 species, was obtained at Wambong Bay. The previous high of 283 species was recorded during the CI Raja Ampat RAP survey in 2001 at Kri Island. A total of 200 or more species is generally considered as the benchmark for an excellent fish count at a given site. This figure was obtained at 50 percent of Raja Ampat sites, the highest percentage for any area that has been previously surveyed in the "Coral Triangle."

1.3.3 Coral Diversity and the Status of Coral Reefs

Raja Ampat is known to have the highest diversity of hard corals for an area of similar size anywhere in the world. The archipelago is expected to harbor over 75% of worlds known coral species. A total of 488 scleractinian corals were identified during this REA. In addition, at least a further 35 species are awaiting identification in consultation with reference collections. Of these, 13 are expected to be new to science. This compares to 445 species in North Sulawesi, 379 species in Milne Bay and 347 in Kimbe Bay, PNG. Including a similar survey in 2001, this brings the total number of species confirmed for Raja Ampat to at least 537 scleractinian species of coral. Soft coral diversity was also very high. At least 41 of the 90 Alcyonacean genera known worldwide were recorded.

Overall, reefs and coral communities in the Raja Ampat area were in very good health. Coral cover was moderate at about 33%. However, reefs did not appear to be suffering from any recent serious detrimental effects. There was no obvious evidence of the bleaching events that caused extensive mortality to reefs in the region in 1998. No evidence of current or recent crown-of-thorns starfish outbreaks or other coralivorous impacts. There was very little sediment and pollution impact.

Raja Ampat had many unusual coral habitat and coral community types. This was particularly apparent around Misool Island and Wayag Island. Many reefs did not show known or predictable zonation of coral communities. In addition, vertical (depth related) distribution of many coral species was different than what would be expected. Community types also did not demonstrate strong geographic separation. However, water movement, clarity and exposure appears to play a much stronger role in determining community types.

Raja Ampat has high hard coral richness because of its regional position near the center of the 'coral triangle'. It contains high diversity of habitat types, both typical and atypical, and a large variety of coastal and bathymetric profiles. The relatively unspoiled aspect of the reefs in this area helps maintain its high diversity. However, development and an increase of exploitation by human activities in the area would threaten this situation.

Many of the reefs of Raja Ampat appear to have high resilience. Reef complexes around Misool and Kofiau in the southern region demonstrated high survival from the 1998 bleaching event and support strong recruitment in the form of numerous established young coral colonies. This high survival may be attributable to the cooling of heated water by current-induced vertical mixing with deeper cooler water, protection of some communities from damage by sunlight through high island shading, and stress hardening for those shallow coral communities exposed during low tides.

1.3.4 Status of Sea Turtle Populations

This component of the REA identified two areas that host major sea turtle rookeries. The small beaches and coves of the south Misool island chain contain nesting areas for, primarily, Hawksbill turtles (*Eretmochelys imbricata*). The scattered nature of this nesting habitat provides this species with some protection against the typically large subsistence egg harvest and commercial exploitation of the turtle shell. Beaches located on islands contained the highest frequency of nesting evidence. Nesting abundance on mainland Misool beaches was not so prominent. This is thought to be due to proximity of human populations, the frequency of use by transiting fishermen and the occurrence of wild boar that are known to predate eggs from nests.

The islands of Sayang and Piai in northwest Waigeo contain large and concentrated rookeries of Green turtles (*Chelonia mydas*). The timing and magnitude of nesting on these islands is well known to local villages and to commercial turtle poachers. The islands are remote from populated islands and this allows turtle poachers greater ease to carry out their trade. Amid the hundreds of Green turtle nesting depressions lay the evidence of egg collectors and the carapaces of 68 Green turtles. Additional to this subsistence mortality, there is anecdotal evidence from villagers claiming that boats from outside of Raja Ampat visit the area to capture Green turtles for the Bali market.

The archipelago is not known to contain nesting habitat for Leatherback turtles (Dermochelys coriacea). However, there are seasonal sightings of this species by villagers in the straits that separate the main islands. As there is a large Leatherback rookery on the north coast of the Birdshead Peninsular, it is thought that Raja Ampat is a major migration route for Papuan Leatherbacks.

1.3.5 Coastal Botanical Survey

The botanical component of the REA categorised eight principal communities (mangroves, swamp forest, beach forest. lowland forest on deep mineralized soil, secondary forests, savanna, lowland forest on limestone karst, and lowland ultrabasic scrub and forest).

Raja Ampat mangroves are markedly depauperate except in a few places where estuarine flats and tidal rivers have provided ample habitat for the *Bruguiera-Rhizophora* associations. Among investigated sites, the best examples of this community were seen on Misool, along the lower Gam and Kasim rivers. At the second locality, there is a well-developed upstream sequence of mangrove succession. However in most parts of the archipelago, mangroves are sparingly represented.

Sago forests are scattered through the Raja Ampat islands, wherever inundated soils are present. Although floristic diversity is very low, the sago association is of considerable subsistence value as a source of dietary starch obtained from the pith. Beach forests are mostly composed of widely distributed or pantropical taxa, but have been reduced over much of their former range because of anthropogenic pressures. A good example of typical beach forest is present at north Kofiau. On uninhabited Sayang Island, a different sort of beachfront association was recorded on sandy flats.

Lowland forest was found on deep mineralized soil near Kapatlap on Salawati, and on the north and south shores of Batanta. This was probably the most species-rich environment from the survey. In western Raja Ampat, deep soil habitats are generally absent except in the flood plain of large rivers, or in the ravines on limestone karst. Such areas have tall forests comparable to the Batanta/Salawati formations, but are species-poor and of limited size.

Grassy savannas were recorded only at western Misool, at the mouth of the Kasim River and further inland near the Waitama tributary. Both communities are Melaleuca dominant. The communities at both sites are apparently under substrate control, with characteristic occurrences on flat or gently rolling terrain underlain by hardpan and alumina deposits. Although the savannas in Raja Ampat are affected to some degree by fire, the substrate patterns suggest the communities are a long-term response to stable edaphic factors.

Excellent examples of karst vegetation are found in the Misool chain, particularly in the southwest complex of small islets and at the western end of the Misool mainland. Within the Waigeo group, extensive limestone habitats were explored near Aljoei and at Wayag. The survey team explored the ultrabasic zone in a series of ascents along buttress ridges. Most of the vegetation consisted of xeromorphic scrub or woodland. Endemism in such environments was very high, but fire influence was noted at several sites.

1.3.6 The Live Reef Food-Fish Trade

Net cages that hold fishes that are commonly targeted for sale in the live reef food-fish trade contained a very narrow range of species. The contents of holding facilities were inspected whenever they were encountered. Overwhelmingly, the nets contained a moderate number of female coral trout (*Plectropomus leopardus*) and a few juvenile Napoleon wrasse (*Cheilinus undulatus*). Conspicuous by their absence was species of rock cod (*Epinephelus* spp.) and the square tailed coral trout (*P. areolatus*). Gerry Allen reported 14 Napoleon wrasse and rare grouper sightings in 70 hours of scuba diving during the current REA.

A fisherman in Waigama confirmed that divers used cyanide to stun and capture Napoleon wrasse and that grouper spawning aggregations were intensively targeted using hook and line. The general impression gained from interviews was that while some local fishermen participated in the poison fishery, it was primarily non-residents that carried out this activity and that local fishermen targeted known aggregations using hook and line. This is consistent with the findings of Erdmann and Pet (2002).

There are a number of conclusions that might be made from the limited information gathered during this REA and previous assessments. The clearest of these is that Napoleon wrasse is overfished. Just one large male was encountered in the water and one other in a net cage at PT Yellu Mutiara pearl farm. All others were juvenile, indicating that spawning stock could be severely depleted. The species is long lived and has a low replacement capacity, making it highly susceptible to overexploitation (Sadovy, 2002). The second conclusion is that, given the absence of male (larger than about 60cm) *P. leopardus*, it could be presumed that spawning aggregations have been targeted heavily. This species spawn in multiple small aggregations on patch reefs and bommie fields. It is generally only the large dominant males that attend the spawning aggregations and they tend to arrive prior to, and leave later than, the females and are known to visit multiple sites, thereby making themselves more susceptible to aggregation fishing (*Zeller, 1998*). Spawning *P. areolatus*, *Epinephelus fuscoguttatus* and *E. polyphekadion* tend to gather in large aggregations in deepwater passages that are highly susceptible to rapid overexploitation. Consequently, the third conclusion could be that such aggregations have been fished beyond critical levels, which elsewhere has precluded reformation (Jennings and Lock, 1996).

The pattern that typifies live fish trade operations elsewhere in Indonesia and in the Pacific is that an export peak is attained followed by decline within a small number of years. Based on observations and interviews in this and previous assessments, it can be reasonably concluded that the fishery is in decline and that it will inevitably prove unviable. Fishermen at Fafanlap said that stocks of bêche-de-mer and trochus were severely depleted. As cash needs become greater and incomes from fishing decline, there is a possibility that blast fishing could re-emerge as the illegal fishing method of choice following its partial displacement by the higher value poison fishery. Erdmann and Pet (2002) found a high frequency of evidence of blast fishing. Yet, this survey as with McKenna et al. (2002), found little to endorse this finding. Notwithstanding this, blast fishing clearly occurs and there is an urgent need to augment, or at least activate, the existing enforcement capacity currently based at Sorong.

1.3.7 Shark Fin Fishery

One of the more disturbing features of the REA in Raja Ampat was the dearth of shark sightings. Sharks were virtually absent at nearly every survey site, which is typical for most areas in Indonesia and the Philippines (G. Allen – Chapter 3). The paucity of reef sharks is at least partly explained by the shark-fin trade, which has operated steadily throughout Indonesia for at least the past three or four decades. Anecdotal information regarding shark fishing in the Kapadiri area of Waigeo indicated that villagers were paid from Rp1,800,000 to Rp3,000,000 per kilogram of shark fin, depending on quality. The village has a deal with a company in Sorong to concede access to the company fleet. According to villagers, the company pays only Rp500,000 for access, but in return has the carcasses of small and medium-sized sharks brought to shore for the villagers to eat. The larger sharks are dumped. The villages have an ongoing relationship with fishing boats from the Philippines. Virtually all of the support to the village of Kapadiri comes from the Philippine fishing companies who have donated roofing, generators and outboard motors. Again, it seems that non-residents are the primary perpetrators of unsustainable and illegal fishing activity. They are also the greatest beneficiaries. The natural capital of traditional owners is dissipated for a small amount of compensation and the provision of some basic needs that are otherwise unavailable to villagers in remote communities.

Figure 2. Shark fins at a Sorong restaurant (photo by Pawel Achtel).

1.3.8 Priority Conservation Areas

Each component of the REA identified the areas of greatest conservation value and priority. Misool and Kofiau emerged as the highest priority areas for conservation effort, followed closely by islands in Waigeo including P. Sayang, P. Ai and the Wayag group.

The socio-economic component of the REA emphasised that the main issue to be taken into account when devising a conservation initiative for Raja Ampat is that it should provide for the needs of local communities in relation to the ability to earn enough cash to purchase goods and services that cannot be fulfilled from their subsistence way of living. Encouraging local communities to terminate non-sustainable exploitation of resources without providing cash generating alternatives will fail. Secondly, it is important that conservation programs acknowledge and strengthen customary ownership of resources through a participatory process. Considering that there are significant areas in Raja Ampat that have already been declared as protected areas, plus the plan to promote certain areas to be World Heritage (e.g. Kofiau and Wayag), any protected areas in Raja Ampat has potential for successful implementation of a conservation program, so long as the conditions proposed above are met.

General fish diversity was high throughout the Raja Ampat islands. Kofiau consistently had the highest species counts per site (a remarkable average of 228 species). However, other factors need to be considered in assessing the conservation potential of various sites. Underwater and above water aesthetic quality needs to be considered but is difficult to quantify. The following areas are priorities: Kofiau Group, the southeastern "tail" of Misool, and the Wayag Islands.

Misool had the highest diversity of coral community types. Nine out of the 11 distinct coral community types that were identified in Raja Ampat were found in this area. The most uniform area was Kofiau Island. The Misool area, particularly the southwest, has a tremendous variety of habitat types, mostly unusual and unexplored. This would be a priority area for conservation. Second is Kofiau Island, which has probably the highest diversity of coral species for a small island. Wayag Island and its surrounds have outstanding natural beauty and the reefs probably harbour many unusual coral communities.

The botanical survey component of the REA judged conservation priorities on the basis of endemism. The ultrabasic and limestone vegetation are the highest value communities in the Raja Ampat. As presently known, the ultrabasics have more species endemic to its habitats than any of the other communities. The most valuable survey locations are thus the Misool karst and Waigeo. In most Raja Ampat forests, the canopy is composed of major exportable timbers. Although the current concession areas are habitats with good capacities for tree growth, the ultrabasics and limestone karst have stunted vegetation of little value as logging targets, and are at lesser economic risk.

The sea turtle component of the REA judged the south Misool island chain and the northwestern islands of Waigeo as the areas of highest conservation value based on the rookery habitat for Green and Hawksbill turtles at these locations.

1.4 Current Conservation Initiatives

Sorondanya (2003) listed the protected areas that have been established and proposed within the Raja Ampat archipelago (listed below). Of the six established protected areas, five are strict nature reserves, cagar alam, and there is one marine wildlife sanctuary, suaka margasatwa laut. The designation of areas as strict nature reserves seems to mean little to villagers and the management and enforcement issues that accompany designation would appear to be insufficient if existent. There is a need to convert these "paper parks" to meaningful protected areas that allow a variety of activities and engender real custodial responsibility for resource management with enforcement and prosecution support from the Regency government.

Established Conservation Areas:

- S.M.L. – Kepulauan Raja Ampat – 60,000ha SK Menhut No.81/Kpts-II/1993.
- C.A. – P. Salawati Utara – 62,962ha SK Menhut No.1829/Menhut-VI/96, 31st Dec 1996.
- C.A. – P. Batanta Barat – 10,000ha SK No.912/Kpts/Um/7/82, 30th Oct 1982.
- C.A. – Misool Selatan – 84,000ha SK No.716/Kpts/Um/1/82, 18th Oct 1982.
- C.A. – Waigeo Barat – 153,000ha SK No.395/Kpts/Um/5/81, 7th May 1981.
- C.A. – Waigeo Timur – 119,500ha SK No.251/Kpts-II/1996, 25th Nov 1996.

Proposed Conservation Areas:

- S.M.L. – P. Misool Selatan - 4,319ha Rek Bupati No.522.5/477, 25th May 1992.

- S.M.L. – P. Kofiau – 7,197ha Srt. No.375/PPA.030/XII/SBKSDA IRJA I/1992, 21st Dec 1992.
- S.M.L. – P. Asia – 7,000ha Srt. No.151/PPA.030/IV/SBKSDA IRJA I/92 16th Apr 1992.
- S.M.L. – P. Sayang – 96,000ha Srt. No.1308/PPA.030/VII/SBKSDA IRJA I/1992, 20th Jul 1992.
- S.M.L. – Kepulauan Ajue – 168,630ha Rek. Bupati No.050/110, 19th Jan 1994.

1.5 Conservation Recommendations and Follow-up

This extraordinary area clearly is the heart of the heart of marine biodiversity, with approximately 60% of the world's reef building corals (more than 500 identified species) and at least 1,074 species of fishes. Conservation of marine biodiversity in the area is an overriding priority and of major interest to the global community. Four areas of over-riding conservation value and opportunity were identified: the islands of eastern and southern Misool, Kofiau, Sayang and Pulau Ai, and the Wayag islands. While the forests provide no equivalent, compelling argument for conservation based on species richness, they show many elements of special adaptation to the harsh karst and ultrabasic conditions of the islands and consequently harbour a number of endemic species. Further surveys reaching the montane forests will likely yield additional new and endemic species. The four general areas of priority for marine conservation also corresponded to areas of interest for karst forests and it was indicated that conservation areas should be selected on the basis of marine criteria, and then extended to include adjacent forests to capture representative samples of their special features. However, any conservation strategy for the Raja Ampat islands must include sustainable community development options.

A first step in implementing a conservation program was to organize a workshop to disseminate results of this survey. This workshop, held in Saonek (South Waigeo) on August 20-21 2003, would also be instrumental to initiate partnerships and to consult with local communities and local government agencies. Results of the workshop are presented in Chapter 7. Other suggested conservation actions are summarized in Appendix 10.

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Chapter 2

Socio-Economic Conditions in the Raja Ampat Islands

AGUS SUMULE and RYAN DONNELLY

2.1 Summary

Raja Ampat area has recently become an autonomous Regency as part of the central government policy of devolution of authority to the regions. This should, in time, be an opportunity for government to develop social services and infrastructure in remote communities that were not apparent under the wider governance of Sorong. It also brings opportunities for planning development and conservation, but could mean that the new administration will be aiming to increase fiscal revenues through resource utilization.

The majority of the population live within subsistence economies but integration into the cash economy is a rapidly growing phenomenon. Speakers of indigenous Raja Ampat languages – about 10% of the population – rely heavily on subsistence and the sporadic and seasonal access to markets to sell marine invertebrates. Descendent migrant communities tend to have a greater market orientation and are more likely to actively seek opportunities to participate in commercial enterprise.

A custom tenure system exists whereby resources are owned by clans in a defined land-sea continuum. The traditional sasi system of resource management, however, is now severely eroded. The area is large and sparsely populated, making vigilance against contravention of customary laws almost impossible.

Overwhelmingly, it is people from outside Raja Ampat that facilitate the unsustainable exploitation of natural resources. This is exemplified in the occurrence of cyanide fishing for the live reef fish trade, blast fishing and the shark fin and turtle trades. There is little effective enforcement capability and there are compelling accusations of collusion between the outside syndicates and military officials.

A range of regulations exists that apply to fisheries, forestry and environmental protection. There are also a number of gazetted conservation areas. However, these regulations were not readily enforced under the Sorong governance. An opportunity exists now for Raja Ampat to direct all administrative resources to the good of the archipelago and its people.

Whilst there are barriers to achieving conservation initiatives, there is scope for widening the private sector involvement in non-extractive development, such as pearl farming, into tourism development and value-added industries related to the pearl farm industry.

Provided that village communities are given income earning alternatives in the short term and are made fully aware of the long term financial benefits of conservation initiatives, the foundations for greater custodial management of natural resources clearly exists.

2.2 Introduction

This study builds on previous assessments carried out in Raja Ampat Islands (e.g. MeKenna et al. 2002; Erdmann and Pet, 2002). The primary focus of this section is the socio-economic conditions faced by local people and the government of the Raja Ampat Islands, especially in relation to conservation and the utilization of natural resources.

The most comprehensive works on the socio-economic conditions in Raja Ampat was conducted from the late 1970s to early 1980s (e.g. Masinambouw, 1983). The intervening period has witnessed changes to population structure, commercial exploitation of natural resources and the enactment of laws that compound upon the current socio-economic conditions in the archipelago.

It is expected that this report will provide comprehensive information on the most recent situation in the Raja Ampat area, especially in relation to community development and the conservation of Raja Ampat resources. Since the enactment of Law No.26 (2002) as the legal basis for Raja Ampat to become an autonomous Regency, this information is crucial. Its availability will play a significant role in supporting development plans for better governance of the area.

2.3 Aims and Objectives

The aim of this report is to describe the socio-economic conditions of local communities of the Raja Ampat Islands and to gauge the capacity for community based conservation initiatives. Specifically, information will pertain to:

- Population structure and dynamics;
- Government structure and services;
- Role of communities in the natural resource use;
- Income levels and economic activities;
- Tenure issues;
- Cultural regulations governing resource use;
- Influence of outside agencies on resource use;
- Community development issues; and
- Key issues for future conservation and development.

2.4 Methods

Transport logistics involved in the coordination of the various components of the REA precluded a ‘normal’ type of social research, where a researcher would spend approximately one week with the local community at each site in order to obtain a comprehensive understanding of socio-economic conditions. However, the “snow-ball technique” of qualitative research, described by Babbie (1992), was adopted. According to this method, survey results at a particular village confirm issues that had been identified and discussed in previous villages that had been visited. These issues are built upon in discussion until a clearer picture is drawn. No formal questionnaire was employed.

Information used in the development of this report was derived primarily from interviews. Secondary information was derived from reviewing relevant literature. Interviews were conducted with key individuals at the village level and from the conduct of focus discussion groups (Table 1.).

Table 1. Summary of villages interviewed and topics discussed.

Source	Interviewees	Topics
Villages		
Interviews	Village leaders at: • Tomolol; • Yellu; • Harapan Jaya; • Fafanlap; • Kapacol; • Tolobi; • Selpele; • Saliyo; • Kapadiri; • Kabare; and • Urbinasopen.	• Migration history and peopling; • Economic activities and income levels; • Tenure issues and cultural regulations; • Influence of outside agencies on resource use; • Government development plans; • Government regulations and law enforcement; • Community development issues; and • Key issues for conservation and development. Also: • Involvement of outside agencies e.g. pearl farms, logging and commercial fishing; and • Access and compensation issues.
Focus Group Discussion	Open meetings in: • Waigama; • Deer; and • Kabare.	• Availability/depletion of marine resources; • Use of bombing and cyanide, identity of offenders; • Problems encountered whilst attempting to stop bombing and cyaniding; and • The effectiveness of customary mechanisms in dealing with outsiders who exploit community resources.

Interviews were also conducted with commercial operators in Raja Ampat, particularly those that enter into access and compensation agreements with customary owners. Details of these interviews are outlined in Table 2.

Table 2. Summary of outside agencies interviewed and topics discussed

Source	Interviewees	Topic
Outside Agencies		
Pearl Farms	• PT Yellu Mutiara; • PT Cendana Indopearl.	• Role of company security in protecting the surrounding waters from cyaniding and bombing; • Relationship with the local communities; and • Compensation and other benefits to the local communities.
Logging Operation	• PT Usaha Sumber Abadi	• Obtaining permission from community leadership; • Relationship with the local communities; and • Compensation and other benefits to the local communities.
Other	• "Ratu Sayang" Seafood Restaurant; • Irian Diving, Sorong • Local trader	• Illegal trading of seafood products. • Experiences with the conservation efforts in Raja Ampat; • Relationships with the local communities; and • Fish bombing and cyaniding. • Products purchased from local communities, prices.

Further interviews were conducted, beyond the timeframe of the REA, with government officials at the District (kabupaten) level (Table 3.).

Table 3. Summary of government officers interviewed and topics discussed.

Source	Interviewees	Topics
Government		
Fisheries	• Fabanyo, Head of Fisheries, Sorong • Agus Kadiwaru, Fisheries Dept • Israq Abdullah, crime investigator at Fisheries	• Government policies on fisheries development and conservation. • Issues related to commercial fisheries and the involvement of local people. • Law enforcement.
Forestry	• Habel Refassy, Head of Forestry • Din Tafalas, logging agreements intermediary from the Forestry Dept.	• Procedures for logging permit issue by the community. • Community's decision to cooperate with the investor to exploit the forest resources.
Administration	• John Wanane, Regent of Sorong • Head of Provincial Governance Bureau of Papua • Costant Sorondanya, Bureau of Natural Resources Conservation • Head of Misool District police/army.	• Development Policy on Raja Ampat. • Responsibilities of the appointed administrative *Bupati*; and • Relations between the new Raja Ampat Regency with Sorong Regency. • Cooperation with the Regency Government of Sorong on conservation issues; • Regency Regulations on conservation; and • The need for master plan for Raja Ampat conservation. • Law enforcement in relation to the protection of natural resources in Misool District from illegal use.

2.5 Population Structure and Dynamics

The population structure of Raja Ampat should be understood within the context of Papua's contact with regional neighbours. These early contacts are significant to the presence of certain communities in Raja Ampat, namely from the Biak region of Papua as well as the people of Ceram and other Molucca's islands.

Kamma (1982) stated that the Biak-Numfor people of Cenderawasih Bay made voyages to areas far away from their homeland from the 14th century. However, Mampioper (1988) claimed that such voyages occurred as early as the 9th century, when the Biak-Numfor people sailed west to Ternate and Tidore, Salayar, Timor and Java, including areas in the Birdshead region of Papua. These areas were customarily the lands of the Arfak, Karon, Kawe, Siam, and Patani/Sawai people. The voyages were conducted for trade, slavery, warfare, or the pursuit of the belief that their ancestors originated from areas to the west of Papua. As a consequence, descendent Biak-Numfor communities are now found in various places, including the Raja Ampat Islands.

However, the population structure of Raja Ampat is diverse and this complicates the issue of customary resource ownership. Whereas indigenous peoples have been conceptually described as a group of people who have continuously inhabited an area but presently live side by side with migrants (e.g. Burger, 1987; Brownlie, 1992), the concept is not easily defined in the context of Raja Ampat. Almost every community in Raja Ampat that has lived there for a long period of time would claim to be indigenous, including those who freely admit descent from people who originated from the Molluca's and other non-Papuan islands of Ceram, Ternate and Bajo, as well the Biak people from the Gelvink Bay of Papua Island. Other groups, including the Matbat, Salawati, Kawe or Lengenyem people would also claim to be the indigenous people of Raja Ampat.

2.5.1 Old Migrants

The old migrants of Raja Ampat mainly originated from Biak and Numfor islands and from the central Molluca and Halmahera areas. They are called migrants in this sense because they admit that their ancestors originated from elsewhere. For example, Kasim, a 60-year-old leader of Yelu Village, stated that he was the third generation of a Ceram community in South Misool. However, he also stated that many of his contemporaries were not pureCeramese but have local blood as well, since their ancestors intermarried with the indigenous people of Misool. This was the reason for their claim to be the indigenous people of Misool.

In another example, Mahmud Duatan claimed to be the Customary Head of Waigama, Misool, even though he was not a Matbat person. He was a descendant of Ceramese migrants who had lived in Waigama for generations. He stated that he owned an area of land, reef and sea, which he claimed to be part of his customary right. Biak speaking communities in Kofiau and the Ayau islands and other scattered locations in Waigeo have their own land that they claim as their customary land. This was found to be consistent with descendent communities of old migrants from the Mollucca's in Raja Ampat.

Alfred Russell Wallace observed the situation in Weigeo in 1860 (Wallace, 1869), indicating that migration is, and has been, an ongoing phenomenon:

"The people of Waigiou [Waigeo] are not truly indigenes of the island… They appear to be a mixed race, partly from Gilolo, partly from New Guinea. Malays and Alfuros from the former island have probably settled here, and many of them have taken Papuan wives from Salawatty [Salawati] or Dorey [Doreh], while the influx of people from those places, and of slaves, has led to the formation of a tribe exhibiting almost all the transitions from a nearly pure Malayan to an entirely Papuan type."

2.5.2 New Migrants

New migrants, for example those from Molluca or Halmahera, are related to the old migrants who also originated from the same places. Consequently, the new and old migrants can collaborate in the use of natural resources. New migrants can utilize resources so long as the older settlers or indigenous people grant permission.

The question of identifying the real indigenous people of Raja Ampat might not have been important in the past, but has become increasingly sensitive due to ownership disputes over resources, particularly fisheries and forestry. Silzer and Clouse (1991) charted the indigenous languages of Raja Ampat and their speakers. A summary of this information is listed in Table 4.

Table 4. The indigenous languages of Raja Ampat and an estimation of the number of speakers.

Language	Dialect	Location	Speakers
Matbat (Me, Biga)		Misool and the surrounding smaller islands	550
Salawati (Maya)	Maya, Kawit, Banlol, Batanta Island	Salawati and Batanta islands	1,600
Kawe		Kawe Island, western end of Waigeo and its neighboring smaller islands	300
Legenyem		North-west of the main bay of Waigeo and on the southern coast of Waigeo	100*
Amber (Amberi, Waigeo, Waigiu)		North-center of Waigeo Island, and is scattered in various other parts of Waigeo	300

* This figure did not originate from Silzer and Clouse (1991), but was estimated based on advice that the number of speakers of the Legenyem language was approximately one-third of the Kawe or Amber speakers.

Based on the estimated number of indigenous Raja Ampat language speakers, it can be estimated further that, in 2002, the total number of indigenous people of Raja Ampat was about 3,250, or about 10% of the 32,800 extrapolated from the 2000 population total at an annual growth rate of 1.2% (Table 5).

2.6 Population Dynamics

Population statistics for Raja Ampat are presented in Table 5. The data indicates that in 2000, the total population of Raja Ampat was approximately 32,000 people, or nearly 22% of the population of Sorong Regency. The indigenous component of the population is 10%, a figure that is likely to decrease with the onset of anticipated migration from other parts of Indonesia with the opening of the nickel mine at Gag and other large-scale commercial ventures anticipated in the natural resources sector. This figure indicates that indigenous people in Raja Ampat are underrepresented in political decision-making, including the management of natural resources.

Table 5. Raja Ampat population figures, 2000.

Population Indicator	Raja Ampat Districts of Sorong Regency				
	Misool	N. Waigeo	S. Waigeo	Samate	Salawati*
Total population	8,716	5,760	8,161	7,370	2,017
Population density per km^2	3.90	5.52	3.64	9.49	n.a
Sex ratio	102.43	97.75	101.25	96.82	n.a
Household	2,415	1,649	2,484	2,934	n.a
Village	19	15	29	11	n.a

It could be speculated that, due to a relative abundance of resources, an increasing number of people from outside will migrate into the Raja Ampat area, either permanently or temporarily. This phenomenon has been occurring throughout Papua, where net immigration was recorded at just less than 192,000 in 1995. The establishment of the new Raja Ampat Kabupaten will likely increase immigration from various parts of Papua, Mollucas, and Indonesia as a whole, as it is likely to encourage more investment in natural resource based industries. Kompas Daily reported that the population of Timika, where the PT Freeport Indonesia mine is located, reached nearly 90,000 people in July 2002, of which only 36,000 were local people.

2.7 Government Structure

Raja Ampat became part of the Sorong Regency (Kabupaten) when Indonesia assumed control of Papua in 1963. There were only four Districts (Kecamatan) in Raja Ampat until 26th October 2000. After the issue of the Regency Regulation (Peraturan Daerah) of Sorong No.9 (2000), these four Kecamatans were divided into seven (Table 6). Then on the 24th December 2002, a bill regarding the establishment of 14 new Regencies in Papua Province was enacted as Law No.26 (2002). This law established the new Regency of Raja Ampat. The seven Kecamatans remain unchanged but the new capital city is Waisai on Waigeo Island.

Table 6. Government structure in Raja Ampat.

Prior to 26th October 2000 **Sorong Regency**	**26th October 2000 to 24th December 2002 – Sorong Regency.** **After 24th December 2002 – Raja Ampat Regency**	
District (*Kecamatan*)	**District (*Kecamatan*)**	**District Capital**
• Waigeo Utara (North Waigeo)	• Waigeo Utara (North Waigeo) • Kepulauan Ayau (Ayau Islands)	• Kabare • Dorehkar
• Waigeo Selatan (South Waigeo)	• Waigeo Selatan (South Waigeo) • Waigeo Barat (West Waigeo)	• Urbinasopen • Selpele (Pagalol)
• Misool (including the Kofiau islands)	• Misool (including the Kofiau islands) • Misool Timur Selatan (East-South Misool)	• Waigama • Folley
• Samate (including Batanta and other surrounding islands)	• Samate (including Batanta and other surrounding islands)	• Samate

Although there have legally been seven Districts in Raja Ampat since 26 October 2000, it was not until late November 2002 that the Camats (Heads of Districts) of the new Kecamatans were appointed and inaugurated. With the current financial crisis in Indonesia, it will likely take at least five years for the new District administrations to function properly. Until 2004, management of the area will lie with an interim Kabupaten administration, with little organizational capacity, and virtually no control from an elected legislature. Until that period there may be some oversight from Kabupaten Sorong government (as the ‘parent’ administration) but this is likely to be minimal. From early 2003, there will be an immediate shortage of qualified and capable civil servants for both Kabupatens Raja Ampat and Sorong (Sorondanya, 2003).

As an autonomous Regency, Raja Ampat will undertake all government, development, and community service activities as stipulated in the general regional autonomy laws (Laws No.22 (1999) and No.25 (1999)) as well as in the special autonomy law of the Province of Papua (Law No.21 (2001)). Since Raja Ampat is a new Kabupaten, the first Bupati (Regent) will not be elected by the parliament, but is recommended by the Governor of Papua for the approval of the Minister of Interior Affairs. The Parliament of Raja Ampat will elect the definitive Bupati six months after the parliament is established, based on the outcome of the 2004 general election. To date, the Bupati of Kabupaten Raja Ampat has not been appointed by the central government regardless of a candidate being proposed by the Governor of Papua Province.

2.8 Government Services

The Sorong Regency government was expected to play a significant role in providing social services to communities in Raja Ampat. Those services include, but are not limited to, education, health, security, and transportation. In practice, however, access to these services is poor, as will be illustrated in the following discussion.

2.8.1 Education

The official statistics of the Sorong Regency demonstrate impressive education facilities in the Raja Ampat area, as can be seen in Table 7. Note that the data in Table 7 was prior to the division into seven Districts within Sorong Regency. The introduction of the new Districts had not changed the situation in the field. It is predicted that most of the District government efforts for the first five years will be to develop government administration infrastructure.

Table 7. Education facilities in Raja Ampat.

Education Facilities	District in Raja Ampat			
	South Waigeo	North Waigeo	Misool	Samate
Primary School (PS)	27	15	16	14
Junior High School	2	2	3	2
Senior High School	0	0	0	0
PS Teachers	102	59	81	82
Ratio of PS pupils to school	65.30	76.40	117.31	94.50
Ratio of PS pupils to teacher	17.28	19.42	23.17	16.13

Source: Statistics of the Sorong Regency, 2001

As there are approximately 75 villages in the Districts of South Waigeo, North Waigeo, Misool, and Samate of Raja Ampat, there is basically one primary school for every village in Raja Ampat (Table 7). The reality is that not all of the schools operate properly. For example, at Saliyo village (visited on 18th November), we found that the school had not operated since August. This meant that, for half of the semester, none of the children in the village had access to formal learning. This situation was encountered in other villages in remote areas. Primary schools in some villages in Misool, such as in Tomolol, Fafanlap, and Yelu, were operating but only by two or three teachers. The physical condition of the schools was often inadequate, even in the District capital of Waigama.

Junior high schools at Waigama, Deer, and Kabare, however, were all found to be operating properly. The schools were well built and the availability of teachers was reasonably adequate. These schools were equipped with simple libraries and were well used, even though the quantity of reading material was limited.

There is no senior high school in Raja Ampat. The community at Fafanlap village attempted to establish a community-sponsored high school but was forced to close the school down because there is a lack of teachers who are willing to commit to working in remote areas. Consequently, all junior high school graduates from Raja Ampat must travel to Sorong to further their education.

This lack of commitment to work in remote areas from some teachers must be seen as one of the main reasons for poor quality education in Raja Ampat. However, it also demonstrated the lack of accountability that is demanded by government of teachers who do not fulfil contractual obligations. An old teacher in Tolobi, Kofiau islands lamented:

“I should have retired a couple of years ago, but who would teach these children? What would be their future if there were no education? Should I just sit if others [teachers] do not fulfil their responsibilities? I have no other choice but to continue teaching. These kids are my own grandchildren. I am from this village. This is my call. I will continue to teach, even though with very little honorarium.”

2.8.2 Health

Raja Ampat is poorly serviced by government health care. Community Health Centres (Puskesmas) are found only in the four District capitals of the former Sorong Kabupaten. Even then, however, not all of the Puskesmas are served by a medical doctor. Medical supplies in the Puskesmas are dependent upon availability at the Regency level and the availability of transport to remote areas. Many of the village clinics do not have paramedics. The sick and injured must travel to the Puskesma in the District capital or travel as far as Sorong to receive medical assistance. If the patient can afford the cost of transport, and if the sea is navigable, then there is good quality health care available to them. There are six hospitals in Sorong, two of which are owned by the government. If, however, transport is unavailable or unaffordable, the patient has limited, if any, access to modern medical services.

2.8.3 Security

In the context of this report, the issue of security focuses on the capacity of law enforcement authorities to deter or apprehend perpetrators of illegal natural resource exploitation, primarily dynamite and cyanide fishing. The socio-economic team visited the District capitals of Waigama and Kabare partly to assess the capacity of the police service to adequately enforce the law.

On arrival at Waigama, the team inadvertently met the chief of police of Misool District, as he was about to depart for Sorong to join the other 15 officers posted at Waigama. The officers had left the post due to a fasting holiday. The police chief’s departure would leave the District capital with no civilian law enforcement capacity.

The Waigama barracks, a former Dutch police post, was decrepit. It had not been maintained since the 1960s. The walls and floor were broken and the roof leaked. Residential facilities were austere, and there was no secure storage for the antiquated weapons. The Waigama police did not have a boat or outboard motor. The chief of police claimed that there was no District police unit in Raja Ampat that possessed an outboard motor, and that this was the main reason for the inability of the police to enforce the law, especially in relation to illegal exploitation of marine resources. Consequently, it was no surprise to learn that the use of potassium cyanide and dynamite was rampant throughout Raja Ampat.

A Focus Group Discussion was held, involving prominent community figures from Waigama and Salafen villages, as well as with government officials. The chief of the Misool army post stated that the government apparatus was dependent on the generosity of the community for the use of a boat and outboard motor. He noted that the illegal operations often had 150hp motors fitted to their boats, which could easily outrun the slow locally assembled inboard motors of the local vessels.

There is little wonder that some police officers suffer the same lack of commitment to working in remote areas of Raja Ampat that afflicts the teachers. Enforcement facilities are inadequate and the basic infrastructure that is necessary for them to serve the community is not provided. A similar situation was found to exist in Kabare, the capital of North Waigeo. Most of the police officers were in Sorong. The Army post (Koramil) was manned by one soldier and the commandant of Koramil (Danramil).

2.8.4 Transportation

Sea transport is the only means possible for the people of Raja Ampat to travel from village to village, or their District capitals and to Sorong. Almost every household in Raja Ampat has access to row boat, but only about 10% of those households have access to outboard motor. This makes the travel over longer distances very difficult, even prohibitive during the windy season.

The government operates a pioneer ship (kapal perintis) to connect the District capital cities of Raja Ampat with Sorong. It is essentially a cargo ship that also carries passengers. The ship is usually crowded with passengers and their belongings, and lacks basic safety and health facilities.

The pearl farming company, PT Yellu Mutiara, allows villagers residing in proximity to their lease to board their ships to and from Sorong for free. This applies to people from Fafanlap, Yelu, Lilinta, Gamta, Usaha Jaya and Harapan Jaya villages of Misool District.

2.9 Economic Activities and Income Levels

Village communities in Raja Ampat depend on the resources from their coastal waters for food and for their livelihood. However, the pattern and intensity of the exploitation of marine resources is shaped by the season, and also the ethnicity of the various communities. The discussion that follows outlines how the pattern and extent of cash dependence in the archipelago, now and in the future, is linked to population growth and dynamics. This section will describe the challenges faced by local communities as outside commercial interests seek to profit from the natural resources in Raja Ampat, and how the short term financial gain can be too much of a temptation to resist.

2.9.1 Indigenous People

Most indigenous people of Raja Ampat live in predominately subsistence economies, more so than other communities in the archipelago. Most cash income is obtained when they can access the resources and when traders can access them. This mostly occurs when the sea is calm enough to be sailed. In Fafanlap village, for example, this period is mostly from October to April. It is estimated that, during this time, householders could earn from Rp300,000 to Rp1,500,000 per month, depending on the nature of their transport.

From May to September, when the seas are rough, indigenous people of Raja Ampat spend most of their time tending their gardens, which provide most of their staple food and contribute to the family income. For indigenous people in Fafanlap and surrounding villages, this entails producing sago, manihot and bananas, as well as beetle nuts, mango, langsat, and durian. Rice is bought from traders. It appears that the closer an indigenous village is to an urban area (e.g. villages in Salawati or Batanta islands to Sorong), the greater the dependence on rice.

Indigenous people are greatly dependent on collecting and selling invertebrate sea products, such as bia lola (top shells, Trochus niloticus), bia mata bulan (green snails, Turbo marmoratus) and varieties of teripang (sea cucumbers, Holothuria sp) as the main sources of income. They irregularly sell live grouper and Napoleon wrasse to the collectors in their village, as well as lobsters. Drying of molluscs (e.g. bia garo) for food or for sale is common. People also slaughter turtles for food and harvest the eggs from nests (see Chapter 5 of this compilation). Prices paid to collectors of marine invertebrates by a trader in Fafanlap are listed in Table 8.

Table 8. Price of marine commodities at Fafanlap village (November 2002).

Commodity	Price (Rp/kg)
Bia lola (top shells, *Trochus niloticus)*	24,000
Bia mata bulan (green snails, *Turbo marmoratus)*	110,000
Teripang gosok (sea cucumbers, *Holothuria* sp)	200,000
Teripang kongkong (sea cucumbers, *Holothuria* sp)	150,000
Teripang susu (sea cucumbers, *Holothuria* sp)	150,000
Teripang malam (sea cucumbers, *Holothuria* sp)	110,000
Teripang polos (sea cucumbers, *Holothuria* sp)	30,000
Teripang minyak (sea cucumbers, *Holothuria* sp)	12,500

The ease with which access is gained to these commodities varied among villages. Whilst Fafanlap villagers are restricted by season, those in Tomolol, for example, are able to collect bêche-de-mer and other invertebrates throughout the year. This alters the pattern of harvest among different villages. People from Fafanlap and surrounding villages establish camps in the calm season and intensively target the resources, whereas people from Tomolol are able to accumulate the catch throughout the year. Villagers in Tomolol estimated that a family could collect around 800kg of bêche-de-mer per year. However, it was also reported that, in recent years, stocks of bêche-de-mer, trochus and giant clam had been drastically reduced. People from other areas of Indonesia (Buton, Ceram, and even Sumatra) make fishing camps on isolated islands, an issue that will be discussed later in this chapter.

2.9.2 Old Migrants

There are many similarities in the economic activities of the indigenous people of Raja Ampat and the old migrants. The differences primarily relate to the rate of commercialization, and the additional avenues of economic activity explored by people from old migrant communities. In Kofiau islands, for example, the production of copra is a major source of income for Biak speaking communities. However, the price of copra has dropped significantly in recent years and there is no protective pricing policy applied to copra, as there is to rice production. Consequently, copra production has scaled down and people in old migrant communities are forced to seek other sources of income.

This market orientation increases the potential to earn cash in an environment of growing cash need. However, this willingness sometimes manifests in a propensity to join commercial exploitation of natural resources by people from outside the sphere of customary ownership. This is exemplified in Tomolol, where descendent migrants from Ceram reside in satellite villages located within the customary estate. These communities are said to have “the right to eat but not to own”. There is an absence of defined property rights for old migrant communities, save for ambit claims to rights of access. Consequently, there is scant recognition of a custodial responsibility for resource exploitation and conservation. Interviews in Tomolol revealed that fishermen from other parts of Indonesia were granted permission, for a fee, to exploit resources within the customary area by migrant villagers with no authority to do so. As there was neither institutional arbitration from the outside, nor communal consensus from the inside, incidents such as this can create frustration and division between communities, an unlikely situation prior to commercially based competition for resources.

2.9.3 Destructive Fishing Practices

Blast fishing has caused the destruction of reefs throughout the greater Indonesian archipelago. Its practice in Raja Ampat is reportedly conducted primarily by people from outside of the area, mostly by Butonese people from southeast Sulawesi. These operations are said to involve some local people and are often endorsed by the armed forces. The enforcement capacity of authorities in Raja Ampat is inadequate. However, when the authorities collaborate with the perpetrators of illegal and destructive fishing, any measurement of enforcement capacity is irrelevant. Villagers reported feeling powerless when they approached a vessel practicing blast fishing. If a uniformed officer didn’t confront them, then it was a fisherman armed with dynamite.

The live reef food-fish trade that transports large and colorful reef predators, such as groupers and Napoleon wrasse, to the restaurant markets in Hong Kong and other Chinese centers is practiced in Raja Ampat. It is important to note that export of Napoleon wrasse from Indonesia is banned. A major destructive element in this fishery is the use of potassium cyanide to stun individual fish for capture to keep alive for export. The toxic cloud is sufficient to stun the large fish that are targeted, but is deadly to smaller organisms including coral. Again, we were told that fishing operations from Sulawesi and the Mollucca’s drive the trade in Raja Ampat, employing some local fishermen. At a Focus Group Discussion at Waigama, we were told that live fish transport vessels from Hong Kong arrive periodically to collect fish from major holding pens. The District Commissioner was in attendance and he stated that Indonesian military personnel were usually on board.

At Fafanlap village, we were told that villagers that choose to participate in the poison fishery were supplied with boats and all the necessary equipment. In Waigama, we were told that a live fish buyer from Sorong offers fishermen a large down payment in return for sole purchasing rights to that fisherman’s catch. The lump sum is irresistible to some. Unfortunately, once the fisherman starts fishing for his exclusive buyer, he is coerced into fishing heavily every day in order to clear his ‘debt’. Young fishermen know that the poison fishery is a bad thing, but as stocks of marine invertebrates had declined so drastically, this was a source of income that could not easily be ignored.

A live fish trader in Fafanlap village emphasised that the fish are caught using a hook and line. He told us that the best time for catching the targeted species was between November and May. This likely indicates that the seasonal and highly predictable spawning aggregations occur during the middle period of this range on a particular lunar phase. Local fishermen have an intimate knowledge of the location, timing and duration of spawning aggregations on their home reefs. Participation in the live fishery was an opportunity to earn a much-desired income.

Inspection of net cages at this location, as at others in Raja Ampat during this REA, revealed a moderate number of female coral trout Plectropomus leopardus and a small number of juvenile Napoleon wrasse Cheilinus undulatus. There were no rock cods. There were no large (male) groupers evident in any holding facility and there were only rare in situ sightings of groupers by the marine team. The relative scarcity of these reef predators, particularly the absence of males, is a sign of overfishing. Moreover, the scarcity of breeding males undermines the viability of spawning aggregations. Overfishing has been implicated in the disappearance of spawning aggregations throughout the world (e.g. Colin, 1992; Aquilar-Perera and Aguilar-Davila, 1996; Domeier and Colin, 1997). Johannes et al. (1999) listed five locations where grouper stocks had been eliminated as a result of fishing spawning aggregations. These aggregations were intensively targeted using hook and line.

Napoleon wrasse is a slow growing, long-lived species with a low replacement capacity. Consequently, the species is highly vulnerable to overexploitation (Sadovy, 1997). They often exhibit shy behavior and are known to be difficult to catch using a hook and line. Johannes and Riepen (1995) explained that these large fish rove across the reefs by day and sleep in reef caves and under coral ledges at night. Consequently, they are easy targets for divers, particularly at night, even without using cyanide. It is suspected that the majority of Napoleon wrasse caught in Raja Ampat for the live fish trade is caught using potassium cyanide. Enforcement of the trade ban on this species is clearly non-existent.

Interviews in Selpele, western Waigeo, indicated that the best time of the year to catch live fish trade target species was January and February. The catch could weigh up to 500kg, with about 50kg of mamen/mulut tikus and 450kg of tongseng and geha provided by 40 fishermen. Prices paid to fishermen are listed in Table 9. Given that the Napoleon wrasse were all juvenile and the coral trout female, it can be estimated that the gross earnings for Selpele fishermen from the live fish trade, concentrated in January and February, is less than Rp25,000,000 or about Rp580,000 per fishermen. This income is supplementary at best and clearly a fraction of the earnings that would have been garnered at the height of the trade. Since the establishment of a pearl farm by PT Cendana IndoPearl, the number of Selpele villagers involved in the live fish trade is significantly reduced.

Table 9. Prices paid to fishermen for live grouper and Napoleon wrasse at Selpele village.

Type of fish (local names)	Category	Price (Rp/kg)
Tongseng	Big (1.5 kg up)	50,000
	Super	45,000
	Baby	15,000
Geha	Average	15,000
Mamen/mulut tikus	Big	120,000
	Super	90,000
	Baby	60,000

Communities in the villages visited in Kofiau stated that local people participated in both the poison and blast fisheries. Some of these participants reside in Sorong, and it was these people, in particular, who raise the ire of village elders. The following remark was made by a prominent figure in Deer village:

"It's very difficult for me to understand. It was our own customary children [anak-anak adat] who are destroying our marine resources, even though they were educated in the city. We have tried to use customary rules to rebuke them, but they did not want to listen. They said custom [adat] never gave them money, but the people from outside give them money. They also refused to listen to the church [leadership]. It's hard for us to confront our own children."

Growing cash dependence has seen Raja Ampat enter a period of flux. Villagers, in turn, merely respond accordingly to the economic signals. Fishermen in Waigama, for example, say they once caught whale sharks because there was a market for the oil from their liver. There are very few sharks in the Raja Ampat archipelago (Erdmann and Pet, 2002; Chapter 2 of this compilation). Anecdotal information regarding shark fishing in the Kapadiri area of Waigeo indicated that villagers were paid from Rp1,800,000 to Rp3,000,000 per kilogram of shark fin. Philippine fishing boats regularly visit small islands to the north of Waigeo, such as Dorekar, as the islands are an important trading place for protected parrots. In Fafanlap, we were told by a village leader that integration into the cash economy has led young people to capture birds, cut down trees and to disregard future needs for the sake of earning money now. The money, he said, was not only to meet cash needs but also to buy coveted items.

2.9.4 Logging

Since the introduction of the Kopermas (Koperasi Peranserta Masyarakat or Community Cooperative Enterprise) for managing natural resources in Papua in April 1999, the forestry sector in Raja Ampat has been dominated by collaborative arrangements between the leadership of local communities, government officials, military and police, and local timber companies. Such associations have suffered accusations of collusion, and practices that have has led to a sharp increase in forest destruction, both within areas covered by permits, but also in protected areas and nature reserves (Down to Earth Newsletter, 2002).

It was expected that, through Kopermas, local people could manage commercial exploitation of natural resources on their own ancestral lands. The cooperative arrangements with outside companies would allow local people to learn this process whilst maintaining control over their resources. The concept built on Article 33 of the 1945 Constitution that endorsed cooperative enterprise as the embodiment of the principle of brotherhood. However, there is little evidence to suggest that cooperative enterprises have provided prosperity to local people.

The concessions are often poorly managed, destructive, with little transparency and low returns to communities, and allow for smuggling and hence real loss of fiscal opportunity to the area. There is a severe conflict between logging concessions and existing protected areas, most notably on Misool and Salawati islands (Sorondanya, 2003).

Kopermas involved in the exploitation of forest resources have attracted criticism based on the following:

- Due to the capital-intensive nature of the enterprise and the outsourcing of capital investment, it is believed that outsiders stand to reap the majority of the profit, and that local people would be inadequately compensated. This is a valid fear given the external costs of erosion resulting in water quality decline and sedimentation of nearshore reefs, together with loss of amenity and wildlife habitat. There are also longer term cash needs associated with these and other social costs.
- Kopermas forest concessions are typically 250 hectares, which is usually clear-cut. Consequently, forest destruction from Kopermas activity is likely to be more severe than that caused by big forest concession holders (perusahaan pemegang Hak Pengusahaan Hutan)
- Forest management by Kopermas has been linked with illegal logging in protected areas. Participating communities legally own Kopermas. However, if the community is also the customary owner of a specific protected area, logging the area is seemingly in the hands of community leadership. This opens the possibility of the application of pressure from outside investors and can potentially undermine conservation efforts.

These issues were discussed at Kapacol, Waigama and Saliyo, where exploitation of forest resources was examined during the REA. We were told that the logging company initiated contact with the community leadership and the relevant statutory authority in Sorong. Then an advance payment was made to the local community to signal the sincerity of the company’s intentions. The company and community leadership then negotiated the benefits to accrue to the community. Inevitably, some community leaders would be recruited by the company to act as overseers, thereby joining the company payroll.

The 2000 Yearly Work Plan previously determined payment for particular timbers (Table 10). However, dissatisfaction from the participating communities resulted in logging companies agreeing to pay extra from 1st May 2001. It is unknown whether this scale is adhered to or whether the price is negotiated pursuant to other benefits. Communities insisted that compensation should cover payments to local government, the use of land for roads and log ponds, and the utilization of plants and trees. They also insisted that the company meet its community development responsibilities.

Table 10. Prices paid to communities for particular timbers.

Type of Timber	2000 Yearly Work Plan	After 1st May 2001
Merbau	Rp3,000m^{-3}	Rp25,000m^{-3}
non-Merbau		Rp10,000m^{-3}
Indah		Rp50,000m^{-3}
Rimba	Rp2,000m^{-3}	
Mangrove	Rp600m^{-3}	Rp1,000m^{-3}

Payment for co-operative logging rights to outside interests often resulted in disputes among members of the community. This indicated that insufficient consultation within the community had occurred prior to entering into the Koperma. It might also suggest that self-interest was a factor during negotiations or that the final deal lacked transparency.

At Kapacol village, Misool, logging had occurred in a designated conservation area. Our arrival coincided with the departure of logging company representatives, who were leaving after paying community fees for logs they had harvested. It seems that around $US20,000 (about Rp180,000,000) was shared between three villages. Theoretically, this is paid at a rate of about $US5m-3 of timber loaded, and it seems that the company is harvesting around 4,000m3 every three months. The figures may not be exact, but clearly the incentives for villagers to sell timber rights are enormous. The head of the village in Kapacol was not concerned about logging in a protected area. He said that he knew that the area was protected but asked how else his village could make money from their forest.

Community leaders at Saliyo entered into a logging agreement with a company called Masindo, who initiated negotiations and made an advance payment. However, the customary chief rejected the proposal. In response, a representative of Masindo donated sporting equipment, an outboard motor and Rp7,000,000 in cash to the “people” and appointed the customary chief as foreman, paying him Rp500,000 per month.

After the first shipment from Saliyo of 1,200m3, Masindo paid the community with two 40hp outboard motors and six 15hp outboard motors. For the second shipment of 600m3, the community was paid Rp57,000,000. There were only two shipments. The company left, leaving behind a further 600m3 to sold by the community themselves. When asked what had become of the money, one of the elders replied that the money too easily evaporated, although he had used some for his children’s education in Sorong. In Saliyo village, there is no tangible benefit to be seen for the exploitation of the timber resource.

2.9.5 Pearl Farming

We visited pearl farms in Misool (PT Yellu Mutiara) and Waigeo (PT Cendana Indopearl). Both companies have negotiated lease arrangements with customary owners for use of an expansive marine area and both companies rely on local labour. Both operations maintain a close working relationship with communities. The operations are committed to long term production and are now part of the mosaic in Raja Ampat

PT Yellu Mutiara has a 20-year lease that was renewed in 1997. The company employs approximately 200 villagers from neighboring communities, such as Tomalol and surrounding villages. Part of the agreement entails provision of an electricity generator in Tomalol and the fuel to power it. The generator was not in operation during our visit but it is anticipated in the near future. The company also assisted the people in the construction of a church and mosque. Workers are paid in accordance with the provincial minimum standard, which allows each employee to earn at least Rp600,000 per month.

Villagers stated that the company provides free transport, including freight, to and from Sorong. Consequently, some villagers have purchased building materials that would otherwise have incurred prohibitive transport costs. This is seen as a boon to villagers but it has also increased the level of cash dependence in the villages.

The pearl farms maintain a well resourced monitoring and security capability. This has proved invaluable in curbing the incidence of destructive fishing in the area. Since 1996, security from PT Yellu Mutiara has apprehended four vessels with cyanide and turned them over to the authorities. The cyanide could potentially kill many oysters.

Interview respondents in Selpele reported that PT Cendana Indopearl employed 41 local people who were paid in accordance with the provincial minimum standard. PT Cendana Indopearl also undertook community development activities in their neighboring villages, including Selpele. The company assisted the local people with electricity and selling petroleum at a subsidized price. An employee told us that the company had hired a schoolteacher because the government appointed teacher had not stayed long in the remote village.

2.10 Tenure Issues and Cultural Regulations Governing Resource Use

Tenure issues in relation to access to, and the management of, resources in Raja Ampat are similar to the practice of many indigenous communities in Papua Province, Melanesia and the wider Pacific.

As is the case in the Pacific, which has experienced various waves of transmigration over the millennia, new arrivals have limited rights of access to natural resources. Subsistence fishing or harvesting is always free to everyone. Decisions regarding patterns of resource use, including seasonal closure of fishing areas or taboos on the harvest of certain species, are made by the clan hierarchy and must be adhered to by all that reside in, or transit through, an area that is subject to custom ownership and management. Activities of a commercial nature must be approved by the clan hierarchy and this might entail some form of compensation should permission be granted. Continuity of residence and association with a particular area and its people through generations is at the root of the allocation of access rights. Intermarriage and various forms of patrilineal and matrilineal lineage usually contribute to the extent of access rights afforded to an individual. Customary ownership of resources is an evolutionary phenomenon. It is adaptable by necessity, but like other forms of property rights structure, it must be adequately enforced.

Several characteristics of the tenure rights and cultural regulations governing resource use in Raja Ampat have been identified as follows:

- Resources are owned communally rather than individually;
- The sasi system is part of the culture of the Raja Ampat communities. Sasi is mechanism designed to regulate use of natural resources. Based on advice from community members, the clan hierarchy might decide to utilize (buka sasi) or conserve (tutup sasi) particular resources or areas. Sanctions are imposed on those that do not comply with such dictates;
- Access rights granted to third parties are conditional and non-permanent;
- The granting of access rights to resources requires community consensus but the final decision rests with the customary head of the clan;
- The concept of “right to use but not to own” was becoming more popular among the indigenous people of Raja Ampat. This is likely a response to increasing population and commercial activity threatening a long-standing status quo;
- Raja Ampat communities recognize and respect traditional ownership of natural resources and the concomitant rights of access to those resources; and
- Raja Ampat communities expect reciprocity to be practiced when resources are exploited. On a small scale, this might include transiting fishermen sharing subsistence catch. On a commercial scale, it entails the sharing of wealth through the provision of social services and infrastructure.

It must be noted that the system of custom tenure and access rights to natural resources is strong from the community viewpoint, expressed particularly by older members of the community. However, some younger people reject the limitations on resource exploitation imposed by customary measures designed for moderation. This is exacerbated by the disregard for customary rights exhibited by people who come from outside Raja Ampat to exploit resources without permission or compensation with complicity from figures of authority.

2.11 Influence and Involvement of Outside Parties on Resource Use

A question asked repeatedly of communities throughout the REA involved the current status of marine resources compared to that of bygone times. Overwhelmingly, villagers replied that resources had been significantly depleted. Villagers spoke of the minimal effort required to catch a fish for a meal, or to collect sea cucumber and molluscs for sale. The reasons offered by villagers for such depletion unanimously pointed to the exploitation of marine resources by people from outside of Raja Ampat.

This section will explain the involvement of some of those outsiders. The logging and the pearl farming companies have already been explained in previous sections. To a certain degree, these industries are different to other outside parties. The pearl farms, in particular, make a significant and ongoing contribution to communities as part of the reciprocity alluded to in a previous section, whereby social and economic benefit is attained through the provision of some social services and infrastructure, and through the provision of employment. This is not necessarily the case with other outside interests.

2.11.1 Blast Fishermen

It is widely understood and accepted throughout Raja Ampat, and in Sorong, that blast fishing is one of the main reasons for the destruction of marine resources in Raja Ampat. However, the use of explosives for fishing is not a new phenomenon in Raja Ampat. Local people admitted that fish bombing has been practiced since the 1970s, or even earlier, mostly by assembling a 'local bomb' (called dopis by the Biak speaking community) using ammunition from unexploded World War II bombs or bullets.

However, the current bomb is made from urea fertilizer and is usually contained in small plastic jerry cans. This means that the fish bomb is much easier to produce. Local communities in Raja Ampat claimed that they were no longer involved in collecting fish using bombs because it was very difficult for them to obtain urea in Raja Ampat. But, in Sorong mainland, it was relatively easy to obtain fertilizers as they were freely sold in agricultural shops. Also, Sorong was one of the main areas in Papua for the government sponsored transmigration program, which saw the establishment of colonies of settlers from Java and other islands. The Javanese transmigrants used fertilizers intensively to grow food crops.

Fish bombing is conducted without consent from the customary resource owners. Even though the bombing activities are illegal and destructive, it appears that local people do not have any mechanism to control it. Despairingly, when local people decided that it was physically dangerous to deal directly with the perpetrators and to expel them from their customary area, they asked the fishermen to share some of their catch, arguing that "it's better than we have nothing at all."

The bombed fish are sold fresh or as salted fish in Sorong. A teacher in Kapadiri village told the senior author that it is easy to identify the bombed fish in the market. "They are usually of a similar size and of the same species. Also, there will be no sign that those fish were caught using our traditional method, such as with hook or spear."

According to the local communities, people from outside of Raja Ampat were mostly responsible for the use of bombs and potassium cyanide. They include the people from Sorong (such as Pulau Buaya or Rufei/ Lampu Merah areas) as well as people from outside of Papua, such as from Mollucas, various parts of Sulawesi including Buton, and as far as Madura. We obtained a report from the local community that a fleet of Butonese fishermen from Sorong had been operating in the area and collecting fish by using bombs. The fishermen denied using bombs, claiming they collected their fish using hook and line. However, the local people claimed that the Butonese fishermen from Sorong using these types of fleets often came to their area and collected the fish using bombs.

2.11.2 Potassium Cyanide Fishermen

The use of potassium cyanide to collect certain types of live fish was seen by local people as one of the main threats to the sustainability of their marine resources. Potassium cyanide was not made locally, or in Sorong, but is imported from outside.

There are various ships from outside of Papua involved in collecting live fish. This information was learned from interviews with villagers in Saliyo Village:

"There have been a couple of ships operating in our area. These are MV Mioskopal from Ambon, MV Kawan Setia from Makassar, and MV Regina. Each of these ships carried 18 to 20 speedboats equipped with compressors for diving. Compressors allow their divers to stay for a long time under the water, and with potassium cyanide they collected a lot of live fish."

"We caught MV Regina two years ago. It's crew, from Salayar Island in Sulawesi, stole the fish near our islands. We confiscated one of their speedboats with a 15hp outboard motor. We also confiscated their compressors. But later, when only our women and children were left in the village, the ship's crew came back and threatened our families with knives. They took back the motor and compressors."

2.11.3 Ikan Teri Fishermen and the Tuna Fishing Companies

The Raja Ampat Islands is a primary source for tiny fish (known locally as ikan teri), used by tuna fishing companies as bait to catch different types of tuna. These companies usually employ or contract specific fishermen, called nelayan bagan. A bagan is a fishing platform with a cantilevered fish trap. The bagan fishermen operate at night and attract large schools of ikan teri using lights. These fishermen were mostly of Buton origins from South East Sulawesi. There were many bagan camps encountered throughout the archipelago. More often than not, the ikan teri was dried for human consumption.

Three or four fishermen usually man each bagan. If a tuna company employs the fishermen, every second day a company ship would collect the live ikan teri. Each bagan earns from Rp1,200,000 to Rp1,500,000 per month from the company, which would then shared by the fishermen according to their own agreement. Regardless of whether the bagan fishermen dry the ikan teri or keep them alive for bait, they generally have to pay local resource owners for access. However, at one such camp, elders from a migrant village near Tomolol granted access for a fee of Rp100,000 causing a strain in relations with the indigenous owners of the area.

2.11.4 Philippine Fishermen

Philippine fishermen are quite active in the northern parts of the archipelago, particularly in Waigeo. Local people in these remote communities are happy to deal with these people from outside the archipelago because they provide villagers with sought after commodities that are otherwise unavailable to them. The activities of the fishermen, however, are neither legal nor of a sustainable nature, including shark fishing for fins and the trade in exotic birds. The Philippine fishermen reputedly do not employ blast or poison fishing methods. The fishermen have nurtured a relationship with local villagers based on an exchange of gifts, which range from liquor to electricity generators and outboard motors.

One or two Sanger fishermen from South Sulawesi were usually employed by each group of Philippine fishermen to help them in translation when they communicated with the local people. In Saleo village, for instance, we learned that the local people were given a quantity of Tandawai and Klavo liquors. The fishermen donated two electrical generators to the people of Kapadiri village. They were also given two outboard motors. An elder in Kapadiri told us: "If we obtained information that patrolling activities were conducted by the Navy, I would tell those Philippinos. We would hide them if necessary."

2.11.5 Balinese Fishermen

The threat to populations of sea turtles in Raja Ampat was not only due to the traditional use by indigenous people, such as to be used as for making kawes – a local delicacy, but is also caused by the capture of these endangered species by Balinese fishermen on a much larger scale.

Solomon, a native of Saliyo, whom the senior author met at a fishing camp at Wayag Island, described the exploitation of tuturuga (the local name for sea turtles) in his customary area:

"The people from Gebe [of the North Maluku Province, but culturally related to Raja Ampat] took the eggs and brought home about five or six big tuturuga. People from Ayau also came here to kill tuturuga and took the eggs. They asked permission first from us. But the Balinese just came, anchored their boats near Sayang Island, and collected the live tuturuga, as much as they want. I have seen on one occasion approximately 20 live-big-size tuturuga on the deck of a Balinese ship. Those were in one ship only. And those were only what I could see. I did not know how many more [tuturuga] were inside the ship. They took everything: big, small, eggs …"

The five examples of the external exploitation of marine resources in Raja Ampat presented above clearly demonstrates that despite the fact that there are activities conducted by the population of Raja Ampat that can be categorized as threats to the sustainability of the resources, the involvement of outsiders (the non-Raja Ampat population) was clearly the main reason for the depletion of the marine resources in the archipelago. The fact that most of the outsiders were not residents of Sorong, or even the province of Papua, makes any attempt to limit the depletion to require a highly coordinated effort.

2.12 Community Development Issues in Raja Ampat

There is no formal government development plan for the Raja Ampat islands. The current Sorong Regency Strategic Plan itemizes 20 developmental sectors, including industry, security and law enforcement, but no details are provided on how development within the sectors will be conducted in such a unique area as Raja Ampat. However, the Bupati of Sorong stated in an interview that Raja Ampat would rely on fisheries, marine tourism, and mining as key sectors for generating income after it became an autonomous Regency.

The devolution of authority to the regions in Indonesia has tended to occur without adequate measures to improve the capacity of the local government. Such capacity building is crucial for the Raja Ampat Regency, which lacks physical and governmental infrastructure. Based on previous experiences, such as the establishment of Mimika, Paniai and Puncak Jaya Regencies in Papua Province in 1996, it can be anticipated that the presence of a government institution does not necessarily mean that that institution will function properly in the short term. Political decisions by the new Raja Ampat government regarding natural resource exploitation would be of little consequence unless the government was able to improve and strengthen its capacity to fulfil its obligations in the shortest time possible. The failure to do so might result in the increase of illegal and unsustainable uses of marine and forestry resources – a situation that might be worse than when Raja Ampat was still part of Sorong Regency.

Marine tourism is potentially the backbone of the Raja Ampat economy. However, there was no infrastructure developed by the Sorong Regency that could be developed further by the Raja Ampat government. The Bupati of Sorong admitted that the contribution of the tourism industry as a whole was insignificant to the Sorong government budget, even though he realized its potential. Opportunities now exist for the new government to guide the development of a sustainable low impact tourism sector in conjunction with plans aimed at meeting conservation objectives.

2.13 Immediate Challenges Faced by the Raja Ampat Government

Raja Ampat is in a period of transition, both politically and economically. Communities within the archipelago are becoming more cash dependent yet the interim parent administration from Sorong is unlikely to fund the establishment of infrastructure necessary to facilitate a long-term development vision for Raja Ampat given the limited nature of their tenure and the inherent shortage of development funding from the central government.

It is likely that the fiscal capacity of the Raja Ampat Regency will be very limited in the first five to ten years. The annual provision of the General Allocation Fund (Dana Alokasi Umum) from the central government will only be sufficient to cover administrative costs, which will increase now that there are three additional Districts, each requiring staff and facilities. It is unlikely that excess funds will be available to fund the real developments at the community level. It is therefore necessary for the new government to generate it’s own revenue. It must recognise the value of the uniqueness of Raja Ampat and that non-extractive means of resource use should be developed. Consequently, protection of biodiversity is central to long term prosperity.

Sustainable development in partnership with the private sector seems a likely vehicle. A prime example is the lease in Alyui Bay, Waigeo held by PT Cendana Indopearl whereby the local communities gain employment and other benefits, whilst the environment that maintains food provision is unaffected. Unless other passive, non-extractive sources of income are developed, the government might feel compelled to exploit marine and forestry resources in a manner that cannot be sustained.

Any conservation initiative in Raja Ampat must provide local communities with income generating alternatives that satisfy the immediate needs to purchase goods and services that cannot be fulfilled from their subsistence way of living. Conservation organisations must work closely with the new administration and customary resource owners to ensure access entitlements are agreed upon and duly observed. The new government must also strengthen law enforcement, given the relative freedom with which people from outside Raja Ampat can exploit resources within the archipelago using illegal and destructive methods.

2.14 What Can Be Done to Help the People and Government of Raja Ampat?

Within a five-year time frame, it is proposed that the following practical initiatives be addressed:

- Public education concerning the various socio-economic and environmental issues in Raja Ampat: Whilst the archipelago is well known among marine scientists, it is still an unknown area for many, including the people of Indonesia. The majority of published material, including web-based material, is available only in English. Consequently, its role to educate the people of Indonesia is limited. More articles about Raja Ampat should be published in the popular media in Indonesia.
- A workshop on the development and conservation of Raja Ampat should be conducted: Workshops are a valuable tool that allows people from the different sections of society to discuss relevant issues in a forum of open discussion. The present REA revealed that there has never been an opportunity for the people of Raja Ampat to sit down with the private sector, government agencies and conservation organisations to understand the socio-economic and environmental dynamics of Raja Ampat and to actively participate in the identification and agreement of steps to be taken so that a win-win situation can be achieved.
- Combined efforts of conservation and research institutions should be in place in Raja Ampat: Creation of the Raja Ampat Regency should be seen by conservation organisations and research institutions as an opportunity to intensify their efforts in Raja Ampat and to be actively involved in collaborative and holistic planning with the new administration and resource owners. The establishment of research and community outreach facilities in the new capital, Waisai, is proposed. The purpose of the facility is to create a permanent outlet in close proximity to the Bupati and the new parliament that integrates the conservation and research effort and application from such bodies as The Nature Conservancy (TNC), World Wide fund for Nature (WWF), Conservation International (CI), The Indonesian Science Institute (LIPI), The State University of Papua (UNIPA), The Cenderawasih University (Uncen), the Nature Conservation Bureau of the Department of Forestry (PHPA), and the Research Institute of the Department of Forestry (Litbang Kehutanan), etc.

2.15 Areas Likely to Achieve Greatest Conservation Success

There are significant areas in Raja Ampat that have already been declared as protected areas and there are plans to promote certain areas, such as Kofiau and Wayag, to World Heritage status. Any of the protected areas in Raja Ampat has the potential for the successful implementation of a conservation program, provided the conditions proposed above can be implemented.

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Chapter 3

Coral Reef Fishes of the Raja Ampat Islands

GERALD R. ALLEN

3.1 Summary

- A list of fishes was compiled for 50 sites in the Raja Ampat Islands. The survey involved about 70 hours of scuba diving to a maximum depth of 52m.
- The Raja Ampat Islands have one of the world's richest coral reef fish faunas, consisting of at least 1,074 species of which 899 (84%) were observed or collected during the present survey. The present REA resulted in 104 new records for the Raja Ampats, including four new records for Indonesia.
- A formula for predicting the total reef fish fauna, based on the number of species in six key indicator families, indicates that at least 1,149 species can be expected to occur at the Raja Ampat Islands.
- Gobies (Gobiidae), damselfishes (Pomacentridae), and wrasses (Labridae) are the dominant groups at the Raja Ampat Islands in both number of species (137, 114, and 109 respectively) and number of individuals.
- Species numbers at visually sampled sites during the REA survey ranged from 59 to 284, with an average of 185.9.
- 200 or more species per site is considered the benchmark for an excellent fish count. This figure was achieved at 50 percent of Raja Ampat sites.
- Although fish diversity was relatively high, there were signs of overfishing. Napoleon wrasse, which are a good indicator of fishing pressure, were relatively rare. Only 14, mainly small, individuals were observed at nine sites.
- The vicinity of Kofiau was the richest area for reef fishes with an average of 228 species per site. The highest recorded species count (284) for a single scuba dive in the Indo-Pacific region was recorded at site 31 at Kofiau.
- Areas with the highest concentration of fish diversity and consequent high conservation potential include: Kofiau, Alyui Bay on Waigeo, and islands off western Misool (sites 22-27).

3.2 Introduction

The primary goal of the fish survey was to provide a comprehensive inventory of reef species inhabiting the Raja Ampat Islands. This segment of the fauna includes fishes living on or near coral reefs down to the limit of safe sport diving or approximately 50m depth. It therefore excludes deepwater fishes, offshore pelagic species such as flyingfishes, tunas, and billfishes, and most estuarine forms.

Survey results facilitate comparison of the Raja Ampat's faunal richness with adjoining regions in the Indo-Australian Archipelago ("Coral Triangle"). However, the list of Raja Ampat fishes is still incomplete, due to the rapid nature of the survey and secretive nature of many small reef species. Nevertheless, a basic knowledge of the cryptic component of the fauna in other areas, coupled with an extrapolation method utilizing key "index" families can be used to predict the Raja Ampat's overall species total.

3.3 Methods

The fish portion of this survey involved approximately 70 hours of scuba diving by G. Allen to a maximum depth of 52m. A list of fishes was compiled for 50 sites. The basic method consisted of underwater observations made during a single, 60-90 minute dive at each site. The name of each observed species was recorded in pencil on a plastic sheet attached to a clipboard. The technique usually involved rapid descent to 20-50m, then a slow, meandering ascent back to the shallows. The majority of time was spent in the 2-12m depth zone, which consistently harbors the largest number of species. Each dive included a representative sample of all major bottom types and habitat situations, for example rocky intertidal, reef flat, steep drop-offs, caves (utilizing a flashlight if necessary), rubble and sand patches.

Only the names of fishes for which identification was absolutely certain were recorded. However, very few, less than one percent of those observed, could not be identified to species. This high level of recognition is based on more than 25 years of diving experience in the Indo-Pacific and an intimate knowledge of the reef fishes of this vast region as a result of extensive laboratory and field studies.

The visual survey was supplemented with occasional small collections procured with the use of the ichthyocide rotenone and several specimens collected with a rubber-propelled, multi-prong spear. The purpose of the rotenone collections was to flush out small, crevice and sand-dwelling fishes (for example tiny gobies) that are difficult to record with visual techniques.

3.4 Results

The total reef fish fauna of the Raja Ampat Islands reported herein consists of 1,074 species belonging to 91 families (Appendix 1). A total of 899 species were actually recorded during the present REA. The author recorded the additional 175 species during three previous visits in 1998-2001 (see Allen, 2002). Allen (1993 and 1997), Myers (1989), Kuiter and Tonozuka (2001), and Randall et al. (1990) illustrated the majority of species currently known from the area.

3.4.1 General faunal composition

The fish fauna of the Raja Ampat Islands consists mainly of species associated with coral reefs. The most abundant families in terms of number of species are gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), cardinalfishes (Apogonidae), groupers (Serranidae), butterflyfishes (Chaetodontidae), surgeonfishes (Acanthuridae), blennies (Blenniidae), parrotfishes (Scaridae), and snappers (Lutjanidae). These 10 families collectively account for 61 percent of the total reef fauna (Figure 1).

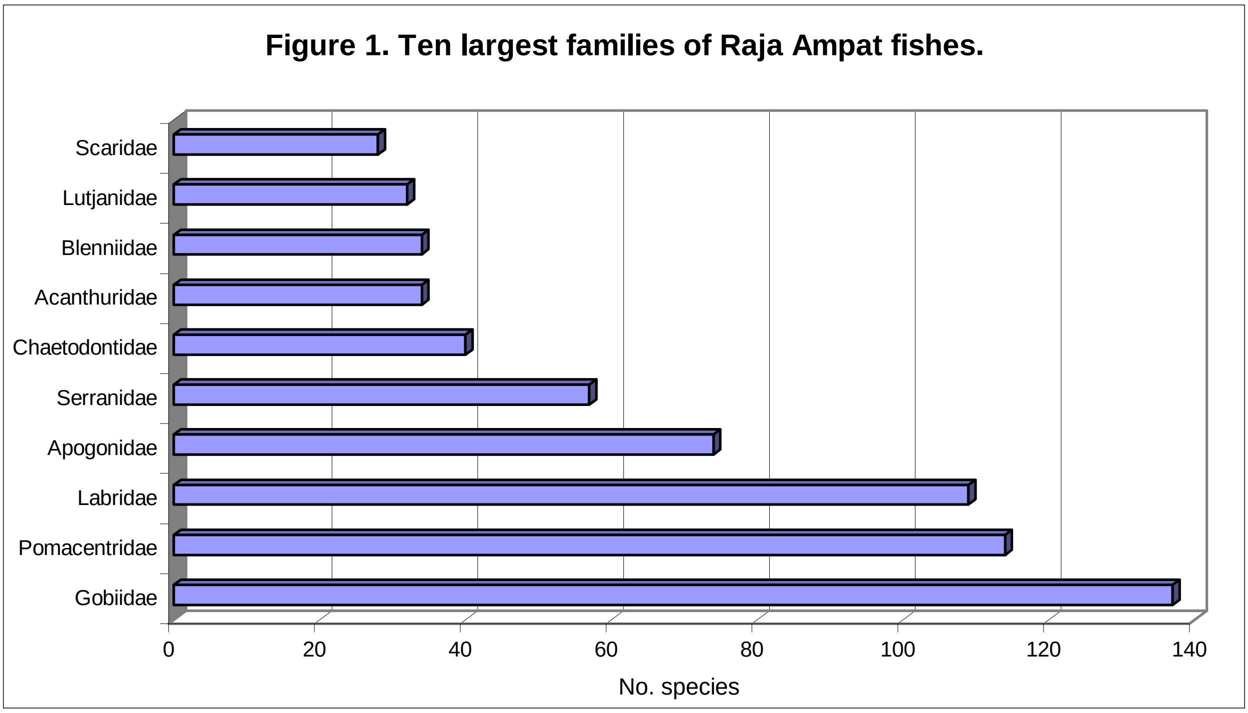

Figure 1. Ten largest families of Raja Ampat fishes

The relative abundance of Raja Ampat fish families is similar to other reef areas in the Indo-Pacific, although the ranking of individual families is variable as shown in Table 1. Although the Gobiidae was the leading family, it was not adequately collected, due to the small size and cryptic habits of many species. Similarly, the moray eel family Muraenidae is consistently among the most speciose groups at other localities, and is no doubt abundant in the Raja Ampats. However, they are best sampled with rotenone due to their cryptic habits.

Table 1. Family ranking in terms of number of species for various localities in the Indo- Pacific region. Data for Milne Bay, Papua New Guinea is from Allen (in press (a)), Togean-Banggai Islands, Indonesia from Allen (2001a), for Calamianes Islands, Philippines from Allen (2001b), for the Chagos Archipelago from Winterbottom et al. (1989), and for the Marshall Islands from Randall and Randall (1987).

Family	Raja Ampats	Milne Bay Province	Togean-Banggai Islands	Calamianes Islands	Chagos Arch.	Marshall Islands
Gobiidae	**1st**	1st	1st	3rd	1st	1st
Pomacentridae	**2nd**	3rd	3rd	1st	3rd	4th
Labridae	**3rd**	2nd	2nd	2nd	2nd	2nd
Apogonidae	**4th**	4th	4th	4th	6th	8th
Serranidae	**5th**	5th	5th	5th	4th	3rd
Chaetodontidae	**6th**	6th	7th	6th	11th	8th
Acanthuridae	**7th**	8th	8th	7th	8th	7th
Blenniidae	**8th**	6th	6th	8th	9th	6th
Lutjanidae	**9th**	9th	9th	9th	7th	18th
Scaridae	**10th**	10th	10th	10th	12th	10th

3.4.2 Fish community structure

The composition of local reef fish communities in the Indo-Pacific region is dependent on habitat variability. The incredibly rich reef fish fauna of Indonesia directly reflects a high level of habitat diversity. Nearly every conceivable habitat situation is present, from highly sheltered embayments with a large influx of freshwater, to oceanic atolls and outer barrier reefs. To a certain degree, the Raja Ampat Islands present a cross-section in miniature of this impressive array of reef environments. However, due to prevailing weather conditions and the protective influence of the large islands of Waigeo, Batanta, Salawati and Misool, much of the surrounding sea is inordinately calm for most of the year. Therefore, fishes usually associated with sheltered reefs are perhaps over-represented.

Similar to other reef areas in the Indo-Pacific, most Raja Ampat fishes are benthic (or at least living near the bottom) diurnal carnivores with 79% and 62% of species being assigned to these respective categories. Approximately 10% of Raja Ampat fishes are nocturnal, 4% are cryptic crevice dwellers, 4% are diurnal mid-water swimmers, and about 3% are transient or roving predators. In addition to carnivores, the other major feeding categories include omnivores (15.1%), planktivores (14.7%), and herbivores (8.2%).

The number of species found at each site is indicated in Table 2. Totals ranged from 59 to 284, with an average of 185.9 per site

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Table 2. Number of fish species observed at each site during TNC survey of the Raja Ampat Islands.

Site	Species	Site	Species	Site	Species	Site	Species
7	170	**21**	201	**34**	217	**48**	191
8	200	**22**	210	**35**	235	**49**	189
9	216	**23**	202	**36**	162	**50**	162
10	192	**24**	134	**37**	174	**51**	163
11	174	**25**	203	**38**	69	**52**	166
12	124	**26**	211	**39**	221	**53**	155
13	59	**27**	219	**40**	138	**54**	211
14	65	**28**	245	**41**	113	**55**	156
15	206	**29**	240	**42**	169	**56**	226
16	261	**30**	241	**43**	208	**57**	204
17	174	**31**	284	**44**	239	**58**	204
18	205	**32**	203	**45**	188		
20	275	**33**	157	**46**	64		

3.4.3 Richest sites for fishes

The total species at a particular site is ultimately dependent on the availability of food, shelter and the diversity of substrata. Well developed reefs with relatively high coral diversity and significant live coral cover were usually the richest areas for fishes, particularly if the reefs were exposed to periodic strong currents. These areas provide an abundance of shelter for fishes of all sizes and the currents are vital for supporting numerous planktivores, the smallest of which provide food for larger predators.

Although silty bays (often relatively rich for corals), mangroves, seagrass beds, and pure sand-rubble areas were consistently the poorest areas for fish diversity, sites that incorporate mixed substrates (in addition to live coral) usually support the most fish species. Sites that encompass both exposed outer reefs as well as sheltered back reefs or shoreline reefs are also correlated with higher than average fish diversity.

The 10 most speciose sites for fishes are indicated in Table 3. The average total for all sites (185.9) was high, especially considering that several of the dive sites involved relatively impoverished habitat situations, such as the highly sheltered waters of bays and narrow channels between clusters of limestone islands.

The total of 284 species at site 31 on Kofiau was the highest total recorded by the author for a single dive anywhere in the Indo-Pacific. It surpassed the previous mark of 283 species recorded at Kri Island, also in the Raja Ampat group.

Table 3. Ten richest fish sites during Raja Ampat survey.

Site no.	General locations	No. spp.
31	Kofiau	284
20	SE Misool	275
16	SE Misool	261
18	Kofiau	245
30	Kofiau	241
29	Kofiau	240
44	Wayag	239
35	Alyui Bay	235
56	E. Waigeo	226
39	Sayang	221

Table 4 presents a comparison of the reef fish fauna of major geographical areas that were surveyed. The highest average number of species (228) was recorded at Kofiau with the lowest value from the Kawe/Wayag/Sayang area.

Table 4. Average number of fish species per site recorded for geographic areas in the Raja Ampat Islands.

Rank	General Area	Site nos.	Avg. species/site
1.	Kofiau	28-33	228.3
2.	Alyui Bay (sites 34-36)	34-36	204.7
3.	W Misool (sites 22-27)	22-27	196.5
4.	SE Misool (sites 7-21)	7-21	187.2
5.	N & E Waigeo	51-58	185.6
6.	Kawe/Wayag/Sayang	37-50	163.5

3.4.4 Coral Fish Diversity Index (CFDI)

Allen (1998) devised a convenient method for assessing and comparing overall reef fish diversity. The technique essentially involves an inventory of six key families: Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae. The number of species in these families is totaled to obtain the Coral Fish Diversity Index (CFDI) for a single dive site, relatively restricted geographic areas (e.g. Raja Ampat Islands) or countries and large regions (e.g. Indonesia).

CFDI values can be used to make a reasonably accurate estimate of the total coral reef fish fauna of a particular locality by means of regression formulas. The latter were obtained after analysis of 35 Indo-Pacific locations for which reliable, comprehensive species lists exist. The data were first divided into two groups: those from relatively restricted localities (surrounding seas encompassing less than 2,000km2) and those from much larger areas (surrounding seas encompassing more than 50,000km2). Simple regression analysis revealed a highly significant difference (P = 0.0001) between these two groups. Therefore, the data were separated and subjected to additional analysis. The Macintosh program, Statview, was used to perform simple linear regression analyses on each data set in order to determine a predictor formula, using CFDI as the predictor variable (x) for estimating the independent variable (y) or total coral reef fish fauna. The resultant formulae were obtained:

1. Total fauna of areas with surrounding seas encompassing more than 50,000km2 = 4.234(CFDI) - 114.446 (d.f = 15; R^2 = 0.964; P = 0.0001);
2. Total fauna of areas with surrounding seas encompassing less than 2,000km2 = 3.39 (CFDI) - 20.595 (d.f = 18; R^2 = 0.96; P = 0.0001).

The CFDI regression formula is particularly useful for large regions such as the Philippines, where reliable totals are lacking. Moreover, the CFDI predictor value can be used to gauge the thoroughness of a particular short-term survey that is either currently in progress or already completed. For example, the CFDI for the Raja Ampat Islands now stands at 345, and the appropriate regression formula (3.39 x 345 - 20.595) predicts an approximate total of 1,149 species, indicating that at least 84 more species can be expected.

On a much large scale, the CFDI can be used to estimate the reef fish fauna of the entire Indo-west Pacific region, a frequent subject of conjecture. Using this method, Allen and Adrim (2003) estimated a faunal total of 3,764 species, a figure that compares favourably with the approximately 3,950 total proposed by Springer (1982). Moreover, Springer's figure covers shore fishes rather than reef fishes and therefore include species not always associated with reefs (e.g. estuarine fishes).

The total CFDI for the Raja Ampat Islands has the following components: Labridae (109), Pomacentridae (114), Chaetodontidae (40), Acanthuridae (34), Scaridae (28), and Pomacanthidae (20). Table 5 presents a ranking of Indo-Pacific areas that have been surveyed to date, based on CFDI values. It also includes the number of reef fishes thus far recorded for each area, as well as the total fauna predicted by the CFDI regression formula.

The only other areas ranked higher than the Raja Ampats are Milne Bay, PNG and Maumere Bay on the Indonesian island of Flores. However, both of these places were studied far more intensively. Conservational International conducted two RAP surveys at Milne Bay (1997 and 2000) with a total of 110 sites. Moreover, additional records were obtained that covered a 20-year period. Maumere Bay was the focus of numerous field trips by G. Allen and R. Kuiter in the 1980s. Also, extensive rotenone collections were procured there during a government-sponsored workshop in 1992. Given the same effort of collecting, the Raja Ampats would certainly surpass both these locations.

Table 5. Coral fish diversity index (CFDI) values for restricted localities, number of coral reef fish species as determined by surveys to date, and estimated numbers using the CFDI regression formula (refer to text for details).

Locality	CFDI	No. reef fishes	Estim. reef fishes
Raja Ampat Islands, Indonesia	**345**	**1074**	**1149**
Milne Bay, Papua New Guinea	337	1109	1313
Maumere Bay, Flores, Indonesia	333	1111	1107
Togean and Banggai Islands, Indonesia	308	819	1023
Komodo Islands, Indonesia	280	722	928
Madang, Papua New Guinea	257	787	850
Kimbe Bay, Papua New Guinea	254	687	840
Manado, Sulawesi, Indonesia	249	624	823
Capricorn Group, Great Barrier Reef	232	803	765
Ashmore/Cartier Reefs, Timor Sea	225	669	742
Kashiwa-Jima Island, Japan	224	768	738
Scott/Seringapatam Reefs, Western. Australia	220	593	725
Samoa Islands	211	852	694
Chesterfield Islands, Coral Sea	210	699	691
Sangalakki Island, Kalimantan,	201	461	660
Bodgaya Islands, Sabah, Malaysia	197	516	647
Pulau Weh, Sumatra, Indonesia	196	533	644
Izu Islands	190	464	623
Christmas Island, Indian Ocean	185	560	606
Sipadan Island, Sabah, Malaysia	184	492	603
Rowley Shoals, Western Australia	176	505	576
Cocos-Keeling Atoll, Indian Ocean	167	528	545
North-West Cape, Western Australia	164	527	535
Tunku Abdul Rahman Is., Sabah	139	357	450
Lord Howe Island, Australia	139	395	450
Monte Bello Islands, W. Australia	119	447	382
Bintan Island, Indonesia	97	304	308
Kimberley Coast, Western Australia	89	367	281
Cassini Island, Western Australia	78	249	243
Johnston Island, Central Pacific	78	227	243
Midway Atoll	77	250	240
Rapa	77	209	240
Norfolk Island	72	220	223

The world's leading country for reef fish diversity, based on CFDI values, is Indonesia. A recent study by Allen and Adrim (2003), which lists a total of 2,056 species from Indonesia, strongly supports this ranking. Table 6 presents CFDI values, number of shallow reef fishes recorded to date, and the estimated number of species based on CFDI data for selected countries or regions in the Indo-Pacific. In most cases, the predicted number of species is similar or less than that actually recorded, and is thus indicative of the level of knowledge. For example, when the actual number is substantially less than the estimated total (e.g. Sabah) it indicates incomplete sampling. However, the opposite trend is evident for Indonesia, with the actual number being significantly greater than what is predicted by the CFDI. The total number of species for the Philippines is yet to be determined and is therefore excluded from Table 6.

Table 6. Coral fish diversity index (CFDI) for regions or countries with figures for total reef and shore fish fauna (if known), and estimated fauna from CFDI regression formula.

Locality	CFDI	No. reef fishes	Estim. Reef fishes
Indonesia	**507**	2056	2032
Australia (tropical)	**401**	1627	1584
Philippines	**387**	?	1525
Papua New Guinea	**362**	1494	1419
S. Japanese Archipelago	**348**	1315	1359
Great Barrier Reef, Australia	**343**	1325	1338
Taiwan	**319**	1172	1237
Micronesia	**315**	1170	1220
New Caledonia	**300**	1097	1156
Sabah, Malaysia	**274**	840	1046
Northwest Shelf, Western Australia	**273**	932	1042
Mariana Islands	**222**	848	826
Marshall Islands	**221**	795	822
Ogasawara Islands, Japan	**212**	745	784
French Polynesia	**205**	730	754
Maldive Islands	**219**	894	813
Seychelles	**188**	765	682
Society Islands	**160**	560	563
Tuamotu Islands	**144**	389	496
Hawaiian Islands	**121**	435	398
Marquesas Islands	**90**	331	267

3.4.5 Zoogeographic affinities of the Raja Ampats fish fauna

Papua Province, Indonesia, belongs to the overall Indo-west Pacific faunal community. Its reef fishes are very similar to those inhabiting other areas within this vast region, stretching eastward from East Africa and the Red Sea to the islands of Micronesia and Polynesia. Although most families, and many genera and species, are consistently present across the region, the species composition varies greatly according to locality.

The Raja Ampat Islands are part of the Indo-Australian region, the richest faunal province on the globe in terms of biodiversity. The nucleus of this region, or Coral Triangle, is composed of Indonesia, Philippines and Papua New Guinea. Species richness generally declines with increased distance from the Triangle, although the rate of attenuation is generally less in a westerly direction. The damselfish family, Pomacentridae, is typical in this regard. For example, Indonesia has the world’s highest total with 138 species, with the following totals recorded for other areas (Allen, 1991): Papua New Guinea (109), northern Australia (95), western Thailand (60), Fiji Islands (60), Maldives (43), Red Sea (34), Society Islands (30), and Hawaiian Islands (15). The damselfishes also provide evidence that the Raja Ampat Islands are very close to the much-debated center of marine diversity. Its total of 114 species is the highest recorded for any similar-sized area in the world. Indeed, only a few countries can match this number.

Allen (2002) analyzed the zoogeographic composition of the Raja Ampat fish fauna. The vast majority (about 60%) of species have wide-ranging distributions in the Indo-Pacific region. A further 17% are widely distributed in the tropical west Pacific. Twenty percent have a more restricted regional distribution that is confined to the Indo-Australian Archipelago. The latter category includes about 25 species that are either confined to Indonesia or the Australia-New Guinea region. These are mainly species that seem to lack efficient dispersal capabilities and are therefore unable to exploit oceanic habitats.

The large number of widely distributed species is not surprising considering that nearly all coral reef fishes have a pelagic larval stage of variable duration. Dispersal capabilities and length of larval life of a given species are usually reflected in its geographic distribution.

3.4.6 Endemism

Considering the broad dispersal capabilities via the pelagic larval stage of most reef fishes, it is not surprising that relatively few fish species are endemic to the Raja Ampat Islands. Six species are presently classified as endemics, but this status is provisional, pending further collecting in adjacent areas, particularly Halmahera, and the adjacent mainland of the Birdshead Peninsula. All of these species belong to families that exhibit parental care and presumably have brief larval stages. The “endemic” species are discussed in the following paragraphs.

Hemiscyllium freycineti (Quoy and Gaimard, 1824) (Hemiscyllidae) - The species is known on the basis of five specimens deposited at the Muséum National d’Histoire Naturelle, Paris and an additional specimen at the Western Australian Museum. French naturalists collected the original specimens between 1817 and 1825 in the vicinity of Waigeo Island. The species is relatively common on shallow reefs, and is mainly seen at night.

Pseudochromis sp. (Pseudochromidae) – This species was commonly sighted on rubble bottoms at the base of steep slopes in about 18 to 20m depth. It was generally seen solitarily or in pairs. It is apparently new and closely related to P. eichleri Gill and Allen from the Philippines. Several specimens were collected by the author on previous trips to the Raja Ampats and are presently being studied by Gill and Allen (Figure 2).

Apogon leptofasciatus Allen, 2001c (Apogonidae) – This species was described on the basis of three specimens collected by the author at Batanta Island in 2001. Only about 15 individuals were sighted at depths between 12-15m. It is apparently rare as none were observed during the TNC survey.

Apogon oxygrammus Allen, 2001c (Apogonidae) – This is another cardinalfish that is apparently rare. Three specimens were collected by the author in 45-50m depth at Pef Island, off the western tip of Gam Island. They were hovering a short distance above a Halimeda-covered rubble bottom among a large aggregation of Apogon ocellicaudus. It differs from all known species in the genus on the basis of color pattern (overall whitish with tapering black mid-lateral stripe that extends onto the caudal fin) and jaw dentition (enlarged teeth in relatively few rows).

Meiacanthus crinitus Smith-Vaniz, 1987 (Blenniidae) – This species was previously known on the basis of 11 specimens collected in 1979 from the vicinity of Batana Island. During the TNC survey, it was occasionally sighted, usually on sheltered reefs with abundant live coral in 1-20m depth. Meiacanthus possess poison fangs and are frequently mimicked by other fishes (Smith-Vaniz, 1976). Juveniles of the threadfin bream *Pentapodus trivittatus* (Nemipteridae) are very similar in appearance to M. crinitus and Smith-Vaniz et al. (2001) suggested that mimicry is involved.

Eviota raja Allen, 2001d (Gobiidae) – This tiny, mid-water hovering goby is common in sheltered water with rich coral growth. It is very similar E. bifasciata, a sympatric species that is distributed across the Indo-Australian Archipelago. The two species differ in colour pattern, most notably the mid-lateral stripe (white in *E. bifasciata*, yellow in the new species) and the dark markings at the upper and lower caudal-fin base (horizontal streaks in E. bifasciata, vertically elongate spots in the new species). They also differ in counts for segmented rays in the second dorsal fin and lateral scale rows (usually 9 and 22 respectively for E. bifasciata and 10 and 25 in the new species) (Figure 3).

Figure 2. New species *Pseudochromis* sp

Figure 3. New species *Eviota raja*.

3.5 New records for Indonesia

Four species were observed during the present survey, which represent new records for Indonesia.

Rabaulichthys altipinnis Allen, 1984 (Anthiinae: Serranidae) - About 15 individuals were seen (site 25, off W. Misool) in 25-30m at the base of a steep outer slope on a rubble-*Halimeda* bottom. Several males were engaged in spectacular courtship displays, consisting of rapid swimming and frequent erection of dorsal and pelvic fins. The species was previously known only from the type locality, Rabaul on the island of New Britain, PNG. In addition, it was recently sighted by divers in the Coral Sea.

Cheilodipterus intermedius Gon, 1993 (Apogonidae) – A small aggregation with six fish was seen sheltering near the reef in 9m depth at site 51 off northern Waigeo. The species has previously been recorded from Palau, Vietnam, Great Barrier Reef, Solomon Islands, and Manu Island, PNG.

Hologymnosus rhodonotus Randall and Yamakawa, 1988 (Labridae) – About five individuals were observed (site 25, off W. Misool) in 30m at the base of a steep outer slope on a rubble-Halimeda bottom. The species has a distinctive pattern of bright red stripes. It was previously known from Okinawa, Philippines, and Hibernia Reef off northwestern Australia.

Echinogobius hayashii Iwata, Hosoya, and Niimura, 1998 (Gobiidae) – Several individuals were observed on a clean, white sand bottom at Sayang Island (site 40) in 12m depth. Two specimens were collected with a muliti-prong spear. It was previously recorded from the Ryukyu Islands, Palau, and Seringapatam Reef off northwestern Australia.

3.6 Historical background

The Raja Ampat Islands have attracted the attention of naturalists and scientists ever since they were first visited by European explorers. Waigeo Island, in particular, was the focus of early French visits by several vessels including L'Uranie (1818-1819), La Coquille (1823), and L'Astrolabe (1826). Consequently, approximately 70 fish species were recorded and Waigeo is an important type locality for a variety of fishes described mainly by Quoy and Gaimard (1824 and 1834), Lesson (1828-1830), and Cuvier and Valenciennes (1828-1849). Fishes that were originally described from Waigeo by early French researchers include such well-known species as the Black-tipped Shark (*Carcharhinus melanopterus*), Bluefin Trevally (*Caranx melampygus*), Bigeye Trevally (*Caranx sexfasciatus*), Semicircular Angelfish (*Pomacanthus semicirculatus*), and Sergeant Major (*Abudefduf vaigiensis*).

Following the early French explorations, most ichthyological activity was provided by Dutch researchers. The famous surgeon-naturalist Pieter Bleeker periodically received specimens from government agents, and in 1868, published on a collection of Waigeo fishes that included 88 species. He added a further 12 species in subsequent papers. Albert Günther, the Curator of Fishes at the British Museum, recorded 28 species from the island of Misool, during the cruise of the "Curacao" in 1865 (Günther, 1873). The Dutch ichthyologists, Weber and de Beaufort, were keenly interested in New Guinean freshwater and marine fishes and contributed to our knowledge of Raja Ampat fishes during the first half of the past century. The work of de Beaufort (1913), in particular, was the most extensive effort on Raja Ampat fishes until recent times, and includes accounts of 117 species based on 748 specimens. These were obtained by de Beaufort during a visit to the East Indies in 1909-1910, and were mainly collected at Waigeo in the vicinity of Saonek Island and Mayalibit Bay. Weber and De Beaufort and various co-authors, including Koumans, Chapman, and Briggs included an additional 67 records from Waigeo and Misool in the Fishes of the Indo-Australian Archipelago (E.J. Brill, Leiden; 11 volumes published between 1921-1962). The Denison-Crockett South Pacific Expedition made small collections at Batanta and Salawati consisting of 29 species that were reported by Fowler (1939). The only other fish collection of note was that by Collette (1977) who reported 37 species from mangrove habitat on Misool and Batanta. The known reef fish fauna of the Raja Ampats prior to the author's investigations stood at approximately 236 species.

The author made the first comprehensive underwater observations of Raja Ampat fishes during two brief visits in 1998-1999. Although the main focus was to document the freshwater fauna, approximately 20 hours of scuba and snorkel diving yielded observations of more than 500 coral reef fishes. The first major survey of the islands was conducted in 2001. The author participated in a marine rapid assessment survey (RAP) organized by Conservation International. A total of 45 sites were assessed during a 15-day period. This effort raised the known reef fish to 970 species (Allen, 2002).

A total of 104 additional species were recorded during the present survey, thus raising the total species count to 1,074. This does not include the following 40 species that were listed by earlier workers, but were not seen during the author's three previous visits or during the present TNC survey: *Moringua abbreviatus*, *M. javanicus*, *M. macrochir*, *Muraenichthys gymnopterus*, *Enchelynassa canina*, *Ecidna delicatula*, *E. zebra*, *Gymnothorax boschi, G. meleagris, G. chilopilus, G. richardsoni, Ophichthys misolensis, Encheliophis homei, E. gracilis, Antennarius hispidus, A. nummifer, A. striatus, Hyporhamphus quoyi, Atherinomorus endrachtensis, Micrognathus brevirostris, Parascorpaena bandanensis, Scorpaenopsis diabolis, Richardonichthys leucogaster, Centrogenys vaigiensis, Epinephelus undulosus, Apogon melas, Carangoides dinema, Gerres abbreviatus, Upeneus sulphureus, Halichoeres timorensis, Calotomus spinidens, Alticus saliens, Blenniella bilitonensis, Istiblennius edentulus , Paralticus amboinensis, Salarias guttatus, Synchiropus picturatus, Eviota zonura, Bathygobius fuscus,* and *Chelonodon patoca*.

3.7 Overview of the Indonesian fish fauna

The Indonesian Archipelago is the world's premier area for marine biodiversity, mainly due to the extraordinary wealth of coral reef organisms. Allen and Adrim (2003) recorded 2,056 species from Indonesia, confirming its position as the richest country in the world for coral reef fishes. This total is compared with other leading countries in Table 9.

Table. 9. The world's leading countries for reef fish diversity (updated from Allen, in press b).

Country	No. species
Indonesia	2,056
Australia	1,627
Philippines	1,525*
Papua New Guinea	1,494
Japan	1,315
Palau	1,254

* Estimated.

Randall (1998) proposed the following factors to account for the extraordinary richness of the Indo-Australian region:

1. Sea temperatures have been very stable during past glacial periods, preventing mass extinctions that occurred elsewhere in the Indo-Pacific;
2. The huge contiguous area of Indonesia and large number of island stepping-stones have formed a "buffer" against extinction;
3. The area is populated by numerous species with relatively short larval periods that are unable to cross deep-water oceanic barriers;
4. Some species have evidently evolved in peripheral regions and were subsequently transported to Indonesia via ocean currents, adding to the overall species richness; and
5. Lowered sea levels during past glacial periods have formed barriers that divided populations that eventually evolved into numerous geminate species pairs. Randall presented examples of 52 such pairings.

Judging from the present REA and other Indonesian fish surveys conducted by the author since 1974, it appears that the area extending from central and northern Sulawesi to the western tip of Papua Province is possibly the world's richest area for reef fishes. The Raja Ampat group is especially rich and appears to be a "cross-roads", containing faunal elements from Papua New Guinea and the Solomon Islands to the east, Palau and the Philippines to the north, and the Moluccas and rest of the Indonesian Archipelago to the west.

Although most of Indonesia's reef fish fauna consists of widely distributed species (largely due to pelagic larval dispersal as already mentioned), there is a significant endemic element, consisting of at least 90 species (Allen and Adrim, 2003). The endemics are scattered widely around the archipelago, but there are several "hotspots", including the Java Sea, Lesser Sunda Islands (especially the Komodo area), northern Sulawesi, and the Raja Ampat Islands (Allen and Adrim, 2003). Most of the endemics, or about 83%, are included in just eight families; particularly prominent are the pseudochromids, blenniids, and pomacentrids. Well over half the species are confined to just nine genera. With the exception of the wrasse genus Cirrhilabrus, these are fishes that invariably exhibit parental egg care with a relatively short pelagic larval stage or have completely abandoned the pelagic stage.

3.8 Discussion and Recommendations

Although illegal fishing with explosives and cyanide occurs at the Raja Ampats, there appears to be less impact from these activities compared to other parts of Indonesia. The majority of sites visited were in good condition with an abundance of fishes. Little, if any, damage to reef habitats due to explosives was noted.

Villagers informed us that cyanide is sometimes used to catch groupers and Napoleon wrasse for the live fish trade. Limited underwater observations of Napoleon wrasse, a conspicuous indicator of fishing pressure, show that it is indeed heavily exploited, a typical situation in Indonesia. It was far more common at the mainly uninhabited Phoenix Islands in the mid Pacific, and at Milne Bay Province, Papua New Guinea, where illegal fishing methods are seldom used (Table 10). With the exception of four large (>100cm) adults, most of the Napoleon wrasse seen during the TNC survey were juveniles under 30-40cm in length.

Table 10. Frequency of Napoleon Wrasse (*Cheilinus undulatus*) for various locations in the Indo-Pacific.

Location	No. sites where seen	% of total sites	Approx. no. seen
Phoenix Islands 2002	47	83.92	412
Milne Bay, PNG – 2000	28	49.12	90
Milne Bay, PNG – 1997	28	52.83	85
Raja Ampat Islands – 2002	**9**	**18.00**	**14**
Raja Ampat Islands – 2001	7	15.55	7
Togean/Banggai Islands – 1998	6	12.76	8
Weh Island, Sumatra – 1999	0	0.00	0
Calamianes Is., Philippines – 1998	3	7.89	5

Sharks were virtually absent at nearly every survey site, which is typical for most areas in Indonesia and the Philippines. The paucity of reef sharks is at least partly explained by the shark-fin trade, which has operated steadily throughout Indonesia for at least the past 3-4 decades.

Table 11 presents the average number of species per site, number of sites where more than 200 species were observed, and the greatest number seen at a single site for recent marine surveys by the author in the "Coral Triangle." Despite a deliberate attempt to sample all habitats, including a relatively high proportion of sheltered environments where fish numbers are often poor, the Raja Ampats exhibited extraordinary faunal richness. A total of 200 or more species is generally considered by the author as the benchmark for an excellent fish count at a given site. This figure was obtained at 51% of Raja Ampat sites, well over twice as many times as its nearest Indonesian rival, the Togean-Banggai Islands

Table 11. Comparison of site data for marine surveys in the coral triangle 1997-2002.

Location	No. sites	Average spp./site	No. 200+ sites	Most spp. one site
Milne Bay, PNG (CI, 1997 and 2000)	110	192	46 (42%)	270
Raja Ampat Islands (CI, 2001; TNC, 2002)	95	184	49 (52 %)	284
Togean/Banggai Is., Sulawesi (CI, 1998)	47	173	9 (19%)	266
Calamianes Is., Philippines (CI, 1998)	21	158	4 (10.5%)	208
Weh I., Sumatra (CI, 1999)	38	138	0	186

Table 12 lists the 12 leading sites for fishes recorded by the author, during nearly 30 years of survey work in the Indo-Pacific region. Eight of the best sites are located in the Raja Ampat Islands, overwhelming evidence for the special status of this area.

Table 12. G. Allen's 12 all-time best dive sites for fishes.

Rank	Location	No. spp.
1	Wambong Bay, Kofiau, Raja Ampat Is.	284
2	Kri Island, Raja Ampat Is.	283
3	SE of Miosba I., Fam Is., Raja Ampat Is.	281
4	Watjoke Island, off SE Misool, Raja Ampat Is.	275
5	Boirama Island, MBP, PNG	270
6	Irai Island, Conflict Group, MBP, PNG	268
7	Dondola Island, Togean Is., Indonesia	266
8	Keruo Island, Fam Is., Raja Ampat Is.	263
9	Pos II Reef, Menjangan I., Bali, Indonesia	262
10	Kalig Island, off SE Misool, Raja Ampat Is.	
11	Equator Islands, Raja Ampat Is.	258
12	NW end Batanta Island, Raja Ampat Is.	246

3.9 Conservation

Every effort should be made to conserve the reefs of the Raja Ampat Islands. Although the present survey was by no means comprehensive, the very rich fauna that was documented over a relatively short period of time indicates an area of extraordinary fish diversity. The author has wide experience throughout the Indonesian Archipelago, and it is my opinion that no other area has as much potential for marine conservation. There are several reasons for this opinion:

- The exceptional habitat diversity and consequent rich fish fauna;
- Good condition of reefs compared to most other parts of Indonesia;
- A high aesthetic value based on the area's superb above-water and underwater scenery;
- A relatively low human population;
- Cultural values by indigenous Papuan people that are highly compatible with reef conservation; and
- The islands harbour a rich, and unique (many endemics) terrestrial fauna, which affords a rare opportunity to implement both marine and terrestrial conservation at the same time.

Given the interest in this area by both TNC and CI, it seems like a wonderful opportunity for these organizations to join forces in designing and implementing an effective conservation program. There is an urgent need to curtail the activities that have already ruined so many reef areas throughout the Indonesian

Archipelago. Community programs need to be designed that allow local villages to regain control of their traditional reef areas, with stiff fines and/or imprisonment facing anyone that uses illegal fishing methods. Also, the practice of outsiders fishing for live groupers and Napoleon wrasse on traditional reefs needs to halted or at least controlled for the benefit of local communities.

3.9.1 Priority areas

Based on a combination of factors, including faunal richness and uniqueness (i.e., presence of fishes not readily seen at most sites), reef characteristics (including general underwater scenery), and above water landscape, the following sites are recommended for possible reserve status.

Southeastern Misool Archipelago (sites 7-13): Although not exceptionally rich for fishes, the area has spectacular above-water scenery consisting of a vast array of highly sculptured limestone islands surrounded by fringing reefs. The area contains an excellent example of a sheltered reef community. There are also some special dive sites, such as site 8, with its unusual underwater tunnel and abundance of soft corals and gorgonians.

West Misool islands (sites 25-27): The cluster of low islets just off the western end of Misool was among the richest for fishes. Although the islands were largely covered by mangrove, a traditionally species-poor habitat for fishes, the channel between Kamet and Kanari islands was incredibly rich. Tidal flushing apparently creates favourable conditions for reef growth and supports an extraordinary amount of biodiversity. In addition, the outer slope off the west side of Kanari Island (site 25) appeared to be affected by cool-upwellings and supported a rich fauna with a high percentage of normally rare fishes such as *Rabaulichtys altipinnis* and *Hologymnous rhodonotus*.

Kofiau (sites 28-33): The reefs of Kofiau are exceptionally rich for fishes, with an average of 228 species per site. No other area of the Coral Triangle surveyed to date can compare with this figure. The Wambong Bay site (31) yielded the highest number (284) of fishes ever recorded by the author for a single scuba dive.

Wayag Island (sites 41-43): Although we did not comprehensively survey the area, the Wayag group possesses a rich variety of sheltered and outer-reef habitats. Its biggest attraction, however, is the maze of picturesque limestone pinnacles. This is one of the most scenic reef areas in Indonesia.

3.9.2 Freshwater collection

A single collection was made in freshwater during the survey on Misool Island. Three species were collected with rotenone from a small tributary of the Wai Tama River: a rainbowfish (Melanotaeniidae) *Melanotaenia misoolensis* Allen, 1982, a gudgeon (Eleotridae) *Oxyeleotris fimbriata* (Weber, 1908), and an apparently undescribed plotosid catfish in the genus Neosilurus. These fishes will be studied by the author in connection with a paper on Raja Ampat freshwater fishes currently in progress.

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Chapter 4

Coral Diversity and the Status of Coral Reefs in the Raja Ampat Islands

EMRE TURAK and JEMMY SOUHOKA

4.1 Summary

- Reefs and coral communities were surveyed at 51 stations, covering the full range of area that was visited. All except 8 of these stations were surveyed at two depth ranges.
- A total of 488 scleractinian corals were identified in the field. In addition, at least a further 35 species are awaiting identification in consultation with reference collections. Of these, 13 are expected to be new to science. This compares to 445 species in North Sulawesi, 379 species in Milne Bay and 347 in Kimbe Bay, PNG. Including a similar survey in 2001, this brings the total confirmed for Raja Ampat to at least 537 scleractinian species of coral. Raja Ampat is expected to harbor over 75% of worlds known coral species.
- To date, Raja Ampat is known to have the highest diversity of hard corals for an area of similar size anywhere on the planet.
- Soft coral diversity was also very high. At least 41 of the 90 Alcyonacean genera known worldwide were recorded.
- Overall, reefs and coral communities in the Raja Ampat area were in very good health. Coral cover was moderate (~33%). However, reefs did not appear to be suffering from any recent serious detrimental effects.
- There was no obvious evidence of the bleaching events that caused extensive mortality to reefs in the region in 1998. No evidence of current or recent crown-of-thorns starfish outbreaks or other coralivorous impacts. There was very little sediment and pollution impact.
- Raja Ampat had many unusual coral habitat and coral community types. Around Misool Island and Wayag Island, this was particularly apparent. Many reefs did not show known or predictable zonation of coral communities. In addition, vertical (depth related) distribution of many coral species was different than what would be expected.
- Misool had the highest diversity of coral community types. Nine out of the 11 distinct coral community types that were identified in Raja Ampat were found in this area. The most uniform area was Kofiau Island.
- Different to anywhere else I have visited so far, the strongest separation of community types in Raja Ampat only followed the depth gradient weakly. Neither was there a strong geographic separation. However water movement, clarity and exposure appears to play a much stronger role in determining community types.
- Raja Ampat has high hard coral richness because of its regional position near the center of the ‘coral triangle’. It contains high diversity of habitat types, both typical and atypical, and a large variety of coastal and bathymetric profiles.
- The relatively unspoiled aspect of the reefs in this area helps maintain its high diversity. However, development and an increase of exploitation by human activities in the area would threaten this situation.
- The Misool area, particularly the southeast has a tremendous variety of habitat types, mostly unusual and unexplored. This would be a priority area for conservation. Second is Kofiau Island, which has probably the highest diversity of coral species for a small island. Wayag Island and its

surrounds have outstanding natural beauty and the reefs probably harbor many unusual coral communities.

4.2 Introduction

Reefs in the Raja Ampat Islands of West Papua province of Indonesia are known to support some of the richest reef fauna in the world (McKenna et al., 2002, Erdman and Pet, 2002). Veron (2002) noted that in this area 565 scleractinian coral species were recorded or are likely to occur. This would make the Raja Ampat Islands one of the richest areas for coral species in the world for areas of a similar size. Fenner (2002) recorded 294 species of scleractinian corals at 45 sites, with ten sites having close to 100 species or above per site. These per site figures already put Raja Ampat among the richest areas of coral diversity in the region.

Raja Ampat is at the eastern end of the coral triangle, an area between the Philippines, western Indonesia and Papua New Guinea, which has the highest coral diversity in the world (Veron, 2000). Recent studies even put the eastern corner of the coral triangle to east PNG. In this case, Raja Ampat would be in the center, in the 'heart of hearts' (Rod Salm), of maximum coral diversity. Its geographic position puts it in an area affected by the Indonesian Throughflow, a southerly flow carrying waters into the Halmahera and Ceram Seas (Erdman and Pet, 2002). This position means that it is bathed by waters from the western equatorial Pacific and provides source material to reefs further to the west in Indonesia, in the Maluku Sea.

This study of corals in Raja Ampat was two fold. At the first level, a complete species inventory of coral and several other sessile reef benthos taxa was compiled. This inventory was both site specific and for the whole area. In addition, the position of Raja Ampat in the region, in terms of species richness, was assessed.

At the second level, the status of the coral reefs and coral communities was assessed. This will provide information for identifying current and potential threats, which would lead to designation of areas needing specific protection and conservation management measures.

4.3 Materials and Methods

The biodiversity of corals includes their habitats, communities, and species and genetic composition. Reefs at 51 locations (GPS stations that were allocated a site number) in Raja Ampat were characterized (Figure 2). At 43 of the locations, sites were surveyed at two depths i.e. Deep: ~10m to maximum depth (.1); and shallow: ~8m to minimum depth (.2). The cutoff point corresponded roughly to the reef 'crest' (margin between the horizontal upper surface of the reef and the slope or drop-off). At six stations, only the shallow sites were sampled, and at two stations, only deep sites were sampled. At each site, the reef was assessed through a careful inventory of coral species, health, and habitat characteristics over sections of reef from 100 to 300m in length. The surveys were conducted using a two tiered method described in DeVantier et al. (1998, 2000). At the first level, a complete inventory of coral species was compiled per site. At the end of each swim, the inventory was reviewed and each taxon was categorized in terms of its relative abundance in the community (Table 1). These broad categories reflect relative numbers of individuals in each taxon at each site, rather than its contribution to benthic cover. For each coral taxon present, a visual estimate of the total amount of injury present on colonies at each site was made, in increments of 0.1, where 0 = no injury and 1 = all colonies dead.

Table 1. Categories of abundance used for recording sessile reef benthos.

Score	Meaning
1	Rare – 1 to 2 colonies seen
2	Uncommon
3	Common
4	Abundant
5	Dominant

In addition, for each species a damage score was attributed and the population, sorted in three size classes - up to 10cm, 10 to 50cm and greater than 50cm colony diameter.

Where sight identification of coral species was not possible, notes and photographs were taken and, if necessary, samples collected to consult with references (Wallace, 1999 and Veron, 2000). When necessary, small coral samples were collected, labeled and taken to Australia to consult with reference collections in the MTQ and AIMS for identification.

At this level, in addition to hard coral species, the same type of data was recorded for soft corals, zoanthids, sponges, macro-algae and other sessile macro-benthos.

Taxa were identified in the field to the following levels:

- Hard corals - species wherever possible, (Veron and Pichon, 1976, 1980, 1982; Veron et al., 1977; Veron and Wallace, 1984; Wallace and Wolstenholme, 1998; Wallace, 1999; Veron, 2000), otherwise genus and growth form (e.g. Porites spp. of massive growth-form).
- Soft corals, zoanthids, corallimorpharians, anemones and some macro-algae - genus or family (Allen and Steene, 1994, Colin and Arneson, 1995, Goslinger et al., 1996; Fabricius and Alderslade, 2001).
- Other sessile macro-benthos, such as sponges, ascidians and most algae - higher taxonomic level, usually phylum plus growth-form (Allen and Steene, 1995, Colin and Arneson, 1995, Goslinger et al., 1996).

At the second level, a series of site characteristics were noted in a semi-quantitative manner: depth range, slope, bottom cover of the major benthic groups, physical structure, reef development level, exposure rating, and visibility (Appendix 2).

To assist in relating community patterns to reef development and the physical environment, each site was classified into one of four categories. For reef development, the categories were:

1. Coral communities developed on rock, sand or rubble;
2. Reefs with no flats but with some carbonate accretion (incipient reefs);
3. Reefs with moderate flats (<50m wide); and
4. Reefs with extensive reef flats (>50m wide).

For exposure to wave energy, the categories were:

1. Sheltered;
2. Semi-sheltered;
3. Semi-exposed; and

4. Exposed.

The Statistica software package was used to produce a hierarchical cluster analysis, which was used to define the major community types present in Raja Ampat. The distance measure used was Squared Euclidean Distance and the clustering strategy was Wards Sum of Squares, after Done (1982), who demonstrated their effectiveness in defining recurrent assemblages within the present type of data set.

4.4 Results

4.4.1 Coral Biodiversity

A total of 488 scleractinian coral species were identified in the field, either in situ or from collected specimens and underwater photographs. A further 35 species are awaiting consultation with reference material in Australia. Of these, at least 13 species might prove to be new to science. This total figure compares to 445 species in North Sulawesi, 379 species in Milne Bay and 347 in Kimbe Bay, PNG (Table 2).

Table 2. Raja Ampat hard coral survey results compared with several other areas in the region and western Indian Ocean. All are values by the same observer using the same method and include material from some unpublished sources by E. Turak

	Raja Ampat	N Sulawesi Indonesia	Banda Islands	East Kimbe Bay	Milne Bay PNG**	North GBR Australia	NW Madagascar
	This study	Turak, 2002	Turak *et al.* 2002	Turak and Aitsi, (in prep)	Turak, 2000^	Turak, 2001^	Turak, 2001
Total species	**488**	445	301	351	393	318	318
Av. no. sp/site	**131**	100	106	124	147	100*	103
% sites with over 1/3 recorded sp.	**18**	8	61	74	82		60
Sites surveyed	**51**	52	18	27	28	26	29
Area (x1000 km^2)	**30**	23	0.4	1.1	15	0.8	1.2
Average % hard coral cover	**33**	21.3	40.3	30	33.3	34.8	35.1

* Is an estimate based on a combination of values for two depths per site
** Incorporates observations of the two authors
^ Turak (2000) and Turak (2001) are from unpublished sources

Including a similar survey in 2001 (Veron 2002), this brings the confirmed total for Raja Ampat to at least 537 scleractinian species of coral (Appendix 3). In total Raja Ampat is expected to harbor over 75% of worlds known coral species.

As well as overall diversity, average site richness and locality richness was very high (Table 3). The Kofiau Island group had the highest average species diversity per site, but southeast Misool was the richest location. Coral species diversity in these locations of relatively small area was comparable to species diversity in much larger areas in different parts of the world (Table 2).

Table 3. Average species richness per site and locality within Raja Ampat.

	East Misool	Southeast Misool	Kofiau Islands	Wayag Islands	Kawe	East Waigeo
Average species per site	130	144	156	135	138	141
Location total	314	339	292	288	247	330
Number of sites	8	8	6	5	3	6

The other hard corals were not very common or abundant. Three species of the non-zooxanthelate scleractinia in Dendrophyllidae were recorded on few of the sites. In addition, eight species in three genera, and another two genera of non-scleractinian corals, were recorded. Of these, the organ pipe coral Tubipora musica was the most common, found at half the sites. Five species of the fire coral, genus Millepora, were found at a good proportion of sites, but never very abundant (Appendix 4).

Soft corals were common and very abundant at some sites. In addition, soft coral diversity was very high. Forty of the 90 Alcyonacean genera in 14 families known worldwide were recorded. In addition, two Pennatulacean and two Antipatharian corals were recorded (Appendix 4).

4.4.2 Community types

Many coral communities in the Raja Ampat area were unusual. Zonation of assemblages did not always follow predicted distribution. Some species that are usually found at greater depths were often found in the shallows, and vice versa. In addition, some assemblages had species composition different than what would usually be expected in that region. For this reason, characteristics of community types listed below, which were identified following analysis, were not always very distinct.

A cluster analysis identified four main groups among all sites, comprising all depths (Figure 1). At the first level, sites of extremely low energy environments were separated, particularly far inside bays, narrow inlets and deep sites. Three clusters were then found in a mixture of clearer water environments. The first cluster contained sites of a mixture of depths, found in clear water, low wave energy environments. A second distinct cluster comprised shallow water sites that were subject to some wave action, and a third cluster comprised mostly deep sites found in areas of high water movement.

It was the combination of deep and shallow water assemblages that formed the more distinct community types, rather than the four main groups themselves. Four major community types, with a total of 10 sub-types, were distinguished (Table 4). A single station of two sites (forming a fifth community type) remained distinct from the rest. These two sites had the highest coral species diversity. Only two sites, each at a single depth, represented two of the sub-type communities. Despite that, community characteristics remained relatively strong, in particular was community type B2 (Table 5). All community types were found throughout the area of survey. However, types A1 and D2 were found mostly in the north, types D3 and D4 mostly in southeast Misool, and type D1 was mostly found around smaller islands (Figure 2). A number of hard and soft coral species were common to all sites and thus formed some of the most abundant species for many community types.

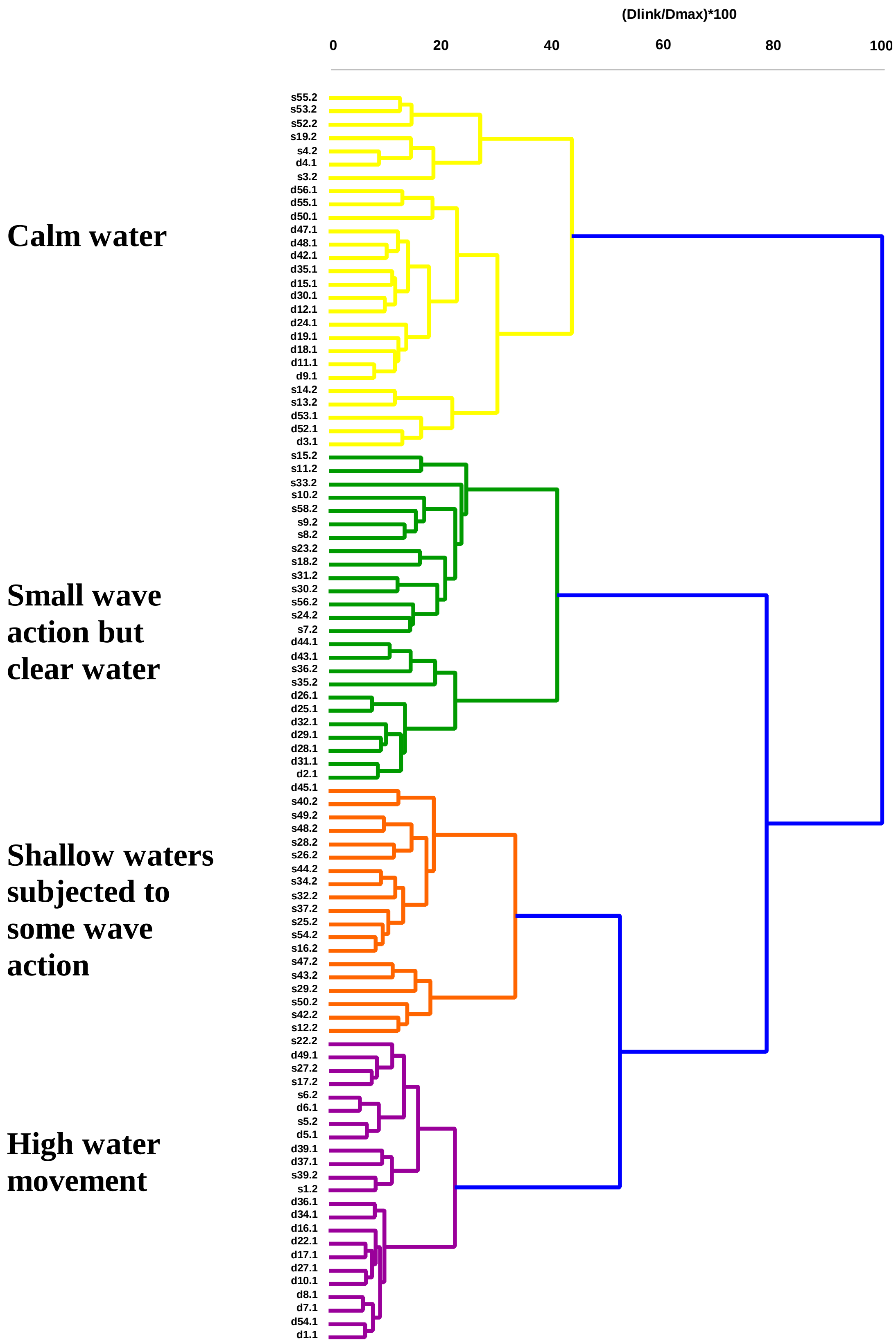

Figure 1. Hierarchical cluster analysis of 94 sites in 52 stations showing the four main groups that form in deep and shallow combinations, and the 11 community types.

Table 4. Brief description of environmental and biological characteristics of the community types with some of the major taxa found in each type. In parenthesis is the number of sites found in each type. Color-coding corresponds to shallow (above) and deep (below) sites that form distinct groups in the cluster analysis.

	Community type	Sites
A (11)	Very protected communities in bays	
A1 (6)	Communities very far in bays and inlets *Pachyseris*, *Hydnophora*, *Seriatopora*, alcyoniid, macro-algae	3, 4, 19, 52, 53, 55
A2 (5)	Communities in protected bays *Fungia, Echinopora, Seriatopora, Isis,* alcyoniid	12, 42, 47, 48, 50
B (8)	Single depth communities	
B1 (4)	Shallow communities between small islands and coast *Acropora*, Pocilloporid, alcyoniid	2, 23, 33, 58
B2 (2)	Communities found far in very narrow inlet *Porites cylindrica, Favia,* macro-algae, *Isis, Heliopora coerolea*	13, 14
B3 (2)	Deep reef falt communities far from shallow areas Pocilloporid, Acroporid, *Xenia*, *Aglaophenia*, *Millepora*	40, 45
C (7)	Communities around headlands with strong currents *Porites*, *Favia,* table *Acropora*, *alcyoniid,* sponge	1, 5, 6, 17, 22, 27, 39
D (24)	Mixed community types	
D1 (7)	Very clear open water communities *Platygyra, Pocillopora, Acropora palifera, Aglaophenia, Nephthea*	25, 26, 28, 29, 32, 43, 44
D2 (5)	Wave impacted hard bottom communities *Acoropora, Pocillopora, Favia, Halimeda,* alcyoniid	16, 34, 37, 49, 54,
D3 (8)	Communities with high species diversity and coral cover *Fungia, Acropora, Oxypora, Pectinia lactuca,* akcyoniid	9, 11, 15, 18, 24, 30, 35, 56
D4 (4)	Communiites with high soft coral cover *Mycedium*, favid, *Pectinia lactuca,* Alcyoniid	7, 8, 10, 36
E (1)	Very high coral species diversity *Montipora*, *Acropora*, alcyoniid	31

Table 5. Site habitat and physical characteristics of the four main, and eleven sub-community types. In parenthesis next to the main type letters is the number of sites found in each group.

Community type	**A** (11)		**B** (8)			**C** (7)	**D** (24)				**E** (1)
	A1	**A2**	**B1**	**B2**	**B3**		**D1**	**D2**	**D3**	**D4**	
Shallow											
Deep											
Number of stations	6	5	4	2	2	7	7	5	8	4	1
Site											
Max. depth (m)	19	19	16	13	22	21	20	20	19	18	28
Min. depth (m)	5	5	3	1	6	6	5	6	5	5	6
Slope (degrees)	29	17	26	40	5	23	19	20	29	29	23
Hard Substratum (%)	72	78	55	70	83	78	80	83	82	79	73
Benthos											
Hard coral (%)	48	44	35	35	40	22	31	14	41	24	20
Soft Coral (%)	4	8	25	0	7	16	9	12	12	24	4
Macro-algae (%)	8	2	6	6	3	6	1	3	2	4	3
Turf-algae (%)	10	10	9	10	10	15	10	13	13	11	10
Coralline algae (%)	0	4	2	8	10	6	9	8	2	4	8
Dead coral (%)	4	2	2	1	1	6	3	1	2	2	0
Substratum											
Continuous pavement (%)	54	58	28	45	60	45	58	69	61	64	60
Large blocks (%)	7	10	15	5	15	19	8	6	11	8	5
Small blocks (%)	12	10	13	20	8	13	14	9	9	8	8
Rubble (%)	17	8	11	8	3	13	13	7	5	5	0
Sand (%)	11	15	34	23	15	10	8	11	13	16	28
Visibility (m)	8	10	15	4	23	21	28	20	15	12	25
Water temperature	29	28	28	29	29	28	27	28	28	28	28
Reef development (1-4)	3	3	2	2	2	2	3	3	4	2	3
Exposure to waves (1-4)	1	1	2	1	2	2	2	3	2	2	2
Average no. of species	140	131	128	99	103	87	151	120	161	135	174

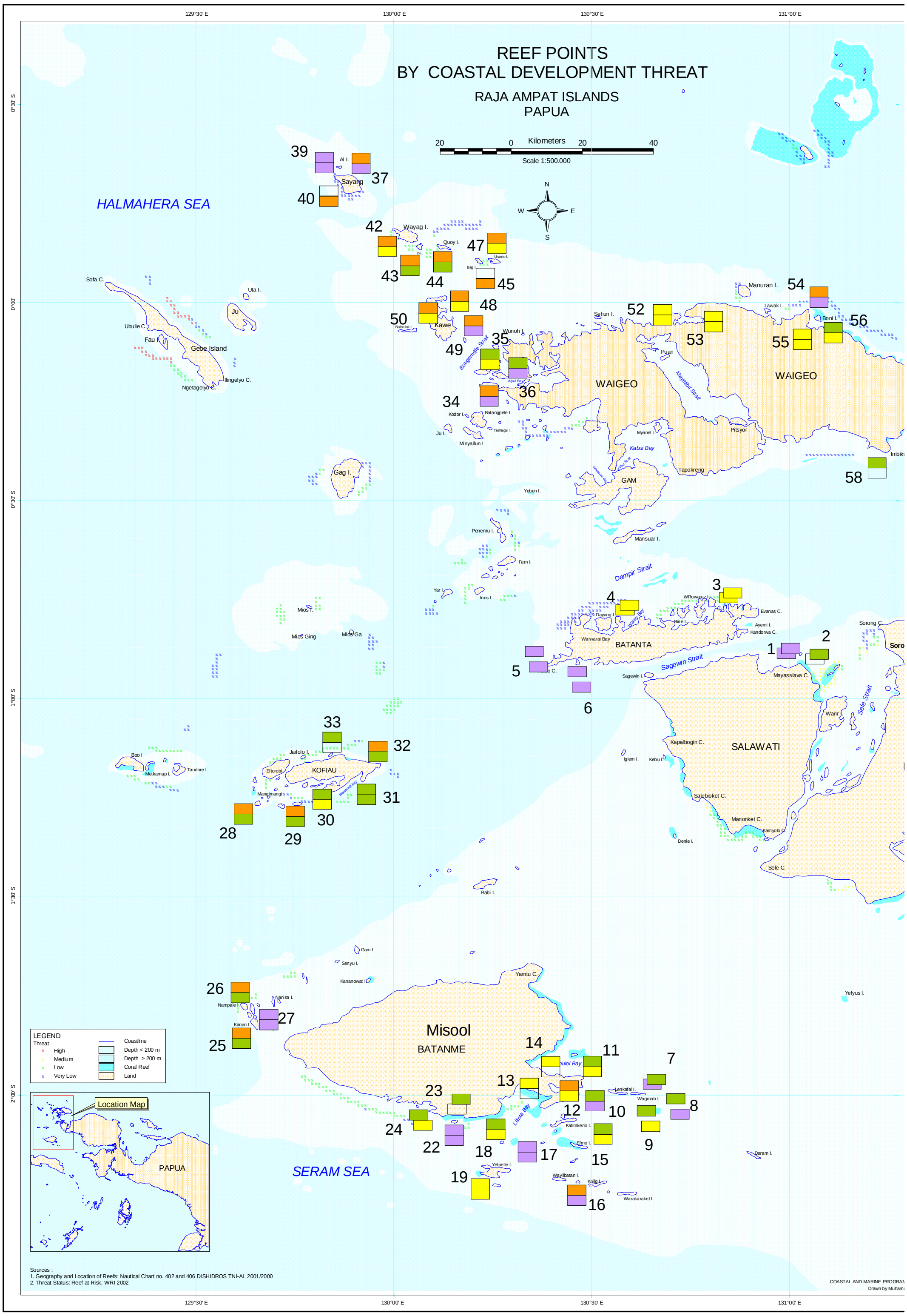

Figure 2. Map of Raja Ampat area survey sites and community types. For color-coding of community types refer to Tables 3 and 4.

A - Very Protected Communities in Bays

Type A1. Communities very far in bays and inlets - Pachyseris, Hydnophora, Seriatopora, alcyoniid, macro-algae.

This community type was found far inside bays and inlets where reefs were extremely sheltered with virtually no wave action. These reefs had low underwater visibility, but where it was sufficiently deep, two depths were sampled. Reefs of this type had the highest hard coral (48%) and macro-algae (8%) cover, and relatively high coral species diversity (140) (Table 5). In the deeper sites, Pachyseris speciosa (Figure 3) were the most common corals. In the shallower sites, Hydnophora rigida, Porites cylindrica and Merulina ampliata were most common. The macro-algae Padina, Halimeda and Dictyota, and alcyoniid soft corals were common (Table 6). With the exception of Jef Pelee Island, south of Misool, this community type was mostly found in the northern half of Raja Ampat, in Batanta and Waigeo (Figure 2).

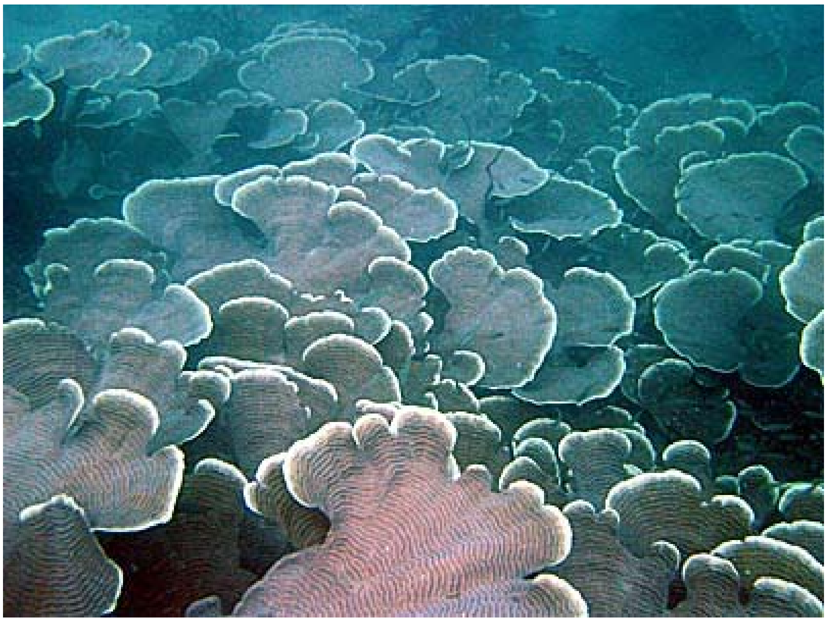

Figure 3. Pachysris beds in Fofak bay, Waigeo

Type A2. Communities in protected bays - Fungia, Echinopora, Seriatopora, Isis, alcyoniid.

This community type was found in relatively protected bays on reefs subjected to minor wave action and very little water current movement. Reefs had relatively low underwater visibility (Table 5), though high coral cover (44%) and high hard coral species diversity (131). The solitary mushroom coral Fungia, Echinopora lamellosa and Paltygyra daedelea were common corals. The soft corals Sinularia, Isis and Sarcophyton (Figure 4) were also common (Table 6). This community type was mostly found in the north, around Wayag and Kawe Islands (Figure 2).

Figure 4. *Sarcophyton* and *Issi* soft corals on a reef flat in west Wayag.

B - Single Depth Communities

Type B1. Shallow communities between small islands and the coast - Acropora, pocilloporid, alcyoniid

This type is a shallow water community found inside channels between smaller islands and adjacent coasts of larger islands. They were found in areas of relative exposure, particularly to currents running through the channels. Reef development was relatively low with the hard substrate, typical of all the community types. Hard coral cover was just above average (35%), though soft coral cover was the highest of all the community types (25%) (Table 5). The branching corals Acropora formosa, A. florida, and the encrusting coral Montipora grisea, were among the most common hard corals (Table 6). The alcyoniid soft corals (Figure 5) and sponges were also common. This community type was found throughout the survey area, in Salawati, Misool, Kofiau and Waigeo (Figure 2).

Figure 5. *Nephthea* and *Seriatopora* on the reef flat at Deer Island, north Kofiau.

Figure 6. Unusual growth of *Porites* in low visibility waters of Papas Tip Pale, Misool

Type B2. Communities found far in very narrow inlet - *Porites cylindrica*, *Favia*, macro-algae, *Isis*, *Heliopora coerolea*

This community type was found at two stations in a narrow inlet in east Misool (Figure 2). It was found in shallow water with a muddy bottom at 13m depth. These reefs had low underwater visibility (Figure 6) and low coral diversity, but above average hard coral cover (Table 5). The most common corals were *Pectinia lactuca*, *Lobophyllia hemprichii* and *Porites cylindrica*. The macro-algae *Sargassum, Padina* and *Halimeda* were present at all sites without being abundant (Table 6).

Type B3. Deep reef flat communities far from shallow areas - pocilloporid, acroporid, *Xenia*, *Aglaophenia*, *Millepora*

This community type was found on flat reef areas far from shore, at a minimum depth of 6m. These reefs had high hard coral cover, though low species diversity. The reefs had the highest coralline-algae cover and the lowest slope of all the communities (Table 5). The Table corals *Acropora clathrata, A. cytherea* and *A. hyacinthus*, (Figure 7) and encrusting corals, *Montipora efflorescens*, *M. grisea* and *M. tuberculosa* were the most common. Soft coral *Xenia*, stinging hydroid *Aglaophenia* and fire coral *Millepora dichotoma* were the other benthos most common (Table 6). This community was found in the north at Sayang and Wayag (Figure 2).

Figure 7. Table Acropora, fire coral *Millepora* and, in the background, stinging hydroid *Agloaphenia*

Type C. Communities around Headlands with Strong Currents - *Porites, Favia,* table *Acropora,* alcyoniid, sponge

This community type was found around headlands or near channel areas between two islands where multidirectional currents are strong (Figure 8). In such areas, hard coral cover was low, species diversity was the lowest, and turf-algae cover was the highest of all communities (Table 5). However, dead coral cover was the highest on these reefs, mainly due to severe damage (possibly fish bombing) to one of the sites near Salawati. Coral species of the massive form, such as *Porites massive*, *Favia matthai* and *Symphyllia agaricia*, *Acropora* species were the most common. Alcyniid soft corals and sponges were also common (Table 6). This community type was found mostly in the southern half of the survey area, south of Batanta and Misool (Figure 2).

Figure 8. Strong currents and large Acropora tables were typical of community type C

Table 6. Top ten hard coral species and other benthos representing each community type. In color legends, sh: shallow; dp: deep. For each taxa, abn: accumulated abundance for all sites, site: number of sites where taxa was found.

Type A1	sh	dp	Type A2	sh	dp
Taxa	**abn**	**site**	**Taxa**	**abn**	**site**
Porites massive	30	11	*Porites* massive	19	10
Seriatopora hystrix	25	11	*Galaxea fasicularis*	17	9
Fungia concinna	23	10	*Seriatopora hystrix*	16	8
Pachyseris speciosa	21	11	*Fungia paumotensis*	16	8
Hydnophora rigida	21	10	*Echinopora lamellosa*	15	7
Porites cylindrica	21	9	*Fungia fungites*	14	7
Goniasatrea pectinata	20	12	*Platygyra daedelea*	13	9
Merulina ampliata	20	11	*Porites vaughani*	13	7
Astreopora gracilis	20	10	*Seriatopora caliendrum*	13	6
Galaxea fasicularis	19	11	*Acropora formosa*	12	6
Padina	19	8	*Sinularia*	14	7
Sarcophyton	16	9	*Isis*	13	5
Sinularia brascica	15	8	*Sarcophyton*	11	6
Halimeda	15	6	*Clavularia*	10	4
Nephthea	13	8	*Halimeda*	9	4
Sinularia	13	7	Sponge	7	3
Sponge	13	6	*Padina*	6	4
Dictyota	13	5	*Lobophytum*	6	3
Briareum	11	5	*Tridacna crocea*	5	4
Polycarpa	11	5	*Tridacna squamosa*	5	4
Type B1	**sh**	**dp**	**Type B2**	**sh**	**dp**
Taxa	**abn**	**site**	**Taxa**	**abn**	**site**
Acropora formosa	9	4	*Porites cylindrica*	5	2
Pocillopora verrucosa	8	4	*Pectinia alcicornis*	5	2
Stylophora pistillata	8	4	*Lobophyllia hemprichii*	5	2
Montipora grisea	8	4	*Goniasatrea pectinata*	5	2
Acropora florida	8	4	*Favia favus*	4	2
Porites massive	8	4	*Favia matthai*	4	2
Goniasatrea pectinata	8	4	*Favia speciosa*	4	2
Platygyra daedelea	7	4	*Platygyra daedelea*	4	2
Symphyllia agaricia	7	4	*Leptastrea transversa*	4	2
Merulina ampliata	7	4	*Mycedium elephantotus*	4	2
Sinularia	10	4	*Polycarpa*	6	2
Nephthea	9	4	*Sargassum*	4	2
Polycarpa	9	4	*Padina*	4	2
Sarcophyton	7	4	*Halimeda*	4	2
Sponge	7	3	*Isis*	3	1
Tubipora musica	6	4	*Heliopora coerolea*	2	1
Paralemnalia	6	3	*Sinularia brascica*	2	1
Dendronephthya	6	3	Gorgonian	2	1
Aglaophenia	6	3	*Zoanthus*	2	1
Cliona	6	3	Sponge	2	1

Table 6. Top ten hard coral species and other benthos representing each community type. In color legends, sh: shallow; dp: deep. For each taxa, abn: accumulated abundance for all sites, site: number of sites where taxa was found.

Type B3	sh	dp	Type C	sh	dp
Taxa	**abn**	**site**	**Taxa**	**abn**	**site**
Favia matthai	5	2	*Porites* massive	29	13
Acropora clathrata	4	2	*Favia matthai*	22	13
Acropora cytherea	4	2	*Pocillopora verrucosa*	17	9
Acropora hyacinthus	4	2	*Symphyllia agaricia*	15	12
Montipora efflorescens	4	2	*Pachyseris speciosa*	14	11
Montipora grisea	4	2	*Montipora grisea*	14	10
Montipora tuberculosa	4	2	*Acropora hyacinthus*	14	9
Pocillopora eydouxi	4	2	*Acropora palifera*	14	7
Seriatopora caliendrum	4	2	*Acropora subulata*	13	8
Stylophora pistillata	4	2	*Platygyra daedelea*	12	11
Xenia	5	2	*Sarcophyton*	25	12
Aglaophenia	5	2	*Sinularia*	25	11
CRA	5	2	Sponge	24	11
Millepora dichotoma	4	2	*Halimeda*	23	10
Sarcophyton	4	2	*Nephthea*	20	10
Sinularia	4	2	*Dendronephthya*	19	8
Lobophytum	4	2	*Xenia*	19	8
Paralemnalia	4	2	Gorgonian	19	8
Nephthea	4	2	*Polycarpa*	18	8
Pinnigorgia	4	2	*Palythoa*	15	9
Type D1	**sh**	**dp**	**Type D2**	**sh**	**dp**
Taxa	**abn**	**site**	**Taxa**	**abn**	**site**
Platygyra daedelea	27	14	*Porites* massive	17	9
Pocillopora verrucosa	26	13	*Pocillopora verrucosa*	15	9
Acropora palifera	25	13	*Favia matthai*	14	10
Porites massive	25	12	*Astreopora myriophthalma*	14	9
Stylophora pistillata	23	11	*Acropora palifera*	14	7
Galaxea fasicularis	22	13	*Galaxea fasicularis*	12	8
Porites nigrescens	22	11	*Acropora clathrata*	12	7
Favia matthai	22	11	*Acropora austera*	12	6
Seriatopora hystrix	22	9	*Acropora millepora*	11	8
Acropora subulata	21	12	*Pocillopora eydouxi*	11	7
Aglaophenia	23	11	*Halimeda*	21	9
Nephthea	22	11	*Sarcophyton*	19	9
Halimeda	22	11	*Sinularia*	17	8
Sinularia	20	10	*Nephthea*	16	7
Xenia	20	8	*Dendronephthya*	15	7
Sarcophyton	17	9	CRA	13	5
Palythoa	15	10	*Paralemnalia*	12	6
Paralemnalia	15	7	*Xenia*	12	6
Sponge	15	7	*Aglaophenia*	12	6
Tubipora musica	14	8	*Polycarpa*	12	6

Table 6. Top ten hard coral species and other benthos representing each community type. In color legends, sh: shallow; dp: deep. For each taxa, abn: accumulated abundance for all sites, site: number of sites where taxa was found.

Type D3	**sh**	**dp**
Taxa	**abn**	**site**
Fungia paumotensis	28	14
Goniasatrea pectinata	27	14
Acropora formosa	27	10
Merulina ampliata	26	16
Fungia danai	26	14
Fungia fungites	26	13
Pocillopora damicornis	25	15
Oxypora crassispinosa	24	15
Pectinia lactuca	24	13
Fungia concinna	24	12
Sarcophyton	29	14
Nephthea	26	13
Sinularia	25	12
Sponge	21	10
Tubipora musica	19	12
Polycarpa	18	9
Paralemnalia	17	9
Peyssonnelia	17	7
Briareum	16	8
Dendronephthya	15	8

Type D4	**sh**	**dp**
Taxa	**abn**	**site**
Mycedium elephantotus	12	7
Goniasatrea pectinata	12	7
Porites massive	11	5
Favites complanata	9	7
Pectinia lactuca	9	6
Pachyseris speciosa	9	5
Fungia concinna	9	5
Favites flexuosa	9	5
Platygyra daedelea	9	5
Acropora formosa	9	4
Sarcophyton	16	7
Sinularia	15	6
Nephthea	13	6
Dendronephthya	12	4
Lobophytum	10	5
Gorgonian	10	4
Palythoa	9	5
Isis	8	3
Polycarpa	8	3
CRA	7	3

Type E	sh	dp
Taxa	**abn**	**site**
Acropora formosa	5	2
Porites cylindrica	5	2
Montipora foliosa	4	2
Montipora grisea	4	2
Montipora informis	4	2
Montipora monasteriata	4	2
Acropora granulosa	4	2
Acropora subglabra	4	2
Pocillopora verrucosa	4	2
Seriatopora caliendrum	4	2
Halimeda	6	2
Nephthea	5	2
Sarcophyton	4	2
Sinularia	4	2
Lobophytum	4	2
Sponge	4	2
Palythoa	3	2
Tubipora musica	2	1
Paralemnalia	2	1
Dendronephthya	2	1

D - Mixed Community Types

<u>Type D1. Very clear open water communities - Platygyra, Pocillopora, Acropora palifera, Aglaophenia, Nephthea</u>

Found in areas of very clear and open water, this community type was wide spread, but mainly around smaller islands. Typified by low macro-algae and sand cover, the lowest water temperatures and the highest underwater visibility (Figure 9), these reefs also had reasonably high species diversity (Table 5). Coral species of the massive growth form, such as Platygyra daedelea, Porites and Favia Matthai, and Acropora palifera were common. Stinging hydroid *Agloaphenia*, soft coral *Nephthea* and other alcyoniid corals were also common (Table 6). Reefs with this community type were found around Kofiau, Wayag and islands northwest of Misool (Figure 2).

Figure 9. Clear water communities with many nephtheid and alcyoniid soft corals in South Walo, Kofiau.

<u>Type D2. Wave impacted hard bottom communities - *Acropora*, *Pocillopora*, *Favia*, *Halimeda*, alcyoniid</u>

Most of the reefs with this community type were in areas open to strong wave and surge action (Figure 10). Hard coral cover (14%) and unconsolidated bottom cover was the lowest of the community types. Species richness was moderate (Table 5). The most common corals were the massive, such as *Porites*, *Favia matthai* and *Astreopora myriophthalma*, and different growth forms of *Acropora*. Alcyoniid soft corals and the green fleshy algae *Halimeda* were present at most sites (Table 6). Most of the reefs with this community were found in the far north section of Raja Ampat (Figure 2).

Figure 10. Sparse wave swept community at North Boni Reef, Waigeo.

<u>Type D3. Communities with high species diversity and coral cover - Fungia, Acropora, Oxypora, Pectinia lactuca, akcyoniid</u>

These communities are usually found in areas facing open water, but relatively protected from direct high wave energy, including the lee side of open water reefs. This community type was found on reefs with maximum reef development value and very high hard coral species diversity (Table 5). In addition, live hard coral cover was high (41%) with some shallow water coral, in particular branching Acropora forming large mono- or multi-specific stands. Solitary mushroom corals such as *Fungia concinna*, *F. danai* and *F. fungites*, and *Oxypora* and *Pectina* corals were also common (Figures 11 and 12). In addition to alcyoniid soft corals and sponges, organ pipe coral Tubipora musica was also common (Table 6). Reef sites with this community type were found throughout the survey area, but mostly around Misool Island (Figure 2).

Figure 11. Fungid corals were very abundant at north Mesemta reef, Misool.

Figure 12. Foliose *Oxypora* intermingled in *Acropora* beds at Los Island reef, Misool.

Type D4. Communities with high soft coral cover - *Mycedium*, favid, *Pectinia lactuca*, alcyoniid, nephtheid

This community type is found in areas of strong current and under karst walls or overhangs where soft coral abundance was high. Reefs with this community type had moderately steep slopes with high hard bottom cover, lower than average hard coral cover, and moderate species diversity (Table 5). Most common corals were *Mycedium elephantotus*, favids (Figure 13) and *Pectinia lactuca*. Alcyoniid soft corals *Sarcophyton, Sinularia* and *Lobophytum*, nephtheids *Nephthea* and *Dendronephthea*, and gorgonian corals were common (Table 6). Three of the four sites with this community type were found on the chain of islands stretching east of Misool (Figure 2).

Figure 13. Favids were common in community type D4.

Type E. Very High Coral Species Diversity - *Montipora*, *Acropora*, alcyoniid

This community type was more of an outlier rather than a community type as such, since it is represented by only one station with a shallow and deep site in Wambong Bay, east Kofiau Island (Figure 2). However, it remains distinct from the rest of the community types and has the highest diversity of hard corals. Habitat characteristics were also unusual. It was found in a very protected bay with very clear water, dropping down in several steps to very deep water with a distinct thermocline. Hard coral cover was relatively low, but with no dead coral (Table 5). *Acropora*, *Montipora*, *Porites* and pocilloporid corals were most common (Figures 14 and 15). The green fleshy algae *Halimeda* and alcyoniid soft corals were also common (Table 6).

Figure 14. Foliose and encrusting *Montipora* sometimes formed large beds in community type E.

Figure 15. Rich community type E in clear water at Wambong Bay, Kofiau.

4.4.3 Reef Health

Reefs in the area were in overall good health. The two main exceptions were a small number of sites where we saw evidence of old and recent blast fishing damage, and bleaching and partial mortality of corals in a number of reef flat sites in Misool and Batanta. The most severe blast fishing damage was at a shallow reef site at Pulau Senapan, near Salawati (site 1.2), where dead coral was estimated to be 60% of bottom cover. However, most blast damage appeared to be old and not all of the observed dead coral could be confidently attributed to this effect. Another reef where we saw several bomb craters was site 26.2 on Nampale Island, west of Misool. In addition, a number of old bomb craters were seen at southwest Ai Island, Wayag and Uranie Islands.

No large-scale coral bleaching damage was observed. However, on a number of reefs, particularly in southeast Misool, bleaching and associated mortality was observed in shallow reef flat corals, due to exposure during exceptionally low tides. In two sites in east Waigeo, small patches of corals were seen that were bleached or pale in color. At Jef Pelee Island (site 19.2), corals in the shallow reef flat were bleached, possibly following severe sedimentation. The whole reef flat was covered with a carpet of very fine, clean sand. It was not possible to learn the cause of this evidently very recent sedimentation. In total, seven sites showed evidence of some degree of bleaching, usually very minor.

Although single crown-of-thorns starfish (COTS) and a small number of feeding scars were seen at four sites, at just one site were there several, but with no major damage. There was no clear evidence of recent COTS damage to any of the sites visited. The coralivorous gastropod Drupella was seen only at Kawe Island (site 49.2) and coral disease was seen at just four sites. However, Cliona, an encrusting sponge that overgrows and kills usually massive corals, was quite common.

Some very large and old corals in relatively good health were often seen. This is usually an indication of healthy well-established communities, which have not been seriously affected by severe impacts in a long time. Some of these colonies were 6-8m in diameter, possibly corresponding to 300-400 plus years of age.

4.5 Discussion

Most coral species had a full geographic spread of the survey area, with the exception of several rare species. The cluster analysis did not detect any strong geographic pattern in the distribution of sites. Habitat diversity was very high and complex. Whilst similar coral reef habitats were found across the full range of the Raja Ampat area, extremely different habitats with corresponding species assemblages were found within close proximity.

The most interesting and unusual reef habitats were found in and around the ridge of islands that extend east from Misool. This long karst ridge was broken up ever more as it extended eastward and was usually cut by perpendicular channels in a north-south direction, thus providing strong tidal currents to rush back and forth through these sometimes very narrow channels. Where the karst drops directly into the sea, undercut overhangs provided unique conditions for unusual habitats and coral assemblages. In these conditions, some hard and soft coral species that are found at greater depths and low light were found just below the surface. Fast currents providing lots of particles for filter feeders, and good flushing, enabled the growth of extensive fields of Dendronephthea soft coral in the shallows.

In several areas, coral reefs and mangroves intermingled. This was usually the case in bays and channels where water was very clear due to constant flushing by tidal currents.

Kofiau contained the richest sites of the expedition. Kofiau reefs were the richest in terms of hard coral diversity. All sites recorded well in excess of 140 species, though they were all in different habitats. In addition, reefs in Kofiau were in excellent condition. There was no evidence of current or recent impact or threat.

The only clear evidence of human impact to the reefs was of blast fishing damage. The highest level of bomb damage was seen on reefs in accessible distance to human populations. A lower level of bombing activity was observed on Ai Island, far from any permanent settlement but frequently visited by fishermen from Halmahera. The highest level of bomb damage was on the northeast corner of Salawati. Here, although we recorded 60% dead coral cover, it is possible that not all the damage could be attributed to bombing. Storm damage afte bombing might also have caused similar damage. Following blast fishing, moderate sized pieces of broken coral can cause further damage in a storm more easily by rolling around and smashing live coral. Our observations differed from Erdman and Pet (2002), who reported extensive blast fishing practice in the area. Our observations were more in concordance with McKenna et al. (2002), who found less evidence of bomb damage. This discrepancy of findings can be related to (as stated in Erdman and Pet, 2002) different methods in site selection and different study area. We worked in a much larger area in slightly different sites than the other two workers.

Although it is quite possible that some level of cyanide fishing is practiced on the reefs in the area, it is rare to see evidence of the impact. The only way is to see the fishermen actually in action, and even so, unless long-term observations are made, it is not possible to evaluate the level of damage inflicted. The only possible evidence is holes of broken coral where the fishermen try to access poisoned fish. Although we did see such holes, it was not possible to confirm their direct connection to cyanide fishing and the extent of damage to the reef.

Several oyster pearl farms are located in Raja Ampat (e.g. Misool, west Waigeo and Kawe). We dived in the vicinity of a pearl farm (site 48, Kawe), where we saw no evidence of impact. However, we also dived in close proximity of another (site 36, near Selpele), where the corals showed the maximum amount of stress. It was not possible, however, to attribute this stress directly to the pearl farm activity at this stage.

4.6 Conclusion

Reefs in Raja Ampat are of great natural beauty and biological richness. Today, it may be possible to consider the reefs of Raja Ampat as a reference, a baseline to reefs worldwide. Perhaps they come close to what we would understand a natural reef environment to appear. However, during the expedition, it was apparent that the ever approaching threat of human expansion and associated exploitation of natural resources was encroaching on the area. Evidence and experience from other parts of the world and Indonesia reminds us that, before long, this unique environment will follow the path of many other natural areas of the world.

Several areas in the Raja Ampat islands were outstanding and unusual to the effect that they warrant further intensive research. This survey of one-hour dives in a few sparsely located sites cannot even begin to document the real riches of the reef habitats of particularly Misool, Wayag, Kofiau, Kawe, …etc.

The main findings and conservation recommendations are:

- Raja Ampat possibly harbors the greatest diversity of scleractinian corals for an area the same size anywhere in the world.
- Raja Ampat has a great variety of reef habitats and many unusual and unknown habitat types.
- Due to its geographic position, species richness and relative reef health, Raja Ampat may be an important, and even essential, source for reefs to the west in the Maluku seas and to the east towards PNG and the Bismarck Sea.
- The main threat to reefs is from overfishing, particularly with destructive methods. Blast fishing and cyanide fishing are the primary offenders.
- Three areas are of particular interest in terms of species diversity and composition, habitat diversity and uniqueness, and natural beauty and wonder (Figure 16). These were:
    - Southeast Misool. Particularly the ridge and string of karst islands extending to the east. This area has many unusual and unique coral and reef habitats waiting to be discovered and studied.
    - Kofiau Island group. Had incredible coral species richness and all reefs in very good condition.
    - Wayag Island group. An area of several possibly new coral species and unknown reef habitats hidden among the myriad of karst and lagoon formations.

Figure 16. Spectacular coral gardens in Raja Ampat.

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Chapter 5

Status of Sea Turtle Populations in the Raja Ampat Islands

CREUSA HITIPEUW

5.1 Summary

- Raja Ampat is a unique site. The archipelago contains a full range of marine and coastal habitats that are important for the breeding, foraging and migration of several species of sea turtles.
- This survey aimed to characterize critical habitats across the Raja Ampat islands that are in use by sea turtles and to assess existing and potential threats to both habitats and population. At 23 locations throughout the archipelago, 38 large and small beaches were scoured for evidence of nesting and predation. A member of a dive team conducted underwater sightings and anecdotal information was collected through interviews with 62 fishermen from 14 villages.
- The survey confirmed the occurrence of Green (Chelonia mydas) and Hawksbill (Eretmochelys imbricata) nesting and foraging populations. Hawksbill nesting abundance was greatest in the southeastern islands of Misool, while a large rookery of Green turtles occurred on Pulau Sayang and Pulau Ai in northwest Waigeo.
- Interview results revealed common sightings of migrating Leatherbacks (Dermochelys coriacea) through Sagawin Strait, Sele Strait and Dampier Strait following the prevailing southward current. These migration routes are likely to have originated from a large Leatherback rookery on the north coast of Papua.
- Sea turtles have long been a source of protein for local villagers. However, the predictability of the timing and location of turtle abundance exposes nesting populations to exploitation on a commercial scale that cannot be sustained.
- Servicing the demand for turtles from outside markets has resulted in illegal poaching from people not in possession of customary access rights. Enforcement capacity within the archipelago is insufficient to circumvent this trade.
- Protection of major rookeries is seen as the best conservation option for sea turtles in Raja Ampat. This survey identifies the islands of southeastern Misool as a major Hawksbill nesting area and the islands of Pulau Sayang and Pulau Ai in northwestern Waigeo as a major rookery for Green turtles. It is strongly recommended that these areas be considered in any conservation initiative in the archipelago.

5.2 Introduction

The main aim of this survey was to characterize critical habitats across the Raja Ampat islands that are in use by sea turtles and to assess existing and potential threats to both habitats and population. This type of information is critical to developing conservation strategies for these species.

Turtle populations, globally, are experiencing dramatic population decline. This is due, primarily, to nesting habitat destruction and disturbance, the incidence of commercial fishing by-catch, hunting, shell marketing and raiding of nests by villagers in subsistence economies. Reviews of the status of sea turtle populations in Southeast Asia by Limpus (1994; 1997) determined that all marine turtle populations in the Indo Pacific region, outside Australia, are severely depleted through overharvesting and excessive incidental mortality. An example is the Sulu Sea turtle nesting islands of Sabah (Malaysia) and the Philippines, where a decline in Green turtle nesting populations of 75-90% was recorded from 1951-1985. Limpus (1997) noted the decline of turtle populations in the Pacific. Several of the largest breeding aggregations, such as Scilly Atoll (French Polynesia), had been depleted by 90% in the last 20 years. At Long Island rookery (northern PNG), it is likely that the annual nesting population of Green turtles has dropped to well below 1,000 females. It was concluded by Limpus (1997) that the rate of turtle harvest exceeds the replacement capacity of existing populations in the entire Pacific region.

Turtle nesting beaches are often located on uninhabited islands, which are sometimes considered sacred to nearby communities. Sea turtles have been considered a central element in customs and beliefs in some communities. Compost (1980) reported a Green turtle rookery on the island of Enu-Karang, in the Arafura Sea that is respected by Arunese as the land of their origins. To Balinese Hindus, the turtle is well regarded for being able to retreat into its shell and for carrying the world on its back. Turtles are sacrificed and the meat is consumed during special ceremonies (WWF Indonesia, 2002). Traditional beliefs and rituals of the Kei islanders of Maluku are associated with the hunt of Leatherback turtles. The belief is equated with the will of the ancestors that requires villagers to hunt for ritual and subsistence. The belief, however, prohibits the trade in Leatherback meat, which is considered a violation of customary rules that may incur the wrath of ancestral spirits (Suáres, 1999). The cultural value of sea turtles in Raja Ampat is currently unknown, but to a Karon ethnic community of the north coast of the Birdshead Peninsular, the Leatherback turtle is believed to have originated from a sea princess who lays eggs for them for food. Bad luck results from disturbing the nesting Leatherback (Teguh, 2000).

Raja Ampat’s remote islands and circulating currents make it ideally suited for the nesting and foraging of sea turtles. Schultz (1987) stated that the northern part of Papua is known to host four marine turtle species:

1. Green (*Chelonia mydas*);
2. Hawksbill (*Eretmochelys imbricata*);
3. Olive Ridley (*Lepidochelys olivacea*); and
4. Leatherback (*Dermochelys coriacea*).

The first three species have previously been noted as abundant in the Raja Ampat islands (e.g. Salm et al., 1982; Petocz, 1987; Tomascik et al., 1997). Earlier reports noted the occurrence of nesting sites of Green and Hawksbill turtles (Salm and Halim, 1984; PHPA, 1992). This information formed the basis for proposed conservation areas in the Raja Ampat islands, including South Misool, Kofiau and Pulau Sayang. Nesting by Leatherback turtles has not been reported on Raja Ampat beaches but the species is suspected to migrate through straits and channels throughout the archipelago to foraging habitat in the Kei islands of southeast Maluku (Suárez and Starbird, 1995).

The expansion of the Balinese turtle fishery towards eastern Indonesia in the mid 1970s caused the depletion of populations in Green turtle rookeries in Sulawesi, Maluku and Papua (Polunin and Nuitja, 1981). Tag recovery programs, reported by Limpus (1994), demonstrated that turtles captured in feeding areas in eastern Indonesia and sent to Bali originated not only from Indonesian rookeries but also from rookeries in Sabah, Papua New Guinea, and Australia. Commercial egg concessions are still issued in parts of Indonesia (e.g. Pangumbahan, West Java, Berau and East Kalimantan). However, population growth and the shift toward cash dependence in many village communities have rendered this practice unsustainable. Declining commercial yield, reported by Limpus (1994), implies a corresponding decline in turtle populations.

Prior to a government ban on the trade of Green turtles in 1999, more than 20,000 specimens were caught annually from all over Indonesia to meet demand from Bali. However, Limpus (1994) estimated that this figure was likely to be as high as 30,000 when accounting for post harvest mortality. Following the 1999 trade ban, additional pressure from the tourism industry in Bali and a campaign by NGOs (including WWF-Indonesia) has significantly reduced supplies of turtle to the Bali market. Mahardika, Turtle Campaign leader of WWF-Wallacea Program, recently observed about 300 turtles at three locations in Tanjung Benoa (Bali) that were kept in holding pens for religious feasts. Acceptance of the use of turtles for cultural purposes complicates enforcement of the trade ban. Local markets outside Bali are believed to trade in turtles and their eggs. However, the volume of trade is unknown.

Groombrige and Luxemoore (1989) stated that populations of Hawksbill turtle on many nesting beaches in the Java Sea have declined by more than 70% as a result of exploitation of both shells and eggs. Large volumes of Hawksbill shells (bekko) have been exported to Japan and other Asian countries for decades (Limpus, 1997), limiting the chance of population recovery. There are currently no known large nesting populations remaining in the Indo-Pacific region. Hawksbill turtles were declared a protected species in 1992. However, trade continues to drive the harvest of the species. Based on a small amount of tag recoveries of this species and the tag recovery patterns of other species, it is postulated that Hawksbills harvested in eastern Indonesia originated from stocks that breed in the north and west of Australia (Limpus, 1997).

The Raja Ampat islands have been described as the core of the world's marine biodiversity. However, the threat to existing turtle populations in the archipelago is increasing in the presence of human population movement and rapid transformation to cash economies. Conservation effort, encompassing the nesting habitat of these ancient animals, must be seen as urgent.

5.3 Methods

This survey was not conducted during the nesting season, which occurs during the southeastern trade wind season. Consequently, a technique described by Schroeder and Murphy (1999) was adopted. The technique is designed to identify and characterize potential nesting beaches without actually seeing gravid turtles. Characteristics consistent with the various species were identified, such as crawl track markings and the dimension of nesting depressions. Frequency of such evidence is used as an index because eggs are laid above high tide, often amongst littoral vegetation, meaning that evidence is apparent for a long period. Evidence of predation, including the presence of eggshells and turtle remains (carapaces, skulls, plastron) was also considered in this survey.

During the three-week survey period, three means of data collection were adopted (Table 1). Beach surveys were limited due to the expedition route, which aimed to facilitate all components of the REA. Consequently, only sandy beaches seen in proximity to the dive sites were surveyed due to transport constraints. Given this, there is clearly many potential nesting beaches that remain unsurveyed, particularly the small, narrow beaches favoured by Hawksbill turtles.

Table 1. Type of data collected in the course of the REA.

Method	Type of Data Collected	Notes
Beach Survey	• Nesting evidence: identification of species from crawl tracks and nest depressions; and • Predation evidence: slaughter of turtles, predation of eggs and probable source.	• Data collected by inspecting beaches and littoral vegetation. • 38 beaches at 23 locations.
Underwater Sightings	• Species identification; and • Size (juvenile, adult)	• Incidental sightings in the conduct of the marine survey
Village Interviews	• Species of turtle most commonly sighted; • Nesting or underwater observations; • Seasonal trend of sightings; • Known nesting sites; and • Type of exploitation activities (subsistence and commercial activity)	• 62 interviews in 14 villages. • Data primarily collected in unison with socio-economic research component. • Some interviews in proximity to nesting beaches.

5.4 Results

Evidence of turtle nesting was found at 17 of the 23 locations surveyed (Table 2). The rate of predation was found to be high. Monitor lizards commonly forage for eggs, evidenced by torn eggshells scattered around the surface. A disturbed nest devoid of eggs indicates human predation of eggs. Human predation on adult females was indicated by the presence of carcasses, which was clearly present on the long beaches of Pulau Sayang and Pulau Ai, northwest Waigeo. Hawksbill nesting activity dominated the small, narrow beaches that are scattered around the southeastern island chain of Misool. Green turtles also made use of these beaches, but were found in greater number on the long beaches of Sayang and Ai Islands. These two islands can be considered a significant Green turtle rookery in Raja Ampat, in particular, and Eastern Indonesia in general.

Table 2. Beach survey results.

Location (No. Beaches Surveyed)		Green (*C. mydas*)			Hawksbill (*E. imbricata*)		
		Nests	Predation		Nests	Predation	
			Human	Other		Human	Other
Salawati: Pulau Senapan/Jef Doif	1	-	-	-	-	-	-
Batanta: SW Mainland	1	-	-	-	-	-	-
Misool: N Wagmab (island chain)	1	4	-	3	-	-	-
Misool: N Farondi (island chain E)	2	5	-	-	2	-	-
Misool: Papas Tip Pale	1	-	-	-	-	-	-
Misool: SW Mate	2	4	1	3	6	2	3
Misool: N Djam	1	-	-	-	10	-	8
Misool: SW Kalig	1	21	-	1	1	-	-
Misool: Waaf	1	2	1	-	17	-	14
Misool: Watjoke (W of Jef Pelee)	1	11	-	-	-	-	-
Misool: Mainland NW	2	1	-	1	-	-	-
Misool: Nampale NW (light house)	1	-	-	-	-	-	-
Misool: Kamet	2	2	-	-	3	-	-
Kofiau: NW islands	4	1	-	-	1	1	-
Kofiau: Wambong	1	3	6	2	1	1	-
Waigeo: Pulau Sayang W	1	241	8	123	4	1	2
Waigeo: Pulau Ai N	1	279	68	x	-	-	-
Waigeo: Wayag SW	2	5	2	-	-	-	-
Waigeo: Stephanie W	1	23	8	-	-	-	-
Waigeo: Quoy SW	3	20	13	-	-	-	-
Waigeo: Uranie	2	6	1	-	-	-	-
Waigeo: Kawe	2	-	-	-	-	-	-
Waigeo: Boni	4	-	-	-	-	-	

A member of the dive team made observations of sea turtles underwater during the conduct of the coral reef survey. Green and Hawksbill turtles were seen at sites predominately around Misool, Kofiau and Waigeo (Table 3). These species were commonly observed by local fishermen, particularly around seagrass beds and coral reefs (Table 4).

Table 3. Results of underwater observation

Green (*Chelonia mydas*)			Hawksbill (*Eretmochelys imbricata*)		
	No.	**Size**		**No.**	**Size**
Misool: Pulau Tiga (SW middle island)	2	juv	Batanta: Tanjung Mabo	1	adult
Misool: Cot Malankari	1	adult	Batanta: Bulbous h'land E of Tg Mabo	1	adult
Waigeo: P. Sayang - small island W	1	adult	Misool: N Wagmab (island chain)	1	adult
Waigeo: Wayag - large bay W	1	adult	Misool: E Bajampop	1	adult
Waigeo: Wayag - center-east	1	adult	Misool: N Djam	1	adult
Waigeo: Kawe - Inner Bay	1	adult	Misool: SW Kalig	1	adult
			Misool: Watjoke (W of Jef Pelee)	1	adult
			Misool: Pulau Tiga (SW side middle is)	1	juv
			Misool: opposite middle P. Tiga	1	adult
			Misool: Cot Malankari	2	adult
			Misool: Nampale NW	6	adult
			Kofiau: S Walo	1	adult
			Kofiau: Anjoean	1	adult
			Kofiau: S Miatkari Island	1	adult
			Waigeo: P. Sayang - small island W	3	adult
			Waigeo: Wayag - center-east	2	adult
			Waigeo: Quoy - islets to south	3	adult
			Waigeo: Bag - southeast	1	adult

Community interview respondents also acknowledged the occurrence of nesting populations of Green and Hawksbill turtles. One respondent, from Kabare, North Waigeo, stated that he had seen a Leatherback turtle nesting site (Table 4). Several of the locally known nesting sites of Hawksbill and Green turtles were clearly stated during interviews but were difficult to locate on existing maps. Further investigation to required to provide a complete overview of the nesting sites across Raja Ampat islands.

Leatherback turtles (locally called as Tabom or Kumep) were sighted by local communities around larger straits of Raja Ampat islands. This species was reported in interviews as migrating across the islands, often in groups, from north to south around September. The appearance of Leatherbacks following the prevailing southward current is common along Sagawin Strait (between south Batanta and Salawati), Sele Strait (between Papua mainland and Salawati) and Dampier Strait (between north Batanta and Weigeo). There is a known Leatherback rookery on the north coast of the Birdshead peninsular. The breeding season for this rookery is March to September (Bhaskar, 1994; WWF, 2002). The prevailing southward current suggests the Raja Ampat archipelago is an important migratory corridor for Papuan Leatherback breeding populations.

The occurrence of Olive Ridley turtle (Lepidochelys olivacea) was not evident through the three survey methods. This species has similar characteristics to the Hawksbill and this might create confusion in underwater identification. Olive Ridleys prefer to nest along the beach zone, which makes observation of nesting evidence difficult, especially in areas such as the southern island chain of Misool, where wave energy is likely to obscure nesting evidence.

Table 4. Summary of village interview results.

Village (No. Interviews)		Location	Species Sighted		Observed Nesting Season	Known Nesting sites	Exploitation Activities
			Nesting	U/water			
Kapatlap	5	Salawati	H'bill	Green, L'back	May-Aug	Bam and Senapan Islands	Egg harvest, underwater poaching
Arefi	8	Salawati	Green, H'bill	Green, H'bill, L'back	Jun-Aug	Doker and Kri Islands	Egg harvest, poaching
Tomolou	6	Misool	Green, H'bill	H'bill, L'back	Aug-Oct	Wowonta Cape, Mustika Isle	Egg harvest, poaching
Yellu	2	Misool	Green, H'bill	Green, H'bill	Aug-Oct	Pinang Island	Egg harvest, poaching, tortoise shell collection
Fafanlap	3	Misool	Green, H'bill	Green	Aug-Oct	Pamali and Damar Islands	Egg harvest, shell collection
Aduwei	2	Misool	Green, H'bill	Green, H'bill, L'back	Aug-Oct	Lapong, Yan, Ombi, Leuw, Berlow Islands	Egg harvest, poaching
Kapacol	4	Misool	Green, H'bill	Green, H'bill, L'back	July-Oct	Waaf, Lii, and Yefbi , Yan Islands	Eggs harvest
Waigama	4	NW Misool	Green, H'bill	Green, H'bill, L'back	Aug-Oct	Naupale, Nanisa, Maslat and Masel Islands	Egg harvest, adult poaching, commercial poaching
Tolobi	3	Kofiau	Green	Green, H'bill	Aug-Oct	Boo Isle	Egg harvest, adult poaching for subsistence
Deer	2	Kofiau	Green, H'bill	Green, H'bill	Aug-Oct	Mustika Isle	Egg harvests
Kapadiri	4	W. Waigei		Green, H'bill, L'back			Subsistence harvest from P. Sayang
Selpele	6	W. Waigeo		Green, H'bill	Jun-Sept	P. Sayang, P. Ai	Subsistence harvest
Saliyo	5	W. Waigeo	Green, H'bill		Jun-Sept	P. Sayang and P. Ai; Wayag Islands	Subsistence harvest (eggs and meats), commercial harvests by outsiders for Bali market
Kabare	8	N. Waigeo	Green, H'bill, L'back		Jul-Aug	Waribar (Yembekali Village) beach	Subsistence harvest for village feasts

5.5 Discussion

Survey results indicate that the south Misool island group and the northwestern islands of Waigeo contain the most significant nesting populations of Green and Hawksbill turtles. One anecdotal account of a nesting Leatherback was found. However, the results attained in this survey were consistent with the assertion that this species migrates through the archipelago but does not use the area for nesting.

5.5.1 South Misool

Misool and its scattered island group comprise narrow beaches varying in length from 75m to 300m. The beaches are fringed by low-level littoral vegetation and are protected by fringing reefs, which are exposed at low tide. Most nesting remnants were found in association with evidence of predation by monitor lizards (Figure 1). This was identified by the presence of torn eggshells that remained on the surface. Hawksbill nests were found on most island beaches but evidence was scarce on mainland beaches, where wild boar is adding to the problem of egg predation. Nests were found beneath beach shrubs and trees. Due to the seasonality of wave energy, most beaches were eroded and remained very narrow with a half to one-meter sand wall. This caused some nesting evidence to be obscured. A small number of Green turtles were also found at the same type of beach. However, more abundant Green turtle nests were observed in southwest Kalig and Watjoke, to the west of Jef Pele, where access to the beaches is easier for these large turtles.

Figure 1. The author with evidence of egg predation by monitor lizards at Wagmab Island, eastern Misool (photo by Duncan Neville).

The underwater observation in this area confirmed the occurrence of Green and Hawksbill turtle of adult and sub-adult size around the reef area. The dominant species sighted was Hawksbills, with six individuals observed at northwest Nampale. Many beaches in the south Misool island group are used by passing fishermen as transit camps during the calm season. It is likely that egg harvests had occurred on these beaches for on-site consumption as eggshells were sighted in old camp areas. At several surveyed sites, carapaces of adult Green turtles were found with spear holes, which suggest that turtles were hunted whilst in the water.

Green turtles mostly concentrate their nesting behavior on particular beaches. This makes them vulnerable to hunting and poaching during the nesting season. The dispersed nesting habits of Hawksbills, however, may save many populations from extinction when facing high exploitation pressures since poachers are largely unable to concentrate their effort on rookery aggregations. Hunters and poachers have instead been forced to net or spear the catch in foraging ground, such as coral reefs and seagrass beds. Considering the worldwide decline of Hawksbill turtle populations, the south Misool islands group can be considered an important rookery with high conservation status. The pit count of Hawksbills at the south Misool island group is comparable to several rookeries in the Java Sea, such as the Tambelan islands (Suganuma et al., 1999).

5.5.2 Northwest Waigeo

The northwestern islands of Raja Ampat serve as important rookeries for Green turtles. In 1992, the area was proposed as a wildlife sanctuary that comprised the islands of Sayang, Ai, Small Mutus, Wayag, Stephanie and Uranie. Concentrated Green turtle breeding populations are located on the islands of Pulau Sayang and Pulau Ai.

Pulau Sayang is the largest island with approximately 9km of beaches, which are fragmented by karsts. A large number of nests were found on the western beach. Monitor lizards predated most of the 241 Green turtle nest pits, which were located beneath littoral vegetation. In addition, four Hawksbill turtle tracks were seen on a stretch of beach that is covered by coral rubble. The evidence varied from nest pits, carcasses, carapace, plastron, skulls and fresh crawling tracks.

Pulau Ai, which is much smaller than Pulau Sayang, is also an important rookery for Green turtles. Sandy beaches, with an approximate length of 3km, are situated on the northern and southern parts of the island. Some 279 Green turtle nest pits were recorded during this survey. A remarkable observation on Pulau Ai was the finding of 68 Green turtle carapaces. This find implies high subsistence exploitation by nearby villagers. Interview respondents at Boni village, North Waigeo said that fishermen occasionally visited the island during the nesting season (August/Sept), as did villagers from Ayau (offshore of North Waigeo).

Several sub-adult Green turtles and adult females were seen alive at fishermen’s campsites in Wayag. The fishermen admitted that the turtles were taken from Pulau Sayang. During the survey period, a typical turtle boat was sighted near Pulau Sayang and was confirmed by a local villager to have loaded turtles from Pulau Sayang and Pulau Ai. During an interview in Selpele, it was revealed that, in 1998, a Balinese boat loaded hundreds of turtles poached from Pulau Sayang and Pulau Ai. Areas such as these that are known to host large aggregations of nesting and foraging turtles are intensively targeted by poachers and must be afforded some kind of protection as part of any effective conservation endeavor.

Green turtles use the small sandy beaches located on the islands of Wayag, Stephanie, Uranie and Quoy as nesting habitat. Northwest Stephanie, the western and southern parts of Quoy, and southwest Uranie contained more evidence of nesting under littoral vegetation. Nesting beaches preferred by Green turtles range from large, open beaches to small inlet beaches with an open offshore approach. It is clear that the islands of northwest Waigeo host significant Green turtle breeding populations. The finding of 68 carapaces and more than 500 nesting pits suggests that several hundred female Green turtles use these beaches to nest. This number is comparable to a known Green turtle rookery in Enu Island, southeast Aru, Maluku (Schultz, 1996, Dethmers, 1999). This population is also subjected to commercial exploitation for the Bali market.

5.5.3 Kofiau

Another area of interest to conservation in Raja Ampat is Kofiau, which comprises several small islands with sandy beaches of varying length. The area is used for copra production, which is one of the main sources of income for local people. Villagers temporarily camped on the otherwise uninhabited islands to service the plantations. Little evidence of nesting was observed during the survey. However, local people encountered on the islands reported occasional nesting of several individual Hawksbill turtles. Visiting villagers ultimately take the turtles and eggs. Six carapaces of sub-adult Green turtles were sighted with spear holes in them. During underwater observation, Hawksbill turtles were sighted at three of the six dive sites located around Kofiau.

5.6 Threats to Turtle Populations in Raja Ampat.

Exploitation of sea turtles for both subsistence and commercial purposes is a long-standing practice in Raja Ampat. Sea turtles have long been a source of protein for local villagers. People from Boni, northern Waigeo admitted taking up to 20 individual nesting turtles from P. Sayang and P. Ai for consumption during Christmas and New Year feasts. Spears are often loaded in fishing boats for use in a chance encounter with a turtle in the water. Some fishers specifically catch turtles for consumption and for sale at nearby villages and occasionally to Sorong. Hawksbills are often the subject of trade because of their valuable shells and Green turtles are caught for consumption. Hunting for subsistence, and poaching for commercial benefit, is most likely to occur during the nesting season abundance.

Given the depth of local knowledge on nesting Hawksbills and the number of clutches laid in a season, it is likely that any sign of nesting activity observed by local people will result in egg harvests. Shifting human population patterns and increasing cash dependence is likely to increase the seasonal depletion of nesting populations. A growing subsistence egg harvest on small populations of turtles, such as the Hawksbills in Raja Ampat, could prove unsustainable in the future, threatening the viability of existing populations.

The commercial harvest is the major threat to turtle populations in Raja Ampat. Turtle meat, eggs, as well as living turtles (mostly Hawksbills), were seen by the author at local markets in Sorong and at the local airport. Interviews at the markets indicated that the turtles originated from Raja Ampat. In addition, village interviews indicated that Balinese boats periodically visited the islands around southern Misool and northern Waigeo. Local authorities arrested a boat loaded with 188 Green turtles, the result of a one-week hunting effort, at Waigama, Misool in 1995 (WWF, 1996).

5.7 Conclusions and Recommendations

The two areas under survey that are regarded as significant nesting areas for turtles in the Raja Ampat islands are the southern Misool islands group and the northwestern islands of Waigeo. The southern Misool islands are important for Hawksbills while the northwestern islands of Waigeo are important for Green turtles. Although there is a paucity of historical nesting data for these particular areas, the presence of a significant number of breeding adults could ensure adequate recruitment to maintain viable populations of these species when appropriate conservation measures are implemented.

The small beaches in the southern Misool area provide critical habitat for breeding Hawksbill populations. The remoteness of the area limits human access, especially from May to September when the seas are rough. This period coincides with the nesting season. Consequently, hunting, poaching and egg harvesting rarely occurs during this time. The islands of Sayang and Ai are important and highly concentrated rookeries for Green turtles in the region. However, amid the large body of nesting evidence was sign of a high level of subsistence exploitation, including many carapaces and carcasses. The presence of the coconut plantation on P. Sayang Island ensures regular visits by local people. Located remote from inhabited islands, P. Sayang and P. Ai also attracts illegal turtle capture, especially for boats destined for distant markets. Turtle population numbers have not previously been recorded. However, it is precautionary in light of the current level of exploitation to include this area in any conservation initiative in Raja Ampat.

The priority areas identified for turtle conservation in this study have previously been proposed for inclusion in a Marine Wildlife Sanctuary in 1992 (Supriatna, 1999). However, as time elapses, the conservation imperative becomes more urgent. Given the population growth and dynamics outlined in Chapter 1 of this compilation, natural resources in Raja Ampat will likely face increased pressure as the growing number of people seek income sources. It is necessary, therefore, that conservation measures be implemented that create alternative sources of income such that protected areas, and the natural resources therein, hold a tangible and ongoing value that stakeholders will take a custodial role in managing.

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Chapter 6

An Ecological Summary of the Raja Ampat Vegetation

WAYNE TAKEUCHI

6.1 Summary

- The Raja Ampat district of Indonesian Papua is one of New Guinea's most unusual floristic environments. The islands contain three of the 22 Papuan areas recognized as centers of very high endemism.
- This rapid-assessment survey examined vegetation patterns across the district, characterizing the major plant communities and identifying existing biodiversity threats.
- Mangroves, beach forest, lowland hill forest, limestone karst, and ultrabasic (serpentine) woodland were the principal natural-growth habitats explored.
- Conservation assets: When judged on the basis of endemism, the ultrabasic and limestone vegetation are the highest value communities in the Raja Ampat. As presently known, the ultrabasics have more species endemic to its habitats than any of the other communities. The most valuable survey locations are thus the Misool karst and Waigeo.
- Ecosystem threats: Naturalized alien plants were not found on serpentine, or on most of the isolated karst islands. Although limestone areas near human settlements often have a few adventives, invasive taxa were absent.
- Although concessional logging is degrading several lowland areas, most of the limestone communities remain in pristine condition. There are substantial prospects for future taxonomic discovery.

6.2 Introduction

Most of western New Guinea (including Misool and northern Salawati, Figures 1-2) is part of a Papuan microcontinent that separated from the Gondwanic landmass during the early Mesozoic, subsequently drifting into its present position independently of the Australian craton (Pigram and Panggabean, 1984; Pigram and Davies, 1987; Hall, 1998). Waigeo and adjacent islands comprise one of only two oceanic terranes in this region of New Guinea. Ultrabasic and limestone substrates have developed distinctive plant communities containing many endemic species, especially in the westernmost islands.

Ironically, considering the overall paucity of information for such environments, the Raja Ampat archipelago was among the first areas to be visited by early explorer-naturalists to eastern Malesia. In 1792–93, the vessels Recherche and Esperance obtained plant collections from Waigeo as part of a general program of regional exploration. Botanical specimens were also taken during visits by the Uranie and Physicienne in 1818–19, and during the cruise of the Astrolabe (1826–29). Early collectors included Beccari (1872–73) on Batanta and Kofiau, and Micholitz in 1890, also on Batanta. Frodin and Gressitt (1982) provide a general account of these early activities. Following the efforts of Cheesman on Waigeo (1938–39) and by Royen on Batanta and Waigeo (Royen, 1960), there was little serious work in the district. Most of the interior sections remain unknown because of the physical difficulties of access and the nearly total absence of service infrastructures.

6.3 Materials and Methods

TNC’s survey of the Raja Ampat archipelago was designed primarily to investigate the diverse reef ecosystems of the area, and secondarily to identify linked land-marine conservation targets for possible community-based initiatives. As ecologist for the forest assessment, the writer was responsible for describing the principal vegetation types and ground-truthing perceived community distributions against a preliminary classification developed from the RePPProT (Regional Physical Planning Program for Transmigration) plant typology maps (RePPProT, 1990; Hardiono, 2002). The floristic evaluations and botanical collecting were conducted with assistance by Duncan Neville (TNC Sulawesi Manager), Johanis Mogea (Herbarium Bogoriense), and Fery Liuw (Departemen Kehutanan Papua).

Forest communities were examined in ad hoc fashion, via walk-through assessment of areas accessed by dinghy or speedboat (Figures 3–5). Community variation was documented by numerous photographs referenced with readings from a handheld GPS recorder. These onshore activities were necessarily constrained by the collateral marine studies and the corresponding movements of the Pindito. Because of the constantly shifting itineraries of the marine team, the forest participants could usually devote only one day to a given site, thus restricting survey coverage to areas near the coast.

Botanical collections were typically made in sets of five duplicates whenever fertile specimens were found. Gatherings were field-packed in newsprint and plastic bags then soaked with 70% ethanol for subsequent processing at Herbarium Bogoriense (BO). Silica-dried samples for DNA sequencing were also obtained if specialists had placed earlier requests for assistance. In order to simplify the vouchering process, collections were numbered under the sequence of botanist J. Mogea. Specimen distributions will occur from BO, with A, K, L, and MAN as the principal recipients (Irawati, pers. comm.). Mogea is preparing a taxonomic account of the botanical findings for separate publication.

6.4 Results

Botanical observation and collecting were complicated by drought conditions caused by the recent El Niño disturbance. The collections tally (550 nos.: Mogea et al. 7,726–8,276) includes about 100 sterile numbers because of the unfavorable phenology. Although the entire district showed signs of drought stress, the severity of the disturbance was greatest in the outer islands (Misool, Kawe, and Waigeo; Figure 6). At

Batanta and Salawati, forest canopies were mostly green (although understoreys were very dry) and there were even brief periods of torrential rain during the visit to those islands.

Among the habitats covered by the TNC-modified RePPProT forest classification, mangroves were apparently the only natural-growth community that could be accurately mapped using Landsat reflectance patterns (see Hardiono, 2002). Topographic and geological maps proved of greater value than any existing forest typing system. The lack of a GIS-based classification equivalent to the Papua New Guinea Resource Information System (PNGRIS) and its generically related Forest Inventory Mapping System (FIMS), is a serious obstacle to survey planning in western New Guinea (see Bellamy and McAlpine, 1995; Hammermaster and Saunders, 1995a,b). To facilitate comparisons with the FIMS classification, the following community descriptions are prefaced by the structural code (in parentheses) for the corresponding formations in East New Guinea.

6.5 Principal Communities

6.5.1 Mangroves (M)

Of all the vegetation types encountered on the survey, the mangrove communities are probably the best studied (e.g. Backer and Steenis, 1951; Ding Hou, 1957, 1958, 1960; Percival and Womersley, 1975; Floyd, 1977; Duke and Jackes, 1987; Erftemeijer et al., 1989; Duke, 1991; Mabberley et al., 1995). Unlike the situation in nearby Telek Bintuni (cf. Erftemeijer et al., 1989; Takeuchi et al., in press), Raja Ampat mangroves are insignificant and markedly impoverished, except in a few places where estuarine flats and tidal rivers have provided ample habitat for the Bruguiera-Rhizophora associations (Figure 7). Among investigated sites, the best examples of this community were seen on Pulau Misool, along the lower Gam and Kasim rivers. At the second locality, there is a well-developed upstream sequence (in order) of Rhizophora mucronata – Ceriops tagal, Bruguiera gymnorrhiza, Nypa fruticans, then a final freshwater assemblage consisting of Xylocarpus granatum, Dolichandrone spathacea, and Heritiera littoralis. However in most parts of the archipelago, mangroves are represented (if at all) only by isolated trees along a foreshore, with no horizontal development of the community.

6.5.2 Swamp woodland (Wsw)

Monodominant forests of Metroxylon sagu (sago) are scattered through the Raja Ampat district, wherever soil flooding is severe. The occurrences are insensitive to substrate. Sago swamps are found on limestone at Kofiau (01°09’25S, 129°51’38E), and on mineral clays at Kapatlap, Salawati. Although the floristic diversity is very low, sago communities are of considerable subsistence value as a source of dietary starch obtained from the Metroxylon trunks (cf. Powell, 1976; Johns and Hay, 1984).

6.5.3 Littoral or beach forest (B)

A distinctive community along many coastlines, beach forests are mostly composed of widely distributed, even pantropical taxa, but have been reduced over much of their former range because of anthropogenic pressures (Wikramanayake et al., 2001). The principal indicator species for this community are Calophyllum inophyllum, Hibiscus tiliaceus, Pandanus tectorius sens. lat., Terminalia catappa, and Thespesia populnea (Figure 8). In Raja Ampat, other associates often included Colubrina asiatica, Parsonsia alboflavescens, Derris indica (Pongamia pinnata), Tacca leontopetaloides, Ximenia americana var. americana, and Vigna marina. Beach forest generally occurs on sand or coralline rubble behind the strand zone. A particularly good example was seen at north Kofiau (01°09’24S, 129°50’47E). On uninhabited Sayang Island (0°16’24S, 129°53’47E), a different type of beach association (BCe) was recorded on sandy flats, consisting of Casuarina equisetifolia, Scaevola sericea, Sophora tomentosa ssp. tomentosa, Spinifex littoreus, and Tournefortia argentea.

6.5.4 Lowland forest on deep mineralized soil (Pl, Hm)

The land team encountered this community type near Kapatlap on Salawati, and on the north and south shores of Batanta, where the vegetation is predominantly a tall stature rainforest similar to those from coastal lowlands of the Bomberai Peninsula (cf. Takeuchi et al., in press). Deep soil habitats (in the eastern Raja Ampat) were probably the most speciose of all the surveyed environments, but were also characterized by plants common in adjacent mainland areas and thus of comparatively low conservation interest (Figures 9, 10). Intsia bijuga, Koordersiodendron pinnatum, Pometia pinnata, and Terminalia cf. copelandii were dominant trees in such situations, with Celtis, Ficus, Dysoxylum, Myristica, and Syzygium the best represented genera in the subcanopy. The regrowth phase included Alstonia scholaris, Gastonia serratifolia, Morinda citrifolia, and Trema cannabina as the most prominent species, at least within the logged-over tracts seen on Batanta and Misool.

In western Raja Ampat, deep soil habitats are generally absent except in the flood plain of large rivers (e.g. Gam and Kasim rivers), or in the ravines on limestone karst (e.g. the numerous islets near Mesemta Bajampop of southeast Misool). Such areas have tall forests comparable to the Batanta/Salawati formations, but are species-poor and usually less than a hectare in size (Figures 11–13). Frequently, the stands are composed of Intsia bijuga, I. palembanica, Vatica rassak, or Pometia pinnata; with Jagera javanica ssp. javanica, Trophis philippinensis, Teijsmanniodendron bogoriense (uncommon), and Maniltoa spp. (M. plurijuga and M. schefferi) underneath. Flindersia amboinensis and F. laevigata var. heterophylla are conspicuous emergents in these tall-forest pockets on the smaller islands, particularly in the Misool group. Osmoxylon sessiliflorum was especially prominent in subcanopies near rivers in Misool. At Jef Pelee (south Misool) a *Homalium foetidum* monodominant forest was encountered on ridge slopes and crests (Figures 14, 15; 02°01’09S, 130°01’28E).

The forest understoreys in Raja Ampat are harder to characterize. Generally, when the canopy has at least 25–50% closure, the groundlayer is already clear. Representative communities in the Misool group had either an open understorey, or a palm-dominant layer of *Licuala* and *rosette*-stage *Calamus* (Figures 16, 17). Ferns, herbs, and cryptogams were hardly ever seen, but it is not known to what extent their absence was due to the severe drought conditions then prevailing. Understoreys with diverse fern populations (*Bolbitis*, *Davallia*, *Drynaria*, *Nephrolepis*, *Sphaerostephanos*, *Tectaria*) were found only in riverine forest near Fanfanlap (west Misool) and at Kofiau (e.g. 01°10’01S, 129°50’30E).

6.5.5 Secondary forests (W)

A substantial but unknown percentage of the Raja Ampat lowlands has been logged by industrial operators and is presently in various stages of recovery. The secondary forests examined by this survey were previously cut at periods ranging from 15 to 30 years ago and are very distinct from more mature communities in the same habitat.

At Kofiau (01°11’03S, 129°43’21E) a 15–year regrowth (Figures 18, 19) was depauperate woodland of *Vitex cofassus*, *Morinda citrifolia*, *Conandrium polyanthum*, and *Ficus* spp. (mainly *F. microcarpa* and *F. prasinocarpa*). *Lunasia amara* var. *amara*, *Leea indica*, and various *Antidesma* and *Macaranga* spp. formed a sparse underlayer. In contrast, an adjacent section of unlogged forest was a closed canopy *Pometia*-dominant community with high frequencies of *Diospyros*, *Horsfieldia*, and *Knema*.

On Sayang, a flat sandy island completely logged in 1984 (0°16’38N, 129°53’48E), the regrowth was of similarly depleted composition, consisting for the most part of a remnant *Artocarpus-Intsia-Pometia* canopy with a second storey of *Calophyllum inophyllum* and *Aglaia argentea* (the last species previously unrecorded for Raja Ampat, cf. Pannell, 1992). *Conandrium polyanthum*, *Codiaeum variegatum* var. *moluccanum*, and *Polyscias cumingiana* were undergrowth species. Dense seedling crops of *Pometia pinnata* often carpeted the ground in spite of drought conditions.

On a number of small islands, repeated anthropogenic disturbances have erased the former forest and a grassy fire disclimax (G) is now all that exists. At Jef Pelee (coral platform: 02°07'03S, 130°19'00E), most of the land surface is covered by a seral community of *Imperata conferta* with *Ischaemum muticum* on the seaward fringe (Figure 20).

At Mesemta Bajampop, a single example was seen of an early succession on karst, consisting of *Dracaena angustifolia* and *Commersonia bartramia*, with an extensive underlayer of *Gahnia aspera* (Figure 21). These sorts of communities are the result of localized disturbance and are too small to be mapped by forest classification systems.

6.5.6 Savanna (SaMl)

Grassy savannas were recorded only on western Misool, at the mouth of the Kasim River and further inland near the Waitama tributary (01°47'23S, 129°53'57E and 01°51'41S, 129°55'05E respectively). The Kasim communities were Melaleuca dominant, but also included smaller individuals of *Pandanus tectorius* and *Timonius timon* in a distinct second layer (Figures 22, 23). The dense 2m+ groundcover was composed of *Ischaemum barbatum* and *Imperata conferta*, together with scattered patches of taller *Saccharum spontaneum* (Figure 24). Indications of recent burn suggest that the Kasim savanna is probably periodically fired.

The Waitama savannas are larger than the *Kasim communities* and include *Eucalyptus cf. papuana* in addition to the more common *Melaleuca leucodendron* sens. lat. (Figure 25). Shrubs were commonly represented by *Baeckea frutescens, Decaspermum bracteatum, Melastoma malabathricum ssp. malabathricum*, and a *Polyscias sp*. The groundlayer of *Ischaemum barbatum* and *Rhynchospora rubra* was habitat-partitioned, the latter species mainly occupying flat areas with the poorest drainage.

In appearance and composition, the Waitama savannas are nearly identical to comparable formations on the Papuan mainland at Bomberai (cf. Takeuchi et al., press). The communities at both sites are apparently under substrate control, with characteristic occurrences on flat or gently undulating terrain underlain by hardpan and alumina deposits (pers. obs.). Although the savannas in the Raja Ampat are affected to some degree by fire, the substrate patterns suggest the communities are a long-term response to stable edaphic factors (cf. Paijmans, 1976).

6.5.7 Lowland forest on limestone karst (Hs, HsCp)

The limestone terrain is one of the most visually stunning and unspoiled environments in the Raja Ampat district. Much of this habitat is a deeply dissected karst, which is often extremely difficult and time-consuming to traverse. A small hill can take an entire morning to ascend, so it is not hard to comprehend the relative lack of botanical collections from such areas.

Excellent examples of karst vegetation are found in the Misool chain, particularly in the southwest complex of small islets and at the western end of the Misool mainland. Within the Waigeo group, extensive limestone habitats were explored near Aljoei (0°11'43S, 130°15'39E) and at Wayag (0°10'21N, 130°01'17E).

Many of the smaller limestone islands are undercut at the highwater line into toadstool platforms, or are sculptured into steep conical stacks (Figure 26). Often the sides of the taller islands have dizzying vertical faces that plunge for hundreds of feet (Figures 27, 28). On Wagmab, the stepped ledges have a stunted woody vegetation, frequently wind-sheared, comprised of *Stenocarpus moorei*, *Exocarpos latifolius*, *Polyscias sp. nov*., *Wikstroemia androsaemifolia*, *Calophyllum* spp. (including the novoguineense complex; cf. Stevens, 1995), and many vines of *Alyxia purpureoclada* (Figure 29). The unusual *Podocarpus polystachyus* is a dwarfed krummholz on solid rock, sprawling across ledges and barely ascending to 1m height. At Wayag, however, crestline populations of the same species grow as erect trees to 7m height (Figure 30; 0°10'25N, 130°01'22E and 0°10'42N, 130°01'16E.

On nearly all the limestone islands, *Gulubia costata* is a conspicuous emergent, often forming dense stands along the higher slopes and crestlines. *Barringtonia*, *Dracaena*, *Ficus*, *Garcinia*, *Gynotroches*, *Myrsine* (*Rapanea*), *Pouteria* (*Planchonella*), *Schefflera*, *Serianthes*, and *Sterculia* are also common subarborescent genera, but a disproportionate number of morphospecies were documented only by sterile or scrappy vouchers and cannot be identified with certainty. Of all the Raja Ampat habitats, the limestone vegetation was the most severely affected by the El Niño drought, and effective documentation of such communities was very difficult under the prevailing conditions. The canopies on most islands were brown and withered, though probably not dead. Limestone karst is undoubtedly a poor reservoir for soil moisture. Stands with green foliage were often restricted to the colluvial accumulations in valleys and small draws, especially on small islands (Figures 11, 12).

Archidendron paluense, *Lunasia amara var. amara*, and the vinelike *Bauhinia binata* (*Lysiphyllum binatum*) were common taxa in karst understoreys of western Raja Ampat, especially on platforms and stacks around Misool proper. At Mesemta Bajampop (southeast Misool), substantial populations of *Rauvolfia moluccana* and *Monophyllaea*, were also noted. The *Archidendron*, *Bauhinia*, *Monophyllaea*, and *Rauvolfia* were newly recorded for the district (cf. Burtt, 1978; Verdcourt, 1979; Nielsen et al., 1984; Hendrian and Middleton, 1999). New registers for such common or conspicuous plants are indications of the undercollected status of the limestone, and show how poorly documented this flora still remains even after more than a century of Papuan exploration.

6.5.8 Lowland ultrabasic scrub and forest (W, HsCp)

Renowned in scientific literature, the Raja Ampat serpentine flora is also one of the region's most picturesque environments. At Kawe (Figures 31, 32) and Waigeo's north shore (Figure 33), the ultrabasic scrub affords breathtaking panoramas of turquoise reefs and red laterite across extensive stretches of coastline.

The TNC survey explored the ultrabasic zone in a series of ascents along steep-sided buttress ridges. Most of the vegetation consisted of xeromorphic scrub or woodland with similar characteristics to communities described in an earlier account of the eastern Waigeo peninsula (Royen, 1960).

During the first landfalls on Kawe (ending at 0°03'07S, 130°08'05E), the forest team found distinctive woodland of *Ploiarium sessile*, *Exocarpos latifolius*, *Gymnostoma rumphianum*, *Decaspermum bracteatum*, *Ixonanthes reticulata*, and *Myrsine rawacensis* (Figure 34). The spreading sympodial crowns of *Ploiarium sessile* were a particularly striking characteristic of this community (Figure 35). In the wide spaces between the larger trees were many shrubs of *Myrtella beccarii*, *Styphelia abnormis* and (in lesser numbers) *Dodonaea viscosa*. Vines of *Alyxia laurina* were common climbers and scramblers. Patches of *Dicranopteris linearis* blanketed the ground nearly everywhere, with *Dianella ensifolia*, *Nepenthes danseri*, *Palhinhaea cernua*, *Machaerina disticha*, and *M. glomerata* scattered mainly over the bare spaces. *Artocarpus*, *Livistona*, and *Vitex* were common on lower slopes and valley floors (Figure 36; 0°03'05S, 130°08'24E).

On the Go Isthmus of Waigeo (Fofak Bay at 0°02'22S, 130°43'43E), the ultrabasics were similar though somewhat richer, and also included *Arytera littoralis*, a small-leaved *Gmelina*, *Melastoma malabathricum ssp. malabathricum*, *Psychotria tripedunculata* (Figure 37), and *Rhodamnia novoguineensis* among the common woody plants. Parts of the scrubland above the bay had been burned, exposing large patches of the distinctive red laterite (Figure 38). Within such areas, the early fire succession consisted of a sparse association of *Commersonia bartramia*, *Myrtella beccarii*, *Scaevola oppositifolia*, and *Styphelia abnormis*. Although the ridgetop habitats are generally of open aspect, the vegetation in the draws is a closed codominant forest of *Dillenia alata* and *Calophyllum spp*. At scattered places in the ultrabasic zone (on both crestlines and depressional areas), the scrub is replaced by a taller *Gymnostoma rumphianum-Sapindaceous* canopy with a *Myrtella beccarii* understorey (e.g. at Kabare, 0°04'18S, 130°56'36E; Figures 39, 40). Unlike the open growth, this taller community (at Kabare) is densely stocked with 7–10m pole-trees including the serpentine indicator *Ploiarium sessile*. *Gymnostoma rumphianum* is an emergent to ca. 25m in height in such situations. The ultrabasic vegetation is thus represented by several communities, collectively forming an intergrading series of facies ranging from bare 'blowouts' (Figure 41) through woodland of varying densities, then finally to a closed multistoried forest.

6.6 Discussion

Raja Ampat plant communities are primarily lowland environments. There are no areas of significant size higher than the 900–1,000m level where montane conditions generally begin (cf. Paijmans, 1975, 1976; Johns, 1977; Grubb and Stevens, 1985; Hammermaster and Saunders, 1995a). Although Royen (1960) describes a mossy montane forest on Mt Buffelhoorn, such habitats could not be visited within the time allowed by the survey schedule. None of the daily excursions from the coast were able to penetrate beyond 500m elevation.

Within the limitations imposed by rapid assessment, it is apparent that the Raja Ampat flora is depauperate and disharmonic relative to adjacent mainland environments and that these distinctions become more pronounced in the outer island groups (e.g. Misool and Waigeo). Many of the most characteristic Papuasian families, including *Annonaceae*, *Elaeocarpaceae*, *Gesneriaceae*, *Lauraceae*, *Melastomataceae, Meliaceae, Piperaceae*, and *Urticaceae*, were poorly represented in the lowland habitats where they are ordinarily prominent. Epiphytes and climbers were also generally scarce, as were several herbaceous families usually found in New Guinea forest understoreys (e.g. *Marantaceae*, *Orchidaceae*, *Zingiberaceae*).

This westward trend of diminishing diversity across the archipelago is correlated to a general reduction in rainfall and to the limiting nature of the western substrates. Rainfall is directly correlated with floristic diversity, more than with any other abiotic factor (Gentry, 1988). The perception of highest richness in the near-mainland environments of Salawati and Batanta, and the impression of lower species counts toward the outer groups, is consistent with annual rainfalls (cf. Mangen, 1993): Salawati and Batanta (3,000–3,500mm); Misool (2,500–3,000mm); Waigeo and adjacent islands (1,500–2,000mm). The floristic trends expected from moisture availability are enhanced by the substrate distinctions. Whereas most edaphic environments in the eastern islands are of mineralized soil, the outer islands are predominantly limestone or ultrabasics, infertile substrates that are known to be limiting for plant growth (Royen, 1963; Kruckeberg, 1985; Brooks, 1987). The synergistic combination of factors results in diminished richness but increased endemism.

In terms of exploration priorities, the highest potential for taxonomic discovery is probably with the Misool karst. Waigeo ultrabasics are comparatively easy to access and the communities are usually of low stature and density, characteristics that favor collection saturation. Most, if not all, of the ultrabasic endemics have probably been discovered. In contrast, the Misool limestone is wetter (notwithstanding conditions during the survey), very difficult to traverse, and suitable collections are much harder to find. A significant number of unknown taxa is likely to be present on the karst. The new distributional records from the survey are suggestive of future opportunities.

6.6.1 Conservation Assets

When judged on the basis of uniqueness, the ultrabasic and limestone vegetation are the highest-value communities in the Raja Ampat archipelago. As presently known, the ultrabasics have more species endemic to its habitats than any of the other communities. Plants restricted to Waigeo serpentine include *Alstonia beatricis*, *Alyxia laurina*, *Archidendron royenii*, *Guioa waigeoensis*, and *Maesa rheophytica*. *Psychotria tripedunculata* is also known primarily from the ultrabasics, with only one record originating elsewhere.

Waigeo's floristic patterns can be understood by comparison with similar areas from other districts in New Guinea. In the Bowutu Mountains of Morobe Province, an elevational sequence of ultrabasic landscapes forms one of the largest features of this type in Papuasia (i.e. the Papuan Ultrabasic Belt, cf. Thompson and

Fisher, 1965; Bain, 1973; Löffler, 1977). The serpentine flora extends across a series of coastal communities beginning at sealevel, in a manner analogous to Waigeo, especially within the Kamiali Wildlife Management Area (KWMA).

KWMA habitats are subject to frequent landslides because of a local combination of humid climate and steep coastal ridges. In the recovery following landslides, the community that develops is a scrub composed primarily of *Myrtella beccarii*, *Dicranopteris linearis*, *Machaerina glomerata*, and *M. rubiginosa*; with (at lesser frequencies) *Stenocarpus moorei* and *Tristaniopsis macrosperma* (Figure 42). In appearance and composition, the pioneer community is very similar to the Waigeo scrubland and also occurs alongside a series of taller forests including many of the same elements (Figure 43). The KWMA community variation clearly represents a successional sequence that can be tracked because of the known history of specific sites.

Royen (1960: 41) described the Waigeo scrub as an edaphic climax, but its spatial proximity and structural resemblance to other communities suggest otherwise. By analogy to similar environments, most of the Waigeo ultrabasics are probably an early stage in a successional sequence caused by fire. The principal characteristics of the open scrub are hardly different from landslide seres of the KWMA, except that the Waigeo communities are much larger, extending continuously over hundreds of hectares. The distinction in spatial scale can be attributed to the presumed fire etiology, which would tend to act over much larger areas than landslides. The etiologies can themselves be explained by the climatic contrasts between the sites. Fires are a common ecological factor in dry environments like Waigeo, while humid localities (KWMA rainfalls are 4,000mm per annum) are naturally susceptible to landslides during periods of heavy rain. Royen's own observations provide evidence of instability in the Raja Ampat ultrabasic vegetation (Royen, 1960). The ridge in the foreground of Figures 33 and 41 was a *Gymnostoma* (=*Casuarina*) forest in 1955 (ibid.: Figure 5). As documented by the TNC survey, that forest now remains only as relictual trees surrounded by scrubland (Figure 44). These open areas are clearly a new development and not a permanent edaphically-induced feature.

The frequent occurrence of fires is currently reflected in the patchy distributions of ultrabasic forest on Waigeo, an expected pattern if seral sequences are being continuously reset over large areas. Although the serpentine scrubland is one of Papuasia's most impressive environments, the rare and endemic taxa are concentrated in the taller vegetation, and this latter habitat probably represents a more valuable conservation asset. In an environment with fire-induced succession, the closed forest (Figures 39, 40) should be the richest community, and thus the more promising target for future exploration.

Apart from the biotic measures, aesthetic considerations are a legitimate part of any environmental evaluation. Waigeo and Misool landscapes are very photogenic, and can serve as focal assets for an ecotourism niche market in combination with the marine attractions, as already demonstrated by the Pindito.

6.6.2 Ecosystem Threats

During the last 50 years, the areas of post-fire succession in northern Waigeo have expanded substantially (compare Royen, 1960: Figures 3, 5). Several endemic plants are probably being threatened by the existence of this historical trend, particularly by the accompanying reductions of taller communities. Among ultrabasic species, *Archidendron royenii*, *Alstonia beatricis*, and *Maesa rheophytica* are still known only from their types, taken in primary forest or older-growth woodland (see Nielsen et al., 1984; Sleumer, 1987; Sidiyasa, 1998). From the circumstances of their collection, these plants are probably associated with the advanced stages of the ultrabasic succession, and their apparent rarity is consistent with habitat reduction caused by increased fire frequency. In contrast, the ultrabasic endemics *Guioa waigeoensis* and *Alyxia laurina* are known by several collections from the open areas, and are probably seral taxa (cf. Welzen, 1989; Middleton, 2000).

Naturalized alien plants were not found on serpentine, or on most of the isolated karst islands at Aljoei and Mesempta Bajampop. Although limestone areas near human settlements often have a few adventives (viz. *Bidens pilosa*, *Boerhavia erecta*, *Euphorbia heterophylla*, *E. hirta*, *Passiflora foetida*, *Stachytarpheta jamaicensis*, *Tridax procumbens* etc.) truly invasive taxa were absent. The noxious *Lantana camara* and *Piper aduncum* were recorded only on Batanta and Salawati. The same factors that make the western environments limiting for plant growth apparently act to discourage the establishment of aliens.

A planted patch of *Hibiscus rosa-sinensis* was seen at uninhabited Wagmab, and even if such occurrences are not threatening, deliberate introductions into otherwise weed-free habitats need to be discouraged by proactive conservation policy. Predictive guidelines for assessing possible invasive success of alien plants have been developed for other island environments (cf. Pheloung et al., 1999; Daehler and Denslow, 2002). Papuan managers administering conservation tracts should consider their application, as most communities in western Raja Ampat are of entirely indigenous or endemic composition. Nowadays, in a world where the spread of aggressive species contributes to homogenization of floras, areas such as the Misool karst are an increasingly rare ecological resource.

Each of the principal islands (Batanta, Misool, Salawati, Waigeo) has sizable set-aside areas designated as nature reserves (Supriatna, 1999). However, existing logging threats are substantial, and commercial operations were filmed during the recent TNC assessment even within the so-called reserves. Although the archipelago is known to have significant plant and faunal assets, many of these are under threat and will require management action to ensure their continuity (ibid.). Unfortunately, in most Raja Ampat forests the emergent canopy is composed of major exportable timbers (*Intsia bijuga*, *I. palembanica*, *Pometia pinnata*, *Flindersia amboinensis*, *Vatica rassak*; see Louman and Nicholls, 1995). These trees occur at stocking densities favoring profitable extraction (Departemen Pertanian Direktorat, 1977). Although the current concessional areas are habitats with good site capacities for tree growth, the ultrabasics and limestone karst have stunted vegetation of little value as logging targets, and are thus at lesser economic risk.

Despite indications that climatic warming will cause substantial reductions in Papuasia's rainforest biome, there have been no attempts to define local planning and management responses to this threat. Baselines are much needed for determining the onset and direction of climate-induced change in a variety of communities. Many Raja Ampat environments would make appropriate stations for monitoring the floristic effects of El Niño oscillations because of their insular and pristine status. The western islands are part of a forest continuum spatially connected to perhumid mainland habitats, extending across a geographic sequence of sparsely inhabited landscape, tectonic, and biotic environments. The district is very suitable as a venue for ecological research.

Nearly all conservation programs in New Guinea are committed exclusively to terrestrial or marine habitats, due to the disparate value of such environments when they occur together at most sites. However, at Misool and Waigeo, highly endemic forest communities lie alongside some of the most diverse reef ecosystems in the world (Figure 45). This unusual combination of world class assets will permit development of holistic strategies for managing the linked land-sea resources. The information needs for integrated planning will be complex, requiring data inputs on wildlife, floristic, recreational, cultural-political, landscape, and human subsistence values. But, owing to the unique nature of the environmental assets in this district, future initiatives have the opportunity of being cost-effective, innovative, and compelling.

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The other expedition participants included Pawel Achtel (Jungle Run Productions, photographer), Gerald Allen (Western Australian Museum), Ryan Donnelly (independent tropical fisheries consultant), Freddy Frommenwiler (Pindito captain), Morgan Gabereau (Jungle Run Productions, producer and co-director), Creusa Tetha Hitipeuw (World Wildlife Fund Sahul), Djuna Ivereigh (Project Bird Watch), Agus Sumule (Universitas Negeri Papua), Yulianus Thebu (World Wildlife Fund Sahul), Emre Turak (Australian Institute for Marine Science), and Joe Yaggi (Jungle Run Productions, team leader).

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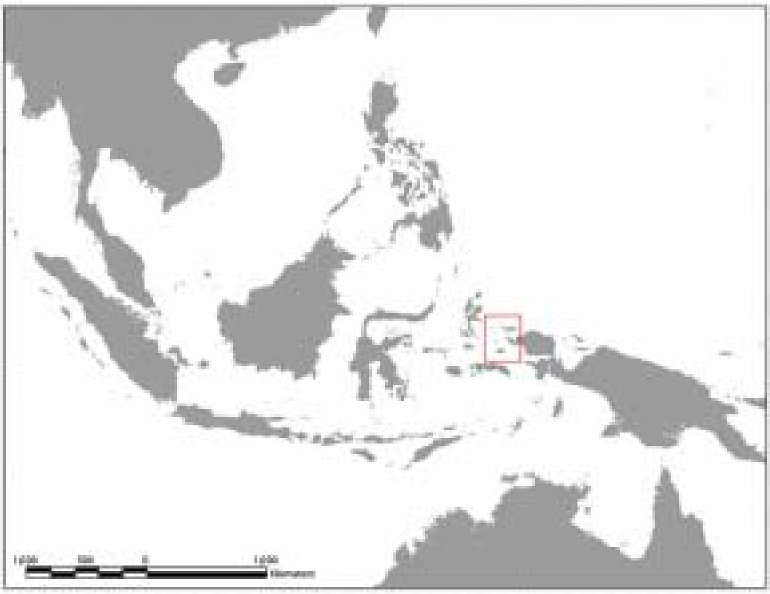

Figure 1. Southeast Asia with location of the Raja Ampat archipelago.

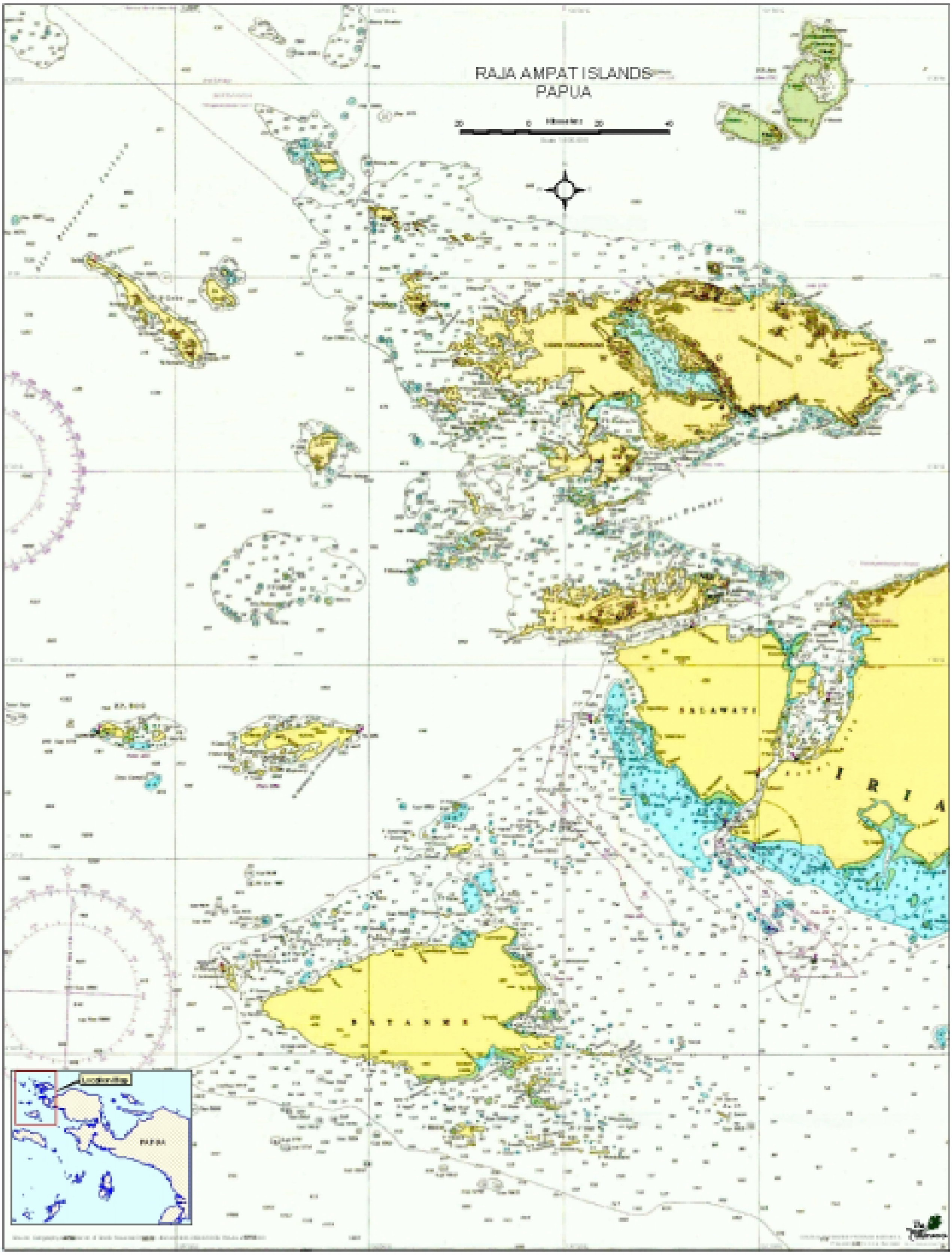

Figure 2. Raja Ampat archipelago. Nautical chart 512 of Dinas Hidro-Oseanografi, Jakarta, Indonesia.

Figure 3. Land team members (Duncan Neville and Fery Liuw) boarding a zodiac after surveying an island in the Jef Pelee group. The 75–ft Pindito lies anchored offshore. Zodiac and speedboat tenders provided daily transport for the landsea survey. Photo November 9, 2002.

Figure 4. For travel over longer distances, the team used a speedboat (‘longboat') of a versatile design widely employed in the Papuan coastal and riverine traffic. Despite their unwieldy appearance the shallow-draft longboats are capable of entering the headwaters of even small streams. A survey longboat is shown here at Wagmab Island. Photo November 4,2002.

Figure 5. Wagmab Island, SE Misool. Forester Fery Liuw searches for botanical specimens in the dry scrub on limestone talus. In spite of exemplary support logistics, collections were few and difficult to obtain because of the unfavorable conditions. Photo November 4, 2002.

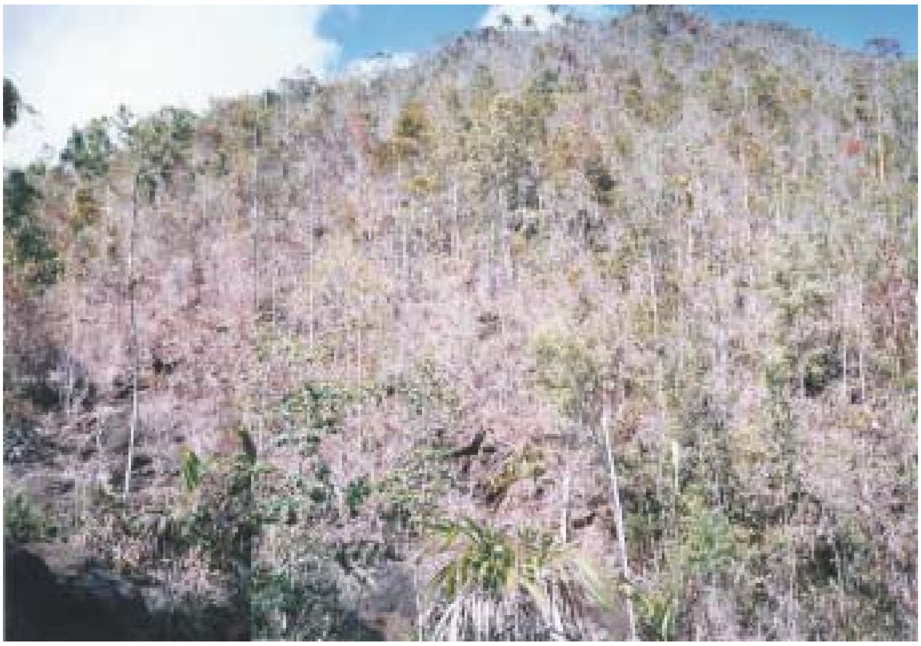

Figure 6. Kawe. Drought-stricken serpentine woodland on steep slopes. Photo November 18, 2002.

Figure 7. Wayag Island. Interior view of a mangrove forest on limestone karst. Trees are represented mostly *by Bruguiera gymnorrhiza* and *Rhizophora mucronata*. Photo November 16, 2002.

Figure 8. Open beach forest on Wagmab. In the western Raja Ampat, mangroves and beach forest are generally scarce. The limestone and serpentine vegetation often extend to the highwater line, displacing the beachfront communities more characteristic of other coastal areas. Photo November 4, 2002.

Figure 9. Forest understory on south Batanta, generally species-rich in comparison to the outer Raja Ampat. Photo November 3, 2002.

Figure 10. Batanta. Lowland coastal forest on deep soils, in the process of conversion to subsistence gardens. Tall canopies(>30 m height) are common on islands close to the New Guinea mainland (i.e. Batanta and Salawati) but are essentiallyabsent on the outer islands. Photo November 3, 2002.

Figure 11. Wagmab. Forest in broad ravine. Communities are denser, taller, and richer than the surrounding vegetation on higher slopes. Photo November 4, 2002.

Figure 12. Interior view of the forest shown in Figure 11. Photo November 4, 2002.

Figure 13. Alluvial forest along the Kasim River of western Misool. Photo November 10, 2002.

Figure 14. Misool. Interior perspective of a *Homalium foetidum*-dominant forest on ridgecrests. Photo November 9, 2002.

Figure 15. As for preceding figure. Showing the canopy closure and crown density. Photo November 9, 2002.

Figure 16. Misool. Understory of a limestone forest. The near-ground interval is generally clear or with scattered palms. Photo November 4, 2002.

Figure 17. Kawe. Characteristic appearance of an understory from serpentine stands in ravines and valleys. Stems are generally of small diameter and herbaceous growth is sparse. The ground layer often has seedling crops of the canopy taxa.Ferns and gingers are conspicuously absent. Photo November 18, 2002.

Figure 18. Kofiau. Regrowth community from a former forest clearfelled 15 years ago. Photo November 12, 2002.

Figure 19. See Figure 18.

Figure 20. Anthropogenic sedge-grassland (*Imperata-Ischaemum-Scleria*) on limestone islands near the Misool mainland. Other seral taxa included *Desmodium umbellatum, Premna serratifolia, Morinda citrifolia,* and *Pandanus tectorius*. Photo November 8, 2002.

Figure 21. Mesemta Bajampop. A seral community on karst, consisting exclusively of *Commersonia bartramia*, *Dracaena angustifolia*, and *Gahnia aspera*. Photo November 5, 2002.

Figure 22. Misool. *Melaleuca leucadendron* s.l., the dominant stand-forming species in the Raja Ampat savannas. The whitish-papery outer bark and drooping leaves are characteristic. Photo November 10, 2002.

Figure 23. Misool. Kasim river savanna. *Timonius timon* forms a second, darker-leaved layer beneath taller *Melaleuca*. Photo November 10, 2002.

Figure 24. As for Figure 23. The grassy groundcover of *Ischaemum barbatum* and *Imperata conferta* is typical. Photo November 10, 2002.

Figure 25. Misool. The large savanna complex at Waitama. Photo November 11, 2002.

Figure 26. Aljoei. Steep sided stacks and platforms, a typical geomorphic feature of the limestone terrain at Misool and Waigeo. Photo November 14, 2002.

Figure 27. Aljoei. Limestone cliffs. Labyrinthine submarine caves are present along many of the underwater walls. Photo November 14, 2002.

Figure 28. Limestone precipices on Wagmab. Photo November 4, 2002.

Figure 29. Wagmab. Vegetation on limestone ledges. Photo November 4, 2002.

Figure 30. Wayag. *Podocarpus polystachyus* (5–7 m tall), a common limestone species. Photo November 16, 2002.

Figure 31. East-central coastline of Kawe island, an ultrabasic outcrop 15 km west of Waigeo. In contrast to the uneven and deeply dissected limestone, ultrabasics are charac teristically composed of massive ridges with uniform slopes (Löffler 1977). Photo November 18, 2002.

Figure 32. Kawe. Three-shot montage (moving N to ESE: top frame to bottom frame) of ultrabasic woodland near the summit. The equator passes slightly to the right of the small island in the near background (center photo). Western Waigeo is on the horizon of the last frame (to ESE). Photo November 17, 2002.

Figure 33. Waigeo ultrabasic scrub at the entrance of Fofak Bay. Center of view to the southeast, showing the irregular outline of limestone karst against the skyline (compare Fig. 31 Kawe island). Foreground: the sympodial architecture of *Ploiarium sessile* is the most distinctive feature of the open community. *Dicranopteris linearis* forms the groundlayer. Photo November 19,2002.

Figure 34. *Myrsine rawacensis* on Kawe ultrabasics. Photo November 17, 2002.

Figure 35. *Ploiarium sessile*, the dominant woody plant in the ultrabasic scrub. Obtuse leaves and sessile flowers immediately distinguish this species from congeners (Kobuski 1950). Originally recorded from Halmahera (ibid.), *P. sessile* is still known from only a few collections. Photo November 17, 2002.

Figure 36. Serpentine bedrock in a large V-valley of south-central Kawe. In spite of the drought, a spring-fed creek flowed for several hundred meters over water falls in the middle valley, before disappearing into crevices along the streambed. A locally-luxuriant vegetation flourished along the banks, with dry woodland (Fig. 6) covering the higher slopes. No aquatic life was present other than small shrimp. Photo November 18, 2002.

Figure 37. The aptly-named *Psychotria tripedunculata*, one of the most common shrubs on the ultrabasics. Photo November 19, 2002.

Figure 38. Waigeo fire successional community. Burning removes the normal groundlayer of *Dicranopteris linearis* and *Machaerina glomerata*, leaving mainly scattered shrubs of *Commersonia bartramia*. Photo November 19, 2002.

Figure 39. A closed stand of pole-stemmed trees near the fire succession shown in Fig. 38. The ultrabasic forest facies is connected to the open vegetation by a continuum of transitional communities. Photo November 19, 2002.

Figure 40. Ultrabasic forest at Kabare. Showing the closed structure of the presumably older growth, often *Gymnostoma-Myrtella* codominant. Photo November 20, 2002.

Figure 41. Waigeo blowout. Large patches of sheet-eroded earth are scattered through the scrubland, exposing the distinctive orange-red laterite of the ultrabasic zone. These erosional features are probably a recent result of forest removal. Although the open communities convey an impression of stability and continuity, the development of such areas is actually part of a historical pattern of ecological degradation. Photo November 19, 2002.

Figure 42. Kamiali, Papua New Guinea. Successional scrub community on a 15-year old landslide. Plants on the exposed ground include *Myrtella beccarii*, *Stenocarpus moorei*, *Dicranopteris linearis*, *Machaerina glomerata*, and *M. rubiginosa*. The dominance of *Cyperaceae* (particularly *Machaerina*) is a curious feature of the ground layer in situations where grasses would ordinarily dominate on conventional substrates. This same pattern occurs on Waigeo serpentine. Photo Feb. 5, 2003.

Figure 43. Kamiali, Papua New Guinea. Serpentine woodland dominated by *Gymnostoma papuana*, *Weinmannia fraxinea*, and *Tristaniopsis macrosperma* in the canopy, and by *Dicranopteris linearis* and *Myrtella beccarii* in the understory. *Kamiali* has about twice the rainfall of Waigeo, resulting in a denser and more diverse vegetation. Many species are common to both districts. Photo October 6, 2002.

Figure 44. Peninsula at mouth of Fofak Bay, Waigeo. Inland view to the north (opposite the perspective in Fig. 33). Mapped as a *Gymnostoma* (*Casuarina*) forest in 1955, this area is now an eroded and depauperate scrubland. A few relictual emergents of *Gymnostoma rumphiana* are visible in the far distance, apparently all which remains of the former forest. Photo November 19, 2002.

Figure 45. Mesemta Bajampop. Scenic limestone forests adjoining a sheltered reef teeming with marine life. Some of the highest coral counts during the survey were recorded from this reef, e.g. from the blue hole in the right frame (Turak, pers. comm.). Photo November 5, 2002.

Chapter 7

Extension Workshop on the Raja Ampat Rapid Ecological Assessment Saonek, 20-21 August 2003

AGUS SUMULE, PAULUS BOLI and RONNY BAWOLE

7.1 Summary

- A workshop was organized by The Nature Conservancy in collaboration with the University of Papua and BKSDA Sorong to disseminate results from the Raja Ampat Rapid Ecological Assessment.
- The workshop was held in Saonek, capital of the South Waigeo District, on August 20-21 2003
- In total, 59 participants were registered (mostly government officials)
- The main finding from the Rapid Ecological Assessment was that the Raja Ampat area harbours the world's most diverse coral reefs
- Participants rated destructive fishing practices, over-exploitation and illegal logging among the most serious threats to the natural resources of Raja Ampat
- Participants underlined the need for a strategic approach to sustainable development of the new *Kabupaten*

7.2 Introduction

From 31 October to 22 November 2002, The Nature Conservancy conducted a Rapid Ecological Assessment in Raja Ampat area, Papua. Participants of the expedition included experts on: coral reef, reef fish, terrestrial vegetation, sea turtles, and socio-economics. When pre-expedition discussions were held in Sorong on the third week of October 2002, The Conservancy promised to community leaders and government officials that as soon as the report draft was completed, a workshop would be conducted in Raja Ampat to report back results of the research to the people and government of Raja Ampat.

On 12 November 2002, the National Parliament of Indonesia passed a bill on the establishment of 14 new regencies in Papua Province. One of these new regencies was Raja Ampat. On December 24 2002, this bill was enacted by President Megawati as the Law of the Republic of Indonesia No. 26 of the year 2002 on the subject of the establishment of 14 new *kabupatens* (regencies). In April 2003, the acting *Bupati* (Regent) of Raja Ampat Regency was appointed and inaugurated by the Minister of the Interior Affairs in Jayapura, witnessed by the Governor of Papua. Since that time, the government of Raja Ampat has been operational.

It was due to this development that the workshop to present the results of the expedition was not conducted in Sorong, the capital city of *Kabupaten* Sorong, but in Saonek, one of the main villages of the new *Kabupaten* Raja Ampat in Waigeo Selatan (South Waigeo) District.

The objectives of the workshop were as follows:

- dissemination of results of the Rapid Ecological Assessment;
- solicit inputs on current threats to coastal and marine biodiversity;
- initiate partnership-building;
- prepare for a more comprehensive workshop that aims to develop a vision and a strategy for marine and coastal conservation and sustainable resource use in the Bird’s Head functional seascape.

To ensure that the objectives could be met, The Conservancy involved the State University of Papua (Unipa) who tasked three staff to facilitate the workshop. Responsibilities of the facilitators were as follows:

- work together with The Conservancy, BKSDA and other local government partners on a workshop agenda;
- co-facilitate the workshop (including translations Bahasa Indonesia – English where required) and
- prepare a draft workshop report that should include (a) a list of perceived threats that were put forward by workshop participants, (b) a list of recommendations put forward by workshop participants, (c) minutes of the workshop and (d) a list of participants.

Facilitators and organizers of the workshop are listed in Table 1.

7.3 Opening Speeches

The workshop was officially opened by the Secretary of the *Kabupaten* Raja Ampat on behalf of the Bupati. The main issues raised by the Bupati were as follows:

- Conservation of the natural resources was the interest of the international agencies because the care of humans for the environment has diminished.
- The presence of the international conservation organizations in Raja Ampat has a positive effect on the development efforts initiated and undertaken by the government.

- Various scientific surveys have been conducted in Raja Ampat, and most of them concluded that the biodiversity of Raja Ampat is among the richest in the world.
- Therefore, this workshop was considered very important to obtain more information from respected international organizations to be used as references by the government in improving the development in fishery and marine sectors, as well as tourism.

Table 1. Workshop facilitators and organizers

Name	**Institution**	**Role**
Agus Sumule	UNIPA	Facilitator
Paulus Boli	UNIPA	Facilitator
Roni Bawole	UNIPA	Facilitator
Constant Sorondanya	BKSDA	Organizer
Peter Mous	TNC SEACMPA	Organizer
Johannes Subijanto	TNC SEACMPA	Organizer
Andreas Muljadi	TNC SEACMPA	Organizer
Richardo Tapilatu	TNC SEACMPA	Organizer
Abdul Halim	TNC SEACMPA	Organizer
Titayanto Pieter	TNC CTRC Bogor	Organizer
Waladi Isnan	PHKA, Directorate of Conservation Areas	Representative
Tetha Hitipeuw	WWF	Representative, guest speaker
Yulianus Thebu	WWF	Representative
Muhammad Farid	CI	Representative, guest speaker
Yaya Mulyana	Ministry of Marine Affairs and Fisheries, Directorate of marine Conservation and Marine National Parks	Representative, guest speaker

The Head of the BKSDA II of Papua Province (Mr. Constant Sorondanya) and the Director of the Directorate for Marine Conservation and National Parks (Bpk. Yaya Mulyana) both welcomed this workshop, and both expected that the workshop would contribute to a better understanding on the necessity to undertake conservation programs and that this workshop would contribute to the sustainable use of Raja Ampat's resources.

7.4 Presentations

The following presentations were made during the workshop:

- An overall context and plan of the workshop, by Agus Sumule.
- Kawasan Perlindungan Laut: Model Pengelolaan untuk Memperbaiki Perikanan Tangkap di Indonesia (Marine Protected Area: A Model to Enhance the Fishery in Indonesia), by Abdul Halim.
- Introducing The Conservancy, by Yohanes Subiyanto; and Introducing Conservatuion International with remarks on the works of CI in Raja Ampat area, by Muhammad Farid.
- Results of The Conservancy's REA in Raja Ampat:
- Documentary film on The Conservancy's REA in Raja Ampat, Producer: Joe Yaggi
- Presentation of the ecoregion concept, by Peter Mous and Teta Hitipeuw

7.4.1 Introducton to the Workshop, by Agus Sumule

Before the opening speeches, Sumule provided the overall context and plan of the workshop to the participants. He explained the objectives of the workshop, and invited the participants to fully partake in the discussions and to provide inputs for the improvement of the quality of the report. He also explained that the workshop participants should always bear in mind two crucial and related issues:

- what conservation strategies should be developed to ensure the Raja Ampat marine and forest resources can be utilized sustainably; and
- what development strategies should be developed to ensure that the utilization of the Raja Ampat resources will increase the well-being of the local communities.

7.4.2 Presentation on the concept of Marine Protected Areas, by Abdul Halim

Halim introduced the concept of Marine Protected Area (MPA), and how these can help to ensure sustainable use of the fishery resources in Indonesia. One of the key words he introduced, and attracted considerable response from the certain participants, was "*daerah larangan tangkap*" (no-take zone) in the MPA concept. A participant (Abdurrahman Wairoy, the Head of Agriculture Dept.) proposed "*waktu larangan tangkap*" (no-take period) as an alternative to the no-take zone concept. The no-take period was considered suitable to the local/indigenous conservation concept called *sasi*. Informal discussions with the participants during the breaks also revealed that the no-take period concept was deemed more suitable to the customary ownership (*pemilikan adat/ulayat*) concept, as all customary communities (*masyarakat adat*) would bear the same responsibility to protect the marine resources.

Other questions raised on no-take zones were:

- How can Marine Protection Area and no-take zones benefit fish populations that migrate large distances? How can no-take zones be applied to the cases where migrating fish cross the government administration area, for instance from Raja Ampat to Fakfak regency?
- How could you convince the community about the advantages of no-take zones?
- can no-take zones create an economic opportunity by enhancing tourism in Raja Ampat?

7.4.3 Introductions to The Nature Conservancy and Conservation International, by Yohanes Subiyanto and Muhammad Farid

Yohanes Subiyanto introduced briefly the activities of The Conservancy in Indonesia and Muhammad Farid introduced the research activities of Conservation International in Raja Ampat. Both presentations were received well by the workshop participants. After the presentations, Peter Mous presented the REA report to the Bupati, while Muhammad Farid presented the report of CI's Rapid Survey in Raja Ampat.

7.4.4 Presentations on the Raja Ampat REA, by Peter Mous, Ferry Liuw, Agus Sumule, and Teta Hitipeuw

The REA results were presented as five modules that comprised:

- Brief introduction on the researchers and methodology of REA, by Peter Mous;
- Results of fish and corral studies, by Peter Mous;
- Results of the forestry study, by Ferry Liuw;
- Results of the socioeconomic study by Agus Sumule;
- Results of the sea turtle study, by Teta Hitipeuw.

A couple of times the participants applauded Peter's presentation when he mentioned the richness of Raja Ampat biodiversity, especially coral and fish. Ferry, Agus and Teta's presentation were also well received.

Comments were given mostly to the socio-economic aspects of the research findings (mostly to the material presented by Agus Sumule). Issues raised by the participants were related to the socio-economic benefits to be gained by the local communities from the sustainable utilization of the marine resources of Raja Ampat, especially from the marine tourism industry.

7.4.5 Video Documentary on the Raja Ampat REA, by Joe Yaggi

The film, which documented the activities of the REA showed the richness of the Raja Ampat resources as well as the human's utilization of those resources (including the destructive ones – illegal logging, blast fishing, etc.). The film presentation was very successful – it was appreciated not only by the workshop participants but also by the community of Saonek.

7.4.6 Presentations on Ecoregional Planning, by Peter Mous and Teta Hitipeuw

Peter Mous and Teta Hitipeuw (WWF) presented the concept of ecoregional planning to the participants. Even though these concepts were significant from the conservation strategy point of view, they did not attract much interest from the participants. The main reason could be that the concepts were too theoretical and did not address the immediate needs of the people.

7.5 Closing Speeches

The acting Bupati of Raja Ampat closed the workshop. Before giving his speech, he was shown the video documentary. He highly appreciated the efforts of The Conservancy, and urged the workshop participants as well as the community at large in Saonek to protect and conserve the Raja Ampat Resources. He also urged The Conservancy and other international conservation organizations to continue the conservation works in Raja Ampat, and he promised the full cooperation of his administration.

Before the speech of the Bupati, the First Assistant to the Kabupaten's Secretary (*Asisten I Sekda*), on behalf of the organizer, reported what has been achieved from the workshop. His main points were:

- It became more obvious that the richness of the marine and terrestrial resources in Raja Ampat was extraordinary. He stated that it is the responsibility of all participants to extend this knowledge to all people of Raja Ampat.
- He stated that Raja Ampat's natural resources are facing serious threats: blast fishing, the use of potassium cyanide, over-exploitation of marine resources, as well as illegal logging. Efforts to abate these threats can no longer be postponed.
- It became clearer during the workshop, that cooperation with all parties committed to conserve Raja Ampat natural resources, as well as to improve the living condition of the local people, was crucial. As a new *Kabupaten*, Raja Ampat's government welcomes the interest of others to help.
- Lastly, the Fist Assistant stated that this workshop is only a beginning. More issues need to be discussed, as they were indeed complex. Therefore, the plan of The Nature Conservancy and Conservation International to organize another seminar where conservation issues can be discussed and planned in a more detail was most welcome.

7.6 Group Discussions

Recommendation from the workshop were obtained by asking the participants to form groups and to discuss certain questions. There were 59 people participated in the discussions, divided into eight groups (see Appendix 8).

Questions to stimulate discussions were presented by Agus Sumule to all participants before they were divided into groups. These questions pertained to the most important threats to biodiversity and sustainable use of natural resources, and to enhancement of the welfare of local people. The questions were:

- In your opinion, what are the most serious threats to the sustainability of Raja Ampat resources (marine and terrestrial)? Please name 5 (five) threats and rank them according to the order of importance.
- Who should organize the activities to manage those threats? Please be as specific as possible.
- What types of socio-economic activities which need to be undertaken to improve the welfare of the people? Please name five activities and rank them according to the order of priorities.
- What conditions should be fulfilled so that those activities can be undertaken?

Translated transcripts of the answers provided by each group to the questions above are presented in Appendix 9. The main themes were basically as follows:

- The main threats for the sustainability of the Raja Ampat marine resources were the use of blast fishing, potassium cyanide, trawls, and sea turtles catching.
- The main threat for the sustainability of for the forest/terrestrial resource was illegal logging.
- To solve the above problems several actions must be taken immediately: strict upholding of the law in its broadest meanings – including in terms of a significant presence of well equipped law enforcement officers, the reduction of napoleon/kerapu trading, stop the illegal logging, significantly improve the awareness of the community on the danger of blast fishing.
- The improvement of the socio-economic welfare of the local people can be achieved by the creation of more jobs through the cooperation between the government and the private sectors, including but not limited to programs such as the community based marine tourism industry, sustainable commercial utilization of forest resources, and better practice of fishing and other types of traditional economic utilization of marine resources.
- Relevant government institutions and officials should take a leading role in achieving better management of natural resources and improving the welfare of the people..

7.7 Evaluation and suggestions for future workshops

The workshop of 20-21 August 2003 in Saonek was a success. The results of the REA project were disseminated effectively to the workshop participants. More awareness about the uniqueness and richness of Raja Ampat natural resources (marine and terrestrial) was achieved, as well as about the urgent need to conserve the resources. The Bupati of the newly established *Kabupaten* Raja Ampat, with his staff, showed strong commitment and determination for the realization of sustainable use of Raja Ampat marine and terrestrial resources.

The main problem of this workshop was that the non-government participants were very much limited to the local people of the Saonek area and its neighboring villages. People from other main islands such as Batanta, Misool and Salawati were poorly represented. It is therefore important for The Nature Conservancy to assign its Raja Ampat staff to run a similar type of workshop in Batanta, Misool and Salawati, at least at the district (*kecamatan*/*distrik*) capitals.

The issue of proper representation of local communities, NGOs (including religious organizations) and government officials (including teachers) should be seriously taken into account for the undertaking of future workshops. Only by having a good community representation, the results of any workshop in Raja Ampat can be disseminated effectively to the community in large.

Future workshops should follow up issues which have been discussed and agreed upon in Saonek (20-21 August). The so-called “follow-up” (*tindak lanjut*), should be aimed to develop a clear and specific action plan for government, non-government institutions (including The Conservancy), and the local communities to achieve a sustainable use of Raja Ampat's natural resources. It is therefore suggested that the future workshop should allow the local people to learn from a series of presentations on what development options are available for them to obtain sustainable economic benefits. The Conservancy and the government (Ministry of Marine Affairs and Fishery, Ministry of Forestry of the central government, as well as the *Kabupaten* Raja Ampat and the Papua Province government) need to consider inviting relevant institutions and individuals who have been successful in developing community based marine tourism industry, sustainable commercial utilization of forest resources, better practice of fishing and other types of traditional economic utilization of marine resources, etc.

Future workshop should also include presentations from The Conservancy and other interested conservation organizations, government of Raja Ampat, and relevant institutions of the central and provincial government on what programs can be implemented in the Raja Ampat area. This will allow the local communities to influence processes and to better anticipate changes which might occur in their areas. It will also allow organizations and agencies to coordinate their activities.

Appendices

Appendix 1. List of the Reef Fishes of the Raja Ampat Islands.

This list includes all species of shallow (to 50m depth) coral reef fishes known from the Raja Ampat Islands at 1 December 2002. The list is based on the following sources:

1) Results of the TNC REA survey of 2002;

2) Results of the 2001 CI Marine RAP;

3) 26 hours of scuba-diving observations by G. Allen in 1998 and 1999.

The numbers under the site records column and remarks in the abundance column pertain to the REA survey. "Previously recorded" refers to species not seen during the present survey, but were observed or collected by G. Allen on previous trips.

The phylogenetic sequence of the families appearing in this list follows Eschmeyer (Catalog of Fishes, California Academy of Sciences, 1998) with slight modification (eg. placement of Cirrhitidae). Genera and species are arranged alphabetically within each family.

Terms relating to relative abundance are as follows:

Abundant - Common at most sites in a variety of habitats with up to several hundred individuals being routinely observed on each dive.

Common - seen at the majority of sites in numbers that are relatively high in relation to other members of a particular family, especially if a large family is involved.

Moderately common - not necessarily seen on most dives, but may be relatively common when the correct habitat conditions are encountered.

Occasional - infrequently sighted and usually in small numbers, but may be relatively common in a very limited habitat.

Rare - less than 10, often only one or two individuals seen on all dives.

SPECIES	SITE RECORDS	ABUNDANCE
ORECTOLOBIDAE		
Eucrossorhinus dasypogon (Bleeker, 1867)	22	Rare, only one seen..
HEMISCYLLIIDAE		
Hemiscyllium freycineti (Quoy & Gaimard, 1824)	Previously recorded.	Rarely seen, but nocturnal. Waigeo is type locality.
GINGLYMOSTOMATIDAE		
Nebrius ferrugineus (Lesson, 1830)	Previously recorded.	
CARCHARHINIDAE		
Carcharhinus amblyrhynchos (Bleeker, 1856)	Previously recorded.	
C. melanopterus (Quoy and Gaimard, 1824)	Previously recorded.	
Triaenodon obesus (Rüppell, 1835)	Previously recorded.	
SPHYRNIDAE		
Sphyrna lewini (Griffith & Smith, 1834)	Previously recorded.	Rare, only one seen. A New record for RA.
DASYATIDIDAE		
Dasyatis kuhlii (Müller and Henle, 1841)	11, 21-23, 25-27, 30, 34, 39, 54	Occasionally seen in sandy areas.
Pastinachus sephen (Forsskål, 1775)	28, 40	Rare, only two seen. New record for RA.
Taeniura lymma (Forsskål, 1775)	9, 12, 18a, 35, 36, 42, 54, 56, 58	Occasionally seen in sandy areas.
Urogymnus asperrimus (Bloch & Schnieder, 1801)	33	Rare, only one seen. New record for RA.
MYLIOBATIDAE		
Aetobatus narinari (Euphrasen, 1790)	24, 34, 43	Rare, only three seen.
MOBULIDAE		
Manta birostris (Walbaum, 1792)	21, 44, 54	Rare, only three seen.
Mobula tarapacana (Philippi, 1892)	Previously recorded.	
MORINGUIDAE		
Moringua ferruginea (Bliss, 1883)	Previously recorded.	
M. microchir Bleeker, 1853	Previously recorded.	
MURAENIDAE		
Echidna nebulosa (Thünberg, 1789)	Previously recorded.	
Gymnothorax enigmaticus McCosker and Randall, 1982		
G. fimbriatus (Bennett, 1831)	Previously recorded.	
G. flavimarginatus (Rüppell, 1828)	Previously recorded.	
G. fuscomaculatus (Schultz, 1953)	48	One specimen collected with rotenone.
G. javanicus (Bleeker, 1865)	26, 28, 41, 43, 44, 54	Rare, less than 10 seen.
G. melatremus Schultz, 1953	Previously recorded.	
G. pictus (Ahl, 1789)	Previously recorded.	
G. polyuranodon (Bleeker, 1853)	Previously recorded.	
G. zonipectus Seale, 1906	Previously recorded.	
Rhinomuraena quaesita Garman, 1888	25	Rare, only two seen.
Uropterygius micropterus (Bleeker, 1852)	Previously recorded	
OPHICHTHIDAE		
Leiuranus semicinctus (Lay and Bennett, 1839)	18b	Common at one site.
Muraenicthys macropterus Bleeker, 1857	18b	Collected with rotenone. New record for RA.
Myrichthys colubrinus (Boddaert,1781)	18b	Collected with rotenone.
M. maculosus (Cuvier, 1817)	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
CONGRIDAE		
Gorgasia maculata Klausewitz & Eibesfeldt, 1959	22, 29, 30, 48	Occasional, but locally common. Hundreds seen at site 29.
Heteroconger haasi (Klausewitz and Eibl-Eibesfeldt, 1959)	9, 16, 27, 30, 39	Occasional, but locally common. Hundreds seen at site 30.
CLUPEIDAE		
Herklotsichthys quadrimaculatus (Rüppell, 1837)	Previously recorded.	
Spratelloides delicatulus (Bennett, 1832)	16, 21, 28, 31, 34, 35, 52, 53, 55	Occasional, hundreds seen schooling near surface at several sites.
S. lewisi Wongratana, 1983	8, 10-15	Occasional, but locally abundant.
PLOTOSIDAE		
Plotosus lineatus (Thünberg, 1787)	29, 33, 43, 53	Occasional.
SYNODONTIDAE		
Saurida gracilis (Quoy & Gaimard, 1824)	12, 23	Rare.
S. nebulosa Valenciennes, 1849	21, 39, 44, 50, 58	Occasional.
Synodus dermatogenys Fowler, 1912	10, 11, 15-18a, 20, 21, 23, 24, 27, 28, 30-34, 36, 39, 40, 42, 43, 50, 52, 58	Moderately common, solitary individuals usually seen resting on dead coral or rubble.
S. jaculum Russell and Cressy, 1979	16, 22, 23, 30, 31, 35, 43, 44, 54	Occasional on rubble bottoms..
S. rubromarmoratus Russell and Cressy, 1979	16, 33, 35, 52	Rare, on sand or rubble bottoms.
S. variegatus (Lacepède, 1803)	11, 15-18a, 20, 21, 26, 28, 30, 31, 36, 39, 42, 43, 50, 52, 55, 56, 58	Moderately common, solitary individuals or pairs usually seen resting on live coral..
CARAPIDAE		
Onuxodon margaritiferae (Rendahl, 1921)	Previously recorded.	
BYTHITIDAE		
Brosmophyciops pautzkei Schultz, 1960	34	Two specimen collected with rotenone.
Ogilbia sp. 1	48, 58	Collected with rotenone.
Ogilbia sp. 2	Previously recorded.	
ANTENNARIIDAE		
Antennarius coccineus (Lesson, 1829)	Previously recorded.	
A. dorhensis Bleeker, 1859		
A. pictus (Shaw & Nodder, 1794)	23, 56	Photographed by expedition members. New record for RA.
Histiophryne cryptacanthus (Weber, 1913)	Previously recorded.	
Histrio histrio (Linnaeus, 1758)	38	One specimen captured in floating *Sargassu*m, but released.
GOBIESOCIDAE		
Diademichthys lineatus (Sauvage, 1883)	15, 17, 22, 24, 27-31, 34, 35, 52, 53	Occasional among sea urchins or branching coral.
Discotrema crinophila Briggs, 1976	Previously recorded.	
D. lineata (Briggs, 1966)	34	Rare, photographed by expedition members. New record for RA.
ATHERINIDAE		
Atherinomorus lacunosus (Forster, 1801)	8, 12-14	Occasional large shoals seen.
Hypoatherina temminckii (Bleeker, 1853)	Previously recorded.	
TELMATHERINIDAE		
Kalyptatherina helodes (Ivantsoff & Allen, 1984)	12	Locally common at edge of mangroves at one site.
BELONIDAE		
Platybelone platyura (Bennett, 1832)	17	Rare, less than 10 seen at one site.
Tylosurus crocodilus (Peron & Lesueur, 1821)	9, 17, 20, 25, 33, 34, 44, 54	Occasional, on surfaces at several sites.
HEMIRAMPHIDAE		
Hemirhamphus far (Forsskål, 1775)	30, 56	Rare, only two seen.

SPECIES	SITE RECORDS	ABUNDANCE
Hyporhamphus dussumieri (Valenciennes, 1846)	Previously recorded.	
Zenarchopterus buffonis (Valenciennes, 1847)	Previously recorded.	
Z. dunckeri Mohr, 1926	12, 13, 27, 56	Occasional, but locally common near mangroves at four sites.
HOLOCENTRIDAE		
Myripristis adusta Bleeker, 1853	20, 26, 31, 39, 45, 46, 50, 51, 54, 58	Occasional, sheltering in caves and under ledges. Common at site 54.
M. berndti Jordan and Evermann, 1902	10, 16, 21-23, 25-29, 31, 32, 34, 37, 39, 41, 44, 49-51, 54	Common, sheltering in caves and under ledges.
M. botche Cuvier, 1829	57	Rare..
M. hexagona (Lacepède, 1802)	7-12, 17, 18a, 21, 38, 42, 48, 56	Common, usually in silty bays.
M. kuntee Valenciennes, 1831	26, 27, 35, 37, 39, 40, 42-45, 49, 51-54, 58	Moderately common, sheltering in caves and under ledges, but frequently exposes itself for brief periods.
M. murdjan (Forsskål, 1775)	30, 37, 41	Rare.
M. pralinia Cuvier, 1829	Previously recorded.	
M. violacea Bleeker, 1851	7, 11, 16, 18a, 20, 21, 29, 30, 34-36, 43, 44, 48, 50, 52, 54, 56-58	Moderately common.
M. vittata Valenciennes, 1831	41, 45, 46, 51, 57	Occasional, except abundant at site 57..
Neoniphon argenteus (Valenciennes, 1831)	50, 58	Rare, less than 10 seen. New record for RA.
N. opercularis (Valenciennes, 1831)	21, 31, 37	Rare, only three seen.
N. sammara (Forsskål, 1775)	24, 27, 38, 30, 43, 44, 54-58	Occasional, usually among branches of staghorn *Acropora* coral.
Sargocentron caudimaculatum (Rüppell, 1835)	9, 16, 17, 20-23, 25-32, 34, 35, 37, 39, 40, 43-46, 48, 49, 51, 54, 57, 58	Common.
S. cornutum (Bleeker, 1853)	8, 55	Rare, only about eight seen.
S. diadema (Lacepède, 1802)	35, 40, 43, 44, 56	Rare, less than 10 seen.
S. melanospilos (Bleeker, 1858)	8, 30, 34, 55	Rare, only a few seen at four sites.
S. rubrum (Forsskål, 1775)	11, 14, 21, 24	Occasional, but locally common in silty bays.
S. spiniferum (Forsskål, 1775)	27, 31, 32, 34-37, 42-45, 50, 51, 55, 57	Moderately common, in caves and under ledges.
S. tiere (Cuvier, 1829)	39	Rare, but nocturnal.
S. tiereoides (Bleeker, 1853)	48, 58	Rare, but nocturnal. New record for RA.
S. violaceum (Bleeker, 1853)	43, 48, 53	Rare, only three seen.
PEGASIDAE		
Eurypegasus draconis (Linnaeus, 1766)	Previously recorded.	
AULOSTOMIDAE		
Aulostomus chinensis (Linnaeus, 1766)	9, 21, 27, 29, 31, 35, 37, 39, 44, 45, 48, 50-52, 54, 56-58	Moderately common.
FISTULARIIDAE		
Fistularia commersoni Rüppell, 1835	7, 29, 31, 35, 39, 48-51, 56, 57	Occasional.
CENTRISCIDAE		
Aeoliscus strigatus (Günther, 1860)	7, 33	Rare, only two small aggregations seen.
Centriscus scutatus (Linnaeus, 1758)	15	Rare, only one aggregation seen.
SOLENOSTOMIDAE		
Solenostomus halimeda Orr, Fritzsche & Randall, 2002	34	Rare, one collected. New record for RA.
S. paradoxus (Pallas, 1770)	30, 31, 33	Rare, only three seen. New record for RA.
SYNGNATHIDAE		
Choeroichthys brachysoma Bleeker, 1855		Collected with rotenone.
Corythoichthys amplexus Dawson & Randall, 1975	22	Rare, only one seen. New record for RA

SPECIES	SITE RECORDS	ABUNDANCE
C. flavofasciatus (Rüppell, 1838)	53	Rare, only one seen.
C. haematopterus (Bleeker, 1851)	Previously recorded.	
C. intestinalis (Ramsay, 1881)	Previously recorded.	
C. ocellatus Herald, 1953	Previously recorded.	
C. schultzi Herald, 1953	23	Rare.
C. sp. 1 (RHK sp. 2)	22	Rare, only one seen. New record for RA.
C. sp. 2 (RHK sp. 3)	22	Rare.
Doryrhamphus dactyliophorus (Bleeker, 1853)	31, 34, 49	Only three seen, but a secretive cave and ledge dweller.
D. janssi (Herald & Randall, 1972)	Previously recorded.	
D. pessuliferus (Fowler, 1938)	43	Rare, only one seen. New record for RA.
Halicampus dunckeri (Kaup, 1856)	Previously recorded.	
Halicampus mataafae (Jordan & Seale, 1906)	Previously recorded.	
Hippocampus bargibanti Whitley, 1970	34	Rare, one photographed by expedition member.
H. kuda Bleeker, 1852	Previously recorded.	
Phoxocampus belcheri (Kaup, 1856)	Previously recorded.	
P. tetrophthalmus (Bleeker, 1858)	Previously recorded.	
Siokunichthys nigrolineatus Dawson, 1983	33	Rare, two seen among tentacles of mushroom coral.
Syngnathoides biaculeatus (Bloch, 1785)	Previously recorded.	
Trachyrhamphus bicoarctatus (Bleeker, 1857)	23	Rare, one collected.
SCORPAENIDE		
Dendrochirus zebra (Cuvier, 1829)	22, 27	Rare, only two seen.
Pterois antennata (Bloch, 1787)	48, 50	Rare, but mainly nocturnal.
P. volitans (Linnaeus, 1758)	16, 20, 25, 27, 30, 43, 53, 55, 56	Occasional..
Scorpaenodes guamensis (Quoy and Gaimard, 1824)	18b	One collected with rotenone.
S. hirsutus (Smith, 1957)	Previously recorded.	
S. minor (Smith, 1958)	58	One collected with rotenone. New record for RA.
S. parvipinnis (Garrett, 1863)	Previously recorded.	
Scorpaenopsis macrochir Ogilby, 1910	34	Rare, only one seen.
S. papuensis (Cuvier, 1829)	8, 35, 44	Rare, but difficult to observe due to cryptic colors.
Sebastapistes cyanostigma (Bleeker, 1856)	44, 54	Probably not uncommon, but only two seen among coral branches.
S. strongia (Cuvier, 1829)	Previously recorded.	
Taenianotus triacanthus Lacepède, 1802	Previously recorded.	
TETRAROGIDAE		
Ablabys macracanthus (Bleeker, 1852)	Previously recorded.	
SYNANCEIIDAE		
Inimicus didactylus (Pallas, 1769)	Previously recorded.	Rare, only one seen.
Minous trachycephalus (Bleeker, 1854)	33	Rare, but mainly nocturnal. Photographed by expedition member. New record for RA.
Synanceja horrida (Linnaeus, 1766)	33	Rare, photographed by expedition member.
Synanceja verrucosa (Bloch & Schneider, 1801)	Previously recorded.	
CARACANTHIDAE		
Caracanthus maculatus (Gray, 1831)	54	Probably not uncommon, but only one seen among coral branches.

SPECIES	SITE RECORDS	ABUNDANCE
DACTYLOPTERIDAE		
Dactyloptena orientalis (Cuvier, 1829)	30	Rare. One photographed by expedition member.
PLATYCEPHALIDAE		
Cociella punctata (Cuvier, 1829)	Previously recorded.	
Cymbacephalus beauforti Knapp, 1973	28, 32, 42	Only three seen, but difficult to detect.
Platycephalus sp.	Previously recorded.	
Thysanophrys chiltoni Schultz, 1966	Previously recorded.	
CENTROPOMIDAE		
Psammoperca waigiensis (Cuvier, 1828)	18, 56, 57	Rare, but several seen at each of three sites.. Waigeo is type locality.
SERRANIDAE		
Aethaloperca rogaa (Forsskål, 1775)	7, 9, 11, 16, 17, 20, 23, 27, 28, 31, 36, 37, 41, 42, 44-46, 51, 53-57	Moderately common..
Anyperodon leucogrammicus (Valenciennes, 1828)	18a, 20, 21, 30-32, 34, 35, 43, 45, 53, 54, 57, 58	Occasional
Belonoperca chabanaudi Fowler & Bean, 1930	56	Rare, only one seen. New record for RA.
Cephalopholis argus Bloch and Schneider, 1801	20, 23, 26, 28, 30-32, 37, 39, 40, 43, 45, 49, 51, 54, 57	Occasional.
C. boenack (Bloch, 1790)	7-12, 15, 17, 18a, 20, 21, 24, 52, 53, 55	Moderately common.
C. cyanostigma (Kuhl and Van Hasselt, 1828)	7-12, 16-18a, 20, 21, 28-32, 34-36, 42, 43, 48-50, 52, 53, 55-57	Moderately common on sheltered reefs.
C. leopardus (Lacepède, 1802)	16, 20, 32, 43	Occasional.
C. microprion (Bleeker, 1852)	8-10, 12, 15, 16, 18a, 33, 35, 36, 42, 48, 50, 52, 53, 55, 56	Occasional on relatively silty reefs.
C. miniata (Forsskål, 1775)	8, 9, 16, 17, 20-23, 25-28, 30-32, 35, 37, 39, 41, 44-46, 51, 54, 55, 57	Moderately common, usually in areas of clear water.
C. polleni (Bleeker, 1868)	57	Rare, only one seen on steep drop-off. New record for RA.
C. sexmaculata Rüppell, 1828	7, 8, 28, 32, 54, 55	Occasional, on ceilings of caves on steep drop-offs.
C. sonnerati (Valenciennes, 1828)	26, 56	Rare, only two seen.
C. spiloparaea (Valenciennes, 1828)	16, 20, 28, 31, 32, 37, 54-57	Moderately common in deep water (below 20 m) of outer slopes.
C. urodeta (Schneider, 1801)	16, 20, 22, 23, 25-28, 30-32, 37, 39, 41, 43-46, 49, 51, 54	Moderately common in variety of habitats.
Cromileptes altivelis (Valenciennes, 1828)	9, 13, 15, 31, 36	Rare, only five seen.
Diploprion bifasciatum Cuvier, 1828	7-12, 15, 17, 18a, 23, 28, 30, 34, 36, 48-52	Moderately common in sheltered inshore areas.
Epinephelus areolatus (Forsskål, 1775)	24	Rare. Only one seen.
E. bilobatus Randall & Allen, 1987	7, 8, 13, 14, 16, 17	Occasional in silt-affected areas.
E. caruleopunctatus (Bloch, 1790)	27	Rare, only one adult seen.
E. coioides (Hamilton, 1822)	13, 24, 27	Rare.
E. corallicola (Kuhl and Van Hasselt, 1828)	52	Rare, only one seen.
E. fasciatus (Forsskål, 1775)	8-11, 16, 17, 20, 32, 45, 51	Moderately common.
E. fuscoguttatus (Forsskål, 1775)	21, 25, 26, 29, 31, 54	Rare, only five seen.
E. lanceolatus (Bloch, 1790)	23, 50	Rare, only two seen.
E. macrospilos (Bleeker)	20, 35, 54	Rare, only three seen.
E. maculatus (Bloch, 1790)	23, 27, 29, 31, 40, 56	Occasional.
E. merra Bloch, 1793	15, 18b, 20, 25, 28, 29, 31, 33-35, 38, 39, 42-44, 56, 58	Moderately common.
E. ongus (Bloch, 1790)	11, 13, 56	Rare, only three seen.
E. polyphekadion (Bleeker, 1849)	31, 54	Rare, only two seen.
E. quoyanus (Valenciennes, 1830)	10	Rare, only one seen. New record for RA.
E. spilotoceps Schultz, 1953	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
E. tukula Morgans, 1959	Previously recorded.	
Gracila albimarginata (Fowler and Bean, 1930)	20, 25, 31, 39, 56, 57	Occasional, on steep outer reef drop-offs.
Grammistes sexlineatus (Thünberg, 1792)	51	Rare, only one seen.
Grammistops ocellatus Schultz, 1953	Previously recorded.	
Liopropoma susumi (Jordan & Seale, 1906)	Previously recorded.	
Luzonichthys waitei (Fowler, 1931)	29, 31, 32	Three large aggregations seen.
Plectropomus areolatus (Rüppell, 1830)	36, 54, 58	Rare, only three seen.
P. laevis (Lacepède, 1802)	55	Rare, only one seen.
P. leopardus (Lacepède, 1802)	15-17, 43	Rare, about six seen.
P. maculatus (Bloch, 1790)	7, 10-14, 24, 34, 36, 42, 48, 50, 52, 53, 55	Occasional in silty areas.
P. oligocanthus (Bleeker, 1854)	9, 15-18a, 20, 21, 28, 35, 42, 51, 53-55, 57	Occasional.
Pogonoperca punctata (Valenciennes, 1830)	Previously recorded.	
Pseudanthias bicolor Randall, 1979	16	Rare, but several seen at one site. New record for RA.
P. dispar (Herre, 1955)	20, 25, 29, 31, 41, 57	Moderately common and locally abundant, but seen at few sites.
P. fasciatus (Kamohara, 1954)	Previously recorded.	
P. huchtii (Bleeker, 1857)	8, 9, 16-18a, 20-23, 25-35, 39, 43-45, 51, 57, 58	Abundant, one of most common reef fishes at Raja Ampats.
P. hypselosoma Bleeker, 1878	9, 16, 22, 26, 31, 49	Occasional below 20 m on outer reef slopes.
P. luzonensis (Katayama and Masuda, 1983)	Previously recorded.	
P. pleurotaenia (Bleeker, 1857)	16, 20, 31, 56, 57	Occasional below 20 m on outer reef slopes.
P. randalli (Lubbock & Allen, 1978)	31, 57	Rare, but usually seen in deep water.
P. smithvanizi (Randall & Lubbock, 1981)	57	Rare, but locally common at one site. New record for RA.
P. squamipinnis (Peters, 1855)	16, 22, 23, 25-30, 34, 35, 37, 39, 41, 43, 45, 46, 49, 51, 57	Common, especially plentiful at sites 41 and 46.
P. tuka (Herre and Montalban, 1927)	9, 20, 26, 28-32, 39, 43, 48, 54, 56-58	Moderately common.
Pseudogramma polyacanthum (Bleeker, 1856)	Previously recorded.	
Rabaulichthys altipinnis Allen, 1984	25	Rare, but several seen at one site (collected). New record for Indonesia.
Variola albimarginata Baissac, 1953	17, 21, 23, 25-27, 31, 43-45, 51, 54, 58	Occasional and always in low numbers.
V. louti (Forsskål, 1775)	16, 20, 21, 25, 28, 29, 31, 37, 39, 43-45, 51	Occasional and always in low numbers.
PSEUDOCHROMIDAE		
Amsichthys knighti (Allen, 1987)	41, 58	Several collected with rotenone.
Cypho purpurescens (De Vis, 1884)	Previously recorded.	
Labracinus cyclophthalmus (Müller & Troschel, 1849)	27, 32, 36, 38, 42-44, 50	Occasional.
Lubbockichthys multisquamatus (Allen, 1987)	51	Rare, but cryptic dweller of caves and ledges.
P. bitaeniatus (Fowler, 1931)	7-10, 15, 17, 20, 22, 25-31, 34, 48, 51, 52	Occasional.
P. cyanotaenia Bleeker, 1857	Previously recorded.	
P. elongatus Lubbock, 1980	Previously recorded.	
P. fuscus (Müller and Troschel, 1849)	12-15, 18a & b, 20, 21, 27, 33-35, 38, 40, 42, 43, 50, 52, 53, 55, 56	Occasional, around small coral and rock outcrops.
P. marshallensis (Schultz, 1953)	Previously recorded.	
P. perspicillatus Günther, 1862	12, 22, 27, 29, 30, 34, 36, 40, 43, 54	Occasional around rock outcrops in sand-rubble areas.
P. porphyreus Lubbock & Goldmann, 1974	7-11, 15-18a, 20-26, 28-32, 34, 35, 39, 44, 49, 51, 52, 54, 56-58	Common at base of slopes.
P. sp.	8-12, 22-24, 34, 35, 49	Moderately common on rubble slopes. An undescribed species known only from RA.
P. splendens (Fowler, 1931)	7, 8, 15, 16, 20, 22, 25-32, 43	Moderately common around coral formations.

SPECIES	SITE RECORDS	ABUNDANCE
P. tapienosoma Bleeker, 1853	Previously recorded.	
Pseudoplesiops annae (Weber, 1913)	Previously recorded.	
P. knighti Allen, 1987	48	Collected with rotenone. New record for RA.
P. typus Bleeker, 1858	Previously recorded.	
PLESIOPIDAE		
Calloplesiops altivelis (Steindachner, 1903)	10, 34	Rare, only two seen. New record for RA.
Plesiops coeruleolineatus Rüppell, 1835	Previously recorded.	
Plesiops corallicola Bleeker, 1853	Previously recorded.	
ACANTHOCLINIDAE		
Belonepterygium fasciolatum (Ogilby, 1889)	Previously recorded.	
CIRRHITIDAE		
Cirrhitichthys aprinus (Cuvier, 1829)	16, 22, 23, 26, 27, 29-31, 35, 36, 39-41, 51	Moderately common, usually on sponges.
C. falco Randall, 1963	49	Rare.
C. oxycephalus (Bleeker, 1855)	8, 16, 22, 26, 27, 31, 41, 45, 46, 49, 51, 54	Moderately common.
Cirrhitus pinnulatus (Schneider, 1801)	Previously recorded.	
Cyprinocirrhites polyactis (Bleeker, 1875)	25, 35	Rare, only two seen.
Oxycirrhitus typus Bleeker, 1857	Previously recorded.	
Paracirrhites arcatus (Cuvier, 1829)	37, 45, 47, 51, 58	Occasional.
P. forsteri (Schneider, 1801)	16, 17, 20-, 21, 25, 26, 28, 31, 32, 35, 37, 39-41, 43-46, 49, 51, 54, 56-58	Moderately common, the most abundant hawkfish, but always seen in low numbers.
OPISTOGNATHIDAE		
Opistognathus sp. 1 (“variabilis”)	29	Rare, one collected.
O. sp. 2 (“randalli”)	34	Two specimens collected with rotenone.
O. sp. 3	Previously recorded.	
O. sp. 4	Previously recorded.	
TERAPONTIDAE		
Terapon jarbua (Forsskål, 1775)	Previously recorded.	
Terapon theraps Cuvier, 1829	Previously recorded.	
PRIACANTHIDAE		
Priacanthus hamrur (Forsskål, 1775)	26, 37, 44, 58	Rare, less than 10 seen.
APOGONIDAE		
Apogon angustatus (Smith and Radcliffe, 1911)	41, 51	Rare.
A. aureus (Lacepède, 1802)	10, 15, 16, 22, 27, 29-31, 44	Moderately common.
A. bandanensis Bleeker, 1854	15, 53, 55, 56	Only a few seen, but nocturnal.
A. cavitiensis (Jordan & Seale, 1907)	14, 24	Rare, two seen in silty conditions.
A. ceramensis Bleeker, 1852	12, 50	Only two schools seen, but shelters among mangrove roots.
A. chrysopomus Bleeker, 1854	24	Rare.
A. chrysotaenia Bleeker, 1851	17, 22, 27, 40, 43, 44, 49	Occasional.
A. cladophilus Allen & Randall, 2002	10	Rare, one aggregation of six seen. New record for RA.
A. compressus (Smith and Radcliffe, 1911)	7-9, 12, 21, 35, 36, 42, 52, 53, 56	Moderately common.
A. crassiceps Garman, 1903	34, 58	Collected with rotenone.
A. cyanosoma Bleeker, 1853	8, 9, 16, 18b, 23, 25-31, 35, 36, 43, 44, 54, 58	Moderately common.
A. dispar Fraser and Randall, 1976	16, 46, 53	Three aggregations seen in 20-40 m.
A. doryssa Jordan & Seale, 1906	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
A. evermanni Jordan & Snyder, 1904:	46	Several seen in large cave. New record for RA.
A. exostigma Jordan and Starks, 1906	16, 28, 41	Rare, only three seen.
A. fleurieu (Lacepède, 1802)	16	Rare, only one aggregations seen.
A. fraenatus Valenciennes, 1832	7, 9, 15-17, 23, 26, 29-32, 44, 49, 51, 54, 55	Moderately common under ledges and in coral crevices.
A. fragilis Smith, 1961	23, 24, 52, 53	Rarely seen, but locally abundant. .
A. fuscus Quoy and Gaimard, 1824	Previously recorded.	
A. gilberti (Jordan & Seale, 1905):	24	Rare, only one aggregtion seen. New record for RA.
A. hartzfeldi Bleeker, 1852	55	Rare, only a few seen.
A. holotaenia (Regan, 1905):	25	Rare only three seen. New record for RA (collected).
A. hoeveni Bleeker, 1854	13	Rare.
A. kallopterus Bleeker, 1856	18b, 23, 30, 31, 35, 41, 44, 51, 56	Occasional, but nocturnal.
A. leptacanthus Bleeker, 1856	52	Rarely encountered, but locally common among branching corals at one site.
A. melanoproctus Fraser and Randall, 1976	Previously recorded.	
A. sp. (*"monospilus"*)	22, 23, 27, 29, 33, 36, 40, 44	Occasional.
A. multilineatus Bleeker, 1865	31, 34, 35	Rare, but nocturnal habits.
A. nanus Allen, Kuiter, and Randall, 1994	9, 10, 23	Rarely encountered, but three aggregations seen.
A. neotes Allen, Kuiter, and Randall, 1994	7-12, 17, 53	Occasional aggregations.
A. nigrofasciatus Schultz, 1953	8, 16, 20, 22, 23, 27, 28, 30, 31, 35, 37, 48, 49, 56-58	Moderately common, one of most abundant cardinalfishes, but always in small numbers under ledges and among crevices.
A. notatus (Houttuyn, 1782)	27, 29, 30	Generally rare, but locally common.
A. novemfasciatus Cuvier, 1828		
A. ocellicaudus Allen, Kuiter, and Randall, 1994	10, 15-17, 22, 23, 31, 49, 54	Occasional, but locally common.
A. parvulus (Smith & Radcliffe, 1912)	7, 11, 12, 17, 18a, 20-24, 28, 29, 31-34, 36, 42, 50, 52, 53	Common.
A. perlitus Fraser & Lachner, 1985	Previously recorded.	
A. quadrifasciatus Cuvier, 1828	24, 52, 55	Several seen on open sand bottoms. New record for RA.
A. rhodopterus Bleeker, 1852	Previously recorded.	
A. sealei Fowler, 1918	12, 30, 36, 38, 42, 48	Occasional.
A. selas Randall and Hayashi, 1990	Previously recorded.	
A. leptofasciatus Allen, 2001	Previously recorded.	
A. taeniophorus Regan, 1908	Previously recorded.	
A. talboti Smith, 1961	48	One collected with rotenone.
A. thermalis Cuvier, 1829	13, 14	Rare.
A. timorensis Bleeker, 1854	Previously recorded.	
A. trimaculatus Cuvier, 1828	9, 15, 50, 53, 55	Rare, but difficult to survey due to nocturnal habits.
A. wassinki Bleeker, 1860	22, 33, 42	Few sightings, but locally common on silty reefs.
Apogonichthys ocellatus (Weber, 1913)	Previously recorded.	
Archamia biguttata Lachner, 1951	Previously recorded.	
A. fucata (Cantor, 1850)	7, 10, 15-18a, 22, 23, 27, 30-32, 34, 36, 49, 51, 53, 55, 56	Moderately common.
A. macropterus (Cuvier,1828)	23, 24, 48	Rarely seen, but locally common.
A. zosterophora (Bleeker, 1858)	18a, 24, 48, 52	Rarely seen, but locally common.
Cercamia eremia (Allen, 1987)	Previously recorded.	
Cheilodipterus alleni Gon, 1993	8, 15, 36, 56	Rare.

SPECIES	SITE RECORDS	ABUNDANCE
C. artus Smith, 1961	7, 9, 15, 17, 22, 24, 30, 33, 35, 36, 38, 42, 43, 52, 53, 55, 56, 58	Moderately common, often among branching corals.
C. intermedius Gon, 1993	51	Rare, a group of six seen.. New record for Indonesia.
C. macrodon Lacepède, 1801	8-11, 15-17, 20, 28, 30, 45, 48	Moderately common, but always in low numbers (except juveniles).
C. nigrotaeniatus Smith & Radcliffe, 1912	18a, 24, 42, 50, 52, 53, 56	Occasional on sheltered inshore reefs.
C. quinquelineatus Cuvier, 1828	10-12, 15, 18a, 21, 23, 24, 30, 33, 35, 36, 38, 42, 43, 48, 50, 52-56, 58	Common, most abundant member of genus.
C. singapurensis Bleeker, 1859	Previously recorded.	
Fowleria aurita (Valenciennes, 1831)	18b	Collected with rotenone.
F. punctulata (Rüppell, 1832)	Previously recorded.	
F. vaiulae (Jordan & Seale, 1906)	18b, 33, 58	Rare. Photographed by expedition member. New record for RA.
Gymnapogon sp.	Previously recorded.	
G. urospilotus Lachner, 1953	Previously recorded.	
Pseudamia gelatinosa Smith, 1955	Previously recorded.	
P. hayashi Randall, Lachner and Fraser, 1985	34	Four collected with rotenone.
Pseudamia zonata Randall, Lachner and Fraser, 1985	46	About 15 seen at end of 100 m long cave in 18 m depth. New record for RA.
Rhabdamia cypselurus Weber, 1909	16, 17, 22, 23, 25, 30, 51	Occasionally observed, but sometimes in large numbers swarming around coral bommies.
Siphamia versicolor Smith & Radcliffe, 1911	34	Rare. Photographed by P. Achtel.
R. gracilis (Bleeker, 1856)	7, 16, 17, 22, 23, 25, 27, 29-33, 44, 51, 53, 58	Moderately common, forming large aggregations around coral heads. Photographed.
Sphaeramia nematoptera (Bleeker, 1856)	12, 14, 15, 24, 33, 50, 53	Occasional, but locally common among sheltered corals.
S. orbicularis (Cuvier, 1828)	12-14	Common along sheltered shores of rocky islets and in mangroves.
SILLAGINIDAE		
Sillago sihama (Forsskål, 1775)	Previously recorded.	
MALACANTHIDAE		
Hoplolatilus cuniculus Randall & Dooley, 1974	20	Rare, several seen below 40 m. New record for RA.
H. fronticinctus (Günther, 1887)	31	Rare, several adults with large rubble mounds seen below 40 m. New record for RA.
H. purpureus Burgess, 1978	31, 32, 43	Rare, several pairs seen below 30 m.
H. starcki Randall and Dooley, 1974	20, 31	Rare on steep outer slopes.
Malacanthus brevirostris Guichenot, 1848	22, 29-31, 39, 40, 51, 54, 58	Occasional.
M. latovittatus (Lacepède, 1798)	16, 22, 27, 31, 39, 45, 54	Occasional.
ECHENEIDAE		
Echeneis naucrates Linnaeus, 1758	22, 23, 30, 34, 53, 55	Occasional.
CARANGIDAE		
Alectis ciliaris (Bloch, 1788)	31	Rare, only one seen. New record for RA.
Atule mate (Cuvier, 1833)	23, 24, 33	Rare, but three schools seen. New record for RA.
Carangoides bajad (Forsskål, 1775)	8, 10, 15-18a, 20-23, 25, 29, 32, 34, 36, 39, 41, 43, 44, 48, 51-58	Moderately common, but usually in low numbers.
C. ferdau (Forsskål, 1775)	29, 30, 36, 44	Rare, less than 10seen.
C. fulvoguttatus (Forsskål, 1775)	Previously recorded.	
C. plagiotaenia Bleeker, 1857	8, 9, 16-18a, 20, 22	Occasional.

SPECIES	SITE RECORDS	ABUNDANCE
Caranx ignobilis (Forsskål, 1775)	31, 41, 54, 57	Rare, four large adults seen.
C. melampygus Cuvier, 1833	16, 25, 26, 28, 31, 37, 39-41, 44-46, 52-58	Moderately common, usually seen solitary or in small schools. Waigeo is type locality.
C. papuensis Alleyne & Macleay, 1877	50	Rare.
C. sexfasciatus Quoy and Gaimard, 1825	7, 27, 41, 52	Rare. Waigeo is type locality.
Elegatis bipinnulatus (Quoy and Gaimard, 1825)	15, 20, 29, 41	Rare, but forms local aggregations.
Gnathanodon speciosus (Forsskål, 1775)	23, 30, 50, 54	Rare, mainly juveniles seen.
Scomberoides lysan (Forsskål, 1775)	8, 28, 39, 53	Rare, but may form local aggregations.
Selar boops (Cuvier, 1833)		
S. crumenophthalmus (Bloch, 1793)	Previously recorded.	
Selaroides leptolepis (Kuhl and van Hasselt, 1833)	15	One school seen.
Trachinotus baillonii Lacepède, 1801)	28, 44	Rare, but may form local aggregations. New record for RA.
T. blochii (Lacepède, 1801)	Previously recorded.	
LUTJANIDAE		
Aphareus furca (Lacepède, 1802):	37, 39, 56, 57	Rare, only four seen. New record for RA.
Aprion virescens Valenciennes, 1830	16, 26, 28-31, 40, 44	Occasional.
Lutjanus argentimaculatus (Forsskål, 1775)	13, 27, 28,50, 56	Occasional, but common at sites 27 and 28.
L. bengalensis (Bloch, 1790)	22	Rare, only a few seen. New record for RA.
L. biguttatus (Valenciennes, 1830)	7-9, 15, 18a, 21, 24, 29, 32, 34, 36, 42, 50, 53, 55-58	Moderately common, mainly on sheltered reefs with rich corals. Especially abundant at site 43.
L.bohar (Forsskål, 1775)	7-10, 15-18a, 20-23, 25-35, 37, 39-46, 48-58	Common.
L. boutton (Lacepède, 1802)	54-56	Generally rare, but locally common on some reefs.
L. carponotatus (Richardson, 1842)	7-18a, 21-24, 34-36, 52, 53, 55	Moderately common, usually on sheltered coastal reefs.
L. decussatus (Cuvier, 1828)	7-12, 15-18a, 20-22, 24-33, 35, 36, 44, 49-52, 54-58	Common, but usually seen in small numbers.
L. ehrenburgi (Peters, 1869)	12-14, 16, 25, 27, 29, 49, 54, 56	Occasional, but locally common at a few sites.
L. fulviflamma (Forsskål, 1775)	7, 9-12, 21, 34, 35, 54, 57	Occasional, but locally common at a few sites.
L. fulvus (Schneider, 1801)	7, 8, 10, 12, 20, 21, 27, 29-32, 37, 38, 48, 49, 54-58	Moderately commom, but usually in small numbers.
L. gibbus (Forsskål, 1775)	7, 8, 12, 16-18a, 20-32, 37-41, 43, 44, 46, 48, 49, 51-58	Moderately common.
L. johnii (Bloch, 1792)	Previously recorded.	
L. kasmira (Forsskål, 1775)	16, 22, 25, 26, 30, 37, 54, 57, 58	Occasional, ususally in low numbers.
L. lemniscatus (Valenciennes, 1828)	23	Rare, only one seen.
L. lutjanus Bloch, 1790	7	Rare, only one seen.
L. monostigma (Cuvier, 1828)	16, 20-32, 34, 35, 37, 39, 40, 45, 49-51, 53, 54, 56-58	Moderately common.
L. quinquelineatus (Bloch, 1790)	10, 16, 17, 22, 27, 29	Occasional.
L. rivulatus (Cuvier, 1828)	24, 27, 28, 35, 49, 50, 52, 53, 55	Occasional large adults seen.
L. rufolineatus (Valenciennes, 1828)	22	Rare, except one aggregation seen. New record for RA.
L. russelli (Bleeker, 1849)	16, 17, 23, 27, 34, 49, 55	Rare, a few solitary fish seen.
L. sebae (Cuvier, 1828)	10	Rare, only one seen.
L. semicinctus Quoy and Gaimard, 1824	7, 8, 11, 15, 18a, 20-22, 24, 26-28, 31-33, 35, 37-39, 4245, 48-51, 53-58	Common. Waigeo is type locality.
L. vitta (Quoy and Gaimard, 1824)	22, 23, 36, 55, 56	Rare, only five seen.
Macolor macularis Fowler, 1931	8, 15, 16, 20, 21, 23, 25-29, 31, 32, 35, 37, 39-41, 43-45, 49, 51, 52, 54-58	Common.
M. niger (Forsskål, 1775)	16, 25, 27, 37, 39, 42, 43, 45, 49, 54	Occasional, but locally common.

SPECIES	SITE RECORDS	ABUNDANCE
Paracaesio sordidus Abe & Shinohara, 1962	28, 57	Two aggregations seen below 40 m on steep drop-offs.
P. xanthurus (Bleeker, 1854):	35	Rare, about six seen in 40 m. New record for RA.
Pinjalo lewisi Randall, Allen, & Anderson, 1987	Previously recorded.	
Symphorichthys spilurus (Günther, 1874)	12, 50	Rare, only two seen.
Symphorus nematophorus (Bleeker, 1860)	11, 17, 22, 23, 30, 40, 44, 49	Occasional in sandy areas.
CAESIONIDAE		
Caesio caerulaurea Lacepède, 1802	8-10, 17, 18a, 23, 29, 31, 34, 36, 41-45, 48-50, 56	Abundant in variety of habitats.
C. cuning (Bloch, 1791)	7-18a, 20, 21, 23-37, 39, 41-45, 48-58	Abundant in variety of habitats, particularly coastal reefs.
C. lunaris Cuvier, 1830	8, 9, 17, 18a, 21, 23, 25-27, 29, 37, 39, 41, 43, 44-45, 48, 49, 56-58	Common.
C. teres Seale, 1906	8, 9, 16, 20, 22, 23, 26, 28, 29, 31, 34, 39, 40, 43-45, 51	Common.
Dipterygonatus balteatus (Valenciennes, 1830)	32	One aggregation seen.
Gymnocaesio gymnoptera (Bleeker, 1856)	29, 31, 32, 43	Occasionally seen with mixed school of fusiliers, mainly *Pterocaesio pisang*.
Pterocaesio digramma (Bleeker, 1865)	15, 21, 43, 49, 50	Occasional.
P. marri Schultz, 1953	8, 9, 12, 17, 27-29, 31, 32, 34, 35, 43-45, 51, 54, 57	Common.
P. pisang (Bleeker, 1853)	7-9, 15-17, 20-36, 42-44, 48-50, 56-58	Common in variety of habitats.
P. randalli Carpenter, 1987	57	Rare, one aggregation seen below 40 m. New record for RA.
P. tessellata Carpenter, 1987	34, 36, 43, 45, 48, 50, 54, 58	Occasional, but locally abundant.
P. tile (Cuvier, 1830)	27, 29, 34-37, 39-41, 44-46, 51, 54, 56-58	Common.
GERREIDAE		
Gerres argyreus (Forster, 1801)	30	Rare, but mainly found on sand. New record for RA.
G. filamentosus Cuvier, 1829	Previously recorded.	
G. oyena (Forsskål, 1775)	34	Rare, but mainly found on sand.
HAEMULIDAE		
Diagramma pictum (Thünberg, 1792)	7, 9, 10, 22, 23, 27, 29, 30, 33, 34, 39	Moderately common, in silty areas.
Plectorhinchus chaetodontoides (Lacepède, 1800)	7-9, 15-17, 26, 28, 30, 31, 35, 39, 40, 48, 50, 52, 53	Moderately common.
P. chrysotaenia (Bleeker, 1855)	7-11, 15, 18a, 22, 23, 29-31, 57	Occasional.
P. gibbosus (Lacepède, 1802)	8	Rare, only one seen.
P. lessoni (Cuvier, 1830)	8-10, 16-18a, 26, 37, 30, 40, 45, 49, 51-53	Occasional. Waigeo is type locality.
P. lineatus (Linnaeus, 1758)	18a, 20, 22, 23, 27, 28, 35, 39-41, 43, 45, 46, 50, 51, 55-58	Moderately common.
P. obscurus (Günther, 1871)	17, 22, 24, 26-28, 30, 31	Occasional.
P. picus (Cuvier, 1830)	28, 37	Rare, two seen. New record for RA.
P. polytaenia (Bleeker, 1852)	8, 10, 16, 26, 27, 29-31, 34, 36, 37, 39, 41-45, 58	Moderately common.
P. unicolor (Macleay, 1883)	Previously recorded.	
P. vittatus (Linnaeus, 1758)	16, 37, 39, 41, 43-45, 58	Occasional.
LETHRINIDAE		
Gnathodentex aurolineatus Lacepède, 1802	23, 26, 27, 39, 43, 44	Occasional.
Gymnocranius grandoculus (Valenciennes, 1830)	27, 30, 54, 56, 58	Rare, less than 10 seen on open sand bottoms.
G. sp.	33, 37, 39, 43	Rare, on open sand.
Lethrinus atkinsoni Seale, 1909	37, 43, 44, 54	Rare, about six seen.
L. erythracanthus Valenciennes, 1830	15, 16, 20, 30, 31, 39, 49, 52, 54-56	Occasional.
L. erythropterus Valenciennes, 1830	8, 9, 15, 18a, 21, 24-26, 28-31, 33-35, 48, 50, 52, 53, 55-57	Moderately common.
L. harak (Forsskål, 1775)	12, 15, 26, 27, 29, 33-35, 38, 44	Moderately common on sheltered reefs near shore.

SPECIES	SITE RECORDS	ABUNDANCE
L. laticaudis Alleyne & Macleay, 1777	Previously recorded.	
L. lentjan (Lacepède, 1802)	58	Rare, one aggregation seen.
L. nebulosus (Forsskål, 1775)	22	Rare, a few seen on open sand bottom. New record for RA.
L. obsoletus (Forsskål, 1775)	15, 16, 22, 23, 25-31, 33, 37-39, 44, 51, 56, 58	Occasional, and always in low numbers.
L. olivaceous Valenciennes, 1830	16, 23, 26, 28, 29, 40, 41, 45	Occasional.
L. ornatus Valenciennes, 1830	24	Rare, only one seen.
L. semicinctus Valenciennes, 1830	Previously recorded.	
L. variegatus Valenciennes, 1830	Previously recorded.	
L. sp. 2 (Carpenter & Allen, 1989)	Previously recorded.	
L. xanthocheilus Klunzinger, 1870	20, 22, 28, 44, 57	Rare, less than 10 fish seen.
Monotaxis grandoculis (Forsskål, 1775)	7-9, 12, 15-18a, 20-29, 31-37, 39-45, 48-52, 54-58	Common. The most abundant lethrinid at the Raja Ampats.
NEMIPTERIDAE		
Pentapodus emeryii (Richardson, 1843)	7, 8, 17, 22, 27, 28, 30, 33, 35, 40, 43, 44, 48, 49, 56	Occasional.
P. sp. (Russell, 1990)	8, 11, 16, 20, 23, 25, 26, 30, 36, 42-45, 49, 51, 54, 56	Moderately common at base of slopes over sand-rubble bottoms.
P. trivittatus (Bloch, 1791)	7, 9-15, 17, 23, 24, 27, 30, 31, 33-36, 42, 48, 50, 52, 53, 55, 56	Moderately common, usually on sheltered coastal reefs.
Scolopsis affinis Peters, 1876	16, 22, 23, 25-27, 29-34, 36, 40, 52, 56	Occasional, but locally common in sandy areas.
S. bilineatus (Bloch, 1793)	8-11, 16, 17, 20-23, 25-40, 42-45, 48-54, 56-58	Common.
S. ciliatus (Lacepède, 1802)	7, 11, 13, 14, 22, 23, 36, 42, 48, 52-54, 56, 58	Moderately common at sites subjected to silting.
S. lineatus Quoy and Gaimard, 1824	9, 20, 25, 29, 30, 34, 35, 38, 44, 48, 56	Moderately common on shallow reefs.
S. margaritifer (Cuvier, 1830)	7-16- 18a, 20-26, 28-31, 33-36, 39, 42-44, 48, 50, 52, 53, 55, 56, 58	Common, especially on sheltered coastal reefs
S. monogramma (Kuhl and Van Hasselt, 1830)	Previously recorded.	
S. temporalis (Cuvier, 1830)	10, 13, 14, 18a, 23, 24, 30, 34, 54, 55, 58	Occasional, over sand bottoms. Waigeo is type locality.
S. trilineatus Kner, 1868	38, 48	Rare.
S. vosmeri (Bloch, 1792)	Previously recorded.	
S. xenochrous (Günther, 1872)	25-27, 37, 39, 43, 44, 54	Occasional, usually below 20 m.
MULLIDAE		
Mulloidichthys flavolineatus (Lacepède, 1802)	7, 9, 12, 15, 18a, 20, 23, 27, 28, 31, 33, 34, 36, 38, 39, 42, 44, 48, 50	Occasional, usually seen in small groups.
M. vanicolensis (Valenciennes, 1831)	31, 37, 39	Rare, only a few seen. New record for RA.
Parupeneus barberinoides (Lacepède, 1801)	Previously recorded.	
P. barberinus (Lacepède, 1801)	7, 8, 10-18a, 20-40, 42-45, 49, 51-58	Common.
P. bifasciatus (Lacepède, 1801)	7-11, 15-18a, 20-23, 25-46, 49, 50, 52, 54, 56-58	Common.
P. cyclostomus (Lacepède, 1802)	8, 16-18a, 20-28, 30-32, 34, 35, 37-45, 48, 49, 54, 55, 58	Moderately common, but in lower numbers than previous two species.
P. heptacanthus (Lacepède, 1801)	23, 30, 33, 34, 48	Rare, less than 10 seen.
P. indicus (Shaw, 1903)	23, 33	Rare, only two seen in silty areas.
P. multifasciatus Bleeker, 1873	7-12, 15-17, 20, 22, 23, 26-37, 39-46, 48-58	Common.
P. pleurostigma (Bennett, 1830)	27, 39, 40, 44	Rare, only four seen.
Upeneus sundaicus (Bleeker, 1855)	40	Rare, several seen at one site. Collected. New record for RA.
U. tragula Richardson, 1846	9, 11-14, 23, 24, 48, 50, 52, 58	Occasional, but mainly found on sand bottoms away from reefs.
PEMPHERIDAE		
Parapriacanthus ransonneti Steindachner, 1870	16, 27, 32, 43, 44, 51	Moderately common, forming large aggreations in caves and crevices.

SPECIES	SITE RECORDS	ABUNDANCE
Pempheris mangula Cuvier, 1829	17, 18a, 37, 46	Occasional, but forming large aggreations in caves and crevices.
P. vanicolensis Cuvier, 1831	7-10, 21, 27-29, 34, 35, 45, 53, 54, 56, 57	Moderately common, forming large aggreations in caves and crevices.
TOXOTIDAE		
Toxotes jaculatrix (Pallas, 1767)	12, 27, 50, 56	Occasional where reef and mangroves in close proximity.
KYPHOSIDAE		
Kyphosus bigibbus Lacepède, 1801		
K. cinerascens (Forsskål, 1775)	16, 17, 28, 32, 39, 43-45, 48, 49, 51-54, 56, 58	Moderately common.
K. vaigiensis (Quoy and Gaimard, 1825)	9, 16-18a, 22, 27, 37, 53	Moderately common.
MONODACTYLIDAE		
Monodactylus argenteus (Linnaeus, 1758)	50	Rare, one aggregation seen.
CHAETODONTIDAE		
Chaetodon adiergastos Seale, 1910	7-11, 13-18a, 20-23, 35-33, 35, 36, 56, 58	Moderately common.
C. auriga Forsskål, 1775	8, 15, 16, 18a, 20-22, 26, 28, 30, 31, 33, 37, 38, 41, 43-46, 49, 54, 58	Moderately common.
C. baronessa Cuvier, 1831	7-11, 15-18a, 20, 21, 24-37, 39, 40, 42-44, 48, 52-58	Common, seen on most dives.
C. bennetti Cuvier, 1831	8-10, 20-22, 31, 32, 56-58	Occasional.
C. burgessi Allen & Starck, 1973	57	Rare, about four seen on steep drop-off in 40-52 m. New record for RA.
C. citrinellus Cuvier, 1831	20, 29, 38, 39, 41, 44-46, 51, 54	Occasional on shallow reefs affected by surge.
C. ephippium Cuvier, 1831	12, 20-22, 25-32, 37-39, 4245, 51, 54-58	Moderately common, but never more than 2-3 pairs seen at a single site.
C. kleinii Bloch, 1790	8-11, 16-18a, 20-23, 25-46, 48-58	Commonly seen at most sites.
C. lineolatus Cuvier, 1831	7-9, 27, 35, 37	Occasional, less common than the very similar *C. oxycephalus*.
C. lunula Lacepède, 1803	7, 17, 18a, 20, 21, 24-26, 30, 31, 48, 55, 56	Moderately common, but always in low numbers at each site.
C. lunulatus Quoy and Gaimard, 1824	7-12, 15-18a, 20-40, 42-45, 48-58	Common, one of the most abundant butterflyfishes at the Raja Ampats.
C. melannotus Schneider, 1801	9-11, 20, 22, 25, 26, 29, 31, 32, 36, 37, 39, 42-45, 49, 57, 58	Moderately common.
C. meyeri Schneider, 1801	16, 20, 21, 26-28, 31, 37, 44, 48, 49, 54	Occasional.
C. ocellicaudus Cuvier, 1831	7-10, 12, 15-18a, 21, 23, 24, 26, 28, 29, 31-33, 35, 36, 38, 42-44, 48, 50-52, 55-58	Moderately common.
C. octofasciatus Bloch, 1787	7, 8, 11, 12, 14, 15, 18a, 21, 24, 30, 36, 42, 48, 50, 52, 53, 55	Moderately common at sheltered sites where reef influenced by silt.
C. ornatissimus Cuvier, 1831	16, 20-23, 25-28, 30-32, 37, 39, 45, 48, 49, 51, 52, 54, 57, 58	Moderaely common in rich coral areas.
C. oxycephalus Bleeker, 1853	18a, 21, 23, 35, 36, 50, 52, 54-57	Moderately common, but always in low numbers.
C. punctatofasciatus Cuvier, 1831	20, 21, 28, 30-32, 57, 58	Occasional, usually in pairs.
C. rafflesi Bennett, 1830	7-11, 16, 189a, 20-22, 25-39, 42-45, 52-54, 56-58	Common, one of the most abundant butterflyfishes at the Raja Ampats.
C. selene Bleeker, 1853	8-10, 17, 26, 27, 29, 34, 35	Occasional, usually below 20 m.
C. semeion Bleeker, 1855	18a, 20, 21, 28, 31, 37, 39, 45, 49-51, 54, 56-58	Occasional.
C. speculum Cuvier, 1831	7, 8, 10, 12, 18a, 20-23, 26-32, 35, 37, 43, 45, 57	Moderately common.
C. trifascialis Quoy and Gaimard, 1824	7-10, 12, 1518a, 20, 21, 25, 26, 29, 30, 32, 34-40, 42-45, 48, 54	Moderately common in areas of tabular *Acropora*.
C. ulietensis Cuvier, 1831	12, 15, 16, 20, 27-31, 35, 37, 39, 43, 50, 52, 54-58	Moderately common.
C. unimaculatus Bloch, 1787	21, 26, 26, 28, 29, 31, 43-45, 52, 54, 55, 57, 58	Occasional.

SPECIES	SITE RECORDS	ABUNDANCE
C. vagabundus Linnaeus, 1758	7-11, 15-18a, 20-22, 24-45, 48-58	Common, one of most abundant butterflyfishes at the Raja Ampats.
C. xanthurus Bleeker, 1857	34	Rare, only one seen in 25 m.
Chelmon rostratus (Linnaeus, 1758)	7, 9-15, 17, 18a, 20	Occasional.
Coradion altivelis McCulloch, 1916	9, 10, 45	
C. chrysozonus Cuvier, 1831	8-12, 15-18a, 23, 27-30, 34-36, 41, 42, 44, 45, 49, 51	Moderately common on sheltered reefs.
Forcipiger flavissimus Jordan and McGregor, 1898	20, 21, 31, 35, 37, 39, 43-45, 48, 49, 52-54, 56-58	Moderately common.
F. longirostris (Broussonet, 1782)	28, 31, 42, 48, 51, 56	Occasional.
Hemitaurichthys polylepis (Bleeker, 1857)	20, 28, 32, 39, 44, 45, 57	Occasional aggregations on outer slopes.
Heniochus acuminatus (Linnaeus, 1758)	8, 9, 13, 14, 16, 28, 30, 39, 45, 46, 48, 53, 55	Occasional.
H. chrysostomus Cuvier, 1831	15, 18a, 20, 21, 26-29, 31-33, 35, 37, 39, 41-43, 45, 48-58	Moderately common.
H. diphreutes Jordan, 1903	25, 29, 32, 41, 44	Occasional, usually in aggregatons.
H. monoceros Cuvier, 1831	Previously recorded.	
H. singularius Smith and Radcliffe, 1911	7-9, 15, 17, 20, 31, 32, 45, 51, 57	Occasional.
H. varius (Cuvier, 1829)	7-10, 15-18a, 20-22, 25-37, 39, 40, 42-45, 48-58	Common.
Parachaetodon ocellatus (Cuvier, 1831)	9, 10, 23, 29	Rare, only four seen.
POMACANTHIDAE		
Apolemichthys trimaculatus (Lacepède, 1831)	16, 20, 22, 25-28, 31, 37, 39, 41, 44-46, 49, 51, 57	Moderately common.
Centropyge bicolor (Bloch, 1798)	9, 10, 16, 17, 20, 22, 23, 25-29, 31-35, 37, 39, 40, 42-46, 49, 51, 54, 55, 57, 58	Common.
C. bispinosus (Günther, 1860)	16, 20, 25, 31, 35, 37, 43, 51, 56, 58	Moderately common.
C. flavicauda Fraser-Brunner, 1933	20, 25, 27, 37, 43, 44, 49	Moderately common on rubble bottoms.
C. nox (Bleeker, 1853)	7, 8, 15-18a, 20, 21, 26, 28, 31, 32, 42, 43, 52, 53, 55-57	Moderately common.
C. tibicen (Cuvier, 1831)	8-10, 16-18a, 20-23, 25-28, 30-37, 39, 42-45, 49, 51, 58	Moderately common.
C. vroliki (Bleeker, 1853)	8-10, 16-18a, 20-35, 37-46, 48, 49, 51, 52, 54-58	Common.
Chaetodontoplus dimidatus (Bleeker, 1860)	28, 34, 35, 37, 39	Occasional, usually below 25 m, but relatively common at site 35.
C. mesoleucus (Bloch, 1787)	7-15, 17, 18a, 21, 23, 24, 27-36, 42, 43, 56	Moderately common.
C. sp. (possibly just white-tailed variey of *C. mesoleucus*)	24, 30, 36, 42, 48, 50, 53, 55	Occasional, usually on very sheltered bays with relatively heavy siltation.
Genicanthus lamarck Lacepède, 1798	8, 16, 17, 20, 25-28, 30-32, 35, 43, 44, 49	Moderately common on outer slopes.
G. melanospilos (Bleeker, 1857)	57	Rare, about 10 seen at one site.
Paracentropyge multifasciatus (Smith and Radcliffe, 1911)	16, 20, 32, 43, 49, 55, 57	Occasional, but seldom noticed due to cave-dwelling habits.
Pomacanthus annularis (Bloch, 1787)	Previously recorded.	
Pomacanthus imperator (Bloch, 1787)	9, 16-18a, 20-23, 25-33, 36, 39, 41-45, 48, 49, 51, 54, 56, 58	Moderately common, but always in low numbers.
P. navarchus Cuvier, 1831	8, 9, 15-18a, 20, 21, 23-33, 35, 36, 39, 42-44, 48, 54, 56, 57	Moderately common.
P. semicirculatus Cuvier, 1831	31, 35, 36, 45, 51	Rare, only about eight seen. Waigeo is type locality.
P. sexstriatus Cuvier, 1831	7-9, 11, 12, 16, 18a, 20-23, 28-36, 39, 41-43, 45, 48, 50, 51, 53, 55, 56	Moderately common.
P. xanthometopon (Bleeker, 1853)	8, 9, 18a, 20, 21, 27, 30, 39, 45, 57, 58	Occasional.
Pygoplites diacanthus (Boddaert, 1772)	7-10, 15-18a, 20, 21, 23-32, 36, 39, 40, 42-45, 48-50, 52-58	Common, one of the most abundant angelfishes in the Raja Ampats.
MUGILIDAE		

SPECIES	SITE RECORDS	ABUNDANCE
Crenimugil crenilabis (Forsskål, 1775)	Previously recorded.	
Liza vaigiensis (Quoy and Gaimard, 1825)	15	One school of about 20 fish seen. Waigeo is type locality.
Valamugil seheli (Forsskål, 1775)	22, 25, 34	Three schools seen with about 20-40 fish in each.
POMACENTRIDAE		
Abudefduf bengalensis (Bloch, 1787)	9-12, 17, 22-24, 56	Occasional.
A. lorenzi Hensley and Allen, 1977	9, 10, 34, 35, 56	Occasional, but locally common in shallow water next to shore.
A. notatus (Day, 1869)	9, 10, 37, 49	Occasional aggregations in rocky surge zone.
A. septemfasciatus (Cuvier, 1830)	16, 34, 56	Rare, but surge zone environment not regularly surveyed.
A. sexfasciatus Lacepède, 1802	7, 9, 15, 18a, 20, 25, 26, 33-36, 48, 56, 57	Moderately common.
A. sordidus (Forsskäl, 1775)	16, 34	Rare, but surge zone environment not regularly surveyed.
A. vaigiensis (Quoy and Gaimard, 1825)	7-11, 16, 17, 21, 25, 27-37, 39, 41, 42, 44-46, 48, 49, 51, 54-58	Common. Waigeo is the type locality.
Acanthochromis polyacantha (Bleeker, 1855)	28-33, 36, 48, 50	Moderately common.
Amblyglyphidodon aureus (Cuvier, 1830)	7-11, 15-18a, 20, 21, 23, 25-32, 35, 39, 44, 48, 49, 51-54, 56-58	Common on steep slopes, but always in low numbers.
A. batunai Allen, 1995	11, 15, 29, 42	Rare.
A. curacao (Bloch, 1787)	7-9, 11, 12, 15, 18a, 20, 21, 24, 48-31, 33-36, 39, 42-44, 48, 50, 52, 53, 44-48	Common.
A. leucogaster (Bleeker, 1847)	7-12, 15, 16, 18a, 20, 21, 23, 24, 26-37, 39, 40, 42-45, 48-50, 52-54, 56-58	Common.
A. ternatensis (Bleeker, 1853)	12-14, 24, 42, 50	Moderately common on silty inshore reefs.
Amblypomacentrus breviceps (Schlegel and Müller, 1839-44)	13, 14, 22, 27, 29, 30, 33, 34, 36, 52, 55	Occasional, around debris and small coral outcrops situated on sloping silt bottoms.
A. clarus Allen & Adrim, 2000	32	Rare, about five seen. New record for RA (two collected).
Amphiprion chrysopterus Cuvier, 1830	37	Rare, only one pair seen.
A. clarkii (Bennett, 1830)	7-10, 15-18a, 20-22, 25-30, 32-35, 37, 39, 40, 42-44, 46, 49, 51, 56-58	One of the two most common anemonefishes at the Raja Ampats.
A. melanopus Bleeker, 1852	9, 10, 22, 37, 44, 48, 56, 57	Occasional.
A. ocellaris (Cuvier, 1830)	8-10, 15, 16, 18a, 20-23, 25-27, 29, 31, 33-36, 39, 41-44, 49, 51, 53, 55, 58	One of the two most common anemonefishes at the Raja Ampats.
A. perideraion Bleeker, 1855	15, 20, 28, 29, 32, 33, 37, 39, 41, 44, 51, 57	Occasional.
A. polymnus (Linnaeus, 1758)	22, 23, 33, 40	Rare, but restricted to featureless silt or sand bottoms away from reefs.
A. sandaracinos Allen, 1972	10, 11, 15, 27, 35, 42, 51	Occasional.
Cheiloprion labiatus (Day, 1877)	11, 15, 29, 38	Rare, about 10 seen.
Chromis alpha Randall, 1988	16, 20, 28, 31, 32, 44, 49, 54, 56, 57	Occasional on steep slopes. Photographed
C. amboinensis (Bleeker, 1873)	7, 8, 15-18a, 20, 21, 23-28, 30-33, 36, 42-44, 48-50, 52, 53, 55-58	Common.
C. analis (Cuvier, 1830)	9, 16, 20, 28, 31, 32, 35, 46, 49, 54, 57	Moderately common on steep slopes.
C. atripectoralis Welander and Schultz, 1951	7-11, 15, 29, 34, 39, 42-44, 58	Common. .
C. atripes Fowler and Bean, 1928	16, 20, 21, 25-28, 30-33, 37, 39-41, 43, 44, 49, 54, 57, 58	Moderately common on steep slopes.
C. caudalis Randall, 1988	15, 16, 20, 25-29, 31, 32, 37, 39, 41, 44, 54, 56-58	Moderately common on steep slopes.
C. cinerascens (Cuvier, 1830)	8, 9, 11, 17	Rare.
C. delta Randall, 1988	16, 20, 28-31, 37, 39, 41, 45, 54, 56, 57	Moderately common, especially on steep slopes below about 15 m depth.
C. elerae Fowler and Bean, 1928	7, 16, 17, 20, 23, 28, 29, 31, 32, 34, 35, 45, 56, 57	Moderately common, always in caves and crevices on steep slopes.

SPECIES	SITE RECORDS	ABUNDANCE
C. lepidolepis Bleeker, 1877	8, 9, 16, 17, 20-23, 25-27, 29-33, 37, 39, 40, 43-45, 48, 51, 56-58	Common.
C. lineata Fowler and Bean, 1928	39, 57	Rare, but easily overlooked.
C. margaritifer Fowler, 1946	9, 16, 20-23, 25-29, 32-35, 37-39, 43-46, 48, 49, 51, 54, 56-58	Common in clear water areas.
C. retrofasciata Weber, 1913	7-9, 1518a, 10-23, 25-37, 39, 42-44, 49,50, 52-56, 58	Common at most sites.
C. scotochiloptera Fowler, 1918	8-11, 16, 17, 22, 25-27, 29, 34, 35, 44	Moderately common.
C. ternatensis (Bleeker, 1856)	7-11, 15-18a, 20, 21, 23-37, 39, 40, 42-44, 48-50, 52-58	Abundant, often forming dense shoals on upper edge of steep slopes.
C. viridis (Cuvier, 1830)	7-12, 15, 18a, 20, 21, 23, 24, 28-31, 34, 35, 38, 39, 40, 42, 48, 53, 56	Abundant in sheltered areas of rich coral, generally in clear water.
C. weberi Fowler and Bean, 1928	8-12, 15-18a, 20, 22, 23, 25-35, 37, 39-46, 48, 49, 51, 52, 54, 56-58	Common.
C. xanthochira (Bleeker, 1851)	16, 20, 25, 26, 28, 32, 39, 44, 45, 49, 57, 58	Moderately common on outer slopes.
C. xanthura (Bleeker, 1854)	8-11, 16-18a, 20-23, 25-32, 35, 37, 39, 40, 43-45, 48, 49, 51, 54, 56-58	Common, especially on steep slopes.
Chrysiptera biocellata (Quoy and Gaimard, 1824)	38	Rare, except locally common at one site.
C. bleekeri (Fowler and Bean, 1928)	17, 20, 23, 25-27, 29, 30, 33-35, 44, 49, 51	Moderately common on rubble bottoms below 15 m.
C. brownriggii (Bennett, 1828)	9-11, 16, 20, 25, 26, 34, 35, 37, 39, 45	Moderately common, usually in shallow beach rock areas affected by surge.
C. caeruleolineata (Allen, 1973)	20	Rare, about 10 seen at one site. New record for RA.
C. cyanea (Quoy and Gaimard, 1824)	7, 9, 29, 31, 35, 38, 48, 56	Occasional, usually in shallow well-sheltered areas with clear water.
C. hemicyanea (Weber, 1913)	7, 11, 12, 14, 15, 18a, 21, 24, 29, 36, 42, 48, 50, 56	Moderately common in sheltered bays and lagoons. Photographed.
C. oxycephala (Bleeker, 1877)	12-14, 18a, 24, 42, 50, 52, 53, 55	Occasional in sheltered bays and lagoons.
C. parasema (Fowler, 1918)	52, 53, 55	Rare, except moderately common on north coast of Waigeo.
C. rex (Snyder, 1909)	16, 20, 21, 37, 49	Occasional, in surge areas off NW Waigeo.
C. rollandi (Whitley, 1961)	7-12, 15-18a, 20-37, 39, 42-45, 48, 50-58	Common, particularly on reef slopes affected by silt.
C. springeri Allen & Lubbock, 1976	7, 15, 18a, 21, 24, 29-31, 33, 36, 42, 50, 52, 56	Moderately common in sheltered bays and lagoons.
C. talboti (Allen, 1975)	7-10, 15-18a, 20-23, 25-35, 37, 39-45, 48, 49, 51, 52, 54, 56-58	Common, except in silty areas.
C. unimaculata (Cuvier, 1830)	11, 34, 35, 38, 39	Occasional, but locally common on shallow reef flats.
Dascyllus aruanus (Linnaeus, 1758)	9, 11, 12, 15, 18b, 23, 24, 27-31, 33-36, 38-40, 42, 43, 50, 53, 56	Common in sheltered waters, forming aggregations around small coral heads.
D. melanurus Bleeker, 1854	11, 12, 24, 29, 31, 33, 35, 36, 38, 42, 48, 50, 53, 56	Moderately common on sheltered reefs.
D. reticulatus (Richardson, 1846)	7-11, 15-18a, 20-23, 25-32, 34-37, 39, 40, 43-45, 48, 49, 51, 53, 54, 56-58	Common.
D. trimaculatus (Rüppell, 1928)	8-12, 15-18a, 20-23, 25-37, 39-46, 48-53, 56-58	Common.
Dischistodus chrysopoecilus (Schlegel and Müller, 1839)	33, 38, 48, 53, 56	Occasional in sand-rubble areas near shallow seagrass beds.
D. fasciatus (Cuvier, 1830)	12	Rare.
D. melanotus (Bleeker, 1858)	11, 15, 18a, 24, 31, 33, 36, 42, 48, 50, 56	Occasional.
D. perspicillatus (Cuvier, 1830)	11-14, 18b, 23, 24, 30, 31, 33, 36, 38, 42, 48, 50, 53, 56	Moderately common in mixed coral-sand habitat near shore.
D. prosopotaenia (Bleeker, 1852)	12-14, 34, 36, 42, 50	Occasional.
D. pseudochrysopoecilus (Allen & Robertson, 1974)	34, 42	Rare, only a few seen. New record for RA.
Hemiglyphidodon plagiometopon (Bleeker, 1852)	7, 8, 11-15, 18a, 24, 29, 33, 36, 42, 48, 50, 52, 53, 55	Moderately common, generally on sheltered reefs affected by silt.

SPECIES	SITE RECORDS	ABUNDANCE
Lepidozygus tapeinosoma (Bleeker, 1856)	20, 26, 29, 35, 39, 40, 43, 44, 55	Moderately common, but locally abundant.
Neoglyphidodon crossi Allen, 1991	18a, 25, 26, 28, 32, 35, 39, 43, 44, 48-50, 54, 57, 58	Occasional, but locally common..
N. melas (Cuvier, 1830)	7-11, 15-18a, 20-22, 24, 26, 28-37, 39, 40, 42-45, 48-50, 53, 54, 56-58	Moderately common, but in low numbers at each site.
N. nigroris (Cuvier, 1830)	7-12, 15, 16, 18a, 20, 21, 24, 26, 28-37, 39, 42-44, 48, 49, 52-57	Common.
N. oxyodon (Bleeker, 1857)	35	Rare, except common at one site.
N. thoracotaeniatus (Fowler and Bean, 1928)	7, 21, 29, 31, 42, 50, 57	Occasional.
Neopomacentrus azysron (Bleeker, 1877)	7, 9, 11, 16, 20, 21, 28, 35, 36, 43, 48, 49, 52, 54	Moderately common, but locally abundant at some sites.
N. bankieri (Richardson, 1846)	8, 10, 11	Occasional, but locally common at some sites.
N. cyanomos (Bleeker, 1856)	7-11, 16, 17, 22, 23, 25-27, 30, 31, 34, 35, 44, 49, 51	Moderately common.
N. filamentosus (Macleay, 1833)	7, 11, 24	Occasional, but locally common on sheltered reefs.
N. nemurus (Bleeker, 1857)	7-12, 15, 18a, 23, 24, 34, 48, 50, 52, 53, 55	Occasional, but locally common on sheltered inshore reefs.
N. taeniurus (Bleeker, 1856)	Previously recorded.	
N. violascens (Bleeker, 1848)	52, 53, 55	Occasional on soft bottoms in silty bays. New record for RA.
Plectroglyphidodon dickii (Liénard, 1839)	9, 10, 16, 20, 26, 28, 32,37-39, 43-45, 51, 54, 57, 58	Moderately common in rich coral areas.
P. lacrymatus (Quoy and Gaimard, 1824)	7-11, 15, 20, 21, 24-35, 37-40, 42-45, 48, 49, 52, 55-58	Common.
P. leucozonus (Bleeker, 1859)	9, 16, 20, 35, 37, 39, 41, 45, 51, 54	Moderately common in surge areas.
Pomacentrus adelus Allen, 1991	7-12, 15-18a, 20, 21, 28-26, 42, 44, 48, 52, 55, 56	Common.
P. amboinensis Bleeker, 1868	7-12, 15-18a, 20-37, 39, 41, 42-45, 48-52, 54, 56-58	Abundant on sand-rubble bottoms.
P. auriventris Allen, 1991	7, 8, 16, 17, 20, 22, 23, 25-35, 37, 39-41, 43-46, 49, 51, 54, 57, 58	Common.
P. bankanensis Bleeker, 1853	7-11, 15-18a, 20-22, 25, 26, 28-40, 42-46, 48, 49, 51, 54, 57, 58	Common.
P. brachialis Cuvier, 1830	8-11, 15-18a, 20-23, 25-37, 39, 40, 42-45, 48, 49, 54, 56-58	Abundant, especially in areas exposed to curents.
P. burroughi Fowler, 1918	11-14, 24, 36, 42, 50, 53, 55, 56	Moderately common, usually on silty inshore reefs.
P. chrysurus Cuvier, 1830	11, 28, 34, 35, 38, 48	Occasional, around small coral or rock formations surrounded by sand.
P. coelestis Jordan and Starks, 1901	7-11, 15-18a, 20-23, 25-35, 37, 39-41, 43-46, 48, 49, 51, 54, 56-58	Common.
P. cuneatus Allen, 1991	7, 8, 10-12, 14, 24, 52, 53, 55	Occasional on silty reefs.
P. grammorhynchus Fowler, 1918	33	Rare, only one group seen.
P. lepidogenys Fowler and Bean, 1928	7-11, 15, 16, 18a, 20-22, 25-29, 31-37, 39, 40, 43, 44, 48, 49, 52, 54, 57, 58	Common.
P. littoralis Cuvier, 1830	11, 12, 15, 18a, 21, 24, 33, 35, 36, 42, 50, 55	Moderately common on silty, well sheltered reefs.
P. moluccensis Bleeker, 1853	7-12, 15-18a, 20-40, 42-45, 48, 49, 52, 53, 55-58	Abundant.
P. nagasakiensis Tanaka, 1917	7-11, 20, 22-24, 26-32, 35-36, 43, 44, 48, 49, 51, 56	Moderately common, around isolated rocky outcrops surrounded by sand.
P. nigromanus Weber, 1913	7-12, 14-18a, 21, 23, 24, 28, 30-36, 42-44, 48, 50, 52-56	Common, usually on slopes in a variety of habitats.
P. nigromarginatus Allen, 1973	9, 16, 20, 26, 28, 49, 56, 57	Occasional on steep slopes.
P. opisthostigma Fowler, 1918	7, 8, 13-15, 21, 35, 55	Occasional, but locally common in sheltered, silty habitats.
P. pavo (Bloch, 1878)	24, 39, 40, 50, 55	Occasional, usually around coral patches in sandy lagoons.
P. philippinus Evermann and Seale, 1907	7-11, 15, 18a, 20, 21, 58	Occasional.
P. reidi Fowler and Bean, 1928	7-10, 15-18a, 20-22, 26-33, 37, 39, 43-45, 49, 51, 54, 56-58	Moderately common, usually on seaward slopes.
P. simsiang Bleeker, 1856	9, 12, 14, 24, 31, 33, 42, 50, 53, 56	Moderately common, usually in sheltered, silty bays.
P. smithi Fowler and Bean, 1928	7-10, 12, 15, 18a, 24, 34-36, 50, 53	Moderately common on sheltered reefs.

SPECIES	SITE RECORDS	ABUNDANCE
P. taeniometopon Bleeker, 1852	12, 27, 50	Rare, only three seen, but frequents mangroves.
P. tripunctatus Cuvier, 1830	13, 14, 27, 35, 56	Occasional in very shallow water next to shore.
P. vaiuli Jordan and Seale, 1906	20, 26, 32, 39, 43, 44, 51, 54, 57	Moderately common, usually on steep outer slopes.
Premnas biaculeatus (Bloch, 1790)	7, 8, 11, 15, 18b, 22-24, 26, 28-33, 48-50, 53, 56	Moderately common.
Pristotis obtusirostris (Günther, 1862)	36	Rare, only one seen (collected). New record for RA.
Stegastes albifasciatus (Schlegel and Müller, 1839)	16, 38	Rare, only a few seen at two sites.
S. fasciolatus (Ogilby, 1889)	16, 20, 25, 26, 34, 37, 39, 44, 45, 49, 54, 57	Occasional in surge areas.
S. lividus (Bloch and Schneider, 1801)	38, 53	Rare.
S. nigricans (Lacepède, 1802)	24, 33, 33-35, 38	Occasional, but locally common.
S. obreptus (Whitley, 1948)	10, 11	Rare.
LABRIDAE		
Anampses caeruleopunctatus Rüppell, 1828	16, 22, 25, 40, 44, 45, 49	Occasional, usually females sighted.
A. geographicus Valenciennes, 1840	Previously recorded.	
A. melanurus Bleeker, 1857	20, 25, 28, 31, 49, 57	Rare, less than 10 seen.
A. meleagrides Valenciennes, 1840	16, 20, 28, 29, 32, 37, 44, 45, 57	Occasional, always in small numbers.
A. neoguinaicus Bleeker, 1878	44, 58	Rare, only five seen.
A. twistii Bleeker, 1856	32	Rare, only one seen.
Bodianus anthioides (Bennett, 1831)	Previously recorded.	
B. axillaris (Bennett, 1831)	Previously recorded.	
B. bilunulatus Lacepède, 1801)	26, 29, 39, 44, 45, 54	Rare, less than 10 seen.
B. bimaculatus Allen, 1973	16, 31, 45	Rare, a few seen on steep outer slopes.
B. diana (Lacepède, 1802)	7-10, 15-18a, 20, 22, 23, 25-32, 34, 35, 37, 39-46, 48, 49, 51, 52, 54, 56-58	Common.
B. mesothorax (Bloch & Schneider, 1801)	7-11, 15-18a, 20-23, 25-29, 31, 32, 34-37, 39, 40, 42-45, 48, 49, 52, 54-58	Common.
Cheilinus chlorurus (Bloch, 1791)	8, 10, 11, 15, 17, 35	Occasional.
C. fasciatus (Bloch, 1791)	7-11, 14-18a, 20-22, 25-37, 42-45, 48, 50, 52-58	Common, several adults seen on most dives.
C. oxycephalus (Bleeker, 1853)	11, 21, 30, 31, 33, 35-37, 39, 42-44, 49, 52, 54, 56, 58	Moderately common.
C. trilobatus Lacepède, 1801	9, 16, 18a, 20-23, 25-32, 34, 35, 37-39, 44, 45, 59, 50, 54, 55, 56-58	Common, several adults seen on most dives.
C. undulatus Rüppell, 1835	7, 15, 18a, 20, 25, 41, 48, 51, 56	Occasional, only 14 seen.
Cheilio inermis (Forsskål, 1775)	10, 11, 21, 22, 25, 35, 40	Occasional, but mostly in weed habitats.
Choerodon anchorago (Bloch, 1791)	7, 10-15, 18a, 23, 24, 28-36, 38, 42, 48, 50, 52, 53, 55, 56	Moderately common, usually in slity areas.
C. schoenleinii (Valenciennes, 1839)	8-10, 17	Occasional.
C. zosterophorus (Bleeker, 1868)	27, 28, 30, 33, 34, 36, 42, 43, 51	Occasional in small groups over sand bottoms.
Cirrhilabrus condei Allen and Randall, 1996	8	Rare, only one seen.
C. cyanopleura (Bleeker, 1851)	8-10, 12, 15-18a, 20-37, 39, 40, 42-46, 48-58	Abundant in variety of habitats, but usually areas exposed to current.
C. exquisitus Smith, 1957	Previously recorded.	
C. flavidorsalis Randall & Carpenter, 1980	25, 30	Rare, only two seen.
C. lubbocki Randall & Carpenter	30	Rare, only two seen. New record for RA.
C. tonozukai Allen & Kuiter, 1999	25, 27, 32, 35, 37, 39, 44, 45, 49	Occasional.
Coris batuensis (Bleeker, 1862)	7, 10, 11, 16, 20, 22, 23, 26-31, 33-37, 39, 40, 42, 43, 48, 58	Moderately common.
C. dorsomacula Fowler, 1908	26, 37, 45	Rare, only three seen. New record for RA

SPECIES	SITE RECORDS	ABUNDANCE
C. gaimardi (Quoy and Gaimard, 1824)	7, 8, 10, 15, 16, 20, 22, 23, 26, 27, 29, 31, 32, 34, 35, 37, 39, 43-45, 49, 51, 54, 58	Moderately common.
C. pictoides Randall & Kuiter, 1982	8, 10, 11, 22-25, 27, 34, 36, 40, 43, 49	Occasional.
Cymolutes torquatus Valenciennes, 1840	33, 40	Rare, only two seen.
Diproctacanthus xanthurus (Bleeker, 1856)	7-12, 15-18a, 20, 21, 23, 24, 26-36, 40, 42-44, 48, 50, 52, 53, 55, 56, 58	Common, but most abundant on protected inshore reefs.
Epibulus insidiator (Pallas, 1770)	7-12, 15-18a, 20-22, 28-32, 35, 36, 39, 40, 42, 44, 45, 48-50, 52-56, 58	Common.
Gomphosus varius Lacepède, 1801	7, 9-11, 15-18a, 20, 25-30, 32, 34, 37-40, 43-45, 49, 54, 57, 58	Common.
Halichoeres argus (Bloch and Schneider, 1801)	7, 11, 12, 20, 35, 38, 48, 56	Occasional, usually in silty, protected areas with weeds.
H. bicolor (Bloch & Schneider, 1801)	13	Rare, about 10 seen at one site. New record for RA (one collected).
H. biocellatus Schultz, 1960	Previously recorded.	
H. chloropterus (Bloch, 1791)	7, 10-15, 24, 30, 31, 33-36, 38, 42, 48, 50, 52, 53, 55, 56	Common, usually on sheltered inshore reefs with sand and weeds.
H. chrysus Randall, 1980	9, 10, 15-17, 20, 22, 23, 25-32, 34, 35, 37, 39, 40, 41, 43-45, 48, 49, 51, 52, 54, 56-58	Common on clean sand bottoms.
H. hartzfeldi Bleeker, 1852	11, 22, 23, 27, 29, 30, 32, 39, 40, 54	Occasional on sand-rubble bottoms.
H. hortulanus (Lacepède, 1802)	7-11, 15-18a, 20-23, 25-32, 34, 35, 37-40, 42-46, 48, 49, 51, 52, 54, 55, 57, 58	Common.
H. leucurus (Walbaum, 1792)	7, 11-15, 17, 18a, 21, 24, 31, 33, 36, 42, 44, 48, 50, 52, 53, 55, 56	Moderately common, usually in silty bays.
H. margaritaceus (Valenciennes, 1839)	7-11, 15, 16, 20, 22, 25, 26, 28-30, 32, 34, 35, 37, 39, 40, 43-46, 51, 54	Common, usually in shallow water next to shore.
H. marginatus (Rüppell, 1835)	9, 10, 15, 16, 20, 25, 26, 28, 31-33, 35, 38, 39, 44, 48, 54, 57	Moderately common.
H. melanochir Fowler & Bean, 1928	49, 54	Rare, only two seen.
H. melanurus (Bleeker, 1851)	8-10, 15-18a, 20-35, 38, 39, 42-45, 48, 52-58	Common.
H. melasmopomus Randall, 1980	20, 31	Rare, only two seen.
H. miniatus (Valenciennes, 1839)	56	Rare.
H. nebulosus Valenciennes, 1839	49	Rare.
H. nigrescens Bleeker, 1862	Previously recorded.	
H. pallidus Kuiter & Randall, 1994	Previously recorded.	
H. papilionaceus (Valenciennes, 1839)	53, 56	Rare, but mainly in shallow seagrass beds.
H. podostigma (Bleeker, 1854)	11, 30, 31, 35, 38	Rare, less than 10 seen.
H. prosopeion (Bleeker, 1853)	8, 9, 11, 15-18a, 20-23, 25-32, 34, 35, 39, 43-45, 49, 51, 54, 56-58	Common.
H. richmondi Fowler & Bean, 1928	8, 21, 39, 31	Rare, only four seen.
H. rubricephalus Kuiter & Randall, 1994	7	Rare, only one seen. New record for RA.
H. scapularis (Bennett, 1832)	9, 11, 12, 15, 20-23, 25, 27-35, 39, 40, 44, 48, 54, 56	Moderately common, always in sandy areas.
H. solorensis (Bleeker, 1853)	8, 10, 16, 20, 23, 25-35, 39, 40, 43, 44, 49, 57	Moderately common, except in silty bays.
H. trimaculatus (Quoy & Gaimard, 1834)	15, 28, 39, 44	Occasional on sand bottoms. New record for RA
Hemigymnus fasciatus (Bloch, 1792)	18a, 20, 26, 30, 32, 35, 37, 39, 40, 42-46, 51, 52, 54, 57	Occasional.
H. melapterus (Bloch, 1791)	7-11, 15, 18a, 20, 21, 23-40, 42-45, 48-50, 53, 55, 56, 58	Common, but in low numbers at each site.
Hologymnosus annulatus (Lacepède, 1801)	28	Rare. New record for RA
H. doliatus (Lacepède, 1801)	10, 16, 20, 25-27, 29-31, 37, 44, 49	Moderately common.

SPECIES	SITE RECORDS	ABUNDANCE
H. rhodonotus Randall & Yamakawa, 1988	25	Rare, several seen at one site. New record for Indonesia.
Labrichthys unilineatus (Guichenot, 1847)	7-11, 15-17, 20, 21, 26, 27, 29-40, 42-44, 48, 50, 52, 55, 56	Common, especially in rich coral areas.
Labroides bicolor Fowler and Bean, 1928	8, 15, 20, 29, 30, 32, 35, 37-40, 42, 43, 52, 56, 58	Occasional, generally in smaller numbers than other *Labroides* species.
L. dimidiatus (Valenciennes, 1839)	7-12, 15-18a, 20-46, 48-58	Moderately common.
L. pectoralis Randall and Springer, 1975	20, 26, 29, 31, 32, 35, 37, 39, 43-45, 55, 57, 58	Occasional.
Labropsis alleni Randall, 1981	7, 20, 21, 31, 32, 42, 50	Occasional.
L. manabei Schmidt, 1930	32, 43	Rare, two adult males seen. New record for RA
Leptojulis cyanopleura (Bleeker, 1853)	8, 10, 11, 22-24, 27, 29, 31, 34, 36, 49, 52	Occasional, but easliy overlooked due to sandy habitat.
Macropharyngodon meleagris (Valenciennes, 1839)	7, 8, 10, 16, 20-22, 25-27, 31, 34, 37, 39, 40, 44, 45, 49, 51, 54, 58	Moderately common, but always in small numbers at each site.
M. negrosensis Herre, 1932	22, 23, 25, 27-31, 39, 43-45, 49, 51, 58	Moderately common, but always in small numbers at each site.
Novaculichthys macrolepidotus (Bloch, 1791)	Previously recorded.	
N. taeniourus (Lacepède, 1802)	16, 21, 25, 30, 31, 39, 44	Occasional.
Oxycheilinus bimaculatus (Valenciennes, 1840)	7, 10, 21, 22, 25, 26, 29-31, 33-35, 39, 40, 44, 49, 51-53, 56	Occasional, around rock and coral outcrops on sandy or rubble bottoms.
O. celebicus (Bleeker, 1853)	7-9, 11, 12, 14, 15, 18a, 21, 24, 29-32, 42, 48, 50, 52, 53, 55, 56	Moderately common on sheltered inshore reefs.
O. diagrammus (Lacepède, 1802)	8-10, 16, 18a, 20, 21, 25, 26, 28, 30, 33-35, 37, 39, 42-45, 55-58	Moderately common, mainly on outer slopes.
O. orientalis (Günther, 1862)	8, 10, 16, 20, 22, 24, 31, 43, 52, 53	Occasional.
O. sp.	Previously recorded.	
O. unifasciatus (Streets, 1877)	25	Rare, only one seen.
Parachelinus cyaneus Kuiter & Allen, 1999	16, 25, 27, 30, 31, 33, 44	Occasional (one collected).
P. filamentosus Allen, 1974	7, 11, 16, 17, 22-25, 27, 29, 31, 32, 34, 39, 43, 44, 49-51	Moderately common, usually in rubble areas.
Pseudocheilinops ataenia Schultz, 1960	53	Rare, only one seen.
Pseudocheilinus evanidus Jordan and Evermann, 1902	10, 20, 30, 37, 39, 40, 44, 51, 56, 58	Occasional.
P. hexataenia (Bleeker, 1857)	9, 10, 15, 20, 21, 25, 26, 28-32, 35, 37, 40, 43-45, 49, 51, 55, 56, 58	Moderately common, only a few seen on each dive, but has cryptic habits.
P. octotaenia Jenkins, 1901	30, 45	Rare, only a few seen. New record for RA
Pseudocoris heteroptera (Bleeker, 1857)	26	Rare, only one adult male seen.
P. philippina Fowler & Bean, 1928	28-31, 58	Occasional.
P. yamashiroi (Schmidt, 1930)	16, 20, 22, 25-27, 31	Occasional, but locally common.
Pseudodax moluccanus (Valenciennes, 1840)	8, 16, 17, 20-22, 25-27, 29-32, 37, 39, 44, 45, 49, 58	Occasional, always in low numbers.
Pseudojuloides kaleidos Randall & Kuiter, 1994	25, 37, 39	Rare, only three seen (one collected).
Pteragogus cryptus Randall, 1981	35, 36	Rarely seen, but cryptic.
P. enneacanthus (Bleeker, 1856)	33, 37	Rarely seen, but cryptic.
Stethojulis bandanensis (Bleeker, 1851)	7, 9, 20, 25, 26, 28-30, 33, 34, 37, 39, 40, 43, 44, 57, 58	Moderately common.
S. interrupta (Bleeker, 1851)	Previously recorded.	
S. strigiventer (Bennett, 1832)	8-11, 15, 18a, 20, 22, 23-27, 30, 31, 33, 38, 40, 51, 54	Moderately common.
S. trilineata (Bloch and Schneider, 1801)	7, 10, 15, 16, 20, 25, 26, 29, 32, 35, 37, 39, 40, 42, 44, 45, 48, 49, 54, 56-58	Moderately common.
Thalassoma amblycephalum (Bleeker, 1856)	8, 9, 16, 17, 20-22, 25-29, 31-33, 35, 37, 39-41, 43-46, 49, 51, 54, 57, 58	Common.
T. hardwicke (Bennett, 1828)	7-11, 15-18a, 20-35, 37-39, 41-45, 48, 49, 54, 56-58	Common.

SPECIES	SITE RECORDS	ABUNDANCE
T. jansenii (Bleeker, 1856)	9-11, 16, 20-22, 25, 26, 28, 30-32, 35, 37, 39-41, 44-46, 49, 51, 54, 57	Common, usually in very shallow water exposed to surge.
T. lunare (Linnaeus, 1758)	7-12, 16-18a, 20-37, 39-45, 48, 50-58	Common.
T. purpureum (Forsskål, 1775)	16, 41, 46	Occasional in surge areas.
T. quinquevittatum (Lay and Bennett, 1839)	39, 54	Rare, except locally common at 2 sites exposed to surge.
Wetmorella albofasciata Schultz & Marshall, 1954	Previously recorded.	
Xyrichtys pavo Valenciennes, 1839	20, 33	Rare, only two seen.
X. twistii (Bleeker, 1856)	40	Rare, except about 20 seen on open sand at one site. New record for RA.
X. spilonotus (Bleeker, 1857)	33, 40, 58	Rare, about 10 seen at three sites. New record for RA
SCARIDAE		
Bolbometopon muricatum (Valenciennes, 1840)	9, 11-14, 17, 18a, 20-22, 26, 28, 34, 41, 45, 49, 50, 55, 58	Occasional, either lone fish or in groups of up to about 5-15 large adults.
Calotomus carolinus (Valenciennes, 1839)	49	Rare, only one seen. .
Cetoscarus bicolor (Rüppell, 1828)	7-11, 15, 18a, 20, 21, 23, 25, 26, 29, 31, 32, 34-37, 42-45, 48, 50, 53-56, 58	Moderately common, but usually in small numbers.
Chlorurus bleekeri (de Beaufort, 1940)	7-12, 15, 17, 18a, 20, 21, 23, 24, 26-37, 39, 40, 42-45, 48-50, 52, 53, 55-58	Common.
C. bowersi (Snyder, 1909)	11, 15, 18a, 22, 31, 48, 52	Occasional.
C. japanensis (Bloch, 1789)	9-11, 16, 28, 32, 37, 39, 44, 45, 48, 54, 57, 58	Occasional.
C. microrhinos (Bleeker, 1854)	8, 9, 15, 21, 25, 34, 37, 39, 41-45, 48, 50, 52, 55, 56	Moderately common.
C. sordidus (Forsskål, 1775)	7, 9, 11, 12, 15-18a, 20-23, 25-32, 34, 35, 37-40, 43-45, 48, 54, 56-58	Common.
Hipposcarus longiceps (Bleeker, 1862)	15, 18a, 20-22, 28, 29, 31, 37, 41-44, 48, 50, 51, 54, 55, 57, 58	Moderately common at sites adjacent to sandy bottoms. Waigeo is type locality.
Leptoscarus vaigiensis (Quoy & Gaimard, 1824)	18b, 53, 56	Rare, but found in seagrass or weedy areas. Waigeo is type locality.
Scarus chameleon Choat and Randall, 1986)	8, 15, 31, 37, 43, 44, 54, 57	Occasional.
S. dimidiatus Bleeker, 1859	7-12, 15, 18a, 20-23, 25-29, 31-33, 37, 38, 42, 48, 50, 52-58	Common.
S. flavipectoralis Schultz, 1958	7-12, 15, 17, 18a, 20-36, 41-45, 48-50, 52-58	Common, one of most abundant parrotfishes at the Raja Ampats.
S. forsteni (Bleeker, 1861)	7-9, 15, 17, 18a, 20, 22, 25, 26, 28, 31, 35, 39, 41, 45, 49, 51, 57	Moderately common.
S. frenatus Lacepède, 1802	8, 25, 32, 43, 48, 57	Occasional.
S. ghobban Forsskål, 1775	7-12, 14, 16, 18a, 20-23, 25-27, 32, 34, 36, 38, 40-42, 45, 51, 53-55, 58	Common.
S. globiceps Valenciennes, 1840	Previously recorded.	
S. hypselopterus Bleeker, 1853	48, 53, 54	Rare.
S. niger Forsskål, 1775	9-12, 15, 20, 21, 24, 28-35, 37, 39, 40, 42-45, 49-55, 57, 58	Common.
S. oviceps Valenciennes, 1839	9, 15, 34, 35, 37	Occasional.
S. prasiognathos Valenciennes, 1839	7, 9-11, 15, 18a, 20, 25, 31, 37, 43, 50, 52, 57	Moderately common.
S. psittacus Forsskål, 1775	18a, 22, 27, 28, 34, 37, 43, 44	Occasional.
S. quoyi Valenciennes, 1840	7-12, 15, 18a, 20, 22, 26, 31, 34, 42, 43, 48, 50, 52, 53, 55, 56	Moderately common, usually on protected inshore reefs with increased turbidity.
S. rivulatus Valenciennes, 1840	9, 20, 21, 25, 26, 28, 34, 35, 39, 40	Occasional..
S. rubroviolaceus Bleeker, 1849	10, 16, 17, 20, 22, 25-28, 32, 37, 39, 41, 43-45, 49, 51, 54, 57	Moderately common.
S. schlegeli (Bleeker, 1861)	7, 9, 18a, 20, 28, 43, 44, 54, 57	Occasional.

SPECIES	SITE RECORDS	ABUNDANCE
S. spinus (Kner, 1868)	7-11, 15, 17, 20, 26, 28, 35, 43, 44, 54, 57	Occasional.
S. tricolor Bleeker, 1849	16, 17, 20-23, 26-28, 31, 35, 41	Occasional
TRICHONOTIDAE		
Trichonotus elegans Shimada & Yoshino, 1984	Previously recorded.	
Trichonotus setiger (Bloch & Schneider, 1801)	23, 30	Rare, a few seen at two sites, but easily overlooked.
PINGUIPEDIDAE		
Parapercis clathrata Ogilby, 1911	25, 26, 28, 39, 40, 45, 49, 54, 58	Occasional.
P. cylindrica (Bloch, 1792)	10	Rare, only one seen.
P. hexophthalma (Cuvier, 1829)	23, 28, 30, 31, 39, 48	Occasional.
P. millepunctata (Günther, 1860)	9, 11, 16, 17, 20, 21, 25, 26, 28, 37, 42-44, 50, 54	Occasional.
P. schauinslandi (Steindachner, 1900)	16, 20, 22, 25, 27, 29, 43	Occasional.
P. sp. 1 (Kuiter & Tonozuka, 2001)	30, 36	Rare. One collected.
P. sp. 1 (Kuiter & Tonozuka, 2001)	27, 29, 30	Occasional.
P. sp. 2 (Kuiter & Tonozuka, 2001)	10-15, 22-24, 30, 31, 33, 34, 36, 43, 49, 52-55, 58	Occasional.
P. tetracantha (Lacepède, 1800)	8, 16, 22, 25-31, 44, 49	Occasional.
P. xanthozona (Bleeker, 1849)	14, 18a, 22-24	Occasional on sheltered reefs.
PHOLIDICHTHYIDAE		
Pholidichthys leucotaenia Bleeker, 1856	8, 23, 29, 35, 37, 45, 53, 57, 58	Moderately common, but usually only juveniles seen.
TRIPTERYGIIDAE		
Enneapterygius philippinus (Peters, 1869)	Previously recorded.	
E. rubricauda Shen & Wu, 1994	Previously recorded.	
E. tutuilae Jordan & Seale, 1906	33	One collected with rotenone. New record for RA.
E. ziegleri Fricke, 1994	Previously recorded.	
Helcogramma striata Hansen, 1986	16, 26, 28, 41, 45, 51	Occasional, but inconspicuous.
H. sp	31	One collected with rotenone.
Ucla xenogrammus Holleman, 1993	48, 50	Rare, only two seen.
BLENNIIDAE		
Aspidontus taeniatus Quoy & Gaimard, 1834	8, 16	Rare, only two seen.
Atrosalarias fuscus (Rüppell, 1835)	11, 33-35	Occasional in rich coral areas.
Blenniella chrysospilos (Bleeker, 1857)	20	Rare, but not readily observed due to shallow wave-swept habitat.
B. periophthalmus (Valenciennes, 1836)	18b	One collected with rotenone. New record for RA.
Cirripectes auritus Carlson, 1981	45	Rare, only one seen. New record for RA.
C. castaneus Valenciennes, 1836	39	Rare, but easily overlooked.
C. filamentosus (Alleyne & Macleay, 1877)	20, 35	Rare, but easily overlooked.
C. polyzona (Bleeker, 1868)	Previously recorded.	
C. quagga (Fowler & Ball, 1924)	Previously recorded.	
C. stigmaticus Strasburg and Schultz, 1953	Previously recorded.	
Crossosalarias macrospilus Smith-Vaniz and Springer, 1971	Previously recorded.	
Ecsenius bandanus Springer, 1971	9-11, 15-18a, 24, 52, 53, 55	Occasional.
E. bathi Springer, 1988	28, 29	Rare, only a few seen.
E. bicolor (Day, 1888)	8, 11, 16, 20, 22, 30, 41, 45, 51	Occasional.
E. lividinalis Chapman and Schultz, 1952	35, 36	Rare, only a few seen.
E. midas Starck, 1969	22, 25	Rare. New record for RA.

SPECIES	SITE RECORDS	ABUNDANCE
E. namiyei (Jordan and Evermann, 1903)	8, 16, 22, 23, 29-31, 34, 35, 45	Occasional.
E. stigmatura Fowler, 1952	7, 9-11, 15-18a, 23, 24, 34-36, 42, 48, 52, 53	Moderately common.
E. trilineatus Springer, 1972	21, 26, 28, 30, 35	Occasional.
E. yaeyamensis (Aoyagi, 1954)	34	Rare, only one seen.
Entomacrodus striatus (Quoy and Gaimard, 1836)	Previously recorded.	
Istiblennius edentulus Bloch and Schneider, 1801	Previously recorded.	
I. lineatus (Valenciennes, 1836)	Previously recorded.	
Laiphognathus multimaculatus Smith, 1955	34	Rare, one specimen collected with rotenone. New record for RA.
Meiacanthus atrodorsalis (Günther, 1877)	16, 17, 34, 39, 50-58	Occasional.
M. crinitus Smith-Vaniz, 1987	12-14, 36, 42, 50, 53, 55	Occasional.
M. ditrema Smith-Vaniz, 1976	Previously recorded.	
M. grammistes (Valenciennes, 1836)	7, 10, 17, 20, 22, 23, 25-36, 42, 48-53, 56, 58	Moderately common.
Petroscirtes breviceps (Valenciennes, 1836)	Previously recorded.	
P. mitratus Rüppell, 1830	18b	One collected with rotenone. New record for RA.
Plagiotremus rhinorhynchus (Bleeker, 1852)	7-11, 15, 20, 22-33, 35, 36, 39-45, 49-58	Common, but alway in low numbers.
P. tapeinosoma (Bleeker, 1857)	20, 22, 26, 40, 44	Rare, only five seen.
Salarias alboguttatus Kner, 1867	18b	One collected with rotenone. New record for RA.
S. fasciatus (Bloch, 1786)	Previously recorded.	
S. patzneri Bath, 1992	12, 14,	Rare, only three seen.
S. *ramosus* Bath, 1992	40	Rare, only one seen.
S. segmentatus Bath & Randall, 1991	42, 52, 53, 55	Occasional.
S. sibogae Bath, 1992	Previously recorded.	
CALLIONYMIDAE		
Anaora tentaculata Gray, 1835	14, 18b	Rare, but easily overlooked (collected).
Callionymus ennactis Bleeker, 1879	18b, 44	
C. delicatulus Smith, 1963	18b	Rare, except locally common at site 18b (collected). New record for RA.
C. pleurostictus Fricke, 1992	18b, 30	Rare.
Synchiropus morrisoni Schultz, 1960	34	One collected with rotenone.
S. moyeri Zaiser & Fricke, 1985	17, 31	Rare.
S. ocellatus (Pallas, 1770)	Previously recorded.	
S. splendidus (Herre, 1927)	Previously recorded.	
ELEOTRIDAE		
Calumia profunda (Larson & Hoese, 1980)	58	Collected with rotenone. New record for RA.
GOBIIDAE		
Acentrogobius janthinopterus (Bleeker, 1852)	Previously recorded.	
A. nebulosus (Forsskål, 1775)	55	Rare, one seen on open sand bottom. New record for RA.
Amblyeleotris arcupinna Mohlmann & Munday, 1999	29, 40, 52	Rare, only three seen.
A. diagonalis Polunin & Lubbock, 1979	23	Rare, only one seen. New record for RA.
A. fasciata (Herre, 1953)	Previously recorded.	
A. fontanesii (Bleeker, 1852)	24, 55	Generally rare, except common at site 24.
A. guttata (Fowler, 1938)	18a, 20, 28-31, 48, 52, 56, 57	Occasional.
A. gymnocephala (Bleeker, 1853)	11, 22, 23, 29	Occasional.
A. latifasciata Polunin & Lubbock, 1979	22, 23, 29, 49, 54	Occasional.

SPECIES	SITE RECORDS	ABUNDANCE
A. periophthalma (Bleeker, 1853)	10-12, 22, 23, 29, 30, 33, 34, 36, 39, 54	Occasional, locally common in some sandy areas.
A. randalli Hoese & Steene, 1978:	56	Rare, only one seen. New record for RA.
A. steinitzi (Klausewitz, 1974)	10, 11, 16, 22, 27, 30, 33, 34, 36, 39, 42, 54	Occasional, locally common in some sandy areas.
A. wheeleri (Polunin and Lubbock, 1977)	10, 22, 28	Rare, only three seen.
A. yanoi Aonuma and Yoshino, 1996	29	Rare, only one pair seen.
Amblygobius buanensis (Herre, 1927)	13, 14, 50	Rare, less than 10 seen. .
A. bynoensis (Richardson, 1844)	12, 14	Rare.
A. decussatus (Bleeker, 1855)	11-14, 24, 31, 33, 34, 50, 52, 53, 55	Moderately common in sheltered silty areas.
A. esakiae Herre, 1939	50	Rare, except several seen at one site.
A. nocturnus (Herre, 1945)	18b, 24, 42, 55	Occasional in strongly silted areas. Photographed.
A. phalaena (Valenciennes, 1837)	11, 12, 23, 27, 33, 38	Occasional.
A. rainfordi (Whitley, 1940)	7, 11, 15, 16, 18a, 20, 21, 24, 31, 34, 48, 52, 53	Occasional, always in low numbers.
Asterropteryx bipunctatus Allen and Munday, 1996	Previously recorded.	
A. semipunctatus Rüppell, 1830	Previously recorded.	
A. striatus Allen and Munday, 1996	18a, 21-24, 28-30, 32, 33, 44, 53, 55	Occasional, but locally abundant.
Bathygobius cocosensis (Bleeker, 1854)	Previously recorded.	
B. cyclopterus (Valenciennes, 1837)	18b	One collected with rotenone.
Bryaninops amplus Larson, 1985	8, 23, 51	Rare, only three seen, but difficult to detect. No doubt common wherever seawhips are abundant.
B. loki Larson, 1985	Previously recorded.	
B. natans Larson, 1986	15, 18a, 20, 21, 56	Occasional.
B. tigris Larson, 1985	Previously recorded.	
B. yongei (Davis & Cohen, 1968)	15	Rare, several seen, but difficult to detect. No doubt common wherever seawhips are abundant.
Cabillus tongarevae (Fowler, 1927)	34	One collected with retonone.
Callogobius maculipinnis (Fowler, 1918)	Previously recorded.	
Coryphopterus duospilus Hoese and Reader, 1985	34	One collected with rotenone.
C. inframaculatus Randall, 1994	9, 31, 41	Occasional on sand under ledges.
C. maximus Randall, 2001	Previously recorded.	
C. melacron Randall, 2001	16, 17, 23	Occasional.
C. neophytus (Günther, 1877)	12, 18b, 41, 48	Occasional.
C. signipinnis Hoese and Obika, 1988	7, 17, 18a, 20-22, 24-29, 31, 32, 35, 36, 41, 42, 48, 50, 52	Moderately common.
Cryptocentroides insignis Seale, 1910	Previously recorded.	
Cryptocentrus cinctus (Herre, 1936)	13, 14, 33, 42	Occasional, but sand habitat not adequately surveyed.
C. cyanotaenia (Bleeker, 1853	13	Rare, one collected with spear. New record for RA.
C. fasciatus (Playfair & Günther, 1867)	12, 22, 23, 29, 30, 33, 36, 40, 58	Occasional, but sand habitat not adequately surveyed.
C. inexplicatus (Herre, 1931)	13, 14	Rare, only two seen. New record for RA.
C. leptocephalus Bleeker, 1876	12, 14	Rare, but sand habitat not adequately surveyed.
C. leucostictus (Günther, 1871)	56	Rare, but sand habitat not adequately surveyed.
C. octofasciatus Regan, 1908	Previously recorded.	
C. sp. 1 (spots on opercle)	Previously recorded.	
C. sp. 2 (blue spots)	13, 14, 50, 52	Rare, but sand habitat not adequately surveyed.
C. sp. 3 (yellowish)	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
C. sp. 4 (“bright eyes”)	Previously recorded.	
C. strigilliceps (Jordan and Seale, 1906)	7, 24, 32, 50, 52, 55	Occasional, but sand habitat not adequately surveyed.
Ctenogobiops aurocingulus (Herre, 1935)	55	
C. crocineus Smith, 1959	18a	Rare. New record for RA.
C. feroculus Lubbock and Polunin, 1977	11, 24, 39, 42, 48, 50, 52, 53, 56	Occasional.
C. pomastictus Lubbock and Polunin, 1977	Previously recorded.	
C. tangaroai Lubbock & Polunin, 1977	43	Rare. Photographed by expedition member. New record for RA.
Echinogobius hayashii Iwata, Hosoya, & Niimura, 1998	40	Several seen at one site on open sand bottom. New record for Indonesia.
Eviota albolineata Jewett and Lachner, 1983	10, 11, 15-18a, 20-23, 25-31, 33, 35	Moderately common, but easily missed due to small size.
E. bifasciata Lachner and Karnella, 1980	7, 50, 52, 53	Occasional in rich coral areas.
E. guttata Lachner and Karanella, 1978	7, 15, 23, 26, 28, 29, 34, 36, 41, 42	Occasional, but easily missed due to small size.
E. herrei Jordan & Seale, 1906	34	Three collected with retonone.
E. lachdeberei Giltay, 1933	13, 14	
E. melasma Lachner & Karanella. 1980	34	One collected with retonone.
E. nigriventris Giltay, 1933	21, 36, 42, 50, 52	Occasional in rich coral areas.
E. pellucida Larson, 1976	7-9, 15, 18a, 20, 21, 23, 26, 28, 31, 34, 35, 41, 42,48, 50, 52, 53, 56-58	Occasional.
E. prasina (Kluzinger, 1871)	18b	Noticed once, but easily missed due to small size.
E. prasites Jordan and Seale, 1906	13-16, 52, 53	Noticed on several occasions, but easily missed due to small size.
E. punctulata Jewett & Lachner, 1983	18b	Two collected with rotenone. New record for RA.
E. queenslandica Whitley, 1932	13, 18b	Rare, but easily missed due to small size (collected).
E. raja Allen, 2001	7, 13-15, 18a, 24, 42, 48, 50, 52, 53, 55, 56	Common in sheltered bays and lagoons.
E. sebreei Jordan and Seale, 1906	10, 11, 16, 20, 25, 28-31, 35, 39, 41, 42	Moderately common, but easily missed due to small size.
E. sp. 1 (sp. 3 of Kuiter and Tonozuka, 2001)	13, 14, 50, 55	Occasional, but easily missed due to small size. New record for RA.
E. sp. 2	Previously recorded.	
E. sp. 3	Previously recorded.	
E. sparsa Jewett and Lachner, 1983	34, 48	Two collected with rotenone.
E. zebrina Lachner & Karanella, 1978	34	Collected with rotenone. New record for RA.
Exyrias bellisimus (Smith, 1959)	13, 14, 52	Rare, a few seen on silty reefs.
E. ferrarisi Murdy, 1985	12	Rare, only one seen. New record for RA.
Exyrias puntang (Bleeker, 1851)	50	Rare, only one seen.
E. sp.	7, 11, 48	Rare, only three seen.
Favonigobius reichei (Bleeker, 1853)	13, 14	Rare, but easily overlooked. New record for RA.
Gladigobius ensifer Herre, 1933	14	Rare, but several seen at one site.
Gnatholepis anjerensis Bleeker, 1851	12, 18b	Rarely seen, but locally common.
G. cauerensis Bleeker, 1853	11, 16, 21-23, 25-29, 31, 44	Rarely seen, but locally common.
Gobiodon citrinus (Rüppell, 1838)	22, 49	Rare, but easily overlooked. New record for RA.
G. okinawae Sawada, Arai and Abe, 1973	15, 50	Rare, but a secretive species that is easily overlooked.
G. spilophthalmus Fowler, 1944	21, 48	Rare, but easily overlooked. New record for RA.
G. unicolor (Castelnau, 1873)	Previously recorded.	
Istigobius decoratus (Herre, 1927)	50	Rarely noticed, but probably more common.

SPECIES	SITE RECORDS	ABUNDANCE
I. ornatus (Rüppell, 1830)	12-14, 56	Rarely noticed, but probably more common.
I. rigilius (Herre, 1953)	9, 15, 17, 23, 28, 30, 31, 34, 39-41, 48	Occasional.
Luposicya lupus Smith, 1959	Previously recorded.	
Macrodontogobius wilburi Herre, 1936	12-14, 18b, 24, 33, 50, 52, 53, 55	Occasional in slilty areas.
Mahidolia mystacina (Valenciennes, 1837)	24, 50, 55	Rare, but sand habitat not adequately surveyed.
Myersina nigrivirgata Akihito & Meguro, 1983	55	Rare, but sand habitat not adequately surveyed. New record for RA.
Oplopomops diacanthus (Schultz, 1943)	33, 36	Rare, but sand habitat not adequately surveyed. Two collected. New record for RA.
Oplopomus oplopomus (Valenciennes, 1837)	12	Rare, but sand habitat not adequately surveyed.
Oxurichthys papuensis (Valenciennes, 1837)	55	Rare, but sand habitat not adequately surveyed. New record for RA.
Periophthalmus argentilineatus (Valenciennes, 1837)	13, 18b	Recorded only twice, but mainly resident of mangroves.
P. kalolo Lesson, 1830	Previously recorded.	
Phyllogobius platycephalops (Smith, 1964)	12, 15, 26, 27, 30, 31, 34, 35	Occasional, but easily overlooked due to small size. Commensal with sponges (*Phyllospongia*).
Pleurosicya labiata (Weber, 1913)	23	Only a few seen, but easily escapes notice due to small size. Commensal with sponges (*Ianthella*).
P. elongata Larson, 1990	42, 50, 52, 53, 55	Only a few seen, but easily escapes notice due to small size. Commensal with sponges (*Xestosponga*).
P. micheli Fourmanoir, 1971	17, 25, 34	Occasional, but easily overlooked. Commensal with hard corals. New record for RA.
P. mossambica Smith, 1959	10, 34	Only a few seen (collected), but easily escapes notice due to small size.
Priolepis fallacincta Winterbottom & Burridge, 1992	34	One collected with rotenone.
Sueviota atrinasa Winterbottom & Hoese, 1988	34	One collected with rotenone.
Signigobius biocellatus Hoese and Allen, 1977	7, 18a, 21, 30, 33, 50, 52, 55	Occasional on silty bottoms.
Stonogobiops xanthorhinica Hoese and Randall,1982	22, 29	Rare, only two pairs seen.
Tomiyamichthys oni (Tomiyama, 1936)	Previously recorded.	
Trimma anaima Winterbottom, 2000	Previously recorded.	
T. benjamini Winterbottom, 1996	9, 15, 16, 31, 53	Occasional, but easily overlooked.
T. emeryi Winterbottom, 1984	Previously recorded.	
T. griffthsi Winterbottom, 1984	7, 11, 12, 15-18a, 20, 21, 26, 48, 50, 52, 53	Occasional, but easily overlooked due to small size and secretive habits.
T. halonevum Winterbottom, 2000	Previously recorded.	
T. macrophthalma (Tomiyama, 1936)	58	Collected with rotenone.
T. naudei Smith, 1957	21, 48, 56	Occasional, but easily overlooked due to small size and secretive habits.
T. okinawae (Aoyagi, 1949)	7	Rare, but easily overlooked due to small size and secretive habits.
T. rubromaculata Allen and Munday, 1995	16, 17, 20	Generally rare, but locally common at three sites.
T. sp. 1 (dusky reddish with small black “ear” spot)	34	Collected with rotenone.
T. sp. 2 (yellow to reddish with black peduncle and white tail)	7	Collected with rotenone.
T. sp. 3 (pinkish, *Gobiodon*-like shape)	22, 34, 48	Collected with rotenone.
T. sp. 4 (spots on opercle edge and pectoral spot)	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
T. striata (Herre, 1945*)*	11, 18b, 21	Rare, but easily overlooked due to small size and secretive habits.
T. taylori Lobel, 1979	16	Rare, but easily overlooked due to small size and secretive habits.
T. tevegae Cohen and Davis, 1969	7, 9, 10, 15-18a, 20, 21, 28, 31, 32, 48, 52, 53, 56, 57	Moderately common, but easily overlooked due to small size and secretive habits.
Valenciennea bella Hoese & Larson, 1994	Previously recorded.	
V. helsdingenii (Bleeker, 1858*)*	30	Rare, only one pair seen.
V. muralis (Valenciennes, 1837)	18b, 23	Rare, only two pairs seen.
V. parva Hoese & Larson, 1994	22, 29, 30, 33, 36, 54	Occasional. New record for RA.
V. puellaris (Tomiyama, 1936)	10, 11, 22, 23, 29-31, 33-36, 39, 40, 49, 54, 58	Occasional.
V. randalli Hoese and Larson, 1994	24	Rare, only one seen.
V. sexguttata (Valenciennes, 1837)	42	Rare, a few seen at one site.
V. strigata (Broussonet, 1782)	9-11, 16, 20, 21, 30, 31, 34, 39, 49, 54	Occasional, in relatively low numbers at each site.
Vanderhorstia ambonoro (Fourmanoir, 1957)	24	Rare, only one seen.
V. lanceolata Yanagisawa, 1978	Previously recorded.	
MICRODESMIDAE		
Aioliops megastigma Rennis and Hoese, 1987	12, 14, 18a, 21, 24, 48, 50, 52, 53	Occasional.
Gunnelichthtys curiosus Dawson, 1968	27, 49	Rare, but easily overlooked. New record for RA.
G. monostigma Smith, 1958	29, 30	Rare, but easily overlooked. New record for RA.
G. pleurotaenia Bleeker, 1858	23, 30	Rare, but easily overlooked.
PTERELEOTRIDAE		
Nemateleotris decora Randall & Allen, 1973	20, 37	Rare, only two seen. New record for RA.
N. magnifica Fowler, 1938	16, 32, 37, 49, 58	Rare, less than 10 seen.
Oxymetopon compressus Chan, 1966	24	Rare, only four seen. New record for RA.
Parioglossus formosus (Smith, 1931)	12, 35, 36	Occasional, but easily overlooked.
P. philippinus (Herre, 1940)	8, 12, 23, 53	Occasional.
Ptereleotris evides (Jordan and Hubbs, 1925)	16, 20, 22, 25, 27, 32, 37, 39, 42, 44, 49, 51, 52, 54, 58	Moderately common.
P. hanae (Jordan & Snyder, 1901)	22, 29	Rare, only two seen.
P. heteroptera (Bleeker, 1855)	19, 20, 22, 25, 31, 32, 39, 40, 49, 51, 54	Occasional, usually below 20 m depth.
P. microlepis Bleeker, 1856	23, 41	Rare.
P. sp. 1 (Kuiter & Tonozuka, 2001)	24, 55, 56	Rare, silty inshore reefs. New record for RA.
P. zebra (Fowler, 1938)	20, 45, 46, 51	Occasional, but locally common.
XENISTHMIDAE		
Xenisthmus polyzonatus (Klunzinger, 1871)	34	Collected with rotenone.
EPHIPPIDAE		
Platax batavianus (Cuvier, 1831)	9, 22	Rare, two large adults seen.
P. boersi Bleeker, 1852	18a, 22, 33, 51, 54, 58	Occasional.
P. orbicularis (Forsskål, 1775)	16, 17, 29, 45, 55	Occasional.
P. pinnatus (Linnaeus, 1758)	11, 15, 22, 27, 33, 35, 37, 39-41, 48, 50, 52, 53	The most common batfish encountered, but only occasional sightings.
P. teira (Forsskål, 1775)	16, 43, 55	Occasional.
SCATOPHAGIDAE		
Scatophagus argus (Bloch, 1788)	Previously recorded.	

SPECIES	SITE RECORDS	ABUNDANCE
SIGANIDAE		
Siganus argenteus (Quoy and Gaimard, 1824)	8, 9, 16, 17, 20-23, 27, 28, 31-33, 36, 44, 54, 56-58	Moderately common.
S. canaliculatus (Park, 1797)	33	Rare, only one seen.
S. corallinus (Valenciennes, 1835)	7-9, 16, 21, 22, 25, 31, 32, 34-38, 42, 56-58	Moderately common.
S. guttatus (Bloch, 1787)	15, 21	Rare, only two seen.
S. javus (Linnaeus, 1766)	8, 9, 48, 51, 58	Occasional.
S. lineatus (Linnaeus, 1835)	7-9, 13, 15, 17, 18a, 21, 23, 32, 35, 48, 50-52, 55-58	Moderately common.
S. puellus (Schlegel, 1852)	7-11, 15, 17, 18a, 20-23, 25-28, 31, 32, 34-40, 42-44, 48, 50, 54, 56-58	Common.
S. punctatissimus Fowler and Bean, 1929	13, 15, 17, 20, 21, 23, 24, 26, 28, 31, 36, 42-44, 50, 54, 56	Moderately common.
S. punctatus (Forster, 1801)	Previously recorded.	
S. spinus (Linnaeus, 1758)	29, 38, 43	Rare.
S. vermiculatus (Valenciennes, 1835)	13, 50	Rare. New record for RA.
S. virgatus (Valenciennes, 1835)	7-11, 14-16, 20-24, 26-28, 30-36, 42, 50-58	Moderately common.
S. vulpinus (Schlegel and Müller, 1844)	7-18a, 20, 21, 24, 26-36, 42-45, 48, 50, 52-58	Moderately common.
ZANCLIDAE		
Zanclus cornutus Linnaeus, 1758	7-12, 15-18a, 20-23, 25-46, 48-58	Common.
ACANTHURIDAE		
Acanthurus bariene Lesson, 1830	9, 10, 16, 17, 27, 28, 44, 48, 49, 51, 54	Occasional. Waigeo is type locality.
A. blochi Valenciennes, 1835	7-11, 16, 18a, 20, 28, 31, 37, 38, 43, 44, 48, 56, 57	Moderately common. .
A. fowleri de Beaufort, 1951	7, 21, 50, 52	Occasional.
A. leucocheilus Herre, 1927	22, 25-29, 31, 32, 34, 37, 42-46, 48, 49, 54, 57	Moderately common.
A. lineatus (Linnaeus, 1758)	7-11, 16, 17, 20, 22, 25-28, 30-32, 34, 35, 37-39, 42-45, 48, 49, 51, 52, 54, 57, 58	Moderately common, usually in shallow surge-affected areas.
A. maculiceps (Ahl, 1923)	20, 37, 39, 44, 45, 54	Occasional.
A. mata (Cuvier, 1829)	8-11, 15-17, 20, 22, 24-27, 29-33, 35-37, 39-42, 44-46, 48, 49, 51, 52	Moderately common, usually on dropoffs in turbid water.
A. nigricans (Linnaeus, 1758)	20, 28, 37, 43-45, 49	Occasional.
A. nigricaudus Duncker and Mohr, 1929	8, 10, 16-18a, 20, 21, 26, 28, 39, 40, 42, 45, 54, 58	Moderately common.
A. nigrofuscus (Forsskål, 1775)	16, 20, 25, 32, 37, 49, 51, 54	Occasional, but easily overlooked.
A. nubilus (Fowler & Bean, 1929)	20, 57	Rare, only two seen on outer drop-offs. New record for RA.
A. olivaceus Bloch and Schneider, 1801	9, 16, 20, 22, 23, 26, 27, 29, 35, 37, 39-41, 44-46, 51, 54, 58	Moderately common on mixed sand-reef.
A. pyroferus Kittlitz, 1834	9, 15-18a, 20-23, 25-32, 34, 35, 37, 39-45, 48, 49, 51-58	Common.
A. thompsoni (Fowler, 1923)	20, 28, 29, 31, 32, 35, 39, 44, 45, 54, 56-58	Moderately common, usually on steep dropoffs.
A. triostegus (Linnaeus, 1758)	7, 9, 34, 35, 38, 44, 56	Occasional, usually in shallow wave-affected areas.
A. xanthopterus Valenciennes, 1835	7, 10, 12-14, 23, 24, 27, 30, 41, 45, 46, 48, 50, 55, 56	Moderately common, usually on sandy slopes adjacent to reefs.
Ctenochaetus binotatus Randall, 1955	8, 10, 11, 15-18a, 20-22, 24-28, 30-37, 39, 40, 42-45, 48-58	Common.
C. striatus (Quoy and Gaimard, 1824)	7-12, 15-18a, 20-22, 24-26, 28-38, 41, 43-45, 48-58	Common, usually in depths less than 10 m.
C. strigosus (Bennett, 1828)	20, 29, 56, 57	Only a few noticed, but hard to differentiate from *C. striatus* at a distance.
C. tominiensis Randall, 1955	15, 31, 42, 48, 50, 53, 55, 57	Occasional.
Naso annulatus (Quoy and Gaimard, 1825)	Previously recorded.	
N. brachycentron (Valenciennes, 1835)	16, 21, 35, 36, 39, 41, 43, 46, 51, 55, 57, 58	Occasional.

SPECIES	SITE RECORDS	ABUNDANCE
N. brevirostris (Valenciennes, 1835)	16, 20, 36, 39, 43, 54	Occasional.
N. caeruleacauda Randall, 1994	16, 31, 32, 35, 37, 41, 43, 44, 48, 49	Occasional.
N. hexacanthus (Bleeker, 1855)	16, 32, 36, 39, 41, 43-46, 48, 49, 51	Moderately common.
N. lituratus (Bloch and Schneider, 1801)	7-9, 15, 17, 18a, 20-23, 25-38, 39-46, 48-58	Common.
N. lopezi Herre, 1927	16, 25, 26, 39, 41, 44, 49	Occasional.
N. minor (Smith, 1966)	31, 32, 43, 44	Occasional schools.
N. thynnoides (Valenciennes, 1835)	25, 27, 35, 37, 45, 49	Occasional large schools seen.
N. unicornis (Forsskål, 1775)	15, 17, 18a, 20, 22, 23, 26, 31, 32, 36, 37, 39, 45, 48, 50-53, 55	Moderately common.
N. vlamingii Valenciennes, 1835	20, 32, 35-37, 40, 41, 43, 45, 49, 51, 54, 56-58	Moderately common, adjacent to steeper outer slopes.
Paracanthurus hepatus (Linnaeus, 1758)	16, 22, 25, 26, 40, 41, 45, 48	Occasional.
Zebrasoma scopas (Cuvier, 1829)	7, 9, 10, 15-18a, 20-45, 48-58	Common.
Z. veliferum (Bloch, 1797)	7, 12, 15-18a, 20-22, 26-33, 35-37, 39, 41-45, 48-58	Common.
SPHYRAENIDAE		
Sphyraena barracuda (Walbaum, 1792)	12, 13, 25, 28, 45	Occasional.
S. flavicauda Rüppell, 1838	10, 33, 42	Rare, three schools of about 10-30 fish seen.
S. jello Cuvier, 1829	41, 45	Rare, only small schools seen.
S. qenie Klunzinger, 1870	41, 45	Rare, two schools seen.
SCOMBRIDAE		
Euthynnus affinis (Cantor, 1849)	15, 20, 57	Rare, but three large schools seen.
Grammatorcynus bilineatus (Quoy and Gaimard, 1824)	21, 25, 32, 35, 37, 39, 45	Occasional.
Gymnosarda unicolor (Rüppell, 1836)	25, 39, 41	Rare, only three seen.
Rastrelliger kanagurta (Cuvier, 1816)	16, 17, 20, 34, 36, 44	Occasional large schools seen.
Scomberomorus commerson (Lacepède, 1800)	15, 23, 27, 53	Rare, four large adults seen.
BOTHIDAE		
Bothus mancus (Broussonet, 1782)	46	Rare, but easily overlooked.
B. pantherinus (Rüppell, 1830)	Previously recorded.	
SOLEIDAE		
Soleichthys heterorhinos (Bleeker, 1856)	Previously recorded.	
BALISTIDAE		
Abalistes stellatus (Bloch & Schneider, 1801)	30	Rare, only one seen. New record for RA.
Balistapus undulatus (Park, 1797)	7-12, 1518a, 20-37, 39-46, 48-58	Common.
Balistoides conspicillum (Bloch and Schneider, 1801)	8, 16, 20, 22, 25-32, 37, 41, 44, 45, 49, 51, 57, 58	Moderately common.
B. viridescens (Bloch and Schneider, 1801)	8-10, 13, 21-28, 31, 32, 34-37, 39, 44, 45, 51, 54, 58	Moderately common.
Canthidermis maculatus (Bloch, 1786)	Previously recorded.	
Melichthys vidua (Solander, 1844)	16, 20-22, 25-28, 31, 32, 37, 39, 40, 43-45, 49, 51, 54, 57	Moderately common.
Odonus niger (Rüppell, 1836)	8-10, 16, 17, 20, 22, 23, 25-32, 35, 37, 39-41, 44-46, 49, 51, 54, 56	Common.
Pseudobalistes flavimarginatus (Rüppell, 1828)	22, 25, 29, 30, 33-35, 40, 42, 48-50, 52, 55, 56, 58	Moderately common, in sheltered sand or rubble areas.
P. fuscus (Bloch & Schneider, 1801)	36	Rare, only one seen.
Rhinecanthus aculeatus (Linnaeus, 1758)	34, 38, 39	Rare, only three seen.
R. rectangulus (Bloch and Schneider, 1801)	37, 41	Rare, less than 10 seen.
R. verrucosus (Linnaeus, 1758)	9, 15, 34, 35, 38, 56	Occasional, but locally common on shallow flats near shore.
Sufflamen bursa (Bloch and Schneider, 1801)	8, 9, 15-17, 20-23, 25-37, 39-46, 48-52, 54, 56-58	Common.

SPECIES	SITE RECORDS	ABUNDANCE
S. chrysoptera (Bloch and Schneider, 1801)	8-12, 15-17, 20, 22, 23, 26, 27, 29, 30, 34-37, 39-45, 48, 49, 51, 54, 56	Common.
S. fraenatus (Latreille, 1804)	22, 27, 28, 40, 41	Occasional.
Xanthichthys auromarginatus (Bennett, 1831)	31	Rare, several seen on steep outer slope.
MONACANTHIDAE		
Acreichthys tomentosus (Linnaeus, 1758)	18b	Rare, only one seen.
Aluterus scriptus (Osbeck, 1765)	22, 33	Rare, only two observed.
Amanses scopas (Cuvier, 1829)	8, 11, 15, 20, 29, 32, 34, 37, 40, 44	Occasional.
Cantherines dumerilii (Hollard, 1854)	16, 45, 58	Rare, only three seen.
C. fronticinctus (Günther, 1866)	9-11, 16, 18a, 20-22, 25, 28, 34, 39-41, 44-46, 49, 54	Occasional.
C. pardalis (Rüppell, 1866)	Previously recorded.	
Oxymonacanthus longirostris (Bloch and Schneider, 1801)	39	Rare, a single pair seen.
Paraluteres prionurus (Bleeker, 1851)	10, 23, 29	Rare, only three seen.
Paramonacanthus japonicus (Tilesius, 1801)	35	Rare, only one seen.
Pervagor janthinosoma (Bleeker, 1854)	Previously recorded.	
P. melanocephalus (Bleeker, 1853)	Previously recorded.	
P. nigrolineatus (Herre, 1927)	Previously recorded.	
Pseudomonacanthus macrurus (Bleeker, 1856)	Previously recorded.	
Rudarius minutus Tyler, 1970	21, 23	Rare, but easily overlooked. New record for RA.
OSTRACIIDAE		
Ostracion cubicus Linnaeus, 1758	15, 22, 23, 26-28, 34, 35, 40, 41, 58	Occasional.
O. meleagris Shaw, 1796	8, 16, 20, 25, 26, 35, 49, 54, 57	Occasional.
O. solorensis Bleeker, 1853	17, 21, 25, 28, 57	Rare, only six seen.
TETRAODONTIDAE		
Arothron caeruleopunctatus Matsuura, 1994	31, 46, 58	Rare, only three seen.
A. hispidus (Linnaeus, 1758)	27, 33, 35	Rare, only three seen.
A. manilensis (Marion de Procé, 1822)	Previously recorded.	
A. mappa (Lesson, 1830)	35, 36, 41, 42, 49	Rare, only five seen.
A. nigropunctatus (Bloch and Schneider, 1801)	9, 10, 16, 18a, 20-22, 25-27, 29, 31, 32, 36, 37, 39, 43, 45, 48, 51-53, 56-58	Moderately common, but always in low numbers.
A. stellatus (Schneider, 1801)	22	Rare, only one seen.
Canthigaster amboinensis (Bleeker, 1865)	Previously recorded.	
Canthigaster bennetti (Bleeker, 1854)	40	Rare, only one pair seen.
C. compressa (Procé, 1822)	Previously recorded.	
C. janthinoptera (Bleeker, 1855)	51	Rare, only one seen.
C. papua Bleeker, 1848	7, 11, 15, 18a, 20, 28, 36, 40, 42, 53	Occasional.
C. valentini (Bleeker, 1853)	10, 16, 17, 22, 23, 25, 27, 29-32, 34, 35, 43-45, 49, 51	Moderately common.
DIODONTIDAE		
Diodon hystrix Linnaeus, 1758	Previously recorded.	
D. liturosus Shaw, 1804	16, 49, 53	Rare, only three seen.

Appendix 2. Full list of zooxanthellate scleractinian corals found at 51 sites at the Raja Ampat Islands.

A total species count for each site is given at the bottom of last page. In all, 482 species are listed in this table.

Zooxanthellate Scleractinia	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Astrocoeniidae																																																			
Stylocoeniella armata														*						*									*	*																	*				
Stylocoeniella cocosensis															*																																				
Stylocoeniella guentheri				*			*				*				*	*	*	*		*		*	*	*					*	*																		*		*	
Palauastrea ramosa												*		*							*																	*									*			*	
Madracis kirbyi																*																																			
Pocilloporidae																																																		
Pocillopora ankeli									*																	*									*		*							*							*
Pocillopora damicornis	*	*		*			*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*		*	*	*		*	*	*	*	*	*		*		*		*		*	*	
Pocillopora danae	*	*		*			*		*	*	*				*	*	*	*	*		*	*	*	*		*	*	*	*	*	*	*		*	*		*	*	*	*		*	*	*	*		*		*	*	
Pocillopora elegans																														*					*					*											
Pocillopora eydouxi	*	*			*	*	*	*	*	*						*	*			*			*	*	*		*	*	*	*	*	*			*		*		*	*	*	*		*				*			*
Pocillopora kelleheri																	*															*																			
Pocillopora meandrina						*				*													*	*					*	*		*			*	*			*	*											*
Pocillopora verrucosa	*	*			*	*	*	*	*	*	*				*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Pocillopora woodjonesi																														*					*																
Seriatopora aculeata	*	*					*		*	*					*		*		*					*	*		*	*	*			*			*	*	*		*		*	*		*	*						
Seriatopora caliendrum	*	*		*					*	*	*	*			*		*				*	*	*	*	*	*	*	*	*	*			*	*			*	*	*	*	*	*	*	*					*		
Seriatopora dedritica																											*	*					*	*								*									
Seriatopora guttatus	*								*		*					*	*		*			*			*		*			*		*																			
Seriatopora hystrix	*	*	*	*						*	*	*		*	*			*	*		*	*			*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*		*	*	*		*	*	
Seriatopora stellata	*																																																		
Stylophora pistillata	*	*	*	*			*	*	*	*	*	*		*	*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*			*
Stylophora subseriata																																		*																	
Acroporidae																																																			
Montipora aequituberculata	*						*							*	*		*		*			*		*	*	*	*	*		*				*					*						*	*		*			
Montipora altasepta																																										*			*						
Montipora angulata																																							*												
Montipora cactus																																							*			*			*	*	*				
Montipora calcarea		*			*			*								*						*				*			*																						*
Montipora caliculata																						*	*	*						*					*		*		*	*	*			*							
Montipora capitata																												*			*													*	*	*	*		*		

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Montipora confusa					*	*		*		*	*				*	*						*	*	*	*	*	*			*			*				*		*	*	*	*		*							
Montipora corbetensis															*			*	*		*	*		*			*	*					*			*		*							*	*	*				*
Montipora crassituberculata																																*																*			
Montipora danae	*		*	*		*			*		*	*		*	*	*		*				*			*	*		*	*	*		*		*	*		*	*	*	*	*			*	*			*	*		*
Montipora deliculata	*			*								*															*				*														*						
Montipora digitata																															*											*									
Montipora efflorescens										*						*				*									*	*					*	*	*			*	*			*							
Montipora florida			*										*	*					*			*										*		*				*							*						
Montipora floweri																													*						*																
Montipora foliosa				*		*	*		*			*			*			*			*		*	*		*	*	*	*	*	*		*						*						*			*			
Montipora foveolata										*																				*					*	*	*				*			*							
Montipora grisea	*	*			*	*	*		*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				*	*	*		*	*	*		*	*		*		*	*	*	*
Montipora hispida	*																										*									*			*			*									
Montipora hodgsoni															*																							*													
Montipora hoffmeisteri		*	*	*	*		*				*			*		*		*			*		*			*			*	*			*		*			*		*			*	*	*	*	*	*	*		*
Montipora incrassata	*	*			*						*			*	*				*											*	*		*	*					*	*											
Montipora informis		*	*	*	*	*	*	*		*	*			*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				*	*	*	*			*	*	*	*		*		*
Montipora mactanensis	*			*								*			*			*													*							*	*												
Montipora malampaya																																						*									*				
Montipora meandrina																						*							*																						
Montipora millepora																																												*							
Montipora mollis					*						*									*																															
Montipora monasteriata	*	*		*	*	*	*			*	*	*			*	*	*	*	*	*	*		*	*		*	*	*	*		*	*			*				*		*		*	*		*		*		*	*
Montipora nodosa							*												*																										*						
Montipora plawanensis																																									*										
Montipora peltiformis																																*	*																		
Montipora porites																										*		*			*								*					*							
Montipora samarensis																															*											*									
Montipora spongodes														*																									*	*	*		*		*						
Montipora spumosa		*											*			*		*			*							*																							
Montipora stellata	*																																													*	*				
Montipora taiwanensis																																			*																
Montipora tuberculosa		*		*	*		*	*	*	*	*				*	*	*	*			*		*	*	*	*	*	*	*	*	*			*	*		*	*	*	*	*			*	*	*	*		*		*
Montipora turgescens					*			*		*						*	*				*						*		*	*						*	*		*									*	*		
Montipora turtlensis																											*						*	*																	
Montipora undata		*			*			*	*												*			*		*	*	*	*	*		*	*					*		*	*			*				*			
Montipora venosa																				*								*																							
Montipora verriculosa									*			*							*				*										*							*									*		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Montipora verrucosa																																			*	*															*
Montipora vietnamensis																																							*		*			*							
Anacropora forbesi			*	*			*												*																																
Anacropora matthai																															*																				
Anacropora puertogalerae			*	*								*							*								*	*	*		*			*											*				*	*	
Anacropora reticulata			*														*																					*		*		*							*	*	
Anacropora spinosa			*	*															*																														*		
Acropora abrolhosensis											*			*	*			*							*		*	*		*	*			*				*	*			*			*					*	
Acropora abrotanoides								*	*	*						*														*					*		*			*								*			
Acropora aculeus		*				*	*		*	*	*	*			*	*	*	*	*	*	*	*		*	*	*	*	*	*	*		*	*	*	*			*	*	*	*		*	*		*	*				*
Acropora acuminata	*							*												*										*																					
Acropora anthocercis	*	*			*			*			*					*	*				*			*						*			*																		
Acropora aspera											*				*			*										*			*	*										*								*	
Acropora austera								*	*	*	*				*	*		*	*			*					*		*			*	*		*	*	*	*	*	*		*	*	*			*	*	*	*	*
Acropora awi				*							*								*		*							*										*				*					*				
Acropora batunai																																																			*
Acropora bifurcata		*			*																		*		*		*														*		*								
Acropora brueggemanni	*		*	*			*					*	*	*	*				*			*					*				*			*		*		*	*			*			*		*				
Acropora carduus			*	*			*		*			*			*			*	*								*	*	*		*		*	*				*	*	*		*			*	*	*			*	*
Acropora caroliniana		*							*	*	*						*	*		*	*	*					*		*	*		*	*									*	*	*	*	*					
Acropora cerealis							*	*		*						*	*			*	*	*	*	*	*	*	*		*	*					*	*	*				*		*	*			*		*	*	
Acropora chesterfieldensis																																			*						*										
Acropora clathrata		*			*			*		*					*	*				*			*	*		*			*	*		*	*		*	*	*		*	*	*		*	*				*		*	
Acropora cophodactyla															*			*	*	*	*		*							*			*		*						*										
Acropora copiosa																																							*			*					*			*	
Acropora crateriformis																			*																																
Acropora cuneata																								*						*					*	*			*	*	*							*			
Acropora cylindrica																																													*						
Acropora cytherea		*			*			*	*	*	*				*				*	*		*	*	*	*	*		*	*	*		*	*		*	*	*		*	*	*		*				*	*			*
Acropora dendrum																																*				*			*		*										
Acropora derewanensis			*											*	*				*																											*					
Acropora desalwii	*																																											*							*
Acropora digitifera						*		*	*	*	*					*	*						*	*	*	*	*	*	*	*	*	*			*	*		*	*	*		*		*				*		*	*
Acropora divaricata	*	*		*	*	*	*		*	*	*	*			*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*					*		*		*			*			*				*
Acropora donei								*									*				*																*				*		*	*							*
Acropora echinata									*													*				*	*				*											*				*			*		
Acropora elegans			*				*	*	*	*		*			*	*	*	*	*		*	*											*										*			*	*				*
Acropora elseyi							*								*			*	*		*	*				*		*	*		*	*		*				*	*			*		*		*			*	*	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Acropora exquisita																																													*						
Acropora florida	*	*			*		*	*	*	*	*				*	*		*	*		*		*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*		*	*						*	*
Acropora formosa		*	*				*	*	*		*	*			*	*	*	*	*		*	*		*	*	*	*	*	*	*	*		*	*				*	*	*		*	*	*	*		*		*	*	*
Acropora gemmifera	*					*	*	*		*	*				*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*			*	*	*	*	*	*		*	*	*							*
Acropora glauca						*																								*		*									*										
Acropora globiceps																																																			*
Acropora grandis	*	*	*				*														*						*	*	*		*	*		*				*	*			*			*	*				*	
Acropora granulosa		*	*					*	*	*	*	*				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*					*	*	*		*	*	*	*	*			*	*
Acropora hoeksemai																														*		*	*				*			*										*	
Acropora horrida	*		*	*					*						*				*		*	*					*	*			*				*		*	*	*												
Acropora humilis		*	*				*	*	*	*	*	*			*	*	*	*	*	*	*	*	*			*		*	*	*		*			*	*	*		*		*	*	*	*		*		*		*	
Acropora hyacinthus	*	*			*	*	*	*	*	*	*				*	*	*	*	*	*	*		*	*	*	*	*		*	*	*	*	*		*	*	*	*	*	*	*	*		*				*	*	*	*
Acropora indonesia															*											*	*	*					*							*							*				*
Acropora inermis																																																			*
Acropora insignis					*	*				*						*		*	*	*	*			*	*	*	*	*	*	*			*						*				*								
Acropora irregularis																																								*											
Acropora kimbeensis																																											*	*						*	
Acropora kirstyae			*	*															*			*																							*				*		
Acropora latistella	*					*		*		*					*	*			*				*			*																	*	*						*	
Acropora listeri																					*														*	*															*
Acropora loisetteae			*	*								*																			*																				
Acropora lokani			*								*																											*		*				*	*		*				*
Acropora longicyathus			*	*								*			*			*	*																			*							*					*	
Acropora loripes	*	*			*	*	*	*	*	*	*	*			*	*	*	*		*	*		*	*		*			*			*	*	*	*	*	*	*		*	*		*	*		*	*		*	*	
Acropora lutkeni					*					*						*				*			*							*											*			*							
Acropora macrostoma																																*	*		*								*	*							
Acropora microclados																*								*			*			*				*	*		*		*	*	*		*	*							*
Acropora microphthalma	*		*	*			*	*	*		*				*			*	*			*				*	*	*	*		*			*				*												*	*
Acropora millepora					*	*	*		*	*	*				*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
Acropora mirabilis																				*																															
Acropora monticulosa								*	*	*						*							*	*				*		*					*		*		*	*	*			*				*			*
Acropora nana	*				*	*										*								*		*				*		*	*		*					*								*			
Acropora nasuta						*		*	*		*				*	*	*				*	*	*	*		*		*	*	*	*	*	*		*	*	*	*	*	*	*		*	*		*		*		*	*
Acropora nobilis	*	*			*		*		*	*	*				*	*							*	*			*	*	*	*		*	*		*	*	*		*	*		*	*		*			*			
Acropora ocellata																																																*			
Acropora orbicularis																																									*										
Acropora palifera	*		*		*	*	*		*	*	*	*			*	*		*	*	*		*	*	*	*	*	*	*	*	*	*	*			*	*		*	*	*	*	*	*	*				*	*	*	*
Acropora palmerae																*																																			

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Acropora paniculata	*						*				*				*				*	*	*	*		*		*		*			*	*	*		*				*	*	*		*	*						*	*
Acropora papillarae							*								*	*									*							*			*		*			*		*									
Acropora pinguis																				*																															
Acropora pichoni							*											*	*																										*		*				
Acropora plana																								*	*																										*
Acropora plumosa															*			*				*																*					*		*		*			*	*
Acropora polystoma																																			*						*							*			
Acropora prostrata																										*				*																					
Acropora pulchra			*	*								*	*	*					*									*	*		*		*	*				*				*				*			*	*	
Acropora robusta									*	*										*	*		*	*		*	*	*	*	*		*			*				*	*		*									*
Acropora rosaria																			*																																
Acropora samoensis			*	*			*				*			*					*		*	*	*		*	*	*	*	*	*					*	*		*			*	*	*	*	*	*	*		*	*	
Acropora sarmentosa				*																			*	*		*	*	*	*	*	*				*			*		*	*			*				*			
Acropora secale					*	*	*	*	*	*					*	*	*			*	*	*	*	*	*	*	*		*	*	*		*		*			*	*		*			*			*		*		
Acropora selago	*				*	*		*	*	*	*				*	*					*	*		*			*			*	*	*							*				*		*					*	*
Acropora seriata																																								*											
Acropora simplex																																											*								
Acropora solitaryensis		*			*			*		*									*	*	*		*	*						*		*	*		*	*			*	*	*			*			*	*		*	
Acropora speciosa																		*																										*							
Acropora spicifera					*																						*																								
Acropora striata											*																							*																	
Acropora subglabra				*			*		*		*				*			*	*		*	*					*	*	*	*	*	*						*	*			*	*			*	*			*	
Acropora subulata	*			*	*	*	*			*					*					*	*	*	*	*	*	*	*		*	*	*		*	*	*	*	*		*	*	*		*	*						*	*
Acropora tenella			*																																																
Acropora tenuis	*			*	*		*	*	*	*	*			*	*	*	*	*			*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*		*	*	*		*	*	*	*		*		*	*
Acropora tortuosa				*											*			*	*								*									*	*	*													
Acropora turaki			*	*			*		*						*				*								*	*											*			*					*				
Acropora valenciennesi	*				*		*	*	*	*	*				*	*	*	*		*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*					*	*
Acropora valida					*		*	*	*	*	*					*		*	*	*	*	*	*	*		*	*		*		*			*	*		*		*		*	*	*	*				*			
Acropora vaughani					*										*											*				*														*			*				
Acropora verweyi																*																			*				*		*	*									
Acropora walindii												*		*	*																														*				*		
Acropora willisae																*																												*							
Acropora yongei									*	*	*				*									*		*	*			*		*	*		*		*			*		*		*		*	*				
Astreopora cuculata													*		*					*													*	*	*						*					*	*	*			
Astreopora expansa																																														*					
Astreopora gracilis		*	*	*	*		*			*			*				*	*	*	*	*	*	*	*		*	*		*	*						*				*			*		*	*	*		*	*	
Astreopora incrustans																																														*					

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Astreopora listeri		*		*	*		*	*		*	*	*	*	*				*			*	*			*				*	*				*	*		*				*		*		*	*	*	*	*		
Astreopora myriophthalma		*		*	*	*	*	*	*	*					*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*		*			*	*		*	*	*	*		*	*		*
Astreopora ocellata											*	*	*							*													*									*	*	*	*					
Astreopora randalli																																										*			*	*				
Astreopora suggesta													*	*	*		*					*					*	*														*		*	*	*	*	*	*	
Euphyllidae																																																		
Euphyllia ancora	*		*			*		*	*		*		*	*	*						*	*				*						*										*	*			*	*				
Euphyllia cristata	*		*	*				*										*			*	*	*									*	*	*	*		*		*	*		*	*		*	*	*		*		
Euphyllia divisa			*				*	*			*	*			*																	*		*												*	*	*			
Euphyllia glabrescens		*	*	*				*					*	*	*						*									*	*	*	*	*						*				*		*					*
Euphyllia paraancora			*																																															
Euphyllia yaeyamensis			*																																															
Catalaphyllia jardinei																																	*				*													
Nemenzophyllia turbida			*																			*																												
Plerogyra simplex																		*	*		*	*																												
Plerogyra sinuosa			*		*	*		*	*		*		*	*	*	*				*	*	*		*									*						*							*	*				
Physogyra lichtensteini		*		*	*		*	*	*	*	*	*			*		*	*	*		*	*		*	*	*	*	*	*	*	*	*	*			*			*	*			*	*	*	*	*	*	*	*	*
Oculinidae																																																		
Galaxea acrhelia												*		*					*			*	*					*						*								*					*			*	
Galaxea astreata	*	*		*	*		*	*	*	*	*	*		*	*		*	*	*		*	*	*	*	*	*	*	*	*	*	*		*	*				*	*	*						*	*		*	*	*
Galaxea fascicularis	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*
Galaxea horrescens			*	*			*					*							*																			*	*				*				*		*	*	
Galaxea longisepta																																												*	*			*		
Galaxea paucisepta							*								*			*	*			*																								*				
Siderasteridae																																																		
Pseudosiderastrea tayami																				*																														
Psammocora contigua										*			*	*																															*	*	*				
Psammocora digitata				*			*	*	*								*		*																								*								*
Psammocora explanulata													*	*				*				*																							*	*			*	
Psammocora haimeana				*					*																				*	*											*									
Psammocora nierstraszi					*	*	*		*			*									*	*	*	*	*	*	*	*		*			*					*	*	*							*			*	*
Psammocora obtusangula															*																																		*	
Psammocora profundacella					*			*									*	*												*			*				*							*		*				*
Psammocora superficialis				*												*	*	*			*																									*		*		
Coscinaraea columna						*		*		*	*	*	*	*	*						*	*					*	*		*			*				*				*							*	*		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Coscinaraea crassa																																																*			
Coscinaraea exesa														*														*																										
Coscinaraea monile										*		*	*																																								
Coscinaraea wellsi																						*																												*					
Agariciidae																																																			
Pavona bipartita		*	*	*	*	*			*			*				*		*		*	*					*		*	*	*	*							*	*										*	*	
Pavona cactus			*	*			*				*	*	*	*	*			*	*			*				*		*			*												*			*	*	*			*	*
Pavona clavus			*				*	*	*			*						*			*	*		*			*		*		*		*		*		*	*			*				*		*		*			*	
Pavona decussata	*		*				*		*	*		*	*	*	*			*			*	*	*		*	*	*	*	*	*	*	*	*										*		*		*	*	
Pavona duerdeni		*			*					*						*		*		*			*			*	*	*					*			*	*	*	*		*											*
Pavona explanulata		*			*	*	*	*	*	*	*	*		*	*	*	*	*	*		*	*			*	*	*	*	*	*			*		*		*	*	*	*	*		*	*	*	*	*	*		*	*
Pavona frondifera												*																																		*		*		*	*	
Pavona maldivensis							*																																													
Pavona minuta							*					*				*					*																														
Pavona varians		*	*	*		*	*	*	*	*	*	*		*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*		*		*	*		*	*	*	*		*	*	*		*	*	*	*	*
Pavona venosa							*					*			*	*			*	*		*					*	*	*				*					*	*			*		*		*	*		*	*	
Leptoseris amitoriensis																																												*				*		*		
Leptoseris explanata	*		*	*	*			*	*	*	*	*			*	*			*	*	*	*	*	*	*			*	*	*		*	*	*	*				*		*		*		*	*	*		*		*
Leptoseris foliosa							*											*																													*		*	*	
Leptoseris gardineri			*																*		*																							*		*		*		
Leptoseris hawaiiensis	*				*	*	*								*	*		*			*	*				*		*		*																		*	*	*	
Leptoseris incrustans							*	*																																												
Leptoseris mycetoseroides					*	*	*	*	*	*	*			*		*				*	*					*	*	*		*			*					*					*				*	*	*	*	*
Leptoseris papyracea																						*																							*				*		
Leptoseris scabra				*		*	*	*	*		*	*			*	*	*		*		*	*							*										*				*	*	*	*	*			*	
Leptoseris solida	*			*				*							*	*								*				*																*					*		*	
Leptoseris striata	*		*	*			*			*				*	*	*	*	*	*																									*	*		*		
Leptoseris yabei																																						*							*						*
Gardineroseris planulata	*	*				*	*	*	*	*	*	*				*					*	*		*	*	*	*	*	*		*	*		*	*		*	*	*		*	*		*					*	
Coeloseris mayeri	*		*	*		*	*			*		*	*	*		*		*	*		*		*		*	*	*	*	*	*		*	*	*	*		*	*	*	*	*	*	*	*		*	*	*	*	*	*
Pachyseris foliosa														*	*					*				*																*					*	*		*	*	*		*	*	
Pachyseris gemmae							*								*				*																																
Pachyseris involuta																															*																		*		
Pachyseris rugosa			*	*				*	*	*		*		*	*			*	*			*				*		*	*	*	*								*		*			*	*	*		*				*
Pachyseris speciosa	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*	*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*

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Fungiidae																																																			
Cycloseris colini																	*																													*	*				
Cycloseris costulata															*	*																																			
Cycloseris cyclolites																		*																																	
Cycloseris erosa																		*																																	
Cycloseris patelliformis															*																																				
Cycloseris sinensis														*																						*										*					
Cycloseris somervillei	*		*			*	*								*																				*												*				
Cycloseris vaughani																*																				*													*		
Cantharellus jebbi					*																																									*	*				
Cantharellus nuomeae																																														*					
Heliofungia actiniformis			*	*					*		*	*	*		*			*			*	*			*	*						*		*				*	*				*			*	*		*		
Fungia concinna			*	*		*	*	*	*	*	*	*	*	*	*	*		*	*		*	*		*		*	*	*	*	*			*	*		*			*				*		*	*	*		*	*	*
Fungia corona									*	*	*				*				*						*		*	*		*	*		*									*									
Fungia danai			*	*		*	*		*	*	*	*		*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*		*	*	*	*		*	*	*			*		*	*	*		*	*	*
Fungia fralinae			*	*								*	*	*				*						*							*			*												*	*				
Fungia fungites			*		*	*	*	*	*		*	*	*	*	*		*	*	*		*	*		*		*	*	*	*	*	*		*	*	*			*	*	*		*	*	*	*	*	*		*	*	*
Fungia granulosa			*	*		*	*		*	*	*	*		*	*						*	*		*		*									*	*		*	*		*	*			*	*	*		*		*
Fungia horrida			*	*			*		*	*	*	*	*	*	*		*	*	*		*	*		*			*	*	*	*			*	*	*			*	*	*		*	*		*	*	*		*	*	*
Fungia klunzingeri			*			*				*	*	*						*			*	*											*									*									
Fungia moluccensis			*									*	*	*	*		*	*	*	*	*	*		*														*		*			*			*	*		*	*	*
Fungia paumotensis	*		*	*		*		*	*	*	*	*		*	*		*	*	*	*	*	*	*	*		*	*	*	*	*	*		*	*	*			*	*	*		*	*	*	*	*	*		*	*	*
Fungia repanda						*				*	*						*						*			*	*	*			*			*	*			*	*	*		*							*		
Fungia scabra				*																	*						*								*																
Fungia scruposa										*	*	*			*		*					*				*			*		*		*	*	*				*	*					*						
Fungia scutaria						*										*	*									*				*					*	*	*		*	*	*	*		*						*	
Fungia spinifer			*																																											*					
Ctenactis albitentaculata	*		*								*	*		*				*		*	*	*					*			*			*	*				*	*				*		*		*			*	*
Ctenactis crassa			*	*			*		*	*	*			*	*		*	*			*	*		*	*		*	*	*	*	*		*	*	*			*	*	*			*		*		*		*	*	*
Ctenactis echinata			*	*		*				*	*				*		*	*	*		*		*	*		*	*	*		*			*	*		*		*	*	*		*	*		*	*	*		*	*	
Herpolitha limax			*	*		*		*		*	*	*	*	*	*		*	*	*	*	*	*	*		*	*	*	*	*	*	*		*	*	*			*	*	*			*	*	*	*	*		*	*	*
Herpolitha weberi											*			*														*										*	*							*	*				
Polyphyllia novaehiberniae																					*					*						*																			
Polyphyllia talpina	*			*							*				*		*		*		*	*				*		*	*		*		*	*	*	*			*	*		*	*	*		*					*
Sandalolitha dentata																						*										*																			
Sandalolitha robusta	*		*	*			*	*	*	*	*				*		*	*	*	*	*	*	*	*	*	*	*			*	*		*	*	*	*		*	*		*	*	*	*		*	*		*	*	*
Halomitra clavator										*	*				*																			*											*		*				
Halomitra meierar																														*			*																		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Halomitra pileus						*					*				*		*				*	*			*		*						*	*	*			*	*	*										*	
Zoopilus echinatus																						*											*					*					*		*	*	*		*		
Lithophyllon mokai			*	*							*		*								*							*	*																	*				*	
Podabacia crustacea			*	*			*	*		*	*	*			*			*	*	*	*	*				*			*	*			*										*		*	*	*	*	*		*
Podabacia motuporensis									*							*	*	*			*			*	*													*							*		*				
Pectinidae																																																			
Echinophyllia aspera								*	*	*	*	*	*	*	*	*		*	*		*	*	*	*		*	*	*	*	*		*	*					*	*	*			*		*	*				*	*
Echinophyllia costata														*	*											*				*																	*				
Echinophyllia echinata			*	*			*			*						*	*	*	*			*				*			*									*					*			*	*			*	
Echinophyllia echinoporoides									*	*					*	*		*	*		*	*				*				*			*						*												
Echinophyllia orpheensis														*				*																																*	*
Echinophyllia patula														*		*		*																																	
Echinomorpha nishihirea							*																																												
Oxypora crassispinosa	*						*		*	*	*	*			*	*	*	*	*		*	*				*		*	*	*		*	*			*				*	*		*		*	*	*		*	*	*
Oxypora glabra									*					*																			*					*	*	*			*		*	*			*		
Oxypora lacera	*	*		*	*		*	*	*	*	*	*		*	*	*	*	*	*		*			*	*	*	*	*	*				*	*				*	*	*		*	*	*	*	*	*	*	*		*
Mycedium elephatotus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*		*			*	*	*	*	*	*	*			*	*	*			*	*		*		*	*	*	*
Mycedium robokaki		*					*		*	*	*	*	*		*		*	*	*	*	*	*	*	*		*	*	*	*	*			*	*		*		*	*	*		*	*		*			*	*	*	*
Mycedium mancaoi							*	*	*	*	*				*	*	*	*			*					*	*	*	*	*								*	*	*		*	*		*		*		*	*	*
Pectinia alcicornis			*						*	*		*	*	*				*	*									*	*					*									*		*	*	*			*	
Pectinia ayleni	*			*			*		*		*																																								
Pectinia elongata			*										*					*																																	
Pectinia lactuca	*	*		*			*	*	*	*	*	*		*	*			*				*	*	*		*	*	*	*	*	*	*	*	*		*	*	*	*	*		*	*	*					*	*	*
Pectinia paeonia		*	*								*			*	*		*	*	*		*	*		*			*		*	*				*				*	*	*					*	*	*		*	*	*
Pectinia pygmaeus														*																																					
Pectinia teres																																										*	*			*	*		*	*	
Pectinia maxima			*								*				*	*		*	*		*	*				*		*					*	*				*				*							*		
Merulinidae																																																			
Hydnophora exesa	*		*				*	*	*	*	*		*	*	*			*				*	*	*	*	*	*	*	*				*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*
Hydnophora grandis								*	*		*															*	*				*	*	*						*				*			*					*
Hydnophora microconos		*				*		*	*	*					*	*	*	*		*	*		*		*	*	*	*	*	*	*	*	*		*		*		*	*	*		*	*							*
Hydnophora pilosa										*	*																			*	*		*	*			*	*	*										*		
Hydnophora rigida			*	*				*	*		*	*	*	*	*	*			*		*	*			*	*	*	*	*	*			*	*			*	*		*		*	*	*		*	*		*	*	*
Merulina ampliata		*	*	*	*		*		*	*	*	*	*	*	*			*	*		*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
Merulina scabricula	*						*		*	*	*	*			*			*	*		*	*	*	*		*	*	*	*	*	*		*					*	*			*	*		*				*	*	*
Scapophyllia cylindrica		*								*												*																												*	

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Dendrophylliidae																																																			
Turbinaria frondens	*				*			*	*		*						*			*						*	*			*	*	*	*	*														*			*
Turbinaria irregularis,									*	*																	*			*								*										*	*		
Turbinaria mesenterina		*		*				*	*	*	*					*	*	*		*	*	*	*	*	*	*			*	*	*	*	*	*	*																
Turbinaria patula																																																			*
Turbinaria peltata		*			*				*		*						*	*						*		*			*	*		*	*	*					*	*	*		*	*		*		*	*		
Turbinaria reniformis		*		*					*	*	*	*		*	*			*	*		*					*			*	*					*							*		*	*				*	*	*
Turbinaria stellulata			*	*			*	*		*			*	*	*		*					*																					*			*			*		*
Mussidae																																																			
Micromussa amakusensis													*	*			*			*			*	*				*		*																					
Micromussa minuta																										*		*			*				*		*		*	*	*										*
Acanthastrea brevis																										*																									
Acanthastrea echinata																		*																*	*						*		*								
Acanthastrea hemprichii								*																				*	*						*																*
Acanthastrea hillae																																					*														
Acanthastrea ishigakiensis													*																																						
Acanthastrea subechinata																																					*		*	*								*			
Acanthastrea regularis							*	*	*	*	*										*	*	*			*		*	*					*									*			*	*	*			
Acanthastrea sp. 1							*											*		*			*					*						*								*	*			*			*	*	
Acanthastrea sp. 2																																										*									
Lobophyllia corymbosa			*											*																				*					*			*					*		*		
Lobophyllia dentatus																		*																								*	*								
Lobophyllia diminuta																																		*																*	
Lobophyllia flabelliformis																					*			*			*						*																	*	*
Lobophyllia hataii			*	*					*	*	*	*	*	*				*	*				*			*			*														*		*	*	*		*	*	*
Lobophyllia hemprichii			*	*		*	*			*		*	*	*	*				*		*	*		*		*	*	*	*	*	*		*	*		*		*	*	*		*	*	*	*	*	*		*		*
Lobophyllia pachysepta														*																																					
Lobophyllia robusta		*					*	*	*	*	*	*		*	*			*		*	*	*				*	*	*	*			*	*		*	*			*	*	*	*	*			*				*	*
Symphyllia agaricia	*	*			*	*	*	*	*	*		*	*	*	*		*			*	*		*	*	*	*	*	*	*	*	*		*	*	*	*	*	*		*		*	*	*				*		*	*
Symphyllia hassi										*	*																	*	*																						
Symphyllia radians		*								*					*					*				*		*		*	*	*	*		*		*		*			*	*							*			*
Symphyllia recta	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*		*	*	*	*		*	*	*	*	*	*	*	*	*	*
Symphyllia valenciennesii									*	*	*									*		*	*			*			*	*				*										*							
Scolymia australis																			*			*																						*						*	*
Scolymia vitiensis													*					*																											*						
Australomussa rowleyensis			*	*			*		*		*		*	*	*		*	*	*		*	*							*									*	*				*	*		*	*	*	*	*	*
Cynarina lacrymalis			*				*							*	*							*																					*	*			*				

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Faviidae																																																			
Caulastrea furcata											*			*																																*					
Caulastrea tumida																																														*					
Favia danae																						*									*														*	*	*		*		
Favia favus		*	*	*		*	*	*	*		*	*	*	*	*	*		*	*			*								*		*	*	*		*		*				*	*		*	*	*		*	*	
Favia helianthoides																	*			*																															
Favia laxa			*											*	*				*			*																								*	*				
Favia lizardensis			*							*	*	*	*	*	*		*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*				*	*	*		*	*			*				*	
Favia maritima			*										*				*					*	*	*			*			*				*						*											
Favia marshae																										*																					*				
Favia matthai	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*		*	*	*	*		*		*	*
Favia maxima																																*	*																	*	*
Favia pallida	*	*	*			*	*	*	*					*			*	*	*	*	*	*	*			*		*	*	*	*	*	*	*	*	*		*	*	*		*	*	*		*	*		*	*	*
Favia rosaria				*														*				*																													
Favia rotumana																													*					*			*			*			*					*			*
Favia rotundata				*				*			*			*			*		*	*		*							*								*	*		*			*							*	
Favia speciosa			*			*	*			*	*	*	*	*	*			*	*		*	*	*					*	*	*	*	*	*	*				*	*	*			*		*	*	*	*			
Favia stelligera								*		*	*				*	*	*						*	*		*		*	*	*	*				*	*		*	*				*	*				*			
Favia truncatus												*				*		*				*	*			*			*	*	*	*					*					*		*	*						
Favia veroni																					*					*			*	*			*				*			*											
Barabattoia amicorum														*								*						*			*															*	*				*
Barabattoia laddi																*	*					*						*									*										*			*	
Favites acuticulis														*																							*		*												
Favites abdita				*	*	*	*	*		*	*	*		*	*	*		*	*		*	*	*		*	*	*		*	*	*	*			*			*	*	*			*			*	*		*	*	*
Favites chinensis												*		*																														*							
Favites complanata	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*		*		*
Favites flexuosa						*	*	*	*	*	*	*	*		*			*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*		*			*	*		*					*	*		*
Favites halicora			*						*	*	*	*	*	*	*				*	*			*					*	*					*				*					*		*	*	*				
Favites micropentagona										*						*							*			*			*	*					*		*			*	*			*							*
Favites paraflexuosa																		*					*		*						*	*					*		*	*	*		*	*							
Favites pentagona	*	*			*		*	*		*	*				*	*		*	*	*	*	*	*	*			*		*	*		*	*	*		*	*		*	*	*			*		*		*			*
Favites russelli		*			*			*	*	*	*	*			*		*		*	*	*	*	*	*		*		*	*		*	*	*		*	*	*	*		*	*		*	*				*		*	*
Favites spinosa																																								*				*							
Favites stylifera																	*						*		*	*										*	*			*	*		*								
Favites vasta											*																							*		*										*			*		
Goniastrea aspera	*								*	*	*	*	*		*	*	*	*	*							*		*	*	*		*								*						*			*		
Goniastrea australensis				*									*		*			*																				*					*					*			
Goniastrea edwardsi		*					*	*	*	*	*	*		*	*	*			*			*		*		*	*		*	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Goniastrea favulus											*																																								
Goniastrea minuta																*													*										*												
Goniastrea pectinata	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Goniastrea retiformis	*					*	*	*	*	*	*	*			*	*		*	*		*		*	*		*	*	*	*	*	*		*		*	*	*		*			*		*	*	*	*			*	*
Platygyra acuta										*		*												*							*			*						*							*				
Platygyra contorta																																								*											*
Platygyra daedalea	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
Platygyra lamellina			*	*		*		*			*				*				*		*							*	*	*			*	*				*		*	*		*		*	*				*	
Platygyra pini		*	*	*			*	*	*	*	*		*		*		*	*	*	*	*	*						*	*	*					*		*	*	*	*		*		*		*	*				
Platygyra ryukyuensis							*		*	*	*				*			*			*	*				*		*	*		*		*	*			*	*	*		*						*			*	
Platygyra sinensis		*				*	*	*	*	*	*					*		*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	*		*	*	*	*	*	*
Platygyra verweyi	*		*				*	*	*	*	*	*				*	*	*			*	*	*	*		*	*	*	*	*	*	*	*		*	*	*			*		*								*	*
Platygyra yaeyemaensis									*	*		*				*										*	*			*							*			*										*	
Oulophyllia bennettae					*				*	*	*							*	*		*	*	*	*		*	*															*				*			*	*	*
Oulophyllia crispa		*		*	*		*	*		*	*				*	*		*		*	*	*		*		*	*	*	*	*		*	*		*		*		*	*		*	*	*					*		*
Oulophyllia levis		*							*												*		*	*		*						*		*																	
Leptoria irregularis																																			*					*			*								
Leptoria phrygia						*		*		*						*	*	*					*	*		*		*	*	*	*		*		*	*	*		*	*		*								*	*
Montastrea annuligera		*													*								*	*	*			*		*																			*		*
Montastrea colemani		*														*		*		*			*														*											*			
Montastrea curta	*							*		*	*			*		*	*	*				*				*		*		*					*					*		*					*	*			
Montastrea magnistellata								*		*	*	*	*					*	*		*		*					*	*					*				*							*				*		
Montastrea salebrosa														*				*	*		*							*						*											*						
Montastrea valenciennesi																																					*						*								
Plesiastrea versipora								*	*	*	*		*		*	*	*			*	*	*			*	*	*	*	*	*	*	*	*	*	*	*		*			*			*			*	*		*	*
Oulastrea crispata															*	*		*																																	
Diploastrea heliopora	*	*		*			*	*	*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*		*	*	*				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Leptastrea aequalis																																					*									*					
Leptastrea bottae			*																																																
Leptastrea pruinosa	*	*	*	*		*	*	*	*	*						*	*	*	*		*	*		*		*	*	*	*	*	*	*					*		*	*		*	*				*	*	*	*	
Leptastrea purpurea				*				*			*				*				*			*							*		*	*	*				*		*		*					*	*		*	*	
Leptastrea transversa	*		*	*			*	*	*	*	*	*	*	*	*		*	*	*	*	*	*				*			*		*			*												*	*		*		
Cyphastrea chalcidium			*					*		*			*	*		*	*	*	*		*		*	*			*	*	*	*		*								*			*	*				*			
Cyphastrea decadia							*															*																													
Cyphastrea japonica							*		*	*		*		*		*		*			*	*	*						*		*						*				*		*		*	*	*		*		*
Cyphastrea microphthalma	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*		*	*	*	*	*	*		*	*	*		*	*		*	*	*	*	*	*	*		*		*	*
Cyphastrea ocellina																																																	*		
Cyphastrea serailia			*	*	*	*	*		*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*			*	*		*			*		*				*	*	*	*		*	*	*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Echinopora gemmacea		*			*				*	*	*	*	*		*	*	*	*	*		*		*			*			*	*			*		*		*	*		*			*	*			*	*	*	*	*
Echinopora hirsutissima		*																																																	
Echinopora horrida							*				*				*				*		*	*							*														*						*	*	
Echinopora lamellosa	*		*				*		*	*	*	*	*		*			*	*		*	*	*	*		*	*	*	*	*			*	*		*		*	*	*	*	*	*	*			*		*	*	
Echinopora mammiformis			*	*							*			*					*																								*			*	*		*	*	
Echinopora pacificus												*		*				*															*												*		*				
Echinopora taylorae															*	*		*																											*	*					
Trachyphyllidae																																																			
Trachyphyllia geoffroyi			*																																																
Poritidae																																																			
Porites aranetai		*	*																																																
Porites annae	*														*				*											*										*											
Porites attenuata	*		*	*	*	*		*				*		*	*	*	*	*			*			*		*	*	*					*				*				*		*	*	*						
Porites cumulatus														*	*				*					*			*			*	*	*	*																		
Porites cylindrica	*		*	*			*					*	*	*	*			*	*		*					*		*	*		*		*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
Porites deformis																																	*																		
Porites densa																																								*											
Porites evermanni														*														*						*						*											
Porites flavus			*																																											*	*		*		
Porites heronensis																														*																					
Porites horizontalata													*	*				*																													*		*	*	
Porites latistellata	*									*	*			*												*		*		*			*		*											*					
Porites lichen	*	*	*	*	*						*	*			*											*	*		*	*			*	*	*				*	*	*		*		*		*	*			*
Porites monticulosa														*	*	*						*		*															*			*			*		*			*	
Porites negrosensis				*																									*						*											*	*		*		
Porites nigrescens	*		*	*			*		*	*	*	*				*		*	*				*	*	*	*			*	*					*	*	*	*	*	*		*	*	*	*				*	*	*
Porites profundus														*																									*							*					
Porites rugosa																																														*	*		*	*	
Porites rus	*	*	*	*			*					*												*		*		*	*				*		*	*				*			*	*	*	*	*		*	*	*
Porites stephensoni																																*																			
Porites tuberculosa		*			*	*						*						*					*	*		*	*						*																		
Porites vaughani	*	*						*			*	*			*	*	*	*	*	*	*		*	*	*	*	*	*	*			*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*
Porites massive	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Goniopora albiconus		*	*									*	*	*				*																*								*		*				*		*	
Goniopora burgosi																												*																		*					
Goniopora columna			*				*	*	*		*										*	*				*	*	*	*				*	*					*	*			*			*	*		*	*	*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	42	43	44	45	47	48	49	50	52	53	54	55	56	58
Goniopora djiboutiensis			*					*					*									*						*	*				*													*			*	*	
Goniopora eclipsensis			*										*	*																				*															*		
Goniopora fruticosa																										*													*	*											
Goniopora lobata	*	*									*				*	*			*										*		*	*	*					*		*			*			*					
Goniopora minor			*												*			*			*	*	*			*		*	*				*		*	*		*	*			*	*			*	*	*			
Goniopora palmensis																																		*																	
Goniopora pandoraensis											*			*																												*							*	*	
Goniopora pendulus								*				*																														*									
Goniopora somaliensis			*	*			*	*	*					*	*	*		*	*				*			*					*	*	*		*					*			*			*	*		*	*	
Goniopora stokesi						*					*		*			*																	*							*			*			*	*				
Goniopora stutchburyi							*	*		*	*		*	*				*			*	*																											*		*
Goniopora tenuidens	*	*	*				*				*				*	*										*	*		*		*	*	*	*	*		*		*	*			*	*		*		*		*	
Alveopora catalai																					*										*																*				
Alveopora daedalea																																*																			
Alveopora excelsa																																								*	*										
Alveopora fenestrata																																							*												
Alveopora gigas															*																															*	*				
Alveopora minuta																																								*								*			
Alveopora spongiosa					*				*	*					*	*														*		*			*					*		*	*								
Alveopora tizardi							*	*													*								*									*	*									*			
	93	90	123	110	76	77	139	122	140	155	164	121	76	121	182	132	110	168	147	86	161	169	120	126	81	169	143	159	174	173	118	112	153	125	135	85	103	134	161	163	103	116	160	129	125	156	163	92	141	154	144

Appendix 3A. Biological and physical characteristics of survey sites.

Key: Decimal site numbers refer to deep (.1) and shallow (.2) depths; Max and Min are depth values; and Slp is the slope. Biotic categories HS, HC, SC, MA, TA, CA and DC are visual estimates of percent cover.

Location	Station name	Site	Max	Min	Slp	HS	HC	SC	MA	TA	CA	DC
Salawati	Pulau Senapan/Jef Doif, NW	**1.1**	41	10	50	90	5	10	20	10	5	1
Salawati	Pulau Senapan/Jef Doif, NW	**1.2**	8	1	5	90	15	10	15	30	5	60
Salawati	Pulau Senapan/Jef Doif, SE	**2.1**	15	8	2	30	30	20	2	10	2	2
Batanta	NE: long inlet	**3.1**	33	8	20	30	5	0	20	10	0	2
Batanta	NE: long inlet	**3.2**	8	1	40	80	70	0	20	10	0	5
Batanta	N-Center: Divided bay E of Warai Bay	**4.1**	35	10	30	20	30	2	10	10	2	2
Batanta	N-Center: Divided bay E of Warai Bay	**4.2**	8	1	40	70	60	1	20	10	0	5
Batanta	Tanjung Mabo	**5.1**	35	10	30	60	10	10	5	10	5	2
Batanta	Tanjung Mabo	**5.2**	8	4	5	90	50	30	10	10	5	5
Batanta	Rocks off headland E of Tg Mabo	**6.1**	40	10	30	50	10	10	10	10	5	0
Batanta	Rocks off headland E of Tg Mabo	**6.2**	8	1	5	95	30	5	10	10	10	2
Misool	N Wagmab (E-center island chain)	**7.1**	28	10	50	70	5	5	1	20	10	0
Misool	N Wagmab (E-center island chain)	**7.2**	8	0.5	80	100	20	40	2	10	10	10
Misool	N Farondi (E-center island chain)	**8.1**	35	10	40	90	10	20	0	10	0	0
Misool	N Farondi (E-center island chain)	**8.2**	8	1	5	100	20	70	0	10	5	0
Misool	S Wagmab (E-center island chain)	**9.1**	35	10	30	70	15	20	0	10	0	0
Misool	S Wagmab (E-center island chain)	**9.2**	8	1	40	95	60	20	0	10	10	2
Misool	E Bajampop (W-center island chain)	**10.1**	25	10	20	80	10	10	10	10	5	0
Misool	E Bajampop (W-center island chain)	**10.2**	8	1	5	95	40	20	2	10	2	1
Misool	Mesemta (W-center island chain)	**11.1**	28	10	20	70	20	20	0	10	0	0
Misool	Mesemta (W-center island chain)	**11.2**	8	1	5	95	80	10	0	5	0	5
Misool	Bajampop (W-center island chain)	**12.1**	20	10	30	70	30	5	5	10	0	2
Misool	Bajampop (W-center island chain)	**12.2**	8	1	10	80	30	5	2	20	0	5
Misool	Papas Tip Pale (W island chain) near cave	**13.2**	10	1	30	60	30	0	10	10	10	0
Misool	Papas Tip Pale (W island chain)	**14.2**	16	1	50	80	40	0	2	10	5	2
Misool	N Djam (southern islands)	**15.1**	36	10	40	70	40	5	5	10	10	0
Misool	N Djam (southern islands)	**15.2**	8	0	40	95	90	5	2	5	5	5
Misool	SW Kalig (southern islands)	**16.1**	36	10	70	90	5	5	0	10	10	0
Misool	SW Kalig (southern islands)	**16.2**	8	1.5	5	100	30	5	1	10	10	2
Misool	SW Mate (southern islands)	**17.1**	40	10	40	90	10	2	0	10	2	0
Misool	SW Mate (southern islands)	**17.2**	8	2	40	100	10	30	0	10	5	0
Misool	Los (southern islands)	**18.1**	33	10	10	90	15	2	2	10	5	0
Misool	Los (southern islands)	**18.2**	8	0	30	95	80	5	5	5	5	2
Misool	Jef Pelee (inner W bay)	**19.1**	35	10	30	50	20	2	0	10	0	2
Misool	Jef Pelee (inner W bay)	**19.2**	8	1	40	80	60	2	0	10	0	10
Misool	Pulau Tiga (SW side middle island)	**22.1**	22	10	30	80	2	20	0	40	5	0
Misool	Pulau Tiga (SW side middle island)	**22.2**	8	1	10	90	5	40	0	30	0	0
Misool	S shore opposite middle P. Tiga island	**23.2**	15	1	50	60	50	20	0	10	0	0
Misool	Jef Bi	**24.1**	22	10	40	60	20	5	0	10	0	0
Misool	Jef Bi	**24.2**	8	1	20	90	40	10	2	10	0	10
Misool	Cot Malankari	**25.1**	18	10	10	70	5	1	1	10	10	0
Misool	Cot Malankari	**25.2**	8	1	5	80	10	2	0	10	10	2
Misool	Nampale NW	**26.1**	22	10	10	80	10	2	0	10	5	0
Misool	Nampale NW	**26.2**	8	0	5	95	20	2	0	10	5	5
Misool	Channel between Kanari & Kamet	**27.1**	22	10	30	60	20	20	5	10	10	0

Appendix 3A. (continued)

Location	Station name	Site	Max	Min	Slp	HS	HC	SC	MA	TA	CA	DC
Misool	Channel between Kanari & Kamet	**27.2**	8	1	20	80	30	20	5	10	10	5
Kofiau	S Walo	**28.1**	47	10	50	85	10	3	0	10	10	0
Kofiau	S Walo	**28.2**	8	1	10	95	30	5	0	10	10	3
Kofiau	Anjoean	**29.1**	16	8	20	70	30	3	1	10	0	0
Kofiau	Anjoean	**29.2**	8	1	10	90	90	5	2	2	0	5
Kofiau	S Miatkari Island	**30.1**	16	8	20	60	30	10	2	10	0	0
Kofiau	S Miatkari Island	**30.2**	8	1	10	70	30	5	2	10	0	3
Kofiau	Wambong Bay	**31.1**	47	10	40	60	10	2	3	10	5	0
Kofiau	Wambong Bay	**31.2**	8	1	5	85	30	5	3	10	10	0
Kofiau	Tg Sool	**32.1**	43	10	50	90	10	2	2	20	10	0
Kofiau	Tg Sool	**32.2**	8	1	20	90	40	10	3	10	10	3
Kofiau	Deer island	**33.2**	16	0.5	20	60	20	40	20	5	0	5
Waigaio	Selpele	**34.1**	30	10	20	50	10	20	3	10	0	0
Waigaio	Selpele	**34.2**	8	0.5	5	90	15	70	5	10	0	2
Waigaio	N of pearl farm	**35.1**	40	10	70	90	10	10	2	70	0	0
Waigaio	N of pearl farm	**35.2**	8	0.5	5	95	40	30	0	10	0	0
Waigaio	E of pearl farm	**36.1**	25	10	10	20	30	20	10	10	0	0
Waigaio	E of pearl farm	**36.2**	8	0.5	20	80	60	10	10	10	0	5
Sayang	N-center	**37.1**	36	10	30	60	10	5	1	10	10	0
Sayang	N-center	**37.2**	8	1	20	90	20	2	3	20	10	1
Sayang	Ai Island S	**39.1**	36	10	20	40	30	5	5	10	10	0
Sayang	Ai Island S	**39.2**	8	4	5	70	80	5	0	5	10	5
Sayang	bommies W	**40.2**	9	5	0	70	60	10	5	10	10	1
Wayag	large bay W	**42.1**	32	10	20	40	30	10	2	10	0	2
Wayag	large bay W	**42.2**	8	1	5	80	60	20	0	10	5	5
Wayag	center-east	**43.1**	40	10	30	60	50	30	2	10	20	5
Wayag	center-east	**43.2**	8	0.5	10	85	60	30	2	10	20	5
Quoy	islets to south	**44.1**	34	10	30	50	20	5	1	10	10	2
Quoy	islets to south	**44.2**	8	1	5	85	50	20	2	10	10	5
Bag	southeast	**45.1**	35	6	10	95	20	3	0	10	10	0
Uranie	west bay	**47.1**	23	10	10	70	40	5	1	2	3	0
Uranie	west bay	**47.2**	8	0.5	10	85	70	20	1	5	2	2
Kawe	middle E bay, S side	**48.1**	37	10	30	80	20	0	0	10	10	0
Kawe	middle E bay, S side	**48.2**	8	1	10	80	20	3	1	10	0	3
Kawe	southern peninsula E bay	**49.1**	32	10	10	80	5	1	0	20	5	0
Kawe	southern peninsula E bay	**49.2**	8	4	5	100	5	3	0	20	5	0
Kawe	inner E bay, S side	**50.1**	33	10	20	95	70	5	2	10	10	2
Kawe	inner E bay, S side	**50.2**	8	1	20	95	70	5	2	10	10	3
Waigeo	island S Tl Fofak opposite mouth	**52.1**	28	10	40	80	30	5	3	10	0	2
Waigeo	island S Tl Fofak opposite mouth	**52.2**	8	0.5	10	95	50	10	0	10	0	0
Waigeo	reef W of Delphine Is, E Fofak Bay	**53.1**	30	10	40	80	50	5	10	10	0	2
Waigeo	reef W of Delphine Is, E Fofak Bay	**53.2**	8	1.5	5	100	70	2	1	10	0	3
Waigeo	Boni island, N reef	**54.1**	25	10	30	80	20	3	10	10	10	0
Waigeo	Boni island, N reef	**54.2**	8	3	3	90	20	2	5	10	20	2
Waigeo	bay W of Boni Island	**55.1**	22	10	30	85	50	10	10	10	0	5
Waigeo	bay W of Boni Island	**55.2**	8	1	20	95	80	5	5	10	0	5
Waigeo	Boni island, S reef	**56.1**	37	10	40	70	40	20	3	10	0	2
Waigeo	Boni island, S reef	**56.2**	8	1	40	90	50	20	0	10	0	3
Waigeo	Wayam island N side	**58.2**	17	1	30	70	40	20	0	10	5	2

Appendix 3B. Reef characteristics.

Physical categories CP, LB, SB, RBL and SN are visual estimates (%) of structural cover; RD and EXP are ratings of reef development and exposure. VIS is underwater visibility (m); WT is seawater temperature; Sp is the number of species recorded for the site; and Tot is the total number of species.

Location	Station name	Site	CP	LB	SB	RBL	SN	RD	EXP	VIS	WT	Sp	Tot
Salawati	Pulau Senapan/Jef Doif, NW	**1.1**	80	0	10	10	0	2	2	25	29	**48**	
Salawati	Pulau Senapan/Jef Doif, NW	**1.2**	70	10	10	10	0	2	3	20	29	**59**	**93**
Salawati	Pulau Senapan/Jef Doif, SE	**2.1**	0	20	10	10	60	2	2	20	29	**90**	**90**
Batanta	NE: long inlet	**3.1**	0	0	30	50	20	3	1	7	29	**57**	
Batanta	NE: long inlet	**3.2**	40	20	20	20	0	3	1	4	29	**94**	**124**
Batanta	N-Center: Div. bay E of Warai Bay	**4.1**	0	10	10	30	50	2	1	10	29	**71**	
Batanta	N-Center: Div. bay E of Warai Bay	**4.2**	40	10	20	20	10	2	1	8	29	**73**	**110**
Batanta	Tanjung Mabo	**5.1**	40	0	20	20	20	3	2	12	28	**58**	
Batanta	Tanjung Mabo	**5.2**	30	50	10	5	5	3	3	20	28	**37**	**76**
Batanta	Rocks off headland E of Tg Mabo	**6.1**	40	0	10	40	10	2	2	20	27	**47**	
Batanta	Rocks off headland E of Tg Mabo	**6.2**	40	30	15	5	0	2	3	15	27	**47**	**77**
Misool	N Wagmab (E-center is. chain)	**7.1**	50	10	10	5	25	3	1	10	27	**31**	
Misool	N Wagmab (E-center is. chain)	**7.2**	100	0	0	0	0	3	1	10	27	**118**	**139**
Misool	N Farondi (E-center is. chain)	**8.1**	80	0	10	5	5	1	2	15	28	**66**	
Misool	N Farondi (E-center is. chain)	**8.2**	100	0	0	0	0	1	3	20	28	**83**	**122**
Misool	S Wagmab (E-center is. chain)	**9.1**	40	20	10	20	10	4	2	20	28	**77**	
Misool	S Wagmab (E-center is. chain)	**9.2**	80	15	0	5	0	4	3	20	28	**88**	**140**
Misool	E Bajampop (W-center is. chain)	**10.1**	50	20	10	10	10	3	2	12	28	**64**	
Misool	E Bajampop (W-center is. chain)	**10.2**	60	20	15	5	0	3	3	12	28	**128**	**155**
Misool	Mesemta (W-center is. chain)	**11.1**	40	10	20	0	30	4	2	8	28	**93**	
Misool	Mesemta (W-center is. chain)	**11.2**	95	0	0	5	0	4	3	8	28	**121**	**164**
Misool	Bajampop (W-center is. chain)	**12.1**	30	20	20	10	20	3	1	6	28	**83**	
Misool	Bajampop (W-center is. chain)	**12.2**	70	0	10	10	10	3	1	6	28	**63**	**121**
Misool	Papas Tip Pale (W is. chain) nr cave	**13.2**	30	10	20	10	30	1	1	4	28	**76**	**76**
Misool	Papas Tip Pale (W is. chain)	**14.2**	60	0	20	5	15	2	1	3	29	**121**	**121**
Misool	N Djam (southern is.s)	**15.1**	40	20	10	10	20	4	2	25	28	**115**	
Misool	N Djam (southern is.s)	**15.2**	95	0	0	5	0	4	3	25	28	**120**	**182**
Misool	SW Kalig (southern is.s)	**16.1**	80	0	10	0	10	3	2	30	29	**75**	
Misool	SW Kalig (southern is.s)	**16.2**	100	0	0	0	0	3	3	30	29	**74**	**132**
Misool	SW Mate (southern is.s)	**17.1**	70	10	10	5	5	3	2	15	28	**69**	
Misool	SW Mate (southern is.s)	**17.2**	80	10	10	0	0	3	3	15	28	**60**	**110**
Misool	Los (southern is.s)	**18.1**	60	20	10	0	10	4	2	12	28	**105**	
Misool	Los (southern is.s)	**18.2**	95	0	0	5	0	4	2	15	28	**111**	**168**
Misool	Jef Pelee (inner W bay)	**19.1**	20	10	20	40	10	4	1	15	27	**82**	
Misool	Jef Pelee (inner W bay)	**19.2**	60	10	10	15	5	4	1	15	27	**99**	**147**
Misool	Pulau Tiga (SW side middle is.)	**22.1**	20	40	20	5	15	1	2	25	28	**37**	
Misool	Pulau Tiga (SW side middle is.)	**22.2**	40	40	10	0	10	1	3	20	28	**64**	**86**
Misool	S shore opp. middle P. Tiga is.	**23.2**	30	20	10	10	30	2	2	10	28	**161**	**161**
Misool	Jef Bi	**24.1**	40	10	10	5	35	4	1	6	28	**85**	
Misool	Jef Bi	**24.2**	80	0	10	0	10	4	1	6	28	**119**	**169**
Misool	Cot Malankari	**25.1**	40	10	20	30	0	3	2	40	27	**80**	
Misool	Cot Malankari	**25.2**	40	10	30	10	10	3	3	30	27	**70**	**120**
Misool	Nampale NW	**26.1**	60	10	10	20	0	3	2	30	27	**95**	
Misool	Nampale NW	**26.2**	70	10	10	15	5	3	3	30	27	**69**	**126**
Misool	Channel between Kanari & Kamet	**27.1**	30	20	20	25	15	2	1	20	27	**37**	
Misool	Channel between Kanari & Kamet	**27.2**	40	20	20	5	15	2	1	20	27	**55**	**81**
Kofiau	S Walo	**28.1**	75	0	10	5	10	4	2	30	27	**121**	

Appendix 3B. (Continued)

Location	Station name	Site	CP	LB	SB	RBL	SN	RD	EXP	VIS	WT	Sp	Tot
Kofiau	S Walo	**28.2**	80	0	15	0	5	4	3	30	27	**106**	**169**
Kofiau	Anjoean	**29.1**	20	20	30	0	30	3	2	25	27	**93**	
Kofiau	Anjoean	**29.2**	70	10	10	5	5	3	2	25	27	**89**	**143**
Kofiau	S Miatkari Island	**30.1**	0	30	30	5	35	4	1	12	28	**96**	
Kofiau	S Miatkari Island	**30.2**	40	10	20	5	25	4	2	12	28	**105**	**159**
Kofiau	Wambong Bay	**31.1**	40	10	10	0	40	3	1	25	28	**110**	
Kofiau	Wambong Bay	**31.2**	80	0	5	0	15	3	2	25	28	**132**	**174**
Kofiau	Tg Sool	**32.1**	80	0	10	0	10	3	2	30	26	**110**	
Kofiau	Tg Sool	**32.2**	70	10	10	0	10	3	3	30	26	**97**	**173**
Kofiau	Deer island	**33.2**	30	10	20	20	20	2	1	10	27	**118**	**118**
Waigaio	Selpele	**34.1**	30	0	20	20	30	2	1	7	27	**64**	
Waigaio	Selpele	**34.2**	70	10	10	0	10	2	2	7	27	**64**	**112**
Waigaio	N of pearl farm	**35.1**	70	15	5	5	5	2	1	15	27	**97**	
Waigaio	N of pearl farm	**35.2**	80	0	15	0	5	2	2	15	27	**100**	**153**
Waigaio	E of pearl farm	**36.1**	0	10	10	10	70	2	1	6	27	**58**	
Waigaio	E of pearl farm	**36.2**	70	0	10	5	15	2	1	8	27	**84**	**125**
Sayang	N-center	**37.1**	40	10	10	35	5	2	2	30	28	**85**	
Sayang	N-center	**37.2**	90	0	0	5	5	2	4	35	28	**91**	**135**
Sayang	Ai Island S	**39.1**	0	30	10	50	10	2	2	35	29	**55**	
Sayang	Ai Island S	**39.2**	50	10	10	0	30	2	2	30	29	**48**	**85**
Sayang	bommies W	**40.2**	30	30	10	0	30	2	2	30	29	**103**	**103**
Wayag	large bay W	**42.1**	20	0	20	20	40	4	1	6	28	**81**	
Wayag	large bay W	**42.2**	60	10	10	15	5	4	1	6	28	**68**	**134**
Wayag	center-east	**43.1**	30	20	10	30	10	3	2	25	29	**112**	
Wayag	center-east	**43.2**	80	0	5	10	5	3	3	25	29	**81**	**161**
Quoy	islets to south	**44.1**	30	10	10	45	5	3	2	20	29	**125**	
Quoy	islets to south	**44.2**	70	0	15	10	5	3	3	20	29	**70**	**163**
Bag	southeast	**45.1**	90	0	5	5	0	2	2	15	29	**103**	**103**
Uranie	west bay	**47.1**	40	20	10	10	20	3	1	12	29	**64**	
Uranie	west bay	**47.2**	60	20	5	10	5	3	2	12	29	**66**	**116**
Kawe	middle E bay, S side	**48.1**	50	20	10	0	20	3	1	10	28	**87**	
Kawe	middle E bay, S side	**48.2**	60	10	10	0	20	3	1	10	29	**107**	**160**
Kawe	southern peninsula E bay	**49.1**	60	10	10	5	15	2	2	10	29	**86**	
Kawe	southern peninsula E bay	**49.2**	80	10	10	0	0	2	3	10	29	**81**	**129**
Kawe	inner E bay, S side	**50.1**	95	0	0	5	0	4	1	25	28	**79**	
Kawe	inner E bay, S side	**50.2**	95	0	0	0	5	4	1	10	29	**77**	**125**
Waigeo	island S Tl Fofak opposite mouth	**52.1**	70	2	10	5	15	4	1	6	29	**88**	
Waigeo	island S Tl Fofak opposite mouth	**52.2**	90	0	5	0	5	4	2	6	29	**117**	**156**
Waigeo	reef W of Delphine Is, E Fofak Bay	**53.1**	60	10	10	10	10	3	1	6	29	**100**	
Waigeo	reef W of Delphine Is, E Fofak Bay	**53.2**	100	0	0	0	0	3	1	6	30	**97**	**163**
Waigeo	Boni island, N reef	**54.1**	70	0	10	0	20	4	3	25	29	**63**	
Waigeo	Boni island, N reef	**54.2**	70	15	5	0	10	4	4	20	29	**42**	**92**
Waigeo	bay W of Boni Island	**55.1**	70	10	5	5	10	3	1	6	29	**79**	
Waigeo	bay W of Boni Island	**55.2**	95	0	0	5	0	3	2	6	29	**94**	**141**
Waigeo	Boni island, S reef	**56.1**	30	30	10	5	25	3	2	25	29	**108**	
Waigeo	Boni island, S reef	**56.2**	90	0	0	5	5	3	2	12	29	**88**	**154**
Waigeo	Wayam island N side	**58.2**	50	10	10	5	25	3	2	20	29	**144**	**144**

Appendix 4. Full list of zooxanthellate scleractinia family, genera and species for Raja Ampat and East Indonesia.

^ = Veron, J.E.N., 2000. Corals of the World. 3 Volumes. M. Stafford-Smith (Ed.). Australian Institute of Marine Science, Townsville.

R = New records for Raja Ampat

E = New records for East Indonesia

• 20 new records for east Indonesia • 82 new records for Raja Ampat	• 15 families • 78 genera

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Family: Astrocoeniidae Koby, 1890					
Genus: *Stylocoeniella* Yabe and Sugiyama, 1935					
Stylocoeniella armata (Ehrenberg, 1834)	*	*	*	*	*
Stylocoeniella cocosensis Veron, 1990	*		R		E
Stylocoeniella guentheri Bassett-Smith, 1890	*	*	*	*	*
Genus: *Palauastrea* Yabe and Sugiyama, 1941					
Palauastrea ramosa Yabe and Sugiyama, 1941	*	*	*	*	*
Genus: *Madracis* Milne Edwards and Haime, 1849					
Madracis kirbyi Veron and Pichon, 1976	*		R	*	*
Family: Pocilloporidae Gray, 1842					
Genus: *Pocillopora* Lamarck, 1816					
Pocillopora ankeli Scheer and Pillai, 1974	*		R		*
Pocillopora damicornis (Linnaeus, 1758)	*	*	*	*	*
Pocillopora danae Verrill, 1864	*	*	*	*	*
Pocillopora elegans Dana, 1846	*		R		E
Pocillopora eydouxi Milne Edwards and Haime, 1860	*	*	*	*	*
Pocillopora kelleheri Veron, 2000	*	*	*	*	*
Pocillopora meandrina Dana, 1846	*	*	*	*	*
Pocillopora verrucosa (Ellis and Solander, 1786)	*	*	*	*	*
Pocillopora woodjonesi Vaughan, 1918	*	*	*	*	*
Genus: *Seriatopora* Lamarck, 1816					
Seriatopora aculeata Quelch, 1886	*	*	*	*	*
Seriatopora caliendrum Ehrenberg, 1834	*	*	*	*	*
Seriatopora dendritica Veron, 2000	*	*	*	*	*
Seriatopora guttatus Veron, 2000	*	*	*	*	*
Seriatopora hystrix Dana, 1846	*	*	*	*	*
Seriatopora stellata Quelch, 1886	*	*	*		*
Genus: *Stylophora* Schweigger, 1819					
Stylophora pistillata Esper, 1797	*	*	*	*	*
Stylophora subseriata (Ehrenberg, 1834)	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Family: Acroporidae Verrill, 1902					
Genus: *Montipora* Blainville, 1830					
Montipora aequituberculata Bernard, 1897	*	*	*	*	*
Montipora altasepta Nemenzo, 1967	*	*	*	*	*
*Montipora angulata (*Lamarck, 1816)	*	*	*		*
Montipora australiensis Bernard, 1897		*	*	*	*
Montipora cactus Bernard, 1897	*	*	*		*
Montipora calcarea Bernard, 1897	*		R	*	*
Montipora caliculata (Dana, 1846)	*	*	*	*	*
Montipora capitata Dana, 1846	*	*	*	*	*
Montipora capricornis Veron, 1985		*	*	*	*
Montipora cebuensis Nemenzo, 1976		*	*	*	*
Montipora cocosensis Vaughan, 1918		*	*		*
Montipora confusa Nemenzo, 1967	*	*	*		*
Montipora corbetensis Veron and Wallace, 1984	*		R	*	*
Montipora crassituberculata Bernard, 1897	*		R	*	*
Montipora danae (Milne Edwards and Haime, 1851)	*	*	*	*	*
Montipora deliculata Veron, 2000	*	*	*		*
Montipora digitata (Dana, 1846)	*	*	*	*	*
Montipora efflorescens Bernard, 1897	*	*	*	*	*
Montipora effusa Dana, 1846				*	*
Montipora florida Nemenzo, 1967	*	*	*		*
Montipora floweri Wells, 1954	*	*	*	*	*
Montipora foliosa (Pallas, 1766)	*	*	*	*	*
*Montipora foveolata (*Dana, 1846)	*		R	*	*
Montipora friabilis Bernard, 1897		*	*	*	*
Montipora gaimardi Bernard 1897		*	*	*	*
Montipora grisea Bernard, 1897	*	*	*	*	*
Montipora hirsuta Nemenzo, 1967		*	R		*
Montipora hispida (Dana, 1846)	*	*	*	*	*
Montipora hodgsoni Veron, 2000	*	*	*	*	*
Montipora hoffmeisteri Wells, 1954	*	*	*	*	*
Montipora incrassata (Dana, 1846)	*	*	*	*	*
Montipora informis Bernard, 1897	*	*	*	*	*
Montipora mactanensis Nemenzo, 1979	*	*	*	*	*
Montipora malampaya Nemenzo, 1967	*		R	*	*
Montipora meandrina (Ehrenberg, 1834)	*	*	*	*	*
Montipora millepora Crossland, 1952	*	*	*	*	*
Montipora mollis Bernard, 1897	*	*	*	*	*
Montipora monasteriata (Forskäl, 1775)	*	*	*	*	*
Montipora niugini Veron, 2000				*	*
Montipora nodosa (Dana, 1846)	*	*	*	*	*
Montipora orientalis Nemenzo, 1967		*	*	*	*
Montipora plawanensis Veron, 2000	*	*	*	*	*
Montipora peltiformis Bernard, 1897	*	*	*	*	*
Montipora porites Veron, 2000	*	*	*	*	*
Montipora samarensis Nemenzo, 1967	*	*	*	*	*
Montipora setosa Nemenzo, 1976				*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Montipora spongodes Bernard, 1897	*		R	*	*
Montipora spumosa (Lamarck, 1816)	*		R	*	*
Montipora stellata Bernard, 1897	*	*	*	*	*
Montipora taiwanensis Veron, 2000	*		*		E
Montipora tuberculosa (Lamarck, 1816)	*	*	*	*	*
Montipora turgescens Bernard, 1897	*	*	*	*	*
Montipora turtlensis Veron and Wallace, 1984	*		R	*	*
Montipora undata Bernard, 1897	*	*	*		*
Montipora venosa (Ehrenberg, 1834)	*		R	*	*
Montipora verrucosa (Lamarck, 1816)	*	*	*	*	*
Montipora verruculosa Veron, 2000	*	*	*	*	*
Montipora vietnamensis Veron, 2000	*	*	*		*
Genus: *Anacropora* Ridley, 1884					
Anacropora forbesi Ridley, 1884	*	*	*	*	*
Anacropora matthai Pillai, 1973	*	*	*	*	*
Anacropora pillai Veron, 2000				*	*
Anacropora puertogalerae Nemenzo, 1964	*	*	*	*	*
Anacropora reticulata Veron and Wallace, 1984	*	*	*	*	*
Anacropora spinosa Rehberg, 1892	*		R	*	*
Genus: *Acropora* Oken, 1815					
*Acropora abrolhosensis*Veron, 1985	*	*	*	*	*
Acropora abrotanoides (Lamarck, 1816)	*	*	*	*	*
Acropora aculeus (Dana, 1846)	*	*	*	*	*
Acropora acuminata (Verrill, 1864)	*	*	*	*	*
Acropora akajimensis Veron, 1990		*	*		*
Acropora anthocercis (Brook, 1893)	*	*	*	*	*
Acropora aspera (Dana, 1846)	*	*	*	*	*
Acropora austera (Dana, 1846)	*	*	*	*	*
Acropora awi Wallace and Wolstenholme, 1998	*	*	*	*	*
Acropora batunai Wallace, 1997	*	*	*	*	*
Acropora bifurcata Nemenzo, 1971	*	*	*		*
Acropora brueggemanni (Brook, 1893)	*	*	*	*	*
Acropora carduus (Dana, 1846)	*	*	*	*	*
Acropora caroliniana Nemenzo, 1976	*	*	*	*	*
Acropora cerealis (Dana, 1846)	*	*	*	*	*
Acropora chesterfieldensis Veron and Wallace, 1984	*		R	*	*
Acropora clathrata (Brook, 1891)	*	*	*	*	*
Acropora convexa (Dana, 1846)		*	*	*	*
Acropora cophodactyla (Brook, 1892)	*		R	*	*
Acropora copiosa Nemenzo, 1967	*	*	*	*	*
Acropora crateriformis (Gardiner, 1898)	*		R	*	*
Acropora cuneata (Dana, 1846)	*	*	*	*	*
Acropora cylindrica Veron and Fenner, 2000	*		R	*	*
Acropora cytherea (Dana, 1846)	*	*	*	*	*
Acropora dendrum (Bassett-Smith, 1890)	*	*	*	*	*
Acropora derewanensis Wallace (1997)	*	*	*	*	*
Acropora desalwii Wallace, 1994	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Acropora digitifera (Dana, 1846)	*	*	*	*	*
Acropora divaricata (Dana, 1846)	*	*	*	*	*
Acropora donei Veron and Wallace, 1984	*	*	*	*	*
Acropora echinata (Dana, 1846)	*	*	*		*
Acropora efflorexcens (Dana, 1846)				*	*
Acropora elegans Milne Edwards and Haime, 1860	*	*	*		*
Acropora elseyi (Brook, 1892)	*	*	*	*	*
Acropora exquisita Nemenzo, 1971	*	*	*	*	*
Acropora fastigata Nemenzo, 1967				*	*
Acropora fenneri Veron, 2000				*	*
Acropora florida (Dana, 1846)	*	*	*	*	*
Acropora formosa (Dana, 1846)	*	*	*	*	*
Acropora glauca (Brook, 1893)	*		R		E
Acropora gemmifera (Brook, 1892)	*	*	*	*	*
Acropora globiceps (Dana, 1846)	*	*	*	*	*
Acropora gomezi Veron, 2000				*	*
Acropora grandis (Brook, 1892)	*	*	*	*	*
Acropora granulosa (Milne Edwards and Haime, 1860)	*	*	*	*	*
Acropora hoeksemai Wallace, 1997	*	*	*	*	*
Acropora horrida (Dana, 1846)	*	*	*	*	*
Acropora humilis (Dana, 1846)	*	*	*	*	*
Acropora hyacinthus (Dana, 1846)	*	*	*	*	*
Acropora indonesia Wallace, 1997	*	*	*	*	*
Acropora inermis (Brook, 1891)	*	*	*	*	*
Acropora insignis Nemenzo, 1967	*	*	*	*	*
Acropora irregularis (Brook, 1892)	*	*	*		*
Acropora jacquelineae Wallace, 1994		*	*	*	*
Acropora kimbeensis Wallace, 1999	*	*	*	*	*
Acropora kirstyae Veron and Wallace, 1984	*		R	*	*
Acropora latistella (Brook, 1891)	*	*	*	*	*
Acropora lianae Nemenzo, 1967				*	*
Acropora listeri (Brook, 1893)	*		R	*	*
Acropora loisetteae Wallace, 1994	*	*	*		*
Acropora lokani Wallace, 1994	*	*	*	*	*
Acropora longicyathus (Milne Edwards and Haime, 1860)	*	*	*	*	*
Acropora loripes (Brook, 1892)	*	*	*	*	*
Acropora lovelli Veron and Wallace, 1984				*	*
Acropora lutkeni Crossland, 1952	*		R	*	*
Acropora macrostoma (Brook, 1891)	*	*	*		*
Acropora meridiana Nemenzo, 1971		*	*	*	*
Acropora microclados (Ehrenberg, 1834)	*	*	*	*	*
Acropora microphthalma (Verrill, 1859)	*	*	*	*	*
Acropora millepora (Ehrenberg, 1834)	*	*	*	*	*
Acropora mirabilis (Quelch, 1886)	*	*	*	*	*
Acropora monticulosa (Brüggemann, 1879)	*	*	*	*	*
Acropora multiacuta Nemenzo, 1967				*	*
Acropora nana (Studer, 1878)	*	*	*	*	*
Acropora nasuta (Dana, 1846)	*	*	*	*	*
Acropora navini Veron, 2000				*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Acropora nobilis (Dana, 1846)	*	*	*	*	*
Acropora cf. *ocellata* (Klunzinger, 1879)	*		R		*
Acropora orbicularis Brook, 1892	*		R	*	*
Acropora palifera (Lamarck, 1816)	*	*	*	*	*
Acropora palmerae Wells, 1954	*		R	*	*
Acropora paniculata Verrill, 1902	*	*	*	*	*
Acropora papillarae Latypov, 1992	*	*	*		*
Acropora parahemprichii Veron, 2000		*	*		*
Acropora parilis (Quelch, 1886)		*	*	*	*
Acropora pectinatus Veron, 2000		*	*		*
Acropora pichoni Wallace, 1999	*		R	*	*
Acropora pinguis Wells, 1950	*	*	*		*
Acropora plana Nemenzo, 1967	*	*	*		*
Acropora plumosa Wallace and Wolstenholme, 1998	*	*	*	*	*
Acropora polystoma (Brook, 1891)	*	*	*	*	*
Acropora prostrata (Dana, 1846)	*	*	*	*	*
Acropora proximalis Veron, 2000		*	*		*
Acropora pulchra (Brook, 1891)	*	*	*	*	*
Acropora rambleri (Bassett-Smith, 1890)		*	*	*	*
Acropora retusa (Dana, 1846)				*	*
Acropora robusta (Dana, 1846)	*	*	*	*	*
Acropora rosaria (Dana, 1846)	*	*	*	*	*
Acropora russelli Wallace, 1994		*	*		*
Acropora samoensis (Brook, 1891)	*	*	*	*	*
Acropora sarmentosa (Brook, 1892)	*	*	*	*	*
Acropora scherzeriana (Brüggemann, 1877)		*	*		*
Acropora secale (Studer, 1878)	*	*	*	*	*
Acropora sekiseinsis Veron, 1990				*	*
Acropora selago (Studer, 1878)	*	*	*	*	*
Acropora seriata Ehrenberg, 1834	*		R	*	*
Acropora simplex Wallace and Wolstenholme, 1998	*		R		E
Acropora solitaryensis Veron and Wallace, 1984	*	*	*	*	*
Acropora speciosa (Quelch, 1886)	*	*	*	*	*
Acropora spicifera (Dana, 1846)	*		R	*	*
Acropora stoddarti Pillai and Scheer, 1976				*	*
Acropora striata (Verrill, 1866)	*	*	*		*
Acropora subglabra (Brook, 1891)	*	*	*	*	*
Acropora subulata (Dana, 1846)	*	*	*	*	*
Acropora tenella (Brook, 1892)	*		R	*	*
Acropora tenuis (Dana, 1846)	*	*	*	*	*
Acropora teres (Verrilll, 1866)				*	*
Acropora tizardi (Brook, 1892)				*	*
Acropora torihalimeda Wallace, 1994				*	*
Acropora tortuosa (Dana, 1846)	*		R	*	*
Acropora tumida (Verrill, 1866)				*	*
Acropora turaki Wallace, 1994	*		R	*	*
Acropora tutuilensis Hoffmeister, 1925				*	*
Acropora valenciennesi (Milne Edwards and Haime, 1860)	*	*	*	*	*
Acropora valida (Dana, 1846)	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Acropora variabilis (Klunzinger, 1879)		*	*		*
Acropora vaughani Wells, 1954	*	*	*	*	*
Acropora vermiculata Nemenzo, 1967		*	*	*	*
Acropora verweyi Veron and Wallace, 1984	*	*	*	*	*
Acropora walindii Wallace, 1999	*	*	*	*	*
Acropora wallaceae Veron, 1990				*	*
Acropora willisae Veron and Wallace, 1984	*	*	*	*	*
Acropora yongei Veron and Wallace, 1984	*	*	*	*	*
Genus: *Astreopora* Blainville, 1830					
Astreopora cuculata Lamberts, 1980	*		R	*	*
Astreopora expansa Brüggemann, 1877	*	*	*	*	*
Astreopora gracilis Bernard, 1896	*	*	*	*	*
Astreopora incrustans Bernard, 1896	*		R	*	*
Astreopora listeri Bernard, 1896	*	*	*	*	*
Astreopora macrostoma Veron and Wallace, 1984				*	*
Astreopora myriophthalma (Lamarck, 1816)	*	*	*	*	*
Astreopora ocellata Bernard, 1896	*	*	*	*	*
Astreopora randalli Lamberts, 1980	*	*	*	*	*
Astreopora scabra Lamberts, 1982	*		R		E
Astreopora suggesta Wells, 1954	*	*	*	*	*
Family: Euphilliidae Veron, 2000					
Genus: *Euphyllia*					
Euphyllia ancora Veron and Pichon, 1979	*	*	*	*	*
Euphyllia cristata Chevalier, 1971	*	*	*	*	*
Euphyllia divisa Veron and Pichon, 1980	*	*	*	*	*
Euphyllia glabrescens (Chamisso and Eysenhardt, 1821)	*	*	*	*	*
Euphyllia paraancora Veron, 1990	*		R	*	*
Euphyllia paradivisa Veron, 1990		*	*		*
Euphyllia yaeyamensis (Shirai, 1980)	*	*	*	*	*
Genus: *Catalaphyllia* Wells, 1971					
Catalaphyllia jardinei (Saville-Kent, 1893)	*		R	*	*
Genus: *Nemenzophyllia* Hodgson and Ross, 1981					
Nemenzophyllia turbida Hodgson and Ross, 1981	*		R	*	*
Genus: *Plerogyra* Milne Edwards and Haime, 1848					
Plerogyra discus Veron and Fenner, 2000	*		R	*	*
Plerogyra simplex Rehberg, 1892	*		R	*	*
Plerogyra sinuosa (Dana, 1846)	*	*	*	*	*
Genus: *Physogyra* Quelch, 1884					
Physogyra lichtensteini (Milne Edwards and Haime, 1851)	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Family: Oculinidae Gray, 1847					
Genus: *Galaxea* Oken, 1815					
Galaxea acrhelia Veron, 2000	*	*	*	*	*
Galaxea astreata (Lamarck, 1816)	*		R	*	*
Galaxea cryptoramosa Fenner and Veron, 2000		*	*		*
Galaxea fascicularis (Linnaeus, 1767)	*	*	*	*	*
Galaxea horrescens (Dana, 1846)	*	*	*	*	*
Galaxea longisepta Fenner & Veron, 2000	*	*	*	*	*
Galaxea paucisepta Claereboudt, 1990	*	*	*	*	*
Family: Siderasteridae Vaughan and Wells, 1943					
Genus: *Pseudosiderastrea* Yabe and Sugiyama, 1935					
Pseudosiderastrea tayami Yabe and Sugiyama, 1935	*		R	*	*
Genus: *Siderastrea* Blainville, 1830					
Siderastrea savignyana Milne Edwards and Haime, 1850				*	*
Genus: *Psammocora* Dana, 1846					
Psammocora contigua (Esper, 1797)	*	*	*	*	*
Psammocora digitata Milne Edwards and Haime, 1851	*	*	*	*	*
Psammocora explanulata Horst, 1922	*	*	*	*	*
Psammocora haimeana Milne Edwards and Haime, 1851	*	*	*	*	*
Psammocora nierstraszi Horst, 1921	*	*	*	*	*
Psammocora obtusangula (Lamarck, 1816)	*	*	*	*	*
Psammocora profundacella Gardiner, 1898	*	*	*	*	*
Psammocora stellata Verrill, 1864		*	*		*
Psammocora superficialis Gardiner, 1898	*	*	*	*	*
Genus: *Coscinaraea* Milne Edwards and Haime, 1848					
Coscinaraea columna (Dana, 1846)	*	*	*	*	*
Coscinaraea crassa Veron and Pichon, 1980	*		R	*	*
Coscinaraea exesa (Dana, 1846)	*	*	*	*	*
Coscinaraea monile (Foskål, 1775)	*		R		*
Coscinaraea wellsi Veron and Pichon, 1980	*		R	*	*
Family: Agariciidae Gray, 1847					
Genus: *Pavona* Lamarck, 1801					
Pavona bipartita Nemenzo, 1980	*	*	*	*	*
Pavona cactus (Forskål, 1775)	*	*	*	*	*
Pavona clavus (Dana, 1846)	*	*	*	*	*
Pavona danae Milne Edwards and Haime, 1860		*	*		*
Pavona decussata (Dana, 1846)	*	*	*	*	*
Pavona duerdeni Vaughan, 1907	*	*	*	*	*
Pavona explanulata (Lamarck, 1816)	*	*	*	*	*
Pavona frondifera (Lamarck, 1816)	*	*	*		*
Pavona maldivensis (Gardiner, 1905)	*	*	*	*	*
Pavona minuta Wells, 1954	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Pavona varians Verrill, 1864	*	*	*	*	*
Pavona venosa (Ehrenberg, 1834)	*	*	*	*	*
Genus: *Leptoseris* Milne Edwards and Haime, 1849					
Leptoseris amitoriensis Veron, 1990	*		R		E
Leptoseris explanata Yabe and Sugiyama, 1941	*	*	*	*	*
Leptoseris foliosa Dineson, 1980	*	*	*	*	*
Leptoseris gardineri Horst, 1921	*	*	*	*	*
Leptoseris hawaiiensis Vaughan, 1907	*	*	*	*	*
Leptoseris incrustans (Quelch, 1886)	*		R	*	*
Leptoseris mycetoseroides Wells, 1954	*	*	*	*	*
Leptoseris papyracea (Dana, 1846)	*	*	*	*	*
Leptoseris scabra Vaughan, 1907	*	*	*	*	*
Leptoseris solida (Quelch, 1886)	*		R	*	*
Leptoseris striata (Fenner & Veron 2000)	*	*	*	*	*
Leptoseris tubulifera Vaughan, 1907		*	*	*	*
Leptoseris yabei (Pillai and Scheer, 1976)	*	*	*	*	*
Genus: *Gardineroseris* Scheer and Pillai, 1974					
Gardineroseris planulata Dana, 1846	*	*	*	*	*
Genus: *Coeloseris* Vaughan, 1918				*	*
Coeloseris mayeri Vaughan, 1918	*	*	*		*
Genus: *Pachyseris* Milne Edwards and Haime, 1849					
Pachyseris foliosa Veron, 1990	*	*	*	*	*
Pachyseris gemmae Nemenzo, 1955	*	*	*	*	*
Pachyseris involuta (Studer, 1877)	*		R	*	*
Pachyseris rugosa (Lamarck, 1801)	*	*	*	*	*
Pachyseris speciosa (Dana, 1846)	*	*	*	*	*
Family: Fungiidae Dana, 1846					
Genus: *Cycloseris* Milne Edwards and Haime, 1849					
Cycloseris colini Veron, 2000	*	*	*		*
Cycloseris costulata (Ortmann, 1889)	*	*	*	*	*
Cycloseris curvata (Hoeksema, 1989)		*	*	*	*
Cycloseris cyclolites Lamarck, 1801	*	*	*	*	*
Cycloseris erosa (Döderlein, 1901)	*	*	*		*
Cycloseris hexagonalis (Milne Edwards and Haime, 1848)		*	*	*	*
Cycloseris patelliformis (Boschma, 1923)	*	*	*	*	*
Cycloseris sinensis (Milne Edwards and Haime, 1851)	*	*	*	*	*
Cycloseris somervillei (Gardiner, 1909)	*	*	*	*	*
Cycloseris tenuis (Dana, 1846)		*	*	*	*
Cycloseris vaughani (Boschma, 1923)	*	*	*	*	*
Genus: *Diaseris*					
Diaseris distota (Michelin, 1843)				*	*
Diaseris fragilis Alcock, 1893			*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Genus: *Cantharellus* Hoeksema and Best, 1984					
Cantharellus jebbi Hoeksema, 1993	*		R	*	*
Cantharellus nuomeae Hoeksema & Best, 1984	*		R		E
Genus: *Helliofungia* Wells, 1966					
Heliofungia actiniformis Quoy and Gaimard, 1833	*	*	*	*	*
Genus: *Fungia* Lamarck, 1801					
Fungia concinna Verrill, 1864	*	*	*	*	*
Fungia corona Döderlein, 1901	*		R	*	*
Fungia danai Milne Edwards and Haime, 1851	*	*	*	*	*
Fungia fralinae Nemenzo, 1955	*	*	*	*	*
Fungia fungites (Linneaus, 1758)	*	*	*	*	*
Fungia granulosa Klunzinger, 1879	*	*	*	*	*
Fungia horrida Dana, 1846	*	*	*	*	*
Fungia klunzingeri Döderlein, 1901	*	*	*	*	*
Fungia moluccensis Horst, 1919	*	*	*	*	*
Fungia paumotensis Stutchbury, 1833	*	*	*	*	*
Fungia repanda Dana, 1846	*	*	*	*	*
Fungia scabra Döderlein, 1901	*	*	*	*	*
Fungia scruposa Klunzinger, 1879	*	*	*	*	*
Fungia scutaria Lamarck, 1801	*	*	*	*	*
Fungia spinifer Claereboudt and Hoeksema, 1987	*	*	*	*	*
Genus: *Ctenactis* Verrill, 1864					
Ctenactis albitentaculata Hoeksema, 1989	*	*	*	*	*
Ctenactis crassa (Dana, 1846)	*	*	*	*	*
Ctenactis echinata (Pallas, 1766)	*	*	*	*	*
Genus: *Herpolitha* Eschscholtz, 1825					
Herpolitha limax (Houttuyn, 1772)	*	*	*	*	*
Herpolitha weberi Horst, 1921	*	*	*	*	*
Genus: *Polyphyllia* Quoy and Gaimard, 1833					
Polyphyllia novaehiberniae (Lesson, 1831)	*		R	*	*
Polyphyllia talpina (Lamarck, 1801)	*	*	*	*	*
Genus: *Sandalolitha* Quelch, 1884					
Sandalolitha dentata (Quelch, 1886)	*	*	*	*	*
Sandalolitha robusta Quelch, 1886	*	*	*	*	*
Genus: *Halomitra* Dana, 1846					
Halomitra clavator Hoeksema, 1989	*	*	*		*
Halomitra meierar Veron and Maragos, 2000	*	*	*		*
Halomitra pileus (Linnaeus, 1758)	*	*	*	*	*
Genus: *Zoopilus* Dana, 1864					
Zoopilus echinatus Dana, 1846	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Genus: *Lithophyllum* Rehberg, 1892					
Lithophyllon mokai Hoeksema, 1989	*	*	*	*	*
Lithophyllon undulatum Rehberg, 1892		*	*	*	*
Genus: *Podabacia* Milne Edwards and Haime, 1849					
Podabacia crustacea (Pallas, 1766)	*	*	*	*	*
Podabacia motuporensis Veron, 1990	*	*	*	*	*
Family: Pectinidae Vaughan and Wells, 1943					
Genus: *Echinophyllia* Klunzinger, 1879					
Echinophyllia aspera (Ellis and Solander, 1788)	*	*	*	*	*
Echinophyllia costata Fenner and Veron, 2000	*	*	*	*	*
Echinophyllia echinata (Saville-Kent, 1871)	*	*	*	*	*
Echinophyllia echinoporoides Veron and Pichon, 1979	*	*	*	*	*
Echinophyllia orpheensis Veron and Pichon, 1980	*	*	*	*	*
Echinophyllia patula (Hodgson and Ross, 1982)	*	*	*	*	*
Echinophyllia pectinata Veron 2000		*	*		*
Genus: *Echinomorpha* Veron, 2000					
Echinomorpha nishihirea (Veron, 1990)	*	*	*		*
Genus: *Oxypora* Saville-Kent, 1871					
Oxypora crassispinosa Nemenzo, 1979	*	*	*	*	*
Oxypora glabra Nemenzo, 1959	*	*	*	*	*
Oxypora lacera Verrill, 1864	*	*	*	*	*
Genus: *Mycedium* Oken, 1815					
Mycedium elephatotus (Pallas, 1766)	*	*	*	*	*
Mycedium mancaoi Nemenzo, 1979	*	*	*	*	*
Mycedium robokaki Moll and Best, 1984	*	*	*	*	*
Genus: *Pectinia* Oken, 1815					
Pectinia alcicornis (Saville-Kent, 1871)	*	*	*	*	*
Pectinia ayleni (Wells, 1935)	*	*	*		*
Pectinia elongata Rehberg, 1892	*	*	*	*	*
Pectinia lactuca (Pallas, 1766)	*	*	*	*	*
Pectinia maxima (Moll and Borel Best, 1984)	*	*	*	*	*
Pectinia paeonia (Dana, 1846)	*	*	*	*	*
Pectinia pygmaeus Veron, 2000	*		R	*	*
Pectinia teres Nemenzo and montecillo, 1981	*	*	*	*	*
Family: Merulinidae Verrill, 1866					
Genus: *Hydnophora* Fischer de Waldheim, 1807					
Hydnophora bonsai Veron, 1990		*	*		*
Hydnophora exesa (Pallas, 1766)	*	*	*	*	*
Hydnophora grandis Gardiner, 1904	*	*	*	*	*
Hydnophora microconos (Lamarck, 1816)	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Hydnophora pilosa Veron, 1985	*	*	*	*	*
Hydnophora rigida (Dana, 1846)	*	*	*	*	*
Genus: *Paraclavarina* Veron, 1985					
Paraclavarina triangularis (Veron and Pichon, 1980)				*	*
Genus: *Merulina* Ehrenberg, 1834					
Merulina ampliata (Ellis and Solander, 1786)	*	*	*	*	*
Merulina scabricula Dana, 1846	*	*	*	*	*
Genus: *Scapophyllia* Milne Edwards and Haime, 1848					
Scapophyllia cylindrica Milne Edwards and Haime, 1848	*	*	*	*	*
Family: Dendrophylliidae Gray, 1847					
Genus: *Turbinaria* Oken, 1815					
Turbinaria frondens (Dana, 1846)	*	*	*	*	*
Turbinaria irregularis, Bernard, 1896	*	*	*	*	*
Turbinaria mesenterina (Lamarck, 1816)	*	*	*	*	*
Turbinaria patula (Dana, 1846)	*		R	*	*
Turbinaria peltata (Esper, 1794)	*	*	*	*	*
Turbinaria reniformis Bernard, 1896	*	*	*	*	*
Turbinaria stellulata (Lamarck, 1816)	*	*	*	*	*
Genus: *Heteropsammia* Milne Edwards & Haime, 1848					
Heteropsammia cochlea (Spengler, 1781)				*	*
Family: Caryophylliidae Gray, 1847					
Genus: *Heterocyathus* Milne Edwards and Haime, 1848					
Heterocyathus aequicostatus Milne Edwards and Haime, 1848				*	*
Family: Mussidae Ortmann, 1890					
Genus: *Blastomussa* Well, 1961					
Blastomussa merleti, Wells, 1961				*	*
Blastomussa wellsi Wijsman-Best, 1973		*	*	*	*
Genus: *Micromussa* Veron, 2000					
Micromussa amakusensis (Veron, 1990)	*	*	*	*	*
Micromussa minuta (Moll and Borel-Best, 1984)	*	*	*	*	*
Genus: *Acanthastrea* Milne Edwards and Haime, 1848					
Acanthastrea bowerbanki Milne Edwards and Haime, 1851		*	*	*	*
Acanthastrea brevis Milne Edwards and Haime, 1849	*		R	*	*
Acanthastrea echinata (Dana, 1846)	*	*	*	*	*
Acanthastrea faviaformis Veron, 2000		*	*		*
Acanthastrea hemprichii (Ehrenberg, 1834)	*	*	*		*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Acanthastrea hillae Wells, 1955	*		R	*	*
Acanthastrea ishigakiensis Veron, 1990	*	*	*	*	*
Acanthastrea lordhowensis Veron and Pichon, 1982		*	*		*
Acanthastrea regularis Veron, 2000	*	*	*	*	*
Acanthastrea rotundoflora Chevalier, 1975		*	*	*	*
Acanthastrea subechinata Veron, 2000	*	*	*		*
Acanthastrea sp. 1	*		R		*
Acanthastrea sp. 2	*		R		*
Genus: *Lobophyllia* Blainville, 1830					
Lobophyllia corymbosa (Forskål, 1775)	*	*	*	*	*
Lobophyllia dentatus Veron, 2000	*	*	*	*	*
Lobophyllia diminuta Veron, 1985	*	*	*	*	*
Lobophyllia flabelliformis Veron, 2000	*	*	*	*	*
Lobophyllia hataii Yabe and Sugiyama, 1936	*	*	*	*	*
Lobophyllia hemprichii (Ehrenberg, 1834)	*	*	*	*	*
Lobophyllia pachysepta Chevalier, 1975	*		R	*	*
Lobophyllia robusta Yabe and Sugiyama, 1936	*	*	*	*	*
Lobophyllia serratus Veron, 2000		*	*		*
Genus: *Symphyllia* Milne Edwards and Haime, 1848					
Symphyllia agaricia Milne Edwards and Haime, 1849	*	*	*	*	*
Symphyllia hassi Pillai and Scheer, 1976	*	*	*	*	*
Symphyllia radians Milne Edwards and Haime, 1849	*	*	*	*	*
Symphyllia recta (Dana, 1846)	*	*	*	*	*
Symphyllia valenciennesii Milne Edwards and Haime, 1849	*	*	*	*	*
Genus: *Scolymia* Haime, 1852					
Scolymia australis (Milne Edwards and Haime, 1849)	*		R	*	*
Scolymia vitiensis Brüggemann, 1878	*		R	*	*
Genus: *Australomussa* Veron, 1985					
Australomussa rowleyensis Veron, 1985	*	*	*	*	*
Genus: *Cynarina* Brüggemann, 1877					
Cynarina lacrymalis (Milne Edwards and Haime, 1848)	*	*	*	*	*
Family: Faviidae Gregory, 1900					
Genus: *Caulastrea* Dana, 1846					
Caulastrea curvata Wijsman-Best, 1972				*	*
Caulastrea echinulata (Milne Edwards and Haime, 1849)				*	*
Caulastrea furcata Dana, 1846	*	*	*	*	*
Caulastrea tumida Matthai, 1928	*		R	*	*
Genus: *Favia* Oken, 1815					
Favia danae Verrill, 1872	*	*	*	*	*
Favia favus (Forskål, 1775)	*	*	*	*	*
Favia helianthoides Wells, 1954	*	*	*	*	*

Zooxanthellate Scleractinia	**This study**	**Raja Ampat Veron, 2002**	**New Total for Raja Ampat**	**East Indonesia Veron, 2000^**	**New Total for East Indonesia**
Favia laxa (Klunzinger, 1879)	*	*	*	*	*
Favia lizardensis Veron and Pichon, 1977	*	*	*	*	*
Favia maritima (Nemenzo, 1971)	*	*	*	*	*
Favia marshae Veron, 2000	*		R		E
Favia matthai Vaughan, 1918	*	*	*	*	*
Favia maxima Veron, Pichon & Wijsman-Best, 1972	*	*	*	*	*
Favia pallida (Dana, 1846)	*	*	*	*	*
Favia rosaria Veron, 2000	*		R		*
Favia rotumana (Gardiner, 1899)	*	*	*	*	*
Favia rotundata Veron, Pichon & Wijsman-Best, 1972	*	*	*	*	*
Favia speciosa Dana, 1846	*	*	*	*	*
Favia stelligera (Dana, 1846)	*	*	*	*	*
Favia truncatus Veron, 2000	*	*	*	*	*
Favia veroni Moll and Borel-Best, 1984	*	*	*	*	*
Favia vietnamensis Veron, 2000				*	*
Genus: *Barabattoia* Yabe and Sugiyama, 1941					
Barabattoia amicorum (Milne Edwards and Haime, 1850)	*		R		E
Barabattoia laddi (Wells, 1954)	*	*	*	*	*
Genus: *Favites* Link, 1807					
Favites abdita (Ellis and Solander, 1786)	*	*	*	*	*
Favites acuticulis (Ortmann, 1889)	*		R		E
Favites bestae Veron, 2000		*	*	*	*
Favites chinensis (Verrill, 1866)	*	*	*	*	*
Favites complanata (Ehrenberg, 1834)	*	*	*	*	*
Favites flexuosa (Dana, 1846)	*	*	*	*	*
Favites halicora (Ehrenberg, 1834)	*	*	*	*	*
Favites micropentagona Veron, 2000	*	*	*	*	*
Favites paraflexuosa Veron, 2000	*	*	*		*
Favites pentagona (Esper, 1794)	*	*	*	*	*
Favites russelli (Wells, 1954)	*	*	*	*	*
Favites cf. *spinosa* (Klunzinger, 1879)	*		R		E
Favites stylifera (Yabe and Sugiyama, 1937)	*	*	*	*	*
Favites vasta (Klunzinger, 1879)	*	*	*	*	*
Genus: *Goniastrea* Milne Edwards and Haime, 1848					
Goniastrea aspera Verrill, 1905	*	*	*	*	*
Goniastrea australensis (Milne Edwards and Haime, 1857)	*	*	*	*	*
Goniastrea edwardsi Chevalier, 1971	*	*	*	*	*
Goniastrea favulus (Dana, 1846)	*	*	*	*	*
Goniastrea minuta Veron, 2000	*		R	*	*
Goniastrea palauensis (Yabe and Sugiyama, 1936)				*	*
Goniastrea pectinata (Ehrenberg, 1834)	*	*	*	*	*
Goniastrea ramosa Veron, 2000	*	*	*		*
Goniastrea retiformis (Lamarck, 1816)	*	*	*	*	*
Genus: *Platygyra* Ehrenberg, 1834					
Platygyra acuta Veron, 2000	*	*	*		*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Platygyra contorta Veron, 1990	*		R	*	*
Platygyra daedalea (Ellis and Solander, 1786)	*	*	*	*	*
Platygyra lamellina (Ehrenberg, 1834)	*	*	*	*	*
Platygyra pini Chevalier, 1975	*	*	*	*	*
Platygyra ryukyuensis Yabe and Sugiyama, 1936	*	*	*	*	*
Platygyra sinensis (Milne Edwards and Haime, 1849)	*	*	*	*	*
Platygyra verweyi Wijsman-Best, 1976	*	*	*	*	*
Platygyra yaeyemaensis Eguchi and Shirai, 1977	*		R		E
Genus: *Oulophyllia* Milne Edwards and Haime, 1848					
Oulophyllia bennettae (Veron, Pichon, 1977)	*	*	*	*	*
Oulophyllia crispa (Lamarck, 1816)	*	*	*	*	*
Oulophyllia levis Nemenzo, 1959	*	*	*		*
Genus: *Leptoria* Milne Edwards and Haime, 1848					
Leptoria irregularis Veron, 1990	*		R	*	*
Leptoria phrygia (Ellis and Solander, 1786)	*	*	*	*	*
Genus: *Montastrea* Blainville, 1830					
Montastrea annuligera (Milne Edwards and Haime, 1849)	*	*	*	*	*
Montastrea colemani Veron, 2000	*	*	*	*	*
Montastrea curta (Dana, 1846)	*	*	*	*	*
Montastrea magnistellata Chevalier, 1971	*	*	*	*	*
Montastrea multipunctata Hodgson, 1985				*	*
Montastrea salebrosa (Nemenzo, 1959)	*	*	*	*	*
Montastrea valenciennesi (Milne Edwards and Haime, 1848)	*	*	*	*	*
Genus: *Plesiastrea* Milne Edwards and Haime, 1848					
Plesiastrea versipora (Lamarck, 1816)	*	*	*	*	*
Genus: *Oulastrea* Milne Edwards and Haime, 1848					
Oulastrea crispata (Lamarck, 1816)	*	*	*	*	*
Genus: *Diploastrea* Matthai, 1914					
Diploastrea heliopora (Lamarck, 1816)	*	*	*	*	*
Genus: *Leptastrea* Milne Edwards and Haime, 1848					
Leptastrea aequalis Veron, 2000	*		R		E
Leptastrea bewickensis Veron and Pichon, 1977				*	*
Leptastrea bottae (Milne Edwards and Haime, 1849)	*	*	*		*
Leptastrea inaequalis Klunzinger, 1879				*	*
Leptastrea pruinosa Crossland, 1952	*	*	*	*	*
Leptastrea purpurea (Dana, 1846)	*	*	*	*	*
Leptastrea transversa Klunzinger, 1879	*	*	*	*	*
Genus: *Cyphastrea* Milne Edwards and Haime, 1848					
Cyphastrea agassizi (Vaughan, 1907)		*	*	*	*
Cyphastrea chalcidium (Forskål, 1775)	*	*	*	*	*
Cyphastrea decadia Moll and Best, 1984	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Cyphastrea japonica Yabe and Sugiyama, 1932	*	*	*	*	*
Cyphastrea microphthalma (Lamarck, 1816)	*	*	*	*	*
Cyphastrea ocellina (Dana, 1864)	*	*	*	*	*
Cyphastrea serailia (Forskål, 1775)	*	*	*	*	*
Genus: *Echinopora* Lamarck, 1816					
Echinopora ashmorensis Veron, 1990				*	*
Echinopora gemmacea Lamarck, 1816	*	*	*	*	*
Echinopora hirsutissima Milne Edwards and Haime, 1849	*	*	*	*	*
Echinopora horrida Dana, 1846	*	*	*	*	*
Echinopora lamellosa (Esper, 1795)	*	*	*	*	*
Echinopora mammiformis (Nemenzo, 1959)	*	*	*	*	*
Echinopora pacificus Veron, 1990	*	*	*	*	*
Echinopora taylorae (Veron, 2000)	*		R		E
Genus: *Moseleya* Quelch, 1884					
Moseleya latistellata Quelch, 1884				*	*
Family: Trachyphyllidae Verrill, 1901					
Genus: *Trachyphyllia* Milne Edwards and Haime, 1848					
Trachyphyllia geoffroyi (Audouin, 1826)	*	*	*	*	*
Family: Poritidae Gray, 1842					
Genus: *Porites* Link, 1807					
Porites aranetai Nemenzo, 1955	*		R		E
Porites annae Crossland, 1952	*	*	*	*	*
Porites attenuata Nemenzo 1955	*	*	*	*	*
Porites australiensis Vaughan, 1918	*	*	*	*	*
Porites cumulatus Nemenzo, 1955	*		R	*	*
Porites cylindrica Dana, 1846	*	*	*	*	*
Porites deformis Nemenzo, 1955	*	*	*	*	*
Porites densa Vaughan, 1918	*	*	*		*
Porites eridani Umbgrove, 1940				*	*
Porites evermanni Vaughan, 1907	*	*	*	*	*
Porites flavus Veron, 2000	*	*	*		*
Porites cf. *heronensis* Veron, 1985	*		R		E
Porites horizontalata Hoffmeister, 1925	*	*	*	*	*
Porites latistellata Quelch, 1886	*	*	*	*	*
Porites lichen Dana, 1846	*	*	*	*	*
Porites lobata Dana, 1846	*	*	*	*	*
Porites lutea Milne Edwards and Haime, 1851	*	*	*	*	*
Porites mayeri Vaughan, 1918		*	*	*	*
Porites monticulosa Dana, 1846	*	*	*	*	*
Porites murrayensis Vaughan, 1918		*	*	*	*
Porites napopora Veron, 2000		*	*		*
Porites negrosensis Veron, 1990	*	*	*		*
Porites nigrescens Dana, 1846	*	*	*	*	*

Zooxanthellate Scleractinia	This study	Raja Ampat Veron, 2002	New Total for Raja Ampat	East Indonesia Veron, 2000^	New Total for East Indonesia
Porites ornata Nemenzo, 1971				*	*
Porites profundus Rehberg, 1892	*	*	*		*
Porites rugosa Fenner & Veron, 2000	*	*	*		*
Porites rus (Forskål, 1775)	*	*	*	*	*
Porites sillimaniana Nemenzo, 1976		*	*	*	*
Porites solida (Forskål, 1775)	*	*	*	*	*
Porites stephensoni Crossland, 1952	*	*	*	*	*
Porites tuberculosa Veron, 2000	*	*	*	*	*
Porites vaughani Crossland, 1952	*	*	*	*	*
Genus: *Goniopora* Blainville, 1830					
Goniopora albiconus Veron, 2000	*	*	*		*
Goniopora burgosi Nemenzo, 1955	*	*	*		*
Goniopora columna Dana, 1846	*	*	*	*	*
Goniopora djiboutiensis Vaughan, 1907	*	*	*	*	*
Goniopora eclipsensis Veron and Pichon, 1982	*	*	*		*
Goniopora fruticosa Saville-Kent, 1893	*	*	*	*	*
Goniopora lobata Milne Edwards and Haime, 1860	*	*	*	*	*
Goniopora minor Crossland, 1952	*	*	*	*	*
Goniopora palmensis Veron and Pichon, 1982	*	*	*	*	*
Goniopora pandoraensis Veron and Pichon, 1982	*	*	*	*	*
Goniopora pendulus Veron, 1985	*	*	*		*
Goniopora polyformis Zou, 1980		*	*		*
Goniopora somaliensis Vaughan, 1907	*	*	*	*	*
Goniopora stokesi Milne Edwards and Haime, 1851	*	*	*	*	*
Goniopora stutchburyi Wells, 1955	*	*	*	*	*
Goniopora tenella (Quelch, 1886)		*	*	*	*
Goniopora tenuidens (Quelch, 1886)	*	*	*	*	*
Genus: *Alveopora* Blainville, 1830					
Alveopora allingi Hoffmeister, 1925				*	*
Alveopora catalai Wells, 1968	*	*	*	*	*
Alveopora daedalea (Forskål, 1775)	*		R	*	*
Alveopora excelsa Verrill, 1863	*		R		E
Alveopora fenestrata (Lamarck, 1816)	*		*	*	*
Alveopora gigas Veron, 1985	*	*	*	*	*
Alveopora marionensis Veron and Pichon, 1982		*	*	*	*
Alveopora minuta Veron, 2000	*		R		E
Alveopora spongiosa Dana, 1846	*	*	*	*	*
Alveopora tizardi Bassett-Smith, 1890	*		R	*	*
Alveopora verrilliana Dana, 1872				*	*
TOTAL	**488**	**452**	**537**	**491**	**579**

Appendix 5. Other non-zooxanthellate and non-scleratinian hard corals, and soft corals recored at the Raja Ampat Islands.

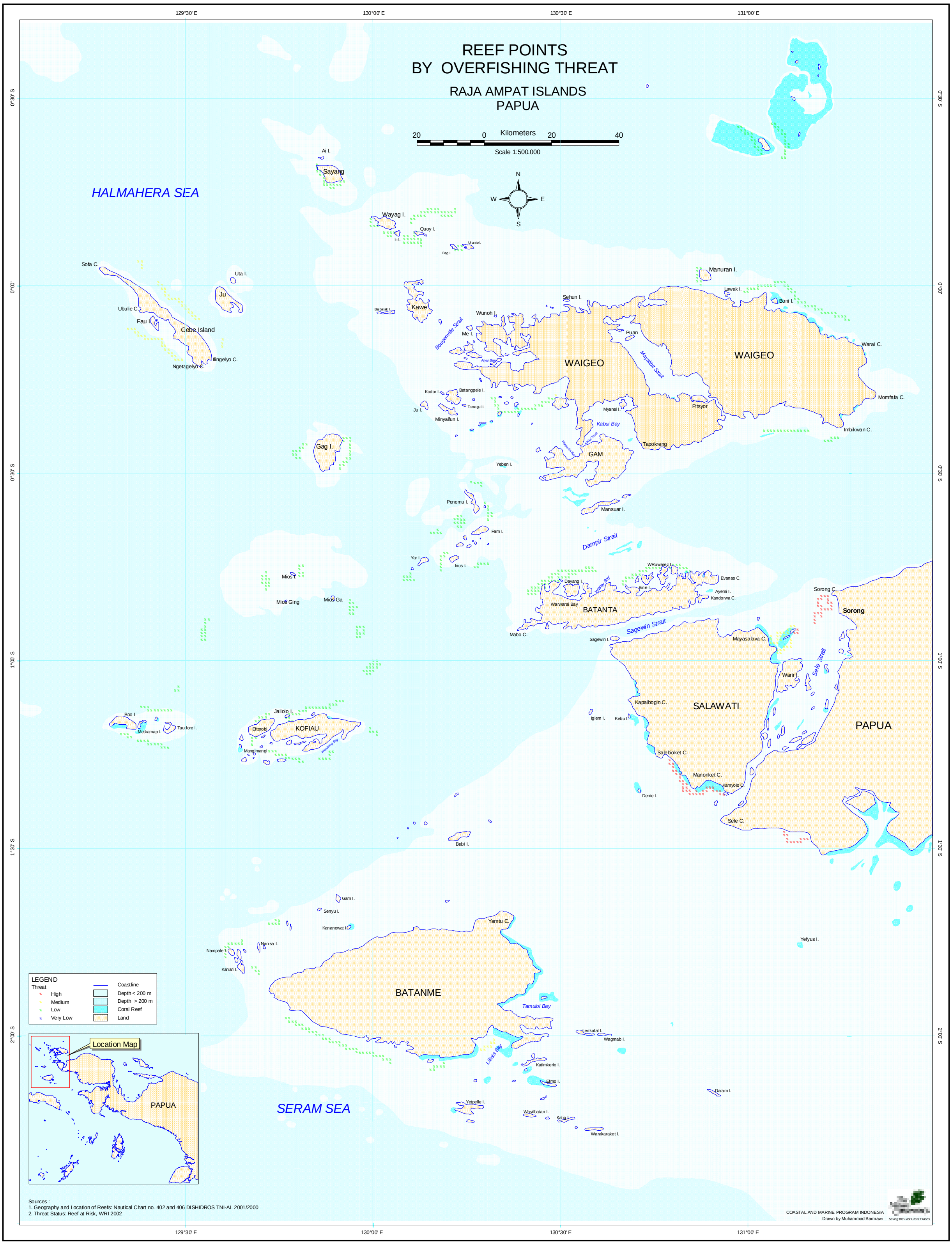
Number of sites at which each taxon was recorded is indicated.

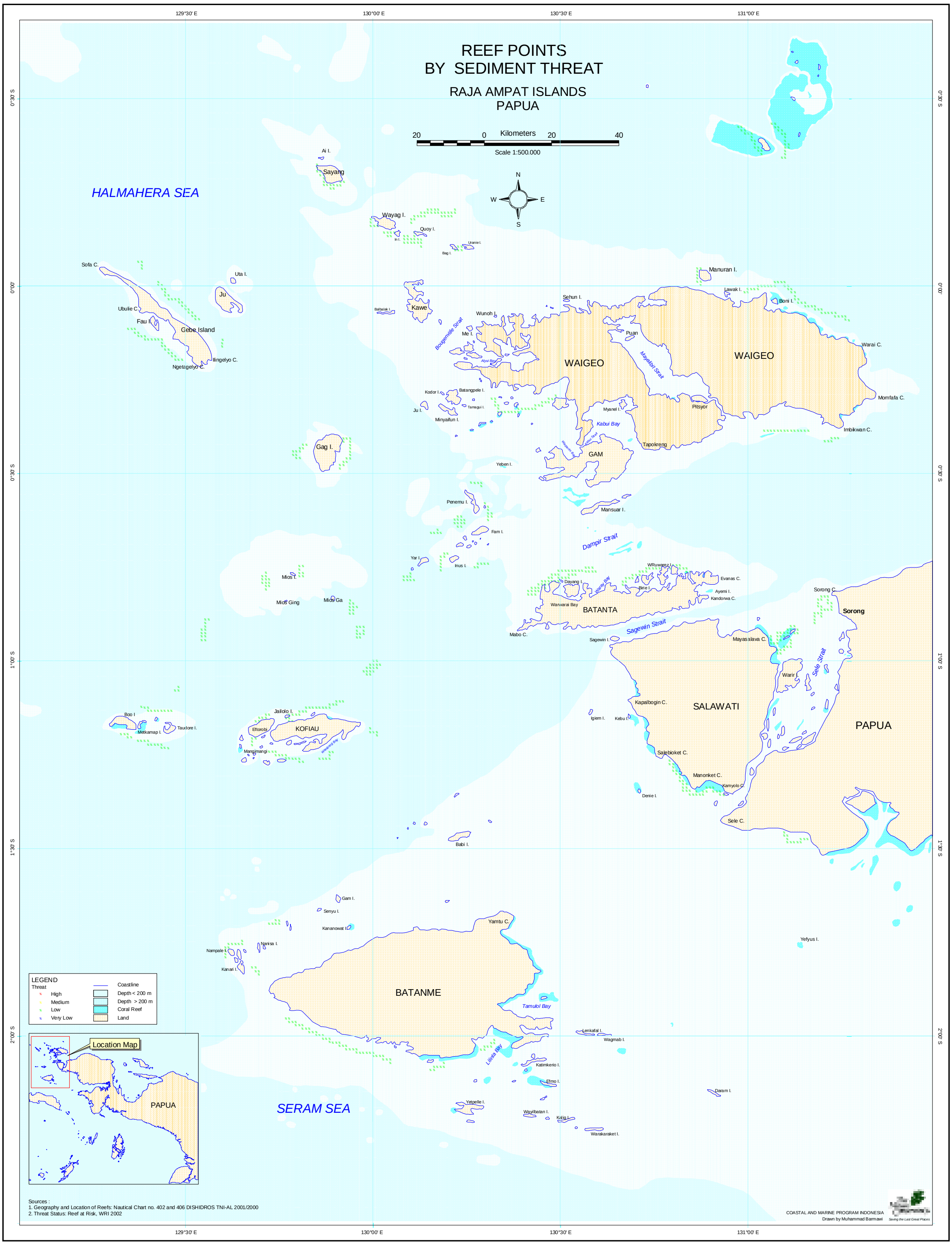
Hard coral Taxa		Soft coral Taxa			
	Sites		**Sites**		**Sites**
Scleractinia		**Alcyonacea**		Briareidae	
				Briareum	38
Dendrophylliidae		Clavulariidae			
Tubastrea micrantha	18	*Clavularia*	25	Anthothelidae	
Tubastrea coccinae	9			*Iciligorgia*	P
Tubastrea folkneri	5	Alcyoniidae		*Solenocaulon*	P
		Cladiella	11		
Milleporina		*Dampia*	11	Supergorgiidae	
		Klyxum	13	*Annella*	P
Milleporidae		*Lobophytum*	40		
Millepora dichotoma	9	*Rhytisma*		Melithaeidae	
Millepora exesa	25	*Sarcophyton*	74	*Acabaria*	P
Millepora intricata	22	*Sinularia* spp.	69	*Melithaea*	P
Millepora platyphylla	14	*Sinularia brascica*	23		
Millepora tenella	32	*Sinularia lamellata*		Plexauridae	
		Sinularia tree	5	*Echinogorgia*	P
Hydroida				*Paraplexaura*	P
		Nephtheidae			
Stylastridae		*Capnella*	20	Gorgoniidae	
Distichopora	5	*Dendronephthya*	39	*Pinnigorgia*	12
Stylaster	7	*Lemnalia*	24	*Rumphella*	31
		Litophyton	2		
Helioporacea		*Nephthea*	65	Ellisellidae	
		Paralemnalia	41	*Elisella*	19
Helioporidae		*Scleronephthya*	7	*Junceella*	15
Heliopora coerolea	21	*Stereonepthya*	16		
Heliopora sp. 1	1	*Umbellulifera*		Isididae	
				Isis	22
Alcyonacea		Nidaliidae			
		Chironephthya	1	**Pennatulacea**	
Tubiporidae		*Nephthyigorgia*	P		
Tubipora musica	47	*Siphonogorgia*	9	Virgulariidae	
				Virgularia	2
		Paralcyoniidae			
		Studeriotes	2	Pteroeididae	
				Pteroeides	4
		Xeniidae			
		Anthelia	8	**Antipatharia**	
		Cespitularia	2		
		Efflatounaria	P	Antipathidae	
		Heteroxenia	5	*Antipathes*	6
		Sympodium	P	*Cirrhipathes*	12
		Xenia	36		

Appendix 6. Reefs at Risk Maps


REEF POINTS
BY DESTRUCTIVE FISHING THREAT
RAJA AMPAT ISLANDS
PAPUA
Kilometers
Scale 1:500.000
HALMAHERA SEA
SERAM SEA
WAIGEO
GAM
BATANTA
SALAWATI
PAPUA
KOFIAU
BATANME
Sorong
Dampir Strait
Sagewin Strait
Sele Strait
Kabui Bay
Tamulol Bay
Sayang
Wayag I.
Gag I.
Gebe Island
Kawe
Manuran I.
Sehun I.
Pitsyor
Tapokreng
Mansuar I.
Penemu I.
Misool
LEGEND
Threat
High
Medium
Low
Very Low
Coastline
Depth < 200 m
Depth > 200 m
Coral Reef
Land
Location Map
Sources :
1. Geography and Location of Reefs: Nautical Chart no. 402 and 406 DISHIDROS TNI-AL 2001/2000
2. Threat Status: Reef at Risk, WRI 2002
COASTAL AND MARINE PROGRAM INDONESIA
Drawn by Muhammad Barmawi

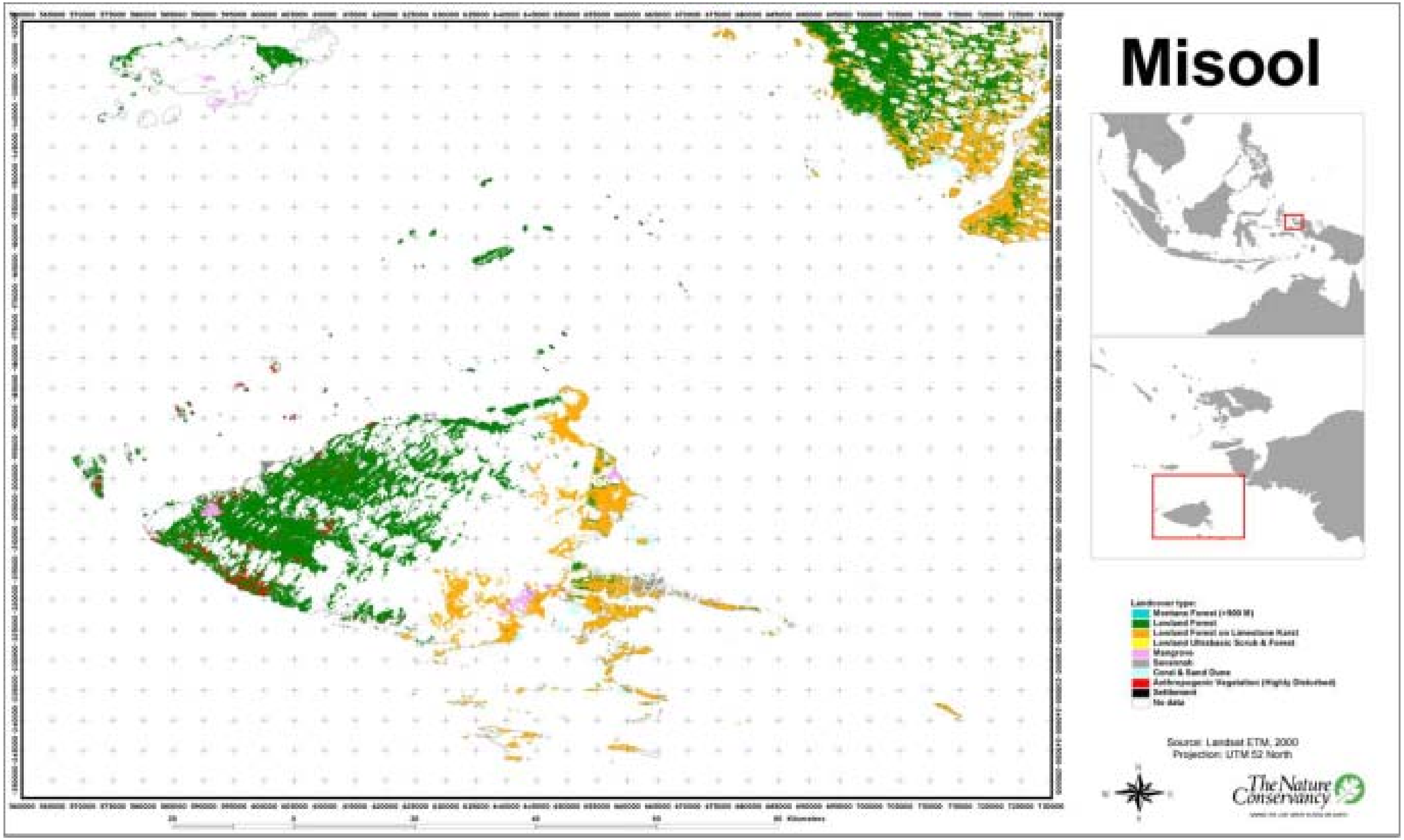

REEF POINTS
BY MARINE POLLUTION THREAT
RAJA AMPAT ISLANDS
PAPUA
Scale 1:500.000
Kilometers
HALMAHERA SEA
SERAM SEA
WAIGEO
WAIGEO
GAM
BATANTA
SALAWATI
PAPUA
KOFIAU
BATANME
Sorong
Dampir Strait
Sagewin Strait
Sele Strait
Kabui Bay
Tamulol Bay
Gag I.
Gebe Island
Kawe
Sayang
Wayag I.
Manuran I.
LEGEND
Threat
High
Medium
Low
Very Low
Coastline
Depth < 200 m
Depth > 200 m
Coral Reef
Land
Location Map
Sources :
1. Geography and Location of Reefs: Nautical Chart no. 402 and 406 DISHIDROS TNI-AL 2001/2000
2. Threat Status: Reef at Risk, WRI 2002
COASTAL AND MARINE PROGRAM INDONESIA
Drawn by Muhammad Barmawi

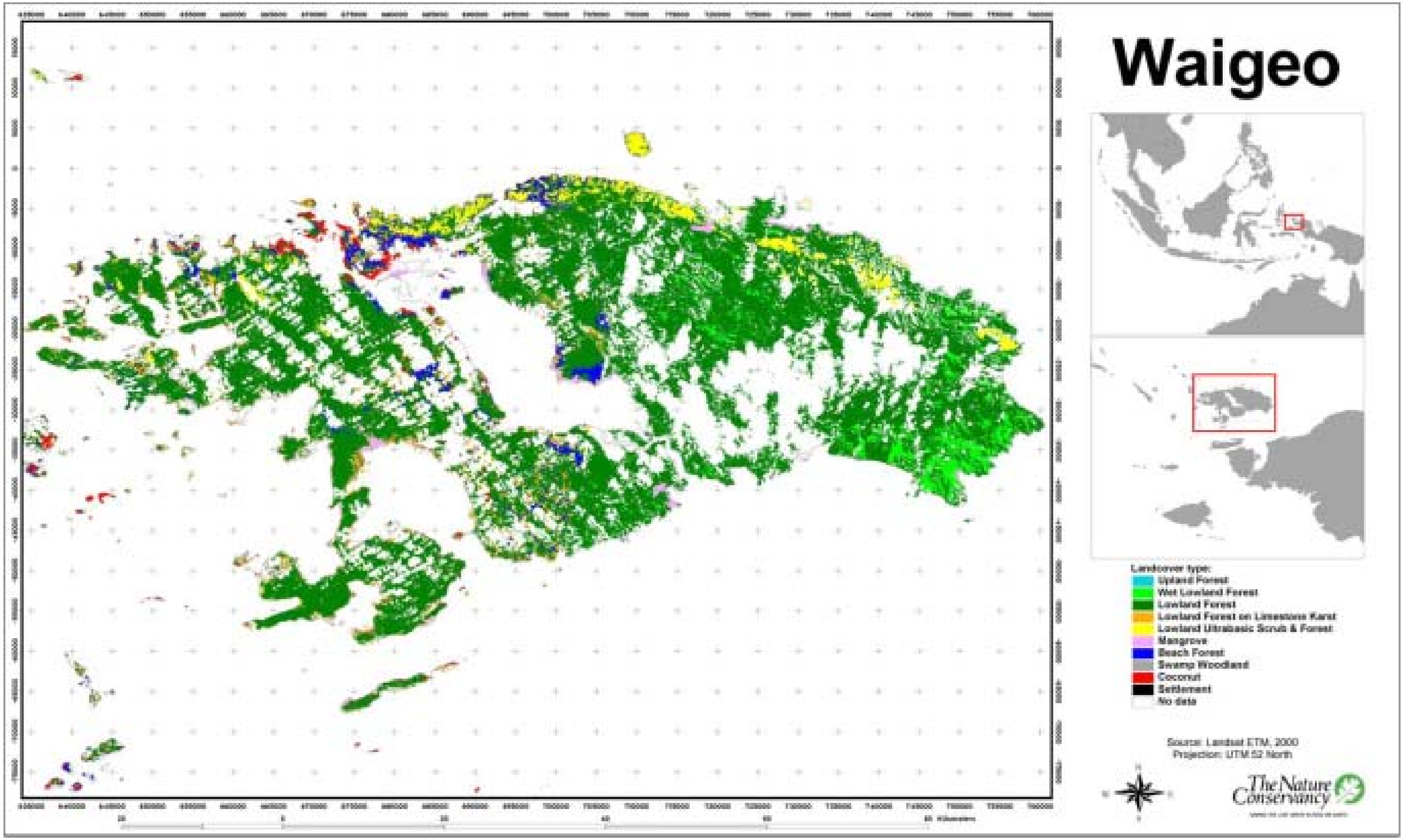

REEF POINTS
BY OVERFISHING THREAT
RAJA AMPAT ISLANDS
PAPUA
Kilometers
20 0 20 40
Scale 1:500.000
N
W
E
S
HALMAHERA SEA
SERAM SEA
WAIGEO
GAM
BATANTA
SALAWATI
PAPUA
KOFIAU
BATANME
Sorong
Dampir Strait
Sagewin Strait
Sele Strait
Kabui Bay
Tamulol Bay
Gebe Island
Gag I.
Sayang
Kawe
Mios I.
LEGEND
Threat
High
Medium
Low
Very Low
Coastline
Depth < 200 m
Depth > 200 m
Coral Reef
Land
Location Map
PAPUA
Sources :
1. Geography and Location of Reefs: Nautical Chart no. 402 and 406 DISHIDROS TNI-AL 2001/2000
2. Threat Status: Reef at Risk, WRI 2002
COASTAL AND MARINE PROGRAM INDONESIA
Drawn by Muhammad Barmawi
129°30' E
130°00' E
130°30' E
131°00' E
0°30' S
0°00'
1°00' S
1°30' S
2°00' S

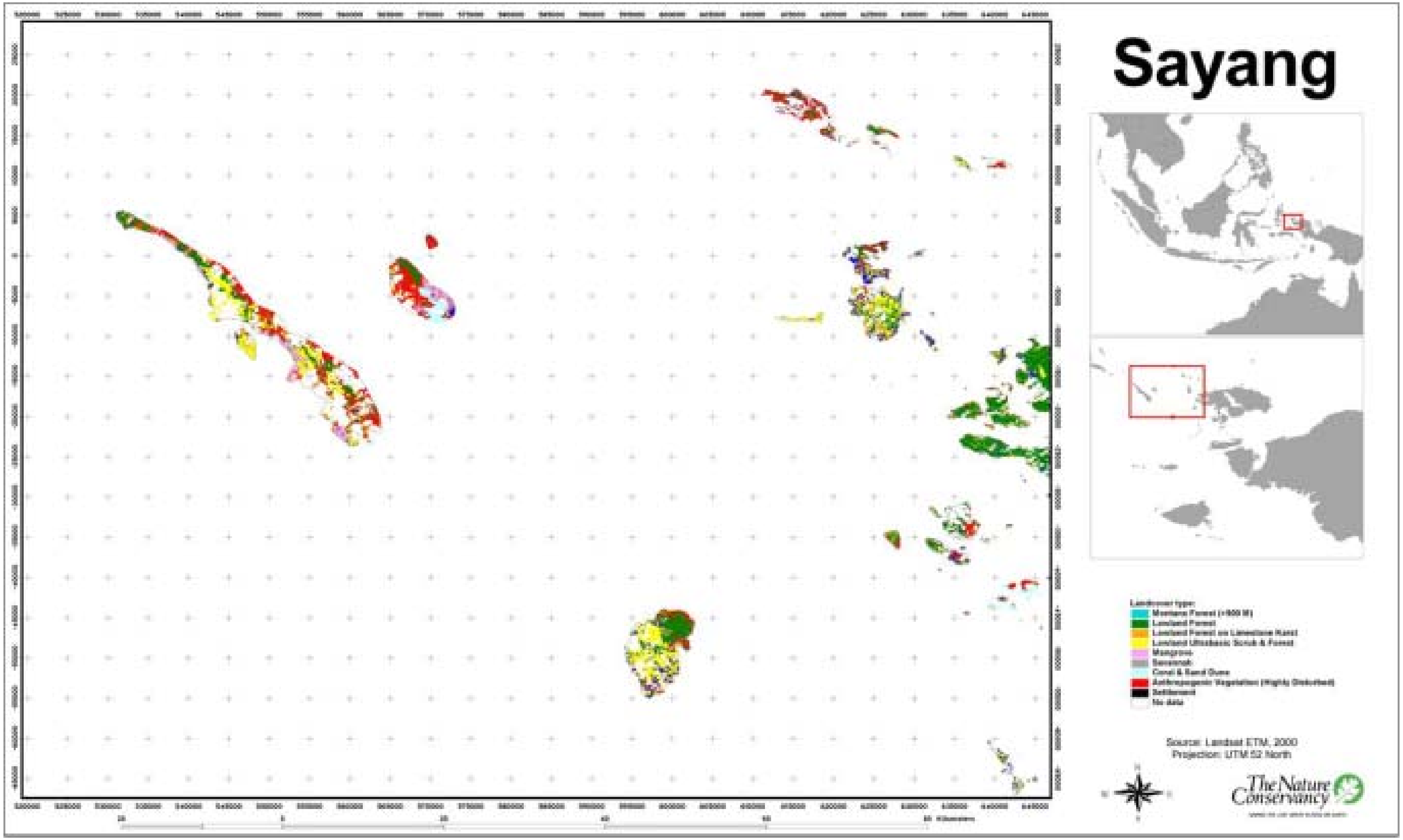

REEF POINTS
BY SEDIMENT THREAT
RAJA AMPAT ISLANDS
PAPUA
Kilometers
Scale 1:500.000
HALMAHERA SEA
SERAM SEA
WAIGEO
GAM
BATANTA
SALAWATI
PAPUA
KOFIAU
BATANME
Sorong
Dampir Strait
Sagewin Strait
LEGEND
Threat
High
Medium
Low
Very Low
Coastline
Depth < 200 m
Depth > 200 m
Coral Reef
Land
Location Map
Sources :
1. Geography and Location of Reefs: Nautical Chart no. 402 and 406 DISHIDROS TNI-AL 2001/2000
2. Threat Status: Reef at Risk, WRI 2002
COASTAL AND MARINE PROGRAM INDONESIA
Drawn by Muhammad Barmawi

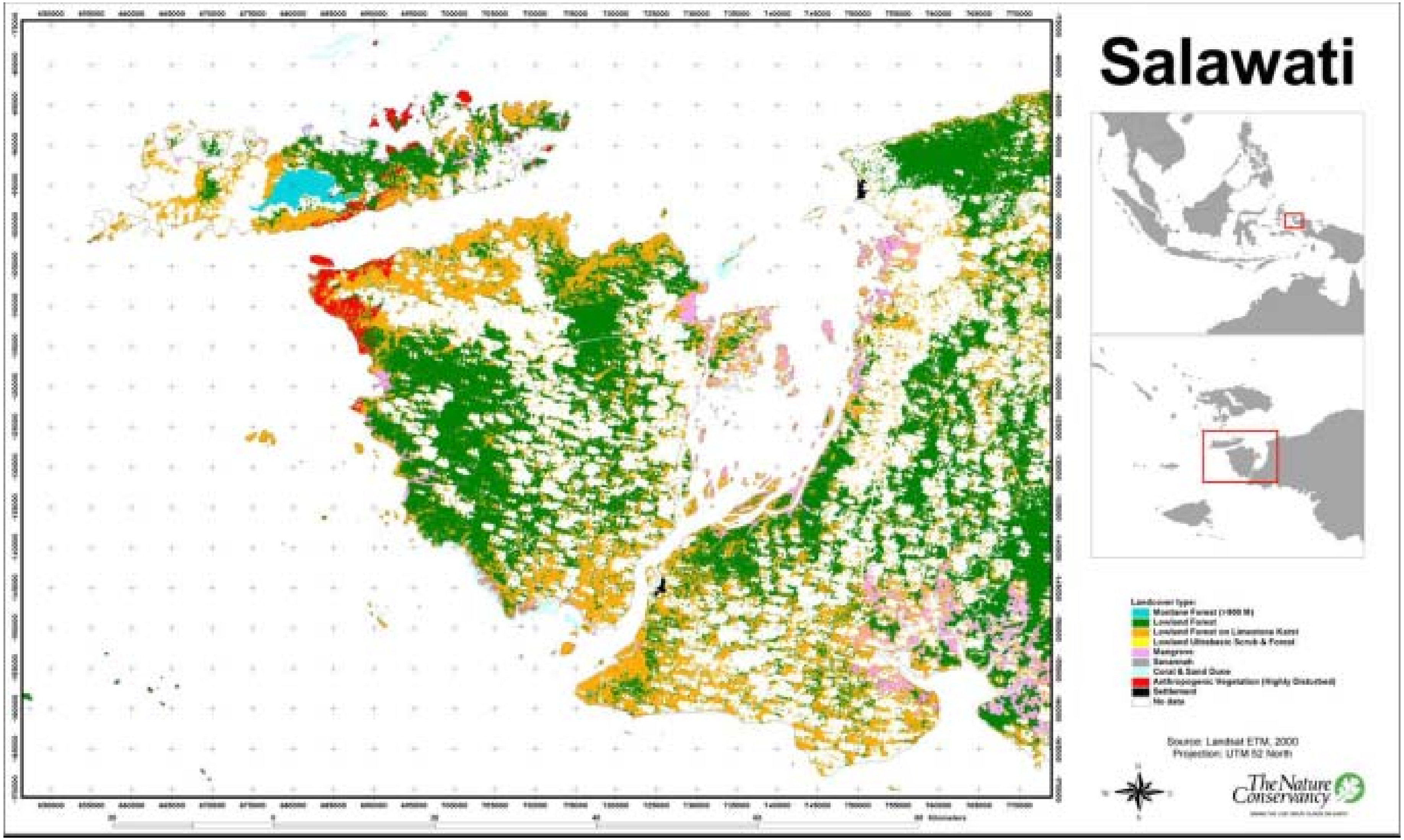

REEF POINTS
BY THREAT INDEX
RAJA AMPAT ISLANDS
PAPUA
Kilometers
20 0 20 40
Scale 1:500.000
N
W
E
S
HALMAHERA SEA
SERAM SEA
WAIGEO
GAM
BATANTA
SALAWATI
PAPUA
KOFIAU
BATANME
Sayang
Gag I.
Gebe Island
Kawe
Sorong
Dampir Strait
Sagewin Strait
Kabui Bay
129°30' E
130°00' E
130°30' E
131°00' E
0°30' S
0°00'
1°00' S
1°30' S
2°00' S
LEGEND
Threat
High
Medium
Low
Very Low
Coastline
Depth < 200 m
Depth > 200 m
Coral Reef
Land
Location Map
Sources :
1. Geography and Location of Reefs: Nautical Chart no. 402 and 406 DISHIDROS TNI-AL 2001/2000
2. Threat Status: Reef at Risk, WRI 2002
COASTAL AND MARINE PROGRAM INDONESIA
Drawn by Muhammad Barmawi

Appendix 7. Vegetation Maps




Waigeo
Landcover type:
Upland Forest
Wet Lowland Forest
Lowland Forest
Lowland Forest on Limestone Karst
Lowland Ultrabasic Scrub & Forest
Mangrove
Beach Forest
Swamp Woodland
Coconut
Settlement
No data
Source: Landsat ETM, 2000
Projection: UTM 52 North
The Nature Conservancy


Sayang
Source: Landsat ETM, 2000
Projection: UTM 52 North
The Nature Conservancy


Salawati
Coral & Sand Dune
Source: Landsat ETM, 2000
Projection: UTM 52 North
The Nature Conservancy

Appendix 8. List of participants of the Raja Ampat workshop

'Group' identifies the group in which participants were discussing the issues mentioned in Chapter 7.

No	Name	Institution	Group
1	Fadhli Umalelen	Pemda Kab. Raja Ampat	I
2	NF. Nambraku	Dinas P dan P, Kab. Raja Ampat	I
3	Abdul R. Wairoy	Dinas Pertanian	I
4	Nyoman Jaya	Asisten II	I
5	Yantho A.	Puskesmas	I
6	Yusdi L.	DKP	I
7	Nixon Mentansan	LPKM	I
8	Abubakar Saka	Eco Papua	II
9	Yohanis Goram Gaman	Konpers	II
10	K. Mambrasar	Dinas P dan P	II
11	Alfaris Labacu	Ka. Dis Wais	II
12	Daniel Goram	Ka. Dis Teluk Mayalibit	II
13	L. Burdam	Dis. Kep Ayau	II
14	M. Sulchan	Dep. Agama	II
15	Mery seseray	Tokoh perempuan	III
16	Ridwan watimena	Tokoh Pemuda	III
17	Alwiyah Gusci	Tokoh perempuan	III
18	Sefnat Dimara	Asisten I PemKab	III
19	Deky Dimara	Nelayan	III
20	Waladi Isnan	PHKA	III
21	N. Yensenem	PU	III
22	A. Ajalo	Kadis Kofiau	IV
23	C. Riupassa	LSM Wallacea	IV
24	Yules Anton	Tokoh adat	IV
25	Alex Mambrasar	FK Gemura	IV
26	St. Rumaseb	Tokoh agama	IV
27	G. Mambraku	Kepala kampong	IV
28	Yustina Kbarek	Din. Pariwisata	IV
29	Y. Mambraku	Bag. Hukum	V
30	Ones Makusi	Masyarakat	V
31	A. Kaisiepo	BP3D Raja Ampat	V
32	Th. Nanuru	Ramil 03	V
33	Sergius Kolomsusu	ToMas	V
34	Aberth Makusi	K. Kampung	V
35	A D B. Kasantaro	BKSDA	V
36	Djafar Umar	Sekdis	VI
37	Steven Numberi	Kadis Waigeo Timur	VI
38	Wem R. Wanma	BKSDA	VI
39	Hanok Naa	BKSDA	VI
40	Fery AM Liuw	BKSDA	VI
41	R. Mahulette	Dishub	VI
42	Melky Makusi	Sekdis Waigeo Tengah	VI
43	Adam Gaman	Kep Kampung	VII
44	Rasyid Umkabu	Tomas	VII
45	Karim Abdulrahman	Pemuda	VII
46	Frando Breemer	BKSDA	VII
47	A. Madjar	Din Perikanan	VII
48	K. Heremba	Dinas P dan P	VII
49	Noak Mayor	Dinas Penerangan	VII
50	Z. Sapulete	ToMas	VII
51	A. Mambraku	Dinas P dan P	VII
52	P. Dimara		VIII
53	Bahar Onim	ToMas	VIII
54	O. Mayor	PemKab	VIII
55	Max Ammer	IWS	VIII
56	A. Mambrisauw	BP3D	VIII
57	Tetha Hitipeuw	WWF Indonesia	VIII
58	Yulianus Thebu	WWF	VIII
59	Inda Arfan	SekDa Raja Ampat	VIII

Appendix 9. Transcripts of issues brought forward by workgroups during the Raja Ampat workshop

Posters prepared by the participants were transcribed and translated as literally as possible

Group1

Threats:

1. Potassium and poison
2. Dynamite fishing
3. Trawling
4. Turtle poaching
5. Illegal logging, taking of stones and sands
6. Coral mining
7. Opening new agricultural areas, and roads development

Facilities that must be made available:

1. Port
2. Marine transportation:
   Patrol transportation
   Public transportation
   Tourism transportation
2. Telecommunication facility
3. Coconut and sago crushing machine?
4. Bank

Anticipation	**Organizer**
1. Enforcement team in every villages are fully equipped	1. Police and Navy
2. Fully equiped patrol boats	2. Government of Raja Ampat
3. No license for commercial fishery	3. Government of Raja Ampat
4. Not using heavy equipments	4. Forestry agency

Improvement of community welfare

Real actions:

1. Sea cucumber, sea weed, and lobster culture
2. Sago processing
3. Home stay development
4. Dried fish making
5. Coconut oil making
6. Cooperative / village depot

Group 2

Threats:

1. The use of fishing gears that are not selective and environmentally benign
2. Bomb, potassium, poison, compressor, trawl, bagan.
3. Weak law implementation system.
4. Licenses giving that are not selective
5. Control systems that are weak
6. Customary rights issues
7. Construction of buildings and roads issues
8. Wildlife poaching
9. Illegal logging
10. Opening of new agricultural areas that are not selective
11. Inter-provincial community migration

Actions:

1. Improve the integrated control system
2. Socialization to community
3. Selective license giving
4. Perform selective controls from all related institutions and community
5. Awareness to community elements (customs, religious, communities, youths, and women)
6. Formation of reconciliation forum for Raja Ampat people
7. Environmentally sounds development
8. Zonation system development
9. Road development will not cut across the island but encircle the island.
10. Improvement of integrated control
11. Awareness to community
12. Limiting the inter-provincial migration

Responsible agencies:

1. District government and related institutions
2. District government, enforcement team, House of Representative, community
3. Traditional institutions / NGO
4. Government (BP3D)/ customary institutions
5. Government / MA
6. Government (Population agency and Transportation agency)

Improvement of community welfare

Real actions:

1. Development of community-based economy; sea cucumber culture, grouper culture, lobster, sea weed, crabs, and shrimps
2. Home industry (terasi, dried fish, hand made skills, diversify food from sago)
3. Planting coconut, chocolate, coffee trees, etc. on critical land.
4. Ecotourism development (homestay, traditional boat, art center, protected area)

Supporting facility:

1. Extension work (tutorial, training, comparative study)
2. Bank service in Saonek (Waisai)
3. Improvement/building new transportation vessels (speed boat, tourism boat,)
4. Communication network
5. Representative of NGOs in District of Raja Ampat (WWF, TNC, CI)

Group 3

Threats (land):

1. Forest cutting/mining
2. Infrastructure development
3. Nomadic agricultural system
4. Forest fire
5. Wildlife poaching

Threats (sea):

1. Fish bomb
2. Sand and coral mining, and taking of marine biota
3. Fish poison
4. Overfishing
5. Mangrove cutting

Actions (land):

1. Forest cutting/mining
    a. Good licensing process is implemented
    b. Forest cutting activities follow the rules
    c. Surveillance and law enforcement
2. Implementing environmental impact assessment
3. Awareness on non-nomadic agricultural practice
4. Fire from new opened agricultural land must be controlled
5. Poaching
    a. Awareness to poacher and buyer
    b. Law enforcement (license, penalty and ruling)

Actions (sea)

1. Law enforcement (1-5)
2. Awareness
3. Regulation of the use of fishing gears
4. Establishment and empowerment of KAMLA and KAMDA

Responsible agencies:

Land:

1. Forestry agency supported by law enforcement agencies, NGO and media.
2. Government of Raja Ampat district NGO, media, customary institutions (LMA)
3. Agricultural agency, LMA, NGO
4. BKSDA and Forestry agency, LMA, NGO
5. BKSDA supported by law enforcement agencies, LMA, NGO

Sea:

1. (1-5) Fisheries and Marine Affairs agency, BKSDA, supported by law enforcement agency, LMA, NGO, media

Community welfare

Real actions:

1. Community-based economy empowerment
2. Improve health quality
3. Improve education quality
4. Partnership development

Strategic planning for Raja Ampat

Supporting facilities:

1. Awareness and training
    a. Investment (partner)
    b. Marketing
2. PUSTU, POLINDES are well functioning (medical drugs and staff available)
3. Education
    a. Infrastructure for education
    b. Teacher quality
    c. Teacher welfare
    d. Education subsidy
4. Data ad information on natural and human resources
5. Science and technology and human resource
6. Safety

Group 4

Threats	Actions	Who
1. Bomb, cyanide, poison	1. Strict law enforcement 2. Reduce trade of grouper and napoleon wrasse 3. Community awareness on the dangers of using bomb	1. Police, judge, related institutions 2. Community, community leader, religious leader, women leader, youth leader 3. NGO
2. Beach erosion	1. Re-plantation/ rehabilitation of coral, mangrove and beach 2. Prohibiting coral mining for construction	1. Fisheries, transportation, forestry 2. NGO 3. Community leaders
3. Laws/regulations that are not fully understood	1. Socialization of law/regulation including customary laws	1. Army 2. Police 3. Custom leaders 4. Law/regulation section of District government 5. Court
4. Illegal logging	1. Strict law enforcement 2. Need inter agencies coordination 3. Need clear delineation of customary ownership 4. Strict control	1. Forestry agency 2. Decision makers 3. Law enforcement agencies 4. Custom leaders 5. NGO
5. Forest cutting	1. Community awareness on non-nomadic agricultural practice	1. Agricultural agency

Group 5

Threats (sea):

1. Bombing, potassium, poisoning
2. Outside fishermen who misused their fishing license
3. Incidental needs that drive people
4. Outside fishermen who fishing with potassium
5. Other environmentally destructive utilization practices

Threats (land):

1. Forest cutting without re-plantation
2. Overproduction on forest cutting
3. Wildlife poaching

Actions taken:

1. Improve surveillance
2. Implementing awareness program
3. Providing communication facility
4. Establishment of WASMAS

Who should organize action:

1. Relevant institutions
2. Kampong government

Social economic activities:

1. Implementing awareness program for community in kampong
2. Improving business capacity
3. Local government programs on business/entrepreneur that directly affecting community.

Facilities needed:

1. Banking
2. Infrastructure

Group 6

Threats (land):

1. Illegal forest cutting
2. Poaching
3. Forest fire
4. Cutting forest without re-plantation

Threats (sea):

1. Bomb/potassium (cyanide)/ poison
2. Fishing with trawl
3. Coral mining for construction
4. Over utilization of turtle meat especially during customary party and wedding

Actions taken:

1. Implement awareness program
2. Law enforcement actions for perpetrators
3. Inter-institutions coordination (District and its subordinate governments)
4. Providing infrastructures

Organizers:

1. Local government
2. Local governmental agencies
   a. Forestry
   b. Transportation
   c. Tourism

Real Actions:

1. Management of incomes that are not optimum
2. Establishment of KOPERMAS
3. The use of appropriate technologies

Facilities needed:

1. Human resources development
2. Availability of transportation facility
3. Provide opportunities for investor/tourist

Group 7

Threats:

1. Bomb and potassium
2. Coral mining
3. Poison from tree's root
4. Illegal forest cut / forest fire
5. Protected wildlife poaching

Actions taken:

1. Inter-agency coordination to prevent the law/rule breaking
2. Law enforcement
3. Joint surveillance team involving relevant institutions, business entrepreneur and community

Organizer:

1. Bupati in his/her capacity as the head of local government will organize relevant technical marine and terrestrial institutions that will also include community.

Community welfare

Important issues:

1. Community empowerment, community directly involve in marine resource management.
2. Local government establishes banking system that will provide soft loan for fishermen to develop their small scale business.
3. Government provides business loan to community in the form of nets, outboard engine / modern fishing gears.
4. Establishment of small cooperative body in each kampong that could improve the local economy.
5. Without license from government/involving local community, investors should not be permitted to conduct business in Raja Ampat.

Supporting facility:

1. Local customary body
2. Involvement of religious leaders, community leaders, youth leaders, women leaders that will lead and organize the activity.

Suggestions:

1. Government facilitates relevant agencies with transportation vessel including its operational costs.
2. Build guard stations in areas suspected for high illegal activities.
3. Catching fish for export must follow the permitted sizes.
4. Bomb and potassium fishermen are punished heavily.

Group 8

Threats

1. Fish bombing conducted by local and outsider/Butung
2. Potassium fishing conducted by local and outsider
3. Coral mining for construction by local people
4. Exploitation of green turtle in P. Sayang by local and outsider
5. Boat anchor
6. Overfishing
7. Beach erosion due to sand mining and mangrove cutting
8. Beach trees cutting
9. Forest/tree cutting
10. Use of heavy equipments to transport the timber from logging activity
11. Forest fire / nomadic agricultural practice
12. Catching and selling of protected animals
13. Issuance of forest utilization license that is not considering the forest overall functions.

Preventive actions:

1. Improve surveillance system by involving relevant institutions and local community.
2. Improve the surveillance facility.
3. Socialization of laws on resource management to community.
4. Dynamite fishermen from P. Buaya, should be sent back home in coordination with the Raja Ampat and City of Sorong governments.
5. Local dynamite fishermen are sent to jail after being prosecuted.
6. Improve education, economy and infrastructures.
7. Improve awareness through religious, customs, and government activities.
8. Improve awareness of government officers.
9. Empower local/community institution
10. Arise traditional wisdom
11. Need to create law for Raja Ampat that can guarantee the investors business existence including their contribution to government and community.
12. Stop logging and utilize forest in sustainable way.
13. Reserve forest as global lungs

Organizers:

1. Raja Ampat government (technical agencies)
2. Community, customary, religious institutions.
3. Local, national and international NGOs.

Community welfare

Actions:

1. Government of Raja Ampat and relevant institutions provide jobs
2. Provide supporting infrastructure (transportation, market)
3. Various entrepreneur models
4. Community-based ecotourism
5. Sustainable forest utilization

Steps:

1. Improve community skills according to jobs requirement
2. Provide business loan and investment models
3. Empowerment
4. Create regulations on contributions, responsibilities and rights of community, government, and private sectors.

Appendix 10. Proposed conservation actions.

Immediate Follow-Up Actions

These activities are designed to prepare a solid foundation for conservation action in the Raja Ampat islands. They aim to develop understanding among all stakeholders concerning conservation issues and opportunities and to prepare the way for collaboration in meeting conservation objectives.

1. Reporting Back

   - Two meetings will be held in 2003 to follow up on the November 2002 REA. The first will feed back the results of the survey to communities and local government. It will elicit responses from participants on their views concerning conservation opportunities and constraints. A report on the first of these dissemination and consultation meetings is included in this document (cf. Chapter 7)

2. Socializing the Results

   - A second, larger meeting will be held after the report is published. Participants will include representatives of local communities; local, district, provincial, and national government agencies responsible for conservation, resource management, and enforcement; the private sector; international organizations committed to supporting conservation in the area (including CI and WWF); interested donors; and representatives of the Ministries of Forestry and of Marine Affairs. It will begin formal multi-stakeholder consultations and identify specific follow-up actions and responsibilities, including funding needs for inclusion in the national budgeting process.

3. Building Partnerships

   - A coordinated conservation program in the Raja Ampat islands among TNC, CI, WWF, and other strategic partners will be developed. TNC, together with its partners, will initiate a dialogue with Indonesian conservation organizations and explore opportunities for partnerships in implementing conservation programs in the Raja Ampat islands.
   - TNC will make a high level visit to Sorong, Manokwari, and Jayapura to (a) meet government and university officials and confirm interest in pursuing conservation activities; (b) meet with WWF staff in Sorong to work out collaboration; and (c) identify partnership opportunities with Papua-based universities, NGOs, and other public and private organizations.

4. Generate Policy Support

   - TNC will take first steps to generate policy support from agencies for enforcement (Navy, Army, and Police) and resource management and conservation (Forestry, Marine Affairs) for conservation initiatives implemented by local communities, government, or other partners in the Raja Ampat islands.
   - An initial business plan that identifies potential long term sources of funding for conservation in the area will be prepared by Community and Conservation Investment Forum (CCIF) for the World Commission on Protected Areas (WCPA) Southeast Asia Marine Working Group.
   - Ecoregional planning efforts in the Flores and Banda Seas will begin in 2003 and will include the marine area around the Raja Ampat islands.

Recommendations for Initiating Conservation Action

At the completion of these initial foundation-building initiatives, it is proposed that the following actions be undertaken. The recommended activities are designed to begin the identification of conservation strategies and the implementation of specific conservation activities in the Raja Ampat islands. These actions pertain specifically to TNC and partners. It is assumed that WWF and CI will implement similar processes in the areas where they commit to implement conservation programs. It is also assumed that TNC, WWF and CI will reach agreement on non-overlapping geographic focus areas for assistance with the development and implementation of conservation programs by partner organizations.

1. Outreach, awareness, constituency building for effective conservation actions

   Building on the activities conducted this year, the Conservancy will work with government authorities, WWF, CI, local NGOs, and other partners to enhance awareness of the importance of conserving resources and assess community development needs and opportunities, including alternative livelihoods. Increased awareness and support for protected area concepts, rules, and borders among local communities is also needed. This will provide a solid foundation and needed local support for effective management, including enforcement actions against destructive fishing practices.

   During the November 2002 REA, community members were surprised and impressed by the biological importance of their islands. Results from REAs and other studies will be compiled into media (print, images) to stress the uniqueness of the islands. This will be reinforced by a traveling exhibition/workshop led by a local NGO, and by editing and production of a short video (footage already in hand).

2. Developing conservation strategies

   TNC and its partners will carry out a conservation area planning process to establish the basis for a resilient, mutually replenishing network of protected areas. Communities (including traditional leadership and youth, church, and other groups), the private sector, national and local government will be fully engaged in this process. Conservation area planning will follow TNC's approach of identifying conservation targets, the factors that threaten these targets, strategies to abate these threats and maintain biodiversity, and indicators with which to measure the success of these strategies. The legal status and boundaries of existing reserves will be clarified, and gaps identified. The identification of spawning aggregation sites and areas that are naturally resistant to coral bleaching will be built into this process, in order to include them in the MPA network. Further assessment of local land and marine tenure systems, as well as traditional systems of seasonal closures of marine resources, will also be conducted to enable this understanding to be fully reflected in planning and implementing conservation activities in the region.

   This planning process will be initiated in late 2003 and take approximately two years to complete. A limited amount of research to meet needs identified in the plan, e.g., on currents and larval dispersal to improve our understanding of connectivity between the Raja Ampat islands and other areas in the Coral Triangle, will be carried out.

3. Establishing pilot conservation actions and expansion to scale

   Based on the conservation area plan and other available information on conservation opportunities, including socio-economic and political factors, and in coordination with CI, WWF, and other partner organizations, TNC will identify two sites at which to help effectively managed marine protected areas. These sites will be selected to conserve especially rich biodiversity and to perform critical functions within a future Raja Ampat MPA network. Leading candidates for these sites are Kofiau and the area around southeast Misool. Both are already proposed as protected areas and have the scale needed to maintain a regionally important larval source, and the former contains the highest fish and coral diversity encountered during the November 2002 REA.

   Beginning in 2004, TNC will engage gradually at these two sites, implementing the following types of activities to provide a solid foundation for conservation:

- Studies of socio-economic conditions and cultural characteristics, identification of targets for community outreach and awareness activities, and design of a social monitoring program to record existing and changing community perceptions;
- Assessment of current conservation status, and protected area management;
- Stakeholder consultations and partner identification, aiming to maximize input on MPA objectives, conservation targets, and options for co-management structures;
- Initial training courses for communities, stakeholders, and responsible government agencies in site conservation planning and MPA management;
- Providing support for mapping and gazetting the reserve areas;
- Developing and achieving stakeholder support for zoning and management plans and, possibly, conservation concessions;
- Developing co-management strategies for multiple use zones with strong community participation, including approaches that build on and reinforce traditional tenure claims;
- Developing a coalition of enforcement agencies (police, navy, local government, communities) to protect the sites;
- Establishing long-term monitoring of biodiversity and threat indices; and
- Providing essential equipment and supplies to support these activities.

4. Management capacity building

The Conservancy will initiate a comprehensive program to strengthen the skills and abilities of MPA co-management partners involved in the two pilot sites. These efforts will be aimed at addressing the threats from destructive fishing, especially by outsiders. Capacity building activities will be integrated – and where possible combined – with similar efforts carried out by TNC's Southeast Asian Center for Marine Protected Areas (SEACMPA) in Wakatobi, Komodo, and elsewhere. Visits by staff in these new reserves to other parks in Indonesia will be supported.

A key method for building management capacity will be intensive on-site training programs for marine conservation practitioners and field staff. Training will be conducted in collaboration with partner NGOs and government agencies. Training activities and modules will be based on the existing capacity and materials available within SEACMPA, including guidelines for incorporating bleaching and spawning aggregations in MPA design and management developed through TNC's global program and EAPEI-funded activities in the Pacific. Training will reflect the latest developments from the field and incorporate effective approaches to site conservation planning, adaptive management, surveillance, community development, co-management systems, and sustainable financing. On-site training will emphasize:

- Community awareness and education, development and participation options;
- Social skills involved with MPA management (negotiation, conflict resolution, community outreach, community participation in surveillance and compliance);
- Monitoring skills for key species groups (e.g., corals) and issues (e.g., LRFT);
- Conservation of endangered marine species with relative high abundance at target sites (e.g., sea turtles, cetaceans, mantas);

- Relevant tropical marine conservation principles – for example, ecoregional planning, building resilience into MPAs and MPA networks; and
- Best practices/codes of conduct/guidelines developed to promote the implementation and voluntary compliance, e.g., spawning aggregation protocols, LRFT industry standards, Marine Aquarium Council (MAC) certification requirements, responsible ecotourism guidelines, and other guidelines in support of sustainable community development.

5. Monitoring

   As part of its support for the two pilot sites, TNC will initiate monitoring programs based on those developed and applied in Komodo, Wakatobi, and (as appropriate) Kimbe Bay. These will begin with monitoring for live coral cover and coral mortality, reef fish aggregation sites, turtles, fish targeted by the LRFT, lobsters, and green snail shells. As these programs are put in place, monitoring of seagrasses, mangroves, and other specific targets identified in the conservation area plan will also be initiated. In addition, regular monitoring of socio-economic issues and stakeholder attitudes will be conducted. Finally, the Conservancy will assist Universitas Negeri Papua, Manokwari, to develop a long-term biodiversity research program in Raja Ampat.

6. Policy and legal support

   Long-term solutions to the issue of resource raiding by outsiders that do not recognize local traditional rights and practices must be developed before effective controls of destructive fishing practices can be implemented. This is an issue that needs to be addressed at multiple levels of government and the judiciary, including government officials and community leaders from neighbouring provinces where the illegal fishers originate. The Conservancy will implement, together with its partners, a focused program of policy and legal support for effective conservation and sustainable use of the resources of marine protected areas within the Raja Ampat islands. Activities will likely include:

   - Inclusion of representatives of various levels of government and communities from neighbouring provinces in stakeholder meetings;
   - Awareness raising and training of journalists;
   - More detailed assessments of specific policy and legal issues and constraints;
   - Assistance to government and communities in the development of appropriate policies at the national and district level for exclusive use rights for local communities in designated traditional use/multiple-use zones of reserves;
   - Promotion of park management plans, borders, and regulations, specifically in relation to resource use licensing through appropriate government agencies; and
   - Help to resolve overlapping authorities of different government agencies, providing a solid basis for enforcement actions, and to facilitate mechanisms for collaboration and communication.

Longer Term Marine Conservation Goals (Five-Year Timeframe)

The long-term results that are desired conservation outcomes are that by 2008:

- The biological diversity of the Raja Ampat islands is maintained at least at 2003 levels; and
- A resilient network of marine protected areas is created in the Raja Ampat islands and sustains functional linkages between this region and other coral reef areas in the Coral Triangle.

The project will seek to accomplish the following objectives by 2008:

- Marine protected areas at two key sites (probably southeast Misool and Kofiau) have full and legal designation; long-term management plans are drafted for these MPAs with full involvement of local stakeholders and national and local governments; destructive fishing within these two MPAs is eliminated.
- Design of a network of priority conservation areas in the Raja Ampat islands is initiated in partnership with key stakeholders and constituencies, based on species and habitat representation, resilience and connectivity, socio-economic opportunities, threats, and development plans.
- Policies that empower communities to enforce traditional tenure claims over marine resources in MPA multiple use zones are in effect.