Working group	Co-chair	CS Presenter	Keynote Speaker	Expert	Rapporteaur	Attendance

Aquatic invertebrates

Glynnis Roberts	✔					YES
Vincent Fleming	✔					YES
Anthony Montgomery		✔				YES
Andy Bruckner						NO
Apu Suharsono		✔				YES
Aisake Batibasaga		✔				NO
Frank Parrish		✔				NO
Guillermo Lacy					✔	YES
Italo Tugliani						NO
Margie Atkinson		✔				YES
Martha Cecilia Prada Triana		✔				YES
Nelson Ehrhart						NO
Patricia DeAngelis		✔				YES
Renaldy Barnuty Navarro						NO
Theofanes Isamu		✔				YES
Wesley Clerveaux						NO

Total Participants : 16

International Expert Workshop on CITES Non-Detriment Findings

Cancun, Mexico, November 2008

Working Group 9

Acuatic Invertebrates

Working Group Summary

The group noted that while CITES-listed aquatic invertebrates had typically been subject to harvests, the nature of some harvests had changed over time – evidenced by the coral trade where collection of dead coral for curios has shifted to live specimens for the aquarium trade. Some significant problems were identified for this group of organisms, especially in relation to the identification of specimens to the level required by CITES, taxonomy and nomenclature issues and addressing multi-species fisheries. After considering various factors that might affect whether any harvests for international trade were detrimental or not, the group suggested that a cyclic adaptive management approach was required to manage harvests – highlighting appropriate risk assessment and feedback mechanisms.

The group suggested a suggested cyclic 4 step process involving the following sequential steps:

- Risk assessment
- Regulating harvests
- Record harvests and population responses
- Review, revise and refine measures and risks

Risk assessment. The group considered this an essential first step, and noted the following issues, amongst others, would inform any assessment of risk, namely: the proportion of the population subject to harvest (whether for domestic or international use, legal and illegal); the value of the commodity in trade; the drivers for the trade (is trade likely to be one-off or ongoing); governance of the resource (if any and whether this is robust or weak); degree of tenure / ownership of the resource and incentives for stewardship; whether the harvested population is derived from wild harvests or a form of captive production system; the biological characteristics of the population, especially its productivity and resilience to harvest; whether stocks are shared (between or within countries) and subject to harvests across their range; external factors (hurricanes, climate change, etc.); and whether the harvest has wider ecosystem impacts on non-target species or habitats and the services they provide. The group recommended that the rationale for risk assessment (whether a qualitative or quantitative) be documented and a review period be determined (if required).

Regulating the harvest. The group recognised the range of standard fishery measures available and noted the following as a toolbox of measures that might be used to ensure harvests were not detrimental. However, they also noted that where non-detriment could not be achieved then restrictions or closure of fisheries and exports might be required. Any measures being applied should be proportionate to the risk and to available capacity (with assumption that the greater the risk the more precautionary the harvest), and that measures are not mutually exclusive. Such measures include limiting harvests spatially or temporally, or by controlling harvest effort and methods; the use of harvest or export quotas; size limits on specimens being taken; setting reference and threshold points; and shifting from wild harvests to other production methods. The need for co-management where relevant, involving the public and other stakeholders, and the need to collaborate over the management of shared stocks were all key factors to address.

Record harvests, trade and population responses. Monitoring the impacts of any harvests through fishery dependent or independent data, trends in populations, shifts in markets and the impact of any external factors is essential to inform any future adjustments to management measures. Regardless of the sources of any data, it is vital to understand both the limitations and the confidence placed in any results. Potential sources of data include CITES trade data, surveys of the resource, local and expert knowledge, landing information (using appropriate conversion factors) and changes in prices or demand for specimens.

Review, revise and refine. Information from monitoring, risks and the effectiveness of measures should be reviewed, with management measures refined or revised as appropriate. Such reviews should ensure that there is still confidence in the trade being non-detrimental before permitting. Gaps in knowledge should be identified and addressed. The original risk assessment should be re-visited and this cyclic adaptive management process continued.

When is non-detriment achieved? Determining when non-detriment is achieved is not a static process but is likely if population trends (or indicators of these), despite harvests, are positive or stable (within defined thresholds) or measures have been set in place to achieve this. Any risks that have been identified should be being effectively mitigated and addressed.

International Expert Workshop on CITES Non-Detriment Findings

Working Group 9

Aquatic Invertebrates

FINAL REPORT

1. Information about the target species or related species

List and briefly describe the <u>elements</u> that could be considered when making Non-detriment findings:

1.1. Biological and species status:

- Biological parameters: reproduction, growth, age at sexual maturity, longevity, productivity, resilience (or vulnerability) to harvest, r or K strategists
- Measures of population size and trends in these – numbers, biomass, age distribution and boundaries/definitions of populations (whether within national jurisdiction or not) etc
- Transboundary populations: identify and define populations which are shared across political boundaries, understanding any biological connectivity or distinctiveness of populations (or conversely whether populations are isolated)
- Local population (relevant for NDF). International population (part of the discussion) –
- Record and understand threats to populations – both direct and indirect and cumulative impacts

1.2. Takes/uses (e.g. harvest regime):

- Harvest scale:
    - o proportion of the population subject to harvest
    - o proportion of harvest destined for export
- Harvest characteristics: season, extractive, non extractive, methods, illegal harvest
- Drivers (causes) of harvesting pressure – commodities in demand, social economics, value of commodities, market trends
- Impact of removal on the wider ecosystem function including impact on non-target organisms through bycatch and any genetic impacts of selective harvest
- Sources of the specimen (wild, captive bred, ranched, other production systems) and their different impacts on wild populations (eg how often are specimens taken from the wild for use in captive

production systems)

- Meaningful metrics (conversion factor) for measures of the trade or harvest (eg converting weight of conch meat to number of individual animals removed)

1.3. Management, monitoring and conservation:

Management

- Understand current and anticipated trade
- Licences (feedback: landing reports, certificates, use permit conditions to require reporting and / or as a means of distributing effort or regulating harvest means)
- Regulations
- Quotas (justified/adaptive)
- Training of harvesters (experience in harvest – health and safety)
- Types of harvesters
- Controlling harvest effort, input and output
- Tenure - is the resource owned or open access.
- Considering differences between measures in different jurisdictions
- Use of specimen size limits to reduce impacts on populations (noting reasons for size limits and what is aimed to be achieved)
- Limits on sex / life history stage
- Build cooperation between range countries, especially where stocks are shared.

Monitoring

- "Stock" assessment (condition assessment)
- Identify and use indicators as proxies for biological characteristics
- Set reference point or thresholds and use these to trigger management interventions

Conservation

- Ecosystem function (how harvest may affect this)
- Effects of the harvest on species
- How much of population is really protected (what is the confidence in any refugia / no take/ no entry zones)
- Measures to avoid localized depletion / concentration of effort

2. Field methodologies and other sources of information.

List and describe examples of field methodologies and other sources of information for monitoring populations and/or regulating harvests which could be utilized to obtain data on the elements described below.

2.1. Biological and species status data (fishery independent data):

- Field surveys
- Local knowledge
- Repeatable standardized surveys
- Understanding the limitations of the information (and risks of any extrapolation)

2.2. Harvesting and trade data (fishery dependent data):

- Identify units of management)
- Distinction between data
- CPUE
- Indicators / proxies of trends in populations
- Market trends – eg in prices for commodities
- WCMC trade databases
- Customs data
- Seizures data

3. Data integration for NDF elaboration

List and/or describe <u>data integration that could be helpful in formulating the non-detriment finding.</u>

- Information generated for other places/species could be helpful
- Enhance data sharing and communications
- Seek expert consensus where data quantity and quality is poor.

4. List and describe the ways <u>data quantity and quality</u> may be assessed

- Size of the population vs size of the harvest indicates risk
- Scale information
- Mechanism to evaluate data quality (specially fishery dependent data) – cross references data sets
- Are different data sources converging or diverging?
- Feedback between management / scientific authorities, experts, over data sources and quality

5. Summarize the common <u>problems, error, challenges or difficulties</u> found on the elaboration of NDF.

- Limitation of information (see 2.1)
- Limited datasets / small sample sizes (risk of extrapolation)
- Distribution and species patterns (e.g. patchiness of distribution in some species), relative abundance

- Taxonomy
    - Identification of the taxa (enforcement people – fisherman and scientist)
    - Lack of availability of identification experts (few people knows)
    - Differences between taxonomic level data is gathered at compared with level that has to be used under CITES
- Dealing with multispecies fisheries
- Identification of gender of some species (clams)
- Taking wider ecosystem view of impact of the fishery
- Bycatch impact on non target organisms
- External factors / events (no way to estimates real effects – risk analyzes) P. e. hurricanes, new parasites (diseases), invasive aliens – seek to anticipate and respond to future threats
- Cumulative effects eg climate change.
- Indirect / unintended consequences – eg impact of bombing or cyanide fishing
- Concentrated impacts of harvests leading to localized depletion
- Fisherman perceptions lead to targeting certain types of individuals (queen conch pearls – thought to be found more often in juvenile specimens)
- Verifying sources specimens (illegal take) / specimens may be routed through least strict controls
- Difficulty of tracking specimens in trade through chain of custody (harvester to trader to export etc)
- Expense and difficulty of acquiring relevant information (may cost more than value of fishery)
- Shift from wild harvest to captive production systems (depending on risk)
-

6. Summarize the main <u>recommendations</u> which could be considered when making an NDF for this taxonomic group.

- See <u>Annex</u> for recommended guidance for non-detriment findings for aquatic invertebrates
- Adaptive approach based originally on little/poor data may enable, over time, better data / confidence in being able to set higher quotas (incentive for fishers to cooperate with data provision)
- The rationale for any NDF should be documented and the sources of information (experts / literature) should be cited.
- Generating databases available
- Parties should identifying gaps and research needs and publicize them to seek support for funding or to encourage research by

specialists

- Need to limit and spread effort of fishery
- Need for good outreach (to harvesters, industry, consumers and public) at both domestic and international level over reasons for fishery and need for controls on management

7. Useful references for future NDF formulation.

- Fish Base (www.fishbase.org)
- Reef Base (www.reefbase.org)
- Original CITES listing proposals
- Significant trade reviews
- CITES trade database and UNEP-WCMC
- FAO and related reports including technical consultations on CITES criteria for commercially exploited aquatic organisms
- Global Biodiversity Information Facility (GBIF www.gbif.org)
- Hexacoralarian of the world (www.kgs.ku.edu/hexacoral/index.html)
- Global coral reef monitoring network
- IUCN red list
- FAO. In prep. Technical guidelines on sustainable management of sea cucumber fisheries. Technical Guidelines for Responsible Fisheries. FAO. Rome.
- Toral-Granda, V.; Lovatelli, A. and M. Vasconcellos (eds.) 2008. Sea cucumbers: a global review on fisheries and trade. FAO Fisheries Technical Paper No. 516. FAO, Rome.

ANNEX
Guidance to Parties on making non-detriment findings for aquatic invertebrates

Approach based on a suggested cyclic 4 step process
- Risk assessment
- Regulating harvests
- Record harvests and population responses
- Review, revise and refine measures and risks

Risk assessment (issues to consider when assessing the risk to the species/population of any harvest with a component destined for international trade)
- Proportion of the population subject (based on data or guesstimate) to harvest whether for domestic or international trade or consumption (based on current or <u>anticipated</u> levels of trade)
- Value of the commodity in trade [**value**] and what are the drivers for the trade (is trade likely to be one-off or ongoing)
- Governance of the resource, if any and whether this is robust or weak – and the risk of any management measures being breached [**violability**] – whether illegal take / trade is significant
- Degree of tenure / ownership of the resource and incentives for stewardship
- Whether the harvested population is derived from wild harvests or a form of captive production system
- Biological characteristics of the population / species / taxon – especially productivity and resilience to harvest and known / perceived trends in species. In multi-species fisheries identify most vulnerable taxa. [**vulnerability**]
- Are stocks shared (by different countries or different authorities within a country) and subject to multiple harvests across their range?
- External factors affecting population – eg hurricanes, climate change, invasive alien species, pollution, habitat loss or damage
- Ecosystem impacts – will the fishery affect other non-target species and / or habitats and the services they provide
- Document or record rationale for risk assessment – may be qualitative or quantitative - and determine review period (if required)

[NB three '**V**s' in bold derived from 1st FAO consultation on CITES criteria for commercially exploited aquatic organisms]

Regulate the harvest – based on assessment of risk above, consider appropriate management measures (suggested toolkit of approaches below) which are proportionate to the risk and to available capacity (with assumption that the greater the risk the more precautionary the harvest – measures are not mutually exclusive and are broadly listed in terms of complexity of implementation)

- Do nothing (but monitor any impacts – see below)
- Use refugia to restrict the proportion of population subject to harvest – refugia may be protected or no-take areas or *de facto* refugia due to limits on fishing capacity (eg deep-water populations not available to harvest by divers) – expanding the proportion of species' range covered by such refugia if greater risk or uncertainty. Complexity of measures range from community controlled no-take zones to designated national / marine parks
- Quotas - on number of specimens that are permitted to be harvested (from defined localities – distribute amongst harvesting areas) or exported – set quotas at lower more precautionary levels (even if these are initially arbitrary) where risk seems high and / or information is poor / uncertain
- Size limits (maximum and/or minimum) – a proxy measure to reduce the impacts of harvests – these may be defined by biological characteristics to limit take to less vulnerable parts of population or may be *de facto* measures due to particular sizes desired in trade (if this is compatible with reducing impacts on populations)
- Limits on fishing effort and / or methods – through limiting number of fishing licences or boats/nets or other gear or time restrictions – seek to train fishermen and enhance standards
- Use appropriate permit / licence or other control mechanisms
- Set thresholds or reference points to determine when management interventions might be required
- Shift from wild harvests to other production systems (eg captive production of giant clams) – this may be driven by desire to reduce pressure on declining wild stocks (linked to re-stocking) or by market demands
- Where appropriate seek to build co-management and public participation (especially traders / applicants) in decision making to increase 'ownership' and understanding of the need for regulation
- For shared stocks, collaborate with other range states to seek combined management measures avoiding cumulative impacts on populations.
- Prohibit exports or harvest / fishery (temporarily) if necessary and risks very high and supporting information uncertain

Record harvests and population responses record impacts of any harvests through fishery dependent or independent data, trends in populations and shifts in markets (proportionate to the risk and to available capacity). Understand the limitations and the confidence you can place in any results.

Fishery independent data

- Surveys of biological parameters of the resource – using repeatable and standardised methods – to determine trends in the resource or in selected indicators

- Ensure that refugia are genuinely acting as such and maintain viable populations of the species and / or contribute recruits to harvested areas.
- Use of local / harvesters / traditional knowledge
- Track changes in status elsewhere especially for shared stocks

Fishery dependent data

- Monitor landings, size of harvested specimens, logbooks, geographic locations of harvests, logbook information, catch per unit effort.
- Use metrics / conversion factors to make data more meaningful in population terms
- Monitor compliance – e.g. proof of legal acquisition, enforcing management measures

Market responses

- Trends in market demand – change in prices or demand for types of specimens / commodities in trade
- Whether illegal trade is known or thought to occur

External factors

- Record impacts of any changing external factors

Review, revise and refine based on information from monitoring review risks and effectiveness of measures and refine/revise management measures as appropriate based on periods relevant to species and / or risks

- Use feedback from monitoring to review and, if necessary, revise management measures.
- Identify gaps in knowledge and, if necessary, undertake work to enable appropriate feedback mechanisms to be established.
- Review original risk assessment

Have we achieved non-detriment?

Non-detriment achieved if population trends (or indicators of these), despite harvests, are positive or stable (within defined thresholds) or measures have been set in place to achieve this. Any risks are being effectively mitigated and addressed.

Aquatic Invertebrate working group

Aquatic invertebrates case studies

- Hard corals – Indonesia & Australia
- Black coral – USA (Hawai'i)
- Queen conch – Colombia
- Giant clams – Palau

Other CITES species not covered

- European date mussel – Lithophaga
- App III listings – 1 sea cucumber & 4 red corals

Working group approach

- No need to treat taxa differently
- No matrix!
- No decision tree!
- No flow chart!
- Used ‘document 2’ as checklist to stimulate thinking
- Some significant problems with taxonomy, identification and multi-species fisheries

Process for NDF

Approach based on a suggested cyclic 4 step process – four ‘R’s

- Risk assessment
- Regulate harvests
- Record harvests, trade and population responses
- Review, revise and refine measures and risks

Potential to produce guidance in a manual

Risk assessment

- Biological characteristics - **vulnerability**
- Proportion of population subject to harvest (legal & illegal, international and domestic) and harvesting methods
- Nature of trade (continuous or one-off) and value of commodity in trade - **value**
- Governance of resource – **'violability'**
- Degree of tenure / ownership of the resource and incentives for stewardship
- Shared stocks / multiple harvests
- External factors – other impacts on populations
- Ecosystem impacts – non-target organisms & habitats
- Document rationale even if only intuitive / qualitative and identify time period for review

Regulate the harvest

Options based on risk assessment and available capacity – toolbox approach – tools not mutually exclusive

- Do nothing (but monitor)
- Use refugia (no-take zones or de facto refuges)
- Quotas (relevant)
- Size limits (relevant)
- Limit harvest effort or methods
- Set thresholds / reference points
- Shift to other production systems
- Seek co-management and public participation
- Collaborate over shared stocks
- Population modelling
- Prohibit harvest / export for a period

Record harvests, trade and population responses

Options based on risk and available capacity – need to consider data limitations

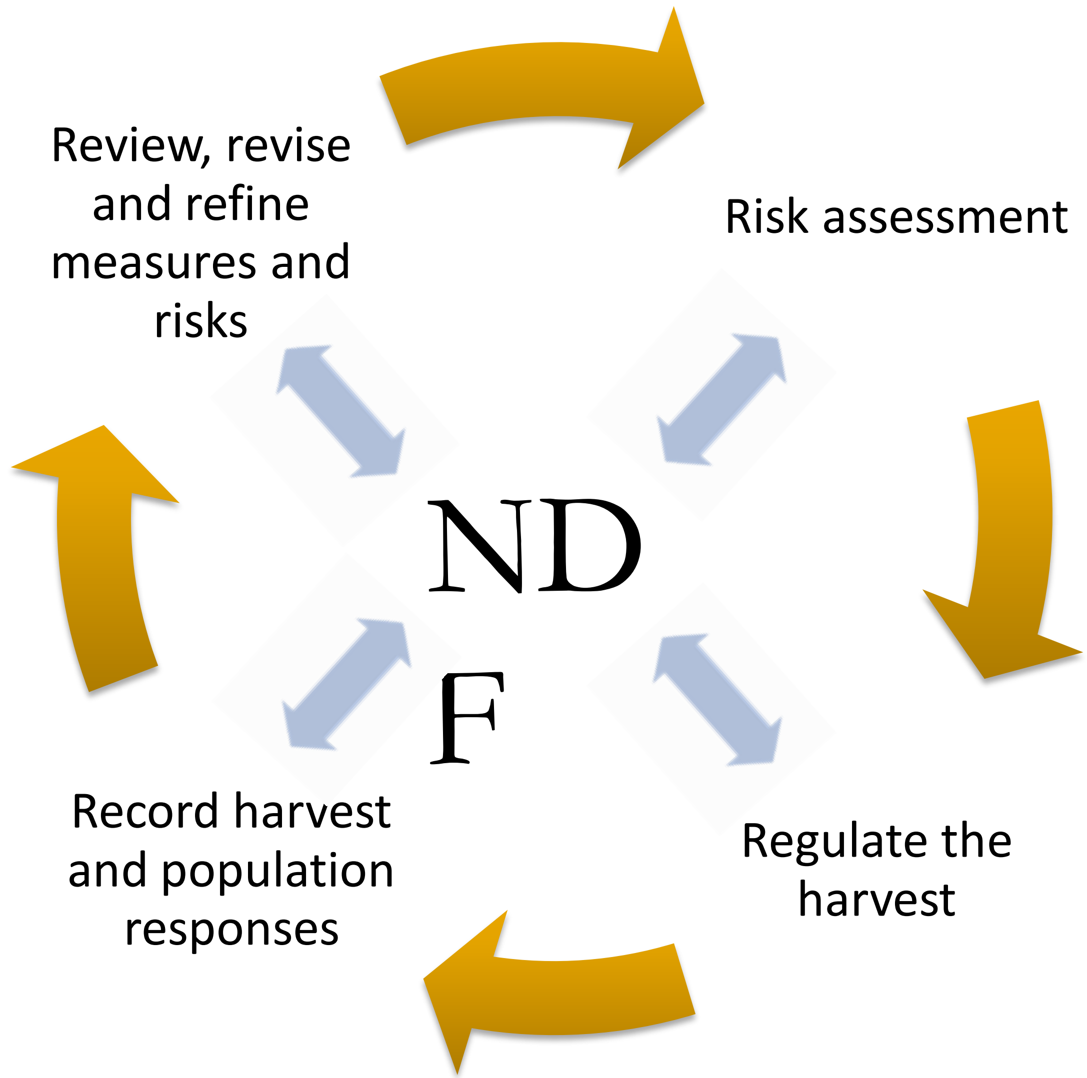
- Fishery independent data (surveys – repeatable and standardised and at suitable taxonomic level, local & expert knowledge and consensus, are any refuges actually functioning)
- Fishery dependent data (landings, cpue, logbooks, size data) with conversion factors
- Market responses (changes in price, market demand) & actual trade (CITES permits)
- External factors (record any changes)

Review, revise, refine

- Use feedback from monitoring to review and if necessary revise management measures
- Identify gaps in knowledge and seek to address
- Review original risk assessment

Have we achieved non-detriment??

- Non-detriment achieved if population trends (or indicators of these), despite harvests, are positive or stable (within defined thresholds) or measures have been set in place to achieve this.
- Any risks are being effectively mitigated and addressed.
- Ongoing process


Review, revise and refine measures and risks
Risk assessment
ND F
Regulate the harvest
Record harvest and population responses

Thankyou!

CASE STUDY FOR BLACK *CORAL* FROM HAWAII

AUTHORS:
Andrew Bruckner
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I. BACKGROUND INFORMATION ON THE TAXA

Currently, raw and worked black coral emanating from the United States is being harvested from Hawaii, where three species (*Antipathes grandis*, *A. dichotoma*, and *A. ulex*) are commercially harvested and only two of which, *A. dichotoma* and *A. grandis*, are currently reported to be exported from the United States. While some general black coral information will be provided, specific information focuses on the two U.S. species currently in trade (A. *grandis* and *dichotoma*).

1. BIOLOGICAL DATA

1.1. *Scientific and common names*

Black coral, in the order Anthipatharia, is comprised of seven families: *Antipathidae*, *Aphanipathidea*, *Cladopathidae*, *Leiopathidae*, *Myriopathidae*, *Stylopathidae* and *Schizopathidea* (ITIS 2007). There are over 200 described species (Opresko 1972; 2001). Overall, 11 genera have been reported in trade, seven of which are reported only to the level of genus; for the other four genera, 13 species are listed in the CITES trade database (Table 1) (WCMC 2008). There are also at least six genera, *Allopathes*, *Antipathella*, *Hillopathes*, *Parantipathes*, *Taxipathes* and *Tropidopathes* that have not been reported in international trade. There is considerable confusion regarding the taxonomy of species of black corals. For instance, *A. dichotoma* is considered synonymous with (*A.* cf. *curvata*), but this species is in the process of being renamed (Opresko, in review). The species *A. ulex* was recently moved to the genus *Myriopathes* with the creation of the new family of *Myriopathidae* in Opresko 2001.

1.2. Distribution

Antipatharians are cosmopolitan in distribution, with the greatest number of species found in the subtropics and tropics. Although a few species occur in shallow waters, most live at depths of 20 m and deeper, to depths of 8000 meters (m). In general, most species and the greatest abundance of individuals occur in tropical seas from 30-80 m depth (Grigg 1993; Sánchez *et al*. 1998). In the United States, black coral occurs off California at depths of 90-360 m (Love *et al*. 2007); the Western Pacific islands, including American Samoa, Guam, Hawaii, and the Northern Marianas, at depths of 5-30 m; the Gulf of Mexico at depths of 56-100 m (Rezak *et al*. 1990); and the Caribbean islands, including Puerto Rico and the U.S. Virgin Islands, at depths of 30-50 m (Sánchez *et al*. 1998).

Two black coral species found in United States waters are currently exported under CITES permits: *Antipathes dichotoma* and *A. grandis*. These species are thought to be endemic to Hawaii, although wild populations have a patchy or fragmented distribution, and colony density is generally low (Grigg 1993; Opresko 2001). In Hawaii, where the only international U.S. export is currently occurring (See 3.2), 14 species of black coral have been identified, of which 9 species are found only below 100 m depth. The two dominant species (*A. dichotoma* and *A. grandis*) are highly aggregated on vertical drop-off's or undercut terraces, and are most abundant in the channel between Maui and Lanai (total area of available habitat is estimated at 1.7 km^2) at 30-110 m depth. A smaller bed exists off Kauai (estimated available area = 0.4 km^2) and another off the southwest coast of the island of Hawaii. The dominant species found in these locations are *Antipathes dichotoma* (95% of the population) followed by *Antipathes grandis*. The lower depth limit of *A. dichotoma* and *A. grandis* coincides with the top of the thermocline in the high Hawaiian Islands (Grigg 1976; 1993).

1.3. Biological characteristics:

1.3.1. *General biological and life history characteristics of the species*

Black corals are colonial cnidarians and may be branching (bushy, feathery, dendritic, fan-shaped, whip-like or bottle-brush shaped) or wire-like without branches (known as wire or whip corals) (Grigg 1993). Black corals have a similar gross appearance to branching gorgonians; however, live specimens can be differentiated by examining the polyps: Black coral polyps have 6 unbranched, non-retractile tentacles versus 8 pinnate tentacles found in gorgonians. Live colonies are usually white, yellow, orange, red or green. A single black coral colony may have thousands of individual polyps; in most species, each polyp has six unbranched, non-retractile tentacles with stinging cells (nematocysts). Unlike other cnidarians, polyps have no structural protection from the abrasive forces associated with strong currents and surge (Kim *et al*. 1992) and tentacles remain expanded during the day. Some species produce enlarged, heavily armed sweeper tentacles in response to organisms that colonize their branchers (e.g., epibionts) (Goldberg *et al*. 1990). The horny axial skeleton is secreted in concentric layers around a hollow core, and is composed of chitin fibrils and non-fibrillar protein (Kim *et al*. 1992) that is similar to the gorgonin material found in gorgonian skeletons. In addition, the skeleton of black coral colonies have small spines; these are absent in gorgonians. Within the order Antipatharia, *Cirrhipathes* has an unbranched skeleton, while others have a branching morphology; genera are separated based on the numbers of mesentaries, number and type of septa, polyp morphology, and size, shape and density of axial spines. Identification of worked black coral to the level of genus is difficult (Opersko 1973).

Antipatharians are carnivorous filter feeders (specifically, planktivores) that ingest amphipods, copepods, chaetognaths, and possibly other zooplankton. Zooplankton is captured using tentacles and nematocysts, but mucus nets and strands, ciliary currents and mesentarial filaments are also important in the capture and ingestion of zooplankton and particulate organic matter (Lewis 1978). Unlike many stony corals and gorgonians, antipatharians do not contain zooxanthellae (symbiotic algae) in their tissues (Grigg 1993).

Black coral is characterized by slow growth, delayed first reproduction, long life, annual release of gametes, high colony fecundity, and low survivorship and recruitment of larvae (Parker *et al*. 1997). Species of black coral are mostly dioecious (having separate sexes); in hermaphroditic species, individual polyps are male or female (Grigg 1993). It is assumed that colonies shed eggs and sperm into the water (broadcast spawning) for external fertilization, although this has only been verified in one species, *A. fiordensis* (Parker *et al*. 1997). Overall, sexual recruitment in Antipatharians is thought to be episodic with the success of a few strong year classes critical to local population abundances (Grigg 1976). Asexual reproduction, involving fragmentation of individual polyps and subsequent formation of small, motile ciliated bodies has been observed in the laboratory under stressful conditions (Miller and Grange 1997).

Colonies of *A. dichotoma* reach reproductive maturity at a height of 64-80 centimeters (cm), corresponding to an age of 10-12 years (Grigg 1977; Grigg 1993). Dispersal of larvae in Hawaiian populations is thought to be very restricted, but populations below 80 m may provide a source of larvae that recruit into shallow areas where harvest occurs (Rick Grigg, personal communication). However, the concept of deep refugia for Hawaiian black corals has never been shown and current work is underway to test this question (Montgomery, personal communication). Larvae are negatively phototactic, but avoid settling below the thermocline where lower temperature may prevent reproduction (Grigg 1993).

Antipatharians exhibit a slow rate of growth. Grigg (1993) characterized black coral as among "the slowest growing organisms of any known fishery past or present" (Grigg 1993). The dominant Hawaiian species, *A. dichotoma*, increases in height by about 6.4 cm/year (2.5 in/year) with no difference noted among different size classes; *A. grandis* grows at about 6.12 cm/year (2.4 in/year) (Grigg 1977). Colonies of *Antipathes* may grow to 2 m (6.5 ft), while wire corals such as *Cirrhipathes* may grow to 5 m (16 ft) in length. The largest and oldest colonies of *A. dichotoma* and *A. grandis* in Hawaii may be older than 75 years of age (Grigg 1976; 1988; 1993).

1.3.2. *Habitat types*

Water currents, turbidity, suspended particulate material, and bottom topography play a key a role in regulating species distribution, composition and abundance. All species require a firm substrate free of sediment, most thrive in areas swept by moderate to strong currents. Colonies are found most frequently near drop-offs, terraces, or under ledges in areas with swift currents; in shallow water, colonies generally inhabit shaded areas or turbid water where surge is minimal. *Antipathes* spp. is one of the shallowest genera, preferring shaded or low light areas and occurring underneath ledges and in shallow water caves, where surge is minimal, or in the open on steep walls at deeper depths. *Antipathes* spp. appears to settle predominantly in depressions, cracks or other rugged features along steep ledges, with few colonies found on smooth basaltic substratum (Grigg 1965). Shallower antipatharians in Hawaii also appear to prefer substrates that are encrusted with calcium carbonate from coralline algae, bryozoans, and corals. Light and temperature appear to influence larvae more than adults. Grigg (1965) reported that adult colonies can withstand light intensities of up to 60% of surface incident light and they survive in shallow water only where surge is minimal and light levels are reduced. In addition, larvae will settle preferentially in areas where light penetration is less than 25% of the surface light (Grigg 1965).

1.3.3. *Role of the species in its ecosystem*

Black coral colonies inhabit a very specific habitat type, and they create critical habitat for invertebrates and fish, including commensal species that are dependent upon black coral for survival. Their erect, branching structure creates substrate for attachment of sponges, tube-worms, barnacles, molluscs, anemones and echinoderms, shelter from predators for small fishes, and a sleeping perch for large fishes and rock lobsters (Grange 1985; Warner 1981). Boland and Parrish (2005) examined the role of black coral and associated fish communities. They reported black coral provided habitat for several species of fishes and the absence of black coral may impact fish assemblages. Several species of molluscs, echinoderms, crustaceans and fishes feed on the coral tissue or the mucus produced by the polyps (Table 3). Species that associate with *Antipathes* include 17 different pontoniine shrimp from the Indo-Pacific (Australia, Madagascar, Kenya, Maldives, Indonesia, Zanzibar, New Caledonia, Borneo, and Hawaii) and the Caribbean (Spotte *et al*. 1994). Many invertebrate species have been found only among antipatharians, including some that only colonize dead skeletons while others inhabit the branches of living colonies (Love *et al*. 2007).

1.4. Population:

1.4.1. *Global Population size*

Black corals are distributed worldwide at ocean depths varying from 30-360 m (98.5 – to 725ft) (Grigg 1993; Sánchez *et al*. 1998). For the purposes of the non-detriment finding, information is presented on the Hawaiian populations.

In Hawaii, black corals are most abundant from 30-100 m depths. In 1975, the average density of the most abundant species, *A. dichotoma* (*A.* cf. *curvata*), was estimated at 0.05 colonies/square meter (m^2). This species occupied an area of 1.68 million m^2 within the Au'au Channel, and had a total standing crop of 166,000 kilograms (kg)) or 84,000 colonies (Grigg 1977). The second most abundant species, **A. grandis** occurred at a density of about 5% that of **A. dichotoma** and contained an estimated standing crop of 40,000 (kg)). Surveys conducted in 1998 indicated that the age frequency distribution and the abundance of colonies were not significantly different between surveys, except for colonies that exceeded 20 years of age. The proportion of 20+ year olds declined from10.8% of the population in 1975 to 8.6% in 1998. In addition, 97% of the population in 1998 consisted of colonies that were less than 23 years of age, indicating that the bed consisted almost entirely of colonies that had recruited since the area was last examined in 1975. These results suggest that between 1975 and 1998, the population remained fairly stable, steady recruitment occurred, and harvest pressure had not exceeded the mean sustainable yield (Grigg 1998). However, from 1999 to 2005, the reported average annual catch more than doubled that for the previous 7-year period, likely due to increased consumer demand and improved fishing techniques (Parrish 2006). Although Grigg (2001) showed a sustainable harvest from 1975 to 1998, both Grigg (2004) and Montgomery (2006) show a decline in younger age classes. Montgomery (2006) showed an increase of total mortality for post harvest age classes in between 1998 and 2004 (19.7% to 30.9%, respectively). In 2004, the pre-harvested age classes showed a zero percent total mortality suggesting that recruitment has been reduced considerably. In addition, black coral reefs previously believed protected from harvest by their extreme depths are experiencing large-scale mortality from invasion by a species of invasive coral (*Carijoa riisei*) (Kahng 2006).

1.4.2. *Current global population trends*
___increasing __X__decreasing __X__stable ____unknown

Global: This is not known. There are very few surveys done in recent years. Most work has focused on Hawaii. It is known that most black coral colonies from tropical coral reefs has been largely depleted at depths accessible by recreational divers, although isolated colonies can still be found below 20 m depth or so throughout the Caribbean and IndoPacific. The only known populations that are of commercial size are now in Hawaii.

Hawaii: Stable to decreasing. Recruitment and growth in managed populations were in near steady state from 1975-1998. Recent research suggests that, since 1998, there has been a decline in larger older classes and a recent decline in age classes under 5 (Grigg 2004; Montgomery 2006). The causes for decline have been attributed to increased consumer demand, improved fishing techniques, and overgrowth by an invasive species (Montgomery 2006). Furthermore, NOAA (73 FR 47098, 2008) reports a decrease in the biomass of black coral within Au'au Channel of at least 25% between 1976-2001 (Grigg 2004), with notable declines in both recruitment and the abundance of legal-sized colonies.

1.5. Conservation status

1.5.1. *Global conservation status* (according to IUCN Red List): *Not listed*

___Critically endangered ___Near Threatened
___Endangered ___Least concern
___Vulnerable ___ Data deficient

1.5.2. *National conservation status for the case study country*

1.5.3. *Main threats within the case study country*

___No Threats
___Habitat Loss/Degradation (human induced)
_X_Invasive alien species (directly affecting the species)
_X_Harvesting [hunting/gathering]
____Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
___Other_______________
___Unknown

Populations of black coral are impacted primarily by harvest pressure, although bycatch associated with trawling (only in limited areas, but outside the United States) and other fishing activities as well as habitat destruction are localized threats, but primarily outside of Hawaii. This is mostly because most black coral is 2 to 7 miles offshore in deeper water (60 m or more, especially in the Au'Au Channel). A significant and increasing threat in Hawaiian waters is an invasive coral, Carijoa spp. which prefers black coral habitat and is overgrowing and smothering black coral colonies. It is thought to have killed 70 % of the black coral trees between 68 – 114 m depth within the coral bed in the Au'Au Channel. However, the impact occurred mostly below the primary operating depth (41 m) of the fishermen, at 85 – 90 m, and is less widespread than previously thought (Kahng and Grigg 2005; Grigg 2004; WPRFMC 2007). Species are particularly vulnerable to overexploitation because of their patchy distribution and potentially limited larval dispersal, slow growth rate, and delayed reproduction. In addition, decades of accumulated standing stock can be collected during short intensive periods of fishing (Grigg 1993), but it is not clear what the longer term impacts are on the population biomass.

Natural mortality also impacts populations. Smothering by sediments, abrasion and overgrowth by encrusting organisms is a major source of mortality in some locations (Grigg 1993). Sedimentation is a problem for nearshore populations in shallow water; it may have minor impacts in deeper areas off Hawaii, but most corals occur in channels with high currents and high visibility, so flushing is likely to remove most sediments. Colonies also die when they break off at their base as a result of bioerosion or physical disturbance. Diseased tissue has been observed infrequently (Rick Grigg, personal communication), but has never been documented. A few predators of antipatharians have been identified, including cyclopoid copepods (family Vahiniidae) and a coralliophilid gastropod (*Rhizochilus antipathicus*).

Probably the greatest threat today is harvest pressure, which may have increased over the last decade to support an increase in demand in black coral and a 25-50% increase in sales since 1998. This has been addressed by the State of Hawaii by relaxing the size limit and introducing a grandfathering scheme that allowed veteran divers (that reported black coral harvest in the preceding 5 years) to collect corals that are at least 0.9 m in height. Previous size limits were not based on a minimum height but rather a minimum basal diameter of 3/4 inch.

Another reason that the fishery has become more efficient is the availability of detailed bathymetric maps and the adoption of GPS positioning (Stone and Shotwell 2007). This has lead to a decline in black coral biomass of 25 % (Grigg 2004), possibly posing a threat to the population. In 1998, after 23 years of harvesting, no colonies older than 27-33 years old were left in the population (Grigg 2001), but mature colonies still remained in the population. Three years later, no colonies older than 24 years were left (Grigg 2004), illustrating a biomass loss due to an increased intensity of fishing.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED.

2.1. Management measures

2.1.1. *Management history*

In Hawaii, commercial black coral beds are located in state and federal waters. State waters include areas within 3 miles of islands as well as inter-island waters and harvest is regulated by the Department of Land and Natural Resources (DLNR)-Division of Aquatic Resources (DAR). The area extending from 3 miles to 200 miles outside the State of Hawaii falls under federal jurisdiction and is referred to as the United States Exclusive Economic Zone (EEZ) (Grigg 1993; NOAA 2006).

2.1.2. *Purpose of the management plan in place*

Hawaii (in both state and federal waters) established management plans for the harvest of black coral to limit the number of fishermen and the amount of harvest, with the goal of ensuring the fishery is sustainable and the black coral colonies are protected from extinction.

2.1.3. *General elements of the management plan*

STATE (DLNR) MANAGEMENT: State management involves a system of licensing and reporting requirements (elaborated upon in Section I.2.2.1), as well as maximum sustainable yields, and minimum size limits (as described below).

FEDERAL PRECIOUS CORAL FISHERY MANAGEMENT PLAN: Regulations have been adopted to include specific provisions for harvest within designated known beds of precious corals. The FMP also includes MSY, size restrictions and gear restrictions (as described below).

MAXIMUM SUSTAINABLE YIELD (MSY): There is an MSY established for federal areas, but not for state waters. In 1976, the maximum sustainable yield (MSY) for the Au'au channel was estimated to be just over 5,000 kg (11,000 lb) for the stock in the Au'au channel and 1250 kg (2,750 lb) for Kauai. As mentioned under 1.4.1, population studies conducted through 1975-1998, indicated a fairly stable population level, with steady recruitment and harvest pressure not exceeding the mean sustainable yield (Grigg 2001). However, from 1999 to 2005, the reported average annual catch more than doubled that for the previous 7-year period, likely due to increased consumer demand and improved fishing techniques. These surveys suggest that the maximum sustainable yield (MSY) should be adjusted downward by approximately 25% (Parrish 2006; Grigg 2004).

MINIMUM SIZE LIMIT: *Antipathes dichotoma* colonies mature at 10-12 years, which corresponds to a 1.25-1.5 cm base diameter and a height of approximately 64-80 cm (25-30 in). Grigg (1976) recommended a minimum size limit of 1.2 m (4 ft) in height and a basal diameter of 2.54 cm (1 in) to ensure that immature colonies are not harvested, and to maximize the mean sustainable yield (MSY). The state has maintained a minimum size requirement for black coral fishing since 1998, limiting harvest to specimens with a minimum base diameter of 1.91 cm (3/4 in) (Hawaii Administrative Rules, 13-91 1999). While a minimum size of 122 cm (48 inches) height or 2.54 cm (1 inch) diameter became effective in federal waters on April 17, 2002, an exemption allowed existing licensed fishers that had reported black coral harvests in the five years prior to 2002 to continue to harvest black coral with a basal diameter of 3/4"(1.9 cm) in federal waters. In 2007, this exemption was removed in order to reduce the impacts of fishing on Au'au

Channel black coral; size limits reverted back to the minimum 2.54 cm basal diameter for all fishers (72 FR 58259[1]).

VOLUNTARY SIZE LIMITS: According to Tony Montgomery (Marine Biologist, Department of Land and Natural Resources (DLNR)-Division of Aquatic Resources (DAR), Honolulu, Hawaii, personal communication 2007), within the last few years, there has also been a voluntary agreement to buy only colonies 122 cm (48 in) in height. Unfortunately, it is not possible to verify whether this practice is being followed. DLNR is in the process of updating their reporting forms to better capture this information (Montgomery, personal communication 2007).

FEDERAL: Black coral is managed under the Fishery Management Plan (FMP) for the Precious Coral Fisheries of the Western Pacific Region. The management plan classifies known beds of precious corals and establishes harvesting methods and limits within these beds. Beds are classified as: 1) Established Beds, 2) Conditional Beds, 3) Refugia Beds, and 4) Exploratory Permit Areas (Grigg 1993). This plan covers all precious corals, and the specific designation of different types of beds refers to other non-black coral precious coral species.

Established beds have a history of harvest, optimum yields have been established on the basis of biological stock assessment techniques, and selective harvesting gear (submersibles or remote control harvester vehicles) is required. Until 2008, Makapu'u (off Oahu) was the only designated Established Bed (Grigg 1993). NOAA recently revised the regulations to include Au'au channel as an established bed and changed the annual MSY of 5,000 kg (11,023 lb) to a biannual MSY; this quota applies to black coral in state and federal waters (73 FR 47098).

Conditional beds are ones for which yields have been estimated on the basis of bed size relative to established beds with the assumption that ecological conditions at established beds are representative of conditions at all other beds. Four beds continue to be designated as conditional beds: Kea-hole Point, Kaena Point, Brooks Banks, and 180 Fathom Bank (73 FR 47098; Grigg 1993). Nonselective harvesting was permitted in the two conditional beds in the Northwest Hawaiian Islands (Brooks and the 180 Fathom Banks) until 1999 (Grigg 1993).

Refugia beds are set aside to serve as baseline study areas and possible reproductive reserves. No harvesting of any kind is permitted in

[1] Regulations and amendments to Federal Fishery Management Plans are published in the Federal Register Notice. These are listed here by the volume (e.g., 72 or 73) and page number.

Refugia. Presently, the WESTPAC bed, between Nihoa and Necker Islands, is the only designated Refugia (73 FR 47098; Grigg 1993). This bed does not contain any black coral (Andy Bruckner, personal communication 2007).

Exploratory permit areas are unexplored portions of the EEZ, where habitat exists, but no beds have been confirmed. There are four exploratory permit areas; one surrounding the Hawaiian Islands, another that encompasses Guam and the Commonwealth of the Northern Marianas (referred to as CNMI), a third that encircles American Samoa, and a fourth, which was created by Amendment 1 to the FMP, which includes the EEZ's of all the remaining U.S. Pacific Island possessions (73 FR 47098; Grigg 1993).

The FMP, as amended in 2002, prohibits the use of nonselective gear (e.g. tangle nets, dredges) throughout the management area. Black coral is primarily found in State waters and the State and the WPFMC jointly manage the resource. Quotas and minimum size limits are monitored through mandatory reporting to NMFS and the Hawaii State Division of Aquatic Resources using coral landing logs and buyer reports.

2.1.4. *Restoration or alleviation measures*

Of the two major commercial beds, one situated off Maui (Au'au Channel) and the other off Kauai (Makawaena Point) (Grigg 1993), Makawaena Point is not currently being harvested.

Black coral is selectively harvested by divers using SCUBA gear, which limits harvest to depths above 246 feet (Kahng 2006). Selective harvest can be accomplished by hand, using axes, hammers, and saws but submersibles have also been employed to harvest other coral species (Grigg 1993). There are significant amounts of black coral that are below the limit of standard SCUBA equipment. These black coral beds, previously believed protected from harvest by their extreme depths, were thought to serve as a refuge for shallower populations. However, surveys from 2001-2004 on reefs below 70-m showed that over 50% of the colonies were overgrown by a species of invasive coral, *Carijoa riisei* (Kahng 2006). Large colonies are most severely impacted and are experiencing large-scale mortality from this invasion (Kahng 2006). State (DLNR) and federal (NOAA) authorities are in the process of amending their regulations and management strategies to address this concern (72 FR 44074).

Maximum Sustainable Yield (MSY): Recent biological data suggest that the MSY should be adjusted downward by approximately 25% (Grigg, 2004; Parrish 2006). State (DLNR) and federal (NOAA) authorities recently amended their regulations to for Au'au channel, where the bulk of black coral harvest occurs. This bed is now designated as an established bed and the allowable harvest has been effectively reduced by 50%. This includes a reduction from an annual harvest quota of 5,000 kg (11,023 lb) in federal waters to a biannual harvest of 5000 kg in both state and federal waters combined (73 FR 47098).

MINIMUM SIZE LIMIT: In 2007, the exemption for fishers who were allowed to continue to harvest black coral with a basal diameter of 3/4"(1.9 cm) was removed in order to reduce the impacts of fishing on Au'au Channel black coral, Now all harvested coral in Federal waters must have a 1" basal diameter (72 FR 58259).

VOLUNTARY SIZE LIMITS: The state is in the process of updating their reporting forms to better capture any industry self-imposed voluntary size limits (Montgomery, personal communication 2007).

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

DLNR requires black coral fishers (coral harvesters) to obtain a state license to harvest from state or federal waters (Commercial Marine License); NOAA requires a federal license for fishing in federal water only (Pacific Precious Coral permit). The number of permitted commercial divers has remained stable over the last decade, varying between 3-5 licensed divers (72 FR 44074; Western Pacific Regional Fishery Management Council 2005).

Fishers are required to report landings by submitting a "Commercial Catch Report," which includes the date, license number, weight, etc. Dealers are not required to have a license, but are required to report first points of purchase from a fisher on the "Commercial Marine Dealer's Report on Purchases of Marine Life" form.

2.2.2. *Confidence in the use of monitoring*

Confidence is high. The state has implemented adaptive management practices, including controlling the number of permitted divers (See Section I.2.2.1), responding to biological research and monitoring data (See Sections I.2.1.4 and I.3.2.2), amending regulations as needed (72 FR 44074; 73 FR 47098), and has been consistently responsive when consulted regarding international exports.

2.3. Legal framework and law enforcement

Black coral is managed under the Fishery Management Plan (FMP) for the Precious Coral Fisheries of the Western Pacific Region. Regulations

implementing the FMP are published in:
Subpart F 50 CFR 665
(Title 50: Wildlife and Fisheries, Part 665—Fisheries In The Western Pacific, Subpart F—Precious Corals Fisheries)
<http://law.justia.com/us/cfr/title50/50-8.0.1.1.10.html#50:8.0.1.1.10.6>

Subpart H 50 CFR 600
(Title 50: Wildlife and Fisheries, Code of Federal Regulations, Part 600—Magnuson-Stevens Act Provisions, Subpart H—General Provisions For Domestic Fisheries)
<http://law.justia.com/us/cfr/title50/50-8.0.1.1.1.html#50:8.0.1.1.1.8>

Hawaii state law concerning black coral is published in:
HAR 13-91
(Hawaii Administrative Rules, 13-91) <http://www.hawaii.gov/dlnr/dar/library/har_toc.htm> [Accessed August 15, 2007].

Black coral has been listed in Appendix II of CITES since 1981. In the United States, CITES is implemented through Section 9 of The Endangered Species Act of 1973, as amended. Regulations implementing this Act are published in:
50 CFR Parts 10, 13, 17, and 23
(Title 50: Wildlife and Fisheries, Code of Federal Regulations, Chapter I—United States Fish And Wildlife Service, Department of the Interior, Parts 10—General Provisions, 13—General Permit Procedures, 17—Endangered and Threatened Wildlife and Plants, and 23—Endangered Species Convention
<http://law.justia.com/us/cfr/title50.html>

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. **Type of use** (origin) **and destinations** (purposes)

Currently, the only CITES-permitted black coral being exported from the United States is harvested from Hawaiian waters (Patricia De Angelis, Division of Scientific Authority (DSA), U.S. Fish and Wildlife Service, Arlington, Virginia). Historically, black coral was used in medicines and religious artifacts. Commercial black coral harvest is primarily for jewelry. The process of working raw black coral into finished products historically was reported to only have about 1% efficiency. This would suggest 4,265 lb) of raw coral would yield only approximately 43 lb finished product. However, Maui Divers (the main producer in Hawaii) claims that waste has been nearly eliminated because they use lasers to cut material. A small trade in live specimens for aquarium organisms has been reported (NOAA 2002), but the size of this trade is unknown.

Beginning of the industry in Hawaii: Of 14 species known to occur in Hawaii, 12 are found below 100 m (330 ft) depth (which is too deep for traditional SCUBA diving) and only three (all shallow water species) are large enough to be of commercial value for coral jewelry (Devaney and Eldridge 1977; Grigg 1993; Grigg and Opresko 1977). Two major commercial beds of black coral were discovered off Hawaii (off Maui (Au'au Channel) and off Kauai (Makawaena Point)) in 1958 at depths between 30 and 75 m (Grigg 1993). One commercial entity established a small black coral jewelry industry in 1960, and as much as 10,000 kg were harvested annually from this bed during the 1960s and 1970s. During the late 1970s and early 1980s the demand for black coral in Hawaii was greatly reduced, but since 1986 the demand has steadily increased, in part because of its designation as Hawaii's state gem. In 1993, this one commercial entity accounted for more than 50% of all locally-produced black coral jewelry in the State (Grigg 1993).

The industry today: The three shallow water species of black coral that are commercially harvested in Hawaii are: *Antipathes grandis*, *A. dichotoma*, and *Myriopathes ulex* (Oishi 1990; Montgomery, personal communication 2007). Hawaiian coral is almost exclusively fished from Maui's Au'au channel, mainly from state waters, where it is most accessible (Montgomery, personal communication 2007). Annual landings average 1,014 kg/year; about 90% of this is for domestic use (Grigg 2004). Trade is no longer dominated by one entity, but 2-3 entities that deal mostly in smaller volumes. In 2007 and 2008, DSA provided NDFs for approximately 4 applicants, for export permits totaling up to 2,439 kg (5,377 lb) raw black coral and 4 kg (8.82 lb) of worked material (P. De Angelis, pers. comm. 2008).

3.2. Harvest:

3.2.1. *Harvesting regime*

Colonies are selectively harvested from up to 75 m depth using SCUBA; Advanced diving techniques including re-breathers, mixed gases and ROVs allow selective harvesting from deeper water, but these methods are not used in Hawaii. Tangle net dredges have also been employed for non-selective harvest, but this is not permitted in Hawaii.

Currently, there are three commercial fishers (harvesters) that are licensed to harvest black coral in Hawaii. Fishers selectively harvest colonies using SCUBA with axes, hammers and saws (Grigg 1993); about 90% of the catch consists of *Antipathes dichotoma*, 9% is

A. grandis and 1% is *Myriopathes. ulex*. From 1981-1990 the state of Hawaii reported that landings of black coral amounted to 6200 kg (13,706 pounds), with an annual take of 72-1977 kg (158-4,351 lb) (Oishi 1990). The total black coral landings increased to over 20,000 lbs over the next seven years (1992-1998) and total catch more than doubled for the seven year period from 1999-2005; overall, landing between 199-2005 comprised 58% of the total harvest since 1985 (Parrish 2006). These increases are due, presumably to increased consumer demand and improved fishing techniques. Given the decrease in biomass, invasion by Carijoa and recent increases in demand, Grigg (2004) suggested that the MSY should be adjusted downward by approximately 25% (Parrish 2006).

3.2.2. *Harvest management/ control* (quotas, seasons, permits, etc.)

There continues to be little black coral harvest from EEZ waters. Today, most harvest (85%) occurs in state waters, in Au'Au channel within 3 miles of shore where black coral is accessible with SCUBA gear (Montgomery, personal communication 2007). State coral resources are managed under a state management program, which has adapted as information on the biology of the species and the effect of harvest has become available.

Licensing: The DLNR requires black coral fishers to obtain a state license to harvest from state or federal waters (Commercial Marine License); NOAA requires a federal license for fishing in federal water only (Pacific Precious Coral permit). The number of permitted commercial divers has remained small and stable over the last decade, varying between 3-5 licensed divers (72 FR 44074; Western Pacific Regional Fishery Management Council 2005).

In addition, improvements in the efficiency of cutting and polishing of black coral has led to a several hundred percent decline in the amount of coral consumed to produce the same value of finished product (Grigg 1998). The state is currently considering amending their regulations to respond to recent information on the effect of harvest in the Au'au Channel, including removing minimum size exemptions, and to respond to infiltration by invasive coral (72 FR 44074). Other conservation strategies include a suggestion to prohibit harvest of coral from depths where conventional SCUBA becomes unsafe (e.g. 80 m) (Rick Grigg, personal communication).

3.3. Legal and illegal trade levels

Global: According to the CITES trade database, black coral trade consists primarily of worked jewelry reported by number of pieces, with a small portion of raw coral traded by weight and less than 1% traded live (WCMC 2008). Overall, 11 genera have been reported; for four genera, trade has been reported in 13 species (Table 1). Over 90% of all records are *Antipatharia* spp., *Antipathes* spp. and *Cirrhipathes* spp., with *Cirrhipathes anguina* and *Antipathes densa* most commonly in trade: *Cirrhipathes* is considered of inferior quality, however it is the most widespread and abundant species. Between 1982-1998 a total of 72 metric tons and 7,400,000 pieces of black coral were recorded as being traded, with most exported from Taiwan, the Philippines, and the Dominican Republic. During this period international trade in black coral, according to the CITES trade database, has averaged 430,000 items per year, with the maximum trade in 1994, and 320,000 items traded in 1998. Trade in processed black coral was lower between 1999-2003 (a minimum of from 126,000 in 2002 and a maximum of 255,000 in 2003), while trade in unprocessed black coral (by weight) ranged from140 kg (2000) to 475 kg (2002). The United States is the major importer, followed by Japan. Exports from the United States have remained consistently very low, with less than 1000 pieces exported per year. The world's largest supplier of worked black coral is Taiwan (>90% of the total), with most reported to be harvested in the Philippines. Trends in the annual volume of trade from the CITES database are shown in Figure 1.

In 1996, 473,000 black coral pieces imported into the United States were reported to be worth $447,000. According to WesPac (2007) the precious coral fishery in Hawaii is worth about US $50 million, including an estimated US$33 million for the black coral fishery alone. Around 1000 people are involved in the fishery, including coral divers, manufacturers and salespeople. The current wholesale value of unworked black coral is about $35 per pound (Grigg, personal communication). Retail prices for manufactured black coral jewelry ranged from around $35-300 for earings, $50-750 for small pendants, to over $3000 for more ornate necklaces and bracelets; the higher priced items typically consist of black coral in a gold setting, often with other precious stones and coral.

II. Non-detriment finding procedure (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

__yes _X*_no

*Although the U.S. Fish and Wildlife Service-Division of Scientific Authority (DSA) does not strictly adhere to the IUCN checklist, many of the concepts, prioritizations, and analyses used in NDFs for exports of U.S. black coral are consistent with those described in the IUCN document.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

DSA uses a combination of peer-reviewed science, provincial management measures, dialogue with provincial authorities and experts, industry reporting, and CITES data to determine whether given exports will be detrimental to the survival of the species or if they will affect the role of the species in its ecosystem.

The relatively small scale of the United States black coral industry (five operators and two major processors located within one state exploiting a small number of beds) facilitates provincial management of the fishery and DSAs analysis of the impacts from harvest and export. In making non-detriment findings for given exports, DSA relies on five basic factors: a) licensing and reporting requirements; b) the science-based minimum size limit imposed and enforced by the State of Hawaii; c) estimates of maximum sustainable yield (MSY) from the exploited beds; d) industry information on yields, material stockpiles, and productivity; and e) practical harvest limitations that result in *de facto* refugia. These parameters are discussed below.

a) Licensing and reporting requirements by DLNR and NOAA: Black coral fishers are required to obtain a state license (Commercial Marine License) to harvest from state or federal waters and a federal license (Pacific Precious Coral permit) to fish in federal waters. CITES applicants are requested to submit copies of these licenses, which are subsequently authenticated by either the Management Authority or Scientific Authority.

The state also requires fishers to submit a "Commercial Catch Report," which includes the date, license number, weight, etc. (Grigg 1993; Montgomery, personal communication 2007). It is difficult, however, to correlate specimens reported on Catch Reports with the specimens to be exported. According to Tony Montgomery (personal communication 2007), this is due to the harvesting process and characteristics of the fishery. The reported weights are estimated, and include base rock. The coral is cured by drying and sold months, sometimes years later. The purchased weights are exact weights, and buyers and fishers negotiate over the amount of base rock attached. Under these circumstances, the weights will never equal, but this does not suggest any wrongdoing (Montgomery, personal communication 2007).

The state does not require dealers to have a license, but they are required to report first points of purchase from a fisher on the "Commercial Marine Dealer's Report on Purchases of Marine Life" form. DSA requests copies of these forms from applicants.

b) Minimum size limits: As noted in answer 2, the State of Hawaii has instituted science-based size limits for wild specimens that evidently promote robust age structure and protect spawning potential in the exploited coral beds. As the Hawaiian black coral industry has evolved, provincial authorities have instituted adaptive management measures, based on research and monitoring, to respond to changes in the biological status of the species. DSA relies on these regulations, and their provincial enforcement, when making determinations that a given piece of raw or worked black coral proposed for export is derived from sustainably harvested colonies.

c) Maximum Sustainable Yield (MSY): DSA also compares total annual removals to estimates of MSY. The documentation requested of CITES applicants (see a) and d)) allows DSA to monitor the amount of processed coral that is exported and the relative importance of domestic vs. international consumption of United States black coral.

For instance, in 1993, the annual reported take was 459.5 kg (1,013 lb) (Grigg 1998). However, one exporter, who purchased over 80% of the total annual harvest, reported to DSA that they purchased 3,719.5 (8,200 lb) from fishers in 1993. Noting this discrepancy, we consulted with provincial authorities. It is important to note that, because purchases may occur up to many years after harvest, the amount of coral purchased in one year, does not necessarily correlate with a harvest toward the MSY in that year (Montgomery, personal communication 2007). This allowed us to modify our permit conditions in order to better capture the information we needed.

d) Industry information on yields, material stockpiles, and productivity: Each CITES applicant wishing to export black coral from the United States must provide detailed accounting of 1) the weight of unworked black coral they purchased in the preceding six months; 2) the amount of unworked coral they have stockpiled; and 3) the number and weight of processed black coral specimens exported in the preceding six months. These data permit DSA to gauge the tonnage of wild specimens used by the major processors and make timely comparisons with MSY levels.

e) The above information is bolstered by the fact that the industry is limited by the time and depth limits of SCUBA equipment during extraction: Areas beyond the reach of standard SCUBA were previously thought to be protected from harvest and serve as refugia for the local populations. However, recent surveys of deeper areas off Hawaii questions these findings, as black coral was not found at the depths and sites previously reported (Montgomery, personal communication).

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

The United States Scientific Authority uses information derived from provincial management agencies, fisheries management councils, and researchers. For worked coral, DSA has used the metric black coral finished products has about 1% efficiency to calculate maximum allowable exports given the amount of raw black coral that they verifiably purchased (with evidence such as receipts and reports of first points of purchase. Provincial permits, licenses and reporting forms are important for determining non-detriment. A copy of our most recent non-detriment finding on black coral is provided (Annex 1).

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

- Minimum colony size limits and MSY estimates are based on peer-reviewed science and are therefore high quality inputs to NDFs by the United States Scientific Authority. Provincial authorities have demonstrated their commitment to maintaining a sustainable industry by its regulatory responsiveness to changes in industry or the status of the species.
- The remote and extreme habitat for black coral in U.S. waters precludes frequent and exhaustive monitoring of the exploited beds. Ongoing research continues to elucidate additional information concerning the threats to and conservation of the species.
- The practical limitations of SCUBA gear are well-documented, and the concept of deepwater refugia for exploited Hawaiian black coral beds is a reasonable part of the U.S. analyses in NDFs.
- Industry self-reporting on stockpiles, coral intake, and production efficiency are relatively low quality data inputs. This is not considered a significant factor given the findings from 1998 on the viability of the exploited beds.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

The main challenges involve obtaining and correctly interpreting available scientific information, as discussed above (Section II. 3). To this end, communication with management agencies and researchers is imperative. Another issue is that the state of Hawaii and the Western Pacific Fishery Management Council frequently changes the regulations, including size restrictions and MSY, based on new scientific data. It is imperative that US FWS is up to date on these recent changes, so that they can consider these when making NDFs.

6. RECOMMENDATIONS

United States exports of black coral are currently limited to specimens harvested from Hawaii. The Hawaiian black coral industry continues to be limited by the small number of licensed commercial black coral fishers (that must meet the State's licensing and reporting requirements) and by the largely inaccessible depths where black coral lives (in most areas black coral exists at depths below which SCUBA equipment can safely be used). The state (DLNR) and federal (NOAA) agencies managing this resource *in situ* have responded to changing trade pressures and biological conditions by adapting their regulations and management strategy to the changing face of this fishery. These agencies have also been responsive to the United States Scientific Authority regarding questions about the industry and information relative to particular exports. Information exchange and cooperation between the DLNR, NOAA, and DSA is essential to making sound NDFs.

It is important to become familiar with the industry, to stay abreast of current research (some of which may not yet be published), to maintain communication and share information with provincial authorities, and, when necessary, to establish clear permit conditions that allow us to better gauge the impact of international trade on the species.

In order to ensure that harvesting is sustainable and it does not significantly limit recruitment, management strategies should include a determination of optimal harvest yields based on measures of abundance, growth, natural mortality and recruitment. Among the guidelines should be a scientifically-based minimum allowable size of harvest that provides sufficient time between age (size) at first reproduction and age (size) at first capture, and an annual, scientifically-based quota. New developments with invasive species and extraction technology (e.g. submersibles) must be monitored closely, and adjustments made as necessary.

The age at maximum yield per recruit 1 for *A. dichotoma* was estimated to be 22-40 years, corresponding to corals that measure 1.7 and 3.2 m in height (oldest black corals can reach 3.5 m across and more than 4 m height). Thus colony height corresponding to MSY was notably larger than what was actually harvested. The reason is an analysis of optimum yield. Harvesting all corals exceeding the height limit of MSY allows 100 % efficiency of the fishery. Less efficiency may result in more profit however, if catch per unit effort and optimum yield are considered. The most economic and yet sustainable strategy often is to fish at low intensity and catch the coral at an 10 earlier age than at maximum sustainable yield. As long as the harvested corals are older than the age at first reproduction, the fishery is sustainable, but care must be taken to control fishing intensity by monitoring programs. This practice does not produce maximum yield, but allows for maximum profit (thus called optimum yield), as yield per fishing effort is maximized (achieving maximum yield may in some cases result in less profit if it requires disproportionally higher fishing effort is necessary) (Georgios Tsounis, personal communication).

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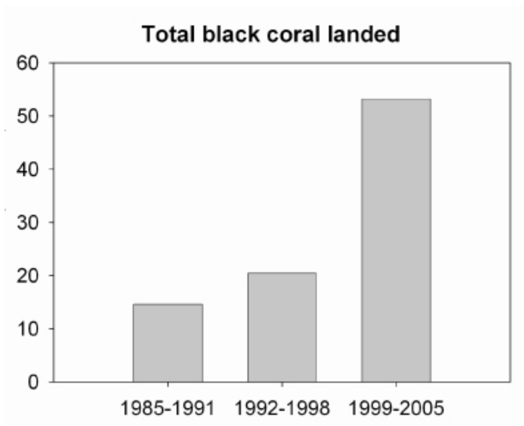

Fig. 1. Landings of black coral in Hawaii. Data are pooled into seven year bins to meet confidentiality requirements for catch reporting. There is also a significant delay between harvest and reporting. Fishermen also commonly collect coral and retain this for several years and only report it after they sell the coral. Landings in the last 7 years comprised 58% of the total catch since 1985. Also, the average annual catch reported for the period 1999-2005 more than doubled the catch for the seven year period prior. Data and figure from Parrish, 2006.

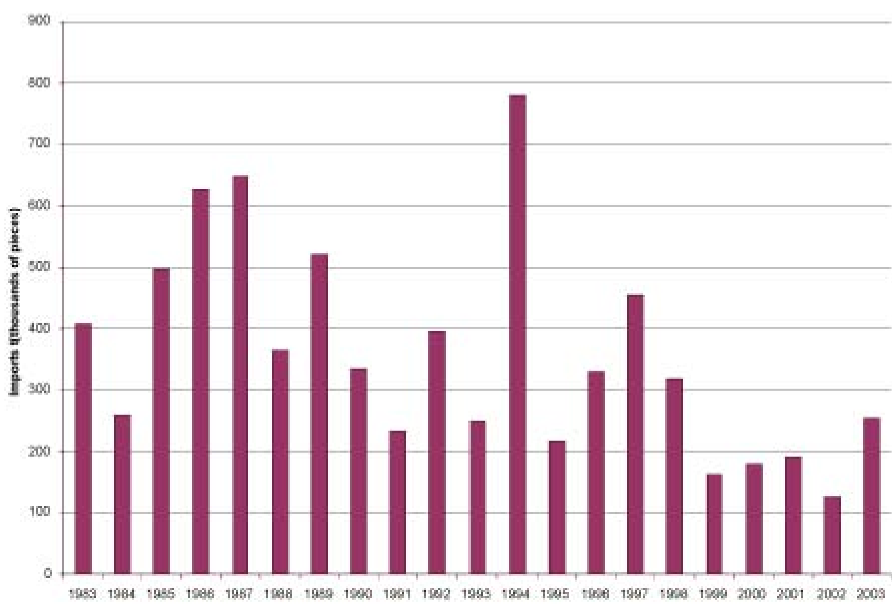

Fig. 2. Total volume of imports of black coral between 1983-2003. All data are from CITES, and include only reports of black coral by piece. Additional trade in black coral is also reported by weight, with hundreds to thousands of kg reported each year.

TAXA	SOURCE	VOLUME (example years)
***Antipatharia* spp.**	**All**	**50,000, 20 kg (2001)**
***Antipathes* spp.**	**All**	**7000 (2001)**
Antipathes crispa	US	100 kg (2002)
Antipathes grandis	All	
*****Antipathes densa***	**All**	**67,000, 19 kg (2001)**
Antipathes japonica	**Taiwan**	**63,000/138,000/43,000 (1988,1992, 1996)**
Antipathes columnaris	New Zealand	6 (2003)
Antipathes plantagenista	Cuba	3 (1996)
Antipathes abies	Philippines	42,700 (1996)
Antipathes dichotoma (A. cf. curvata)	**Papua New Guinea Taiwan, Philippines**	**10,000 (1986)**
Antipathes hirta	TT	2 (2002)
Aphanipathes spp.	U.S., Mexico	1,600 live (1995)
Bathypathes spp.	Philippines	1554 (1986) 6 (2001)
Bathypathes lyra	Russia	18 live (1997)
Bathypathes scoparia	U.S.	5 (1997)
****Cirrhipathes anguina***	**All**	**65,000 (2001)**
Cirrhipathes spiralis	Papua New Guinea Philippines	270 (1987-89) 6,000 (1986)
Cladopathes spp.	Indonesia	16 live (1995); 100 (1986); 2 (2002)
Hexapathes spp.	Taiwan	1 (1996), 2000 (1987) 3 (2002)
Leiopathes spp.	Dominican Republic, Haiti, Thailand	4 (1996; 12 live (1993);152 live (1988); 3 (2001)
Myriopathes japonica	Taiwan	8000 (2003)
Parantapathes	CA	2 (2002)
Sibopathes macrospina	Australia, Fiji	1 (2002), 25 live (1995)
Stichopathes gracilis	U.S.	500 live (1996)
Stichopathes regularis	Mexico	2 live (1997).
Stichopathes longispina	Fiji	1 live (1997); 1 kg (2001)
Schizopathes spp.	CA	3 (1990) 6(2002)

Table 1. Taxa of black corals reported in CITES between 1988-2003. The dominant corals are shown in bold. Several additional taxa of black coral are reported to be in trade at low levels, but they have not been listed in the CITES database. These include the following genera: Hillopathes Parantipathes, Taxipathes and Tropidopathes

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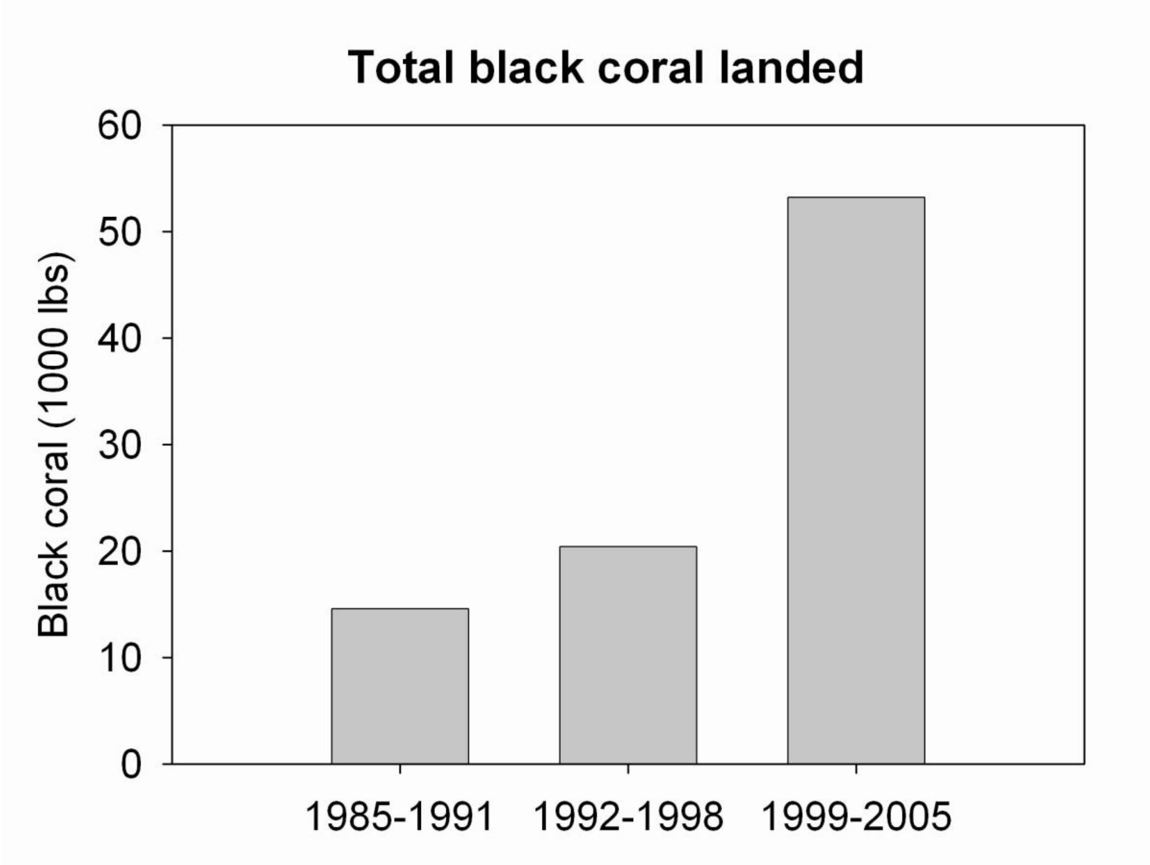

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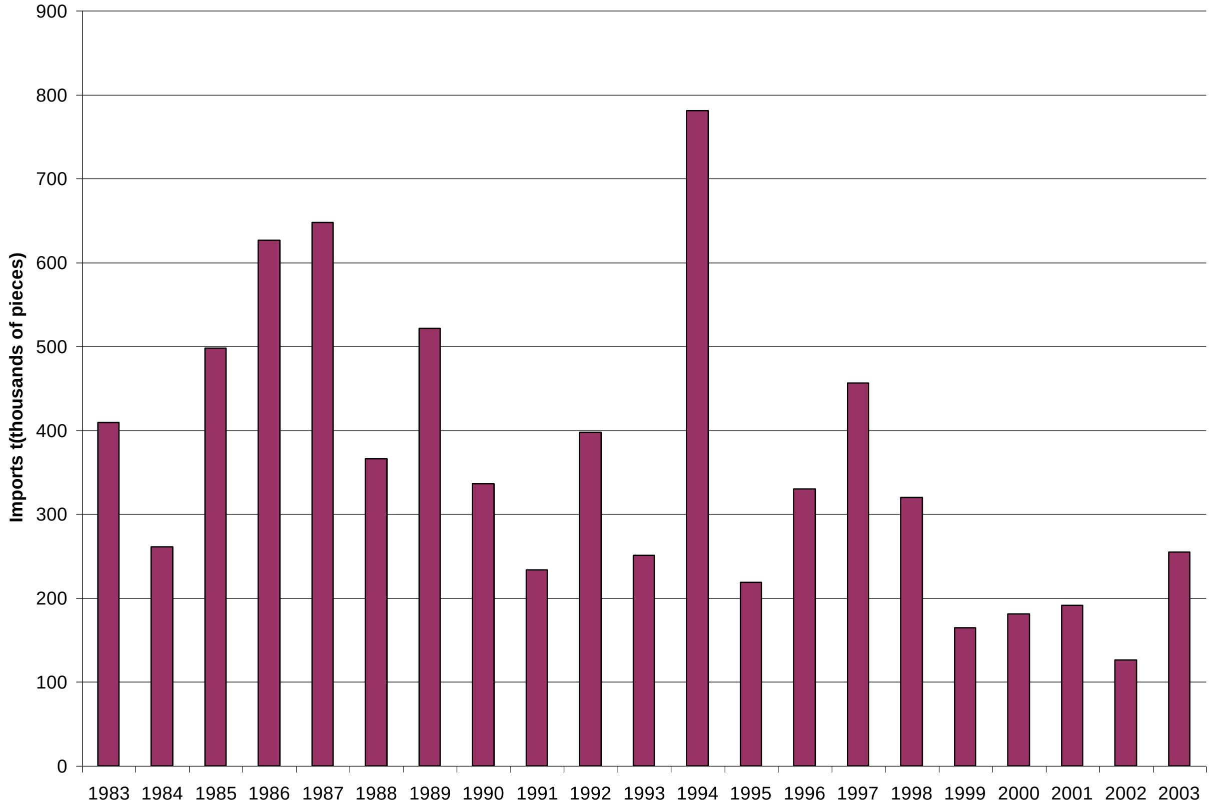

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CASE STUDY FOR BLACK *CORAL* FROM HAWAII

AUTHORS:
Andrew Bruckner, Patricia De Angelis and Tony Montgomery

Currently, raw and worked black coral emanating from the United States is being harvested from Hawaii, where three species (*Antipathes grandis*, *A. dichotoma*, and *A. ulex*) are commercially harvested and only two of which, *A. dichotoma* and *A. grandis*, are currently reported to be exported from the United States.

Although the U.S. Fish and Wildlife Service-Division of Scientific Authority (DSA) does not strictly adhere to the IUCN checklist, many of the concepts, prioritizations, and analyses used in NDFs for exports of U.S. black coral are consistent with those described in the IUCN document. DSA uses a combination of peer-reviewed science, provincial management measures, dialogue with provincial authorities and experts, industry reporting, and CITES data to determine whether given exports will be detrimental to the survival of the species or if they will affect the role of the species in its ecosystem.

The relatively small scale of the United States black coral industry (five operators and two major processors located within one state exploiting a small number of beds) facilitates provincial management of the fishery and DSAs analysis of the impacts from harvest and export. In making non-detriment findings for given exports, DSA relies on five basic factors: a) licensing and reporting requirements; b) the science-based minimum size limit imposed and enforced by the State of Hawaii; c) estimates of maximum sustainable yield (MSY) from the exploited beds; d) industry information on yields, material stockpiles, and productivity; and e) practical harvest limitations that result in *de facto* refugia.

The main challenges involve obtaining and correctly interpreting available scientific information. To this end, communication with management agencies and researchers is imperative, and information exchange and cooperation between the DLNR, NOAA, and DSA is essential to making sound NDFs. Another issue is that the state of Hawaii and the Western Pacific Fishery Management Council frequently changes the regulations, including size restrictions and MSY, based on new scientific data. It is imperative that US FWS is up to date on these recent changes, so that they can consider these when making NDFs.

Case Study for Black Coral From Hawaii

Patricia De Angelis

U.S. Fish and Wildlife

http://www.fws.gov/international

Anthony Montgomery

Hawaii Department of Land and Natural Resources

http://www.hawaii.gov/dlnr/dar

Introduction

Phylum Cnidaria Order Antipatharia (Hexacoral)

>15 species in Hawaii (Taxonomic problems)

Fishery started in 1958 for the jewelry trade

3 species targeted by fishery – 1 dominant target

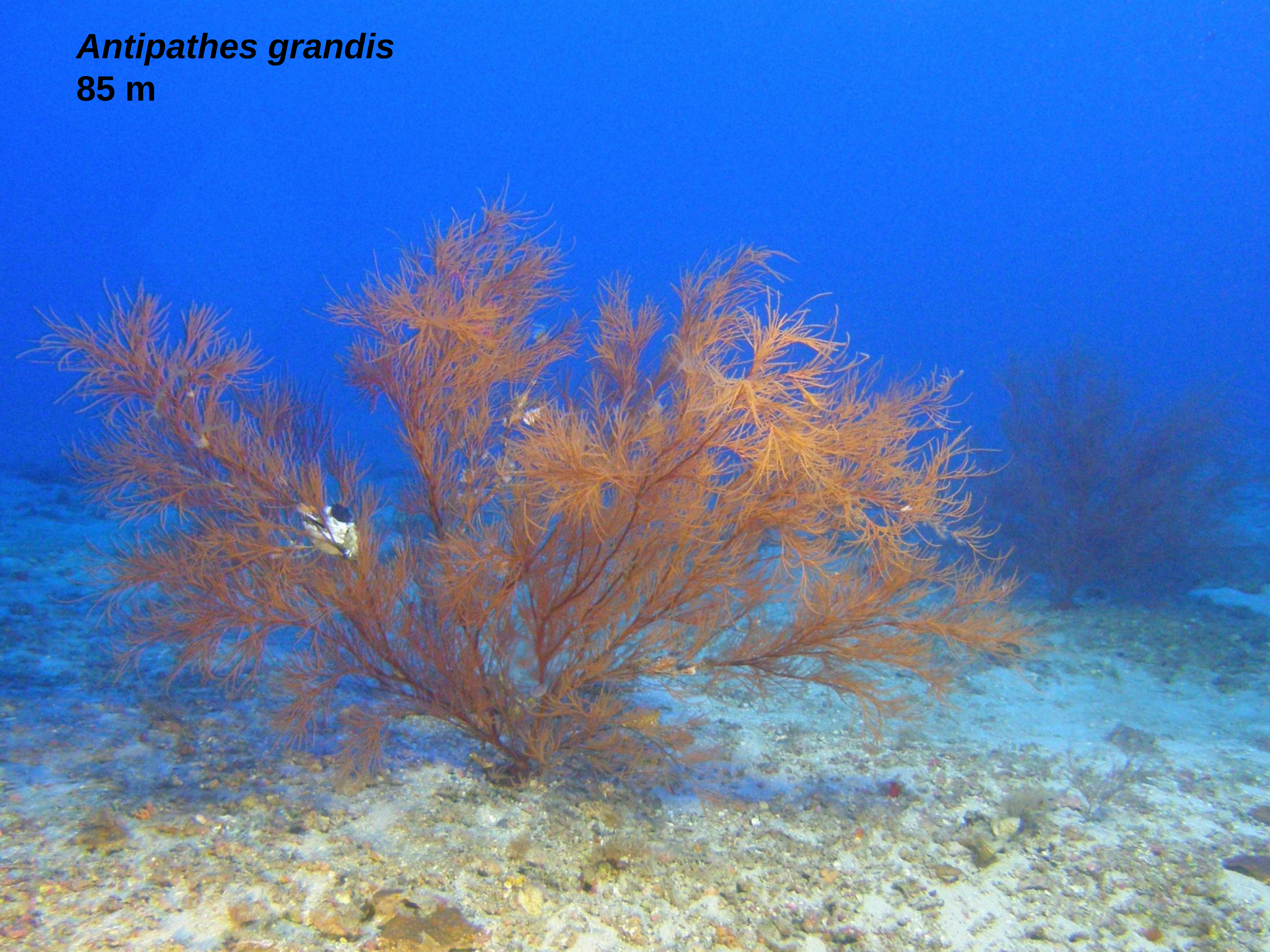
20 – 110 m depth range for targeted species

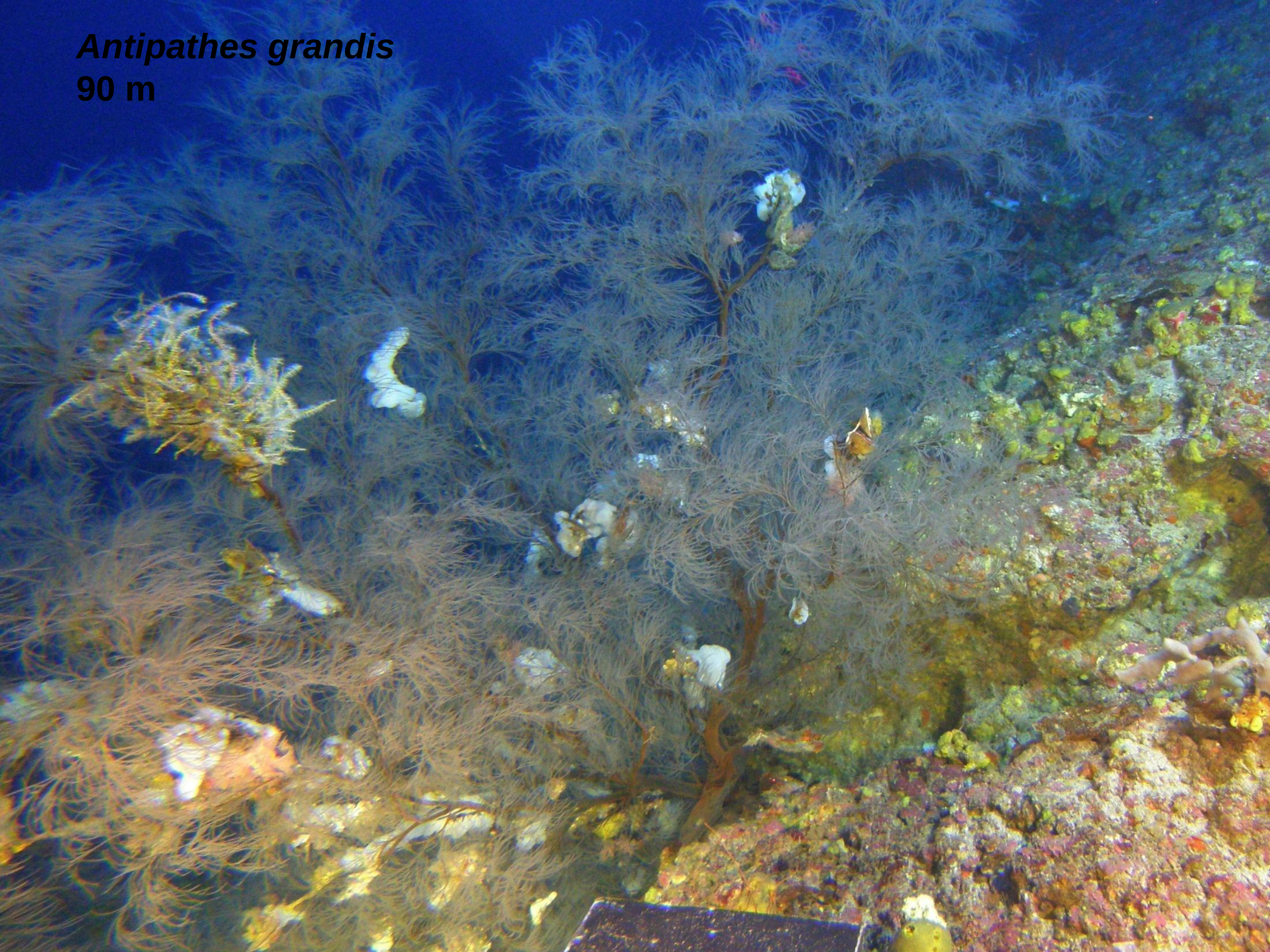
One of few black coral fisheries in Pacific

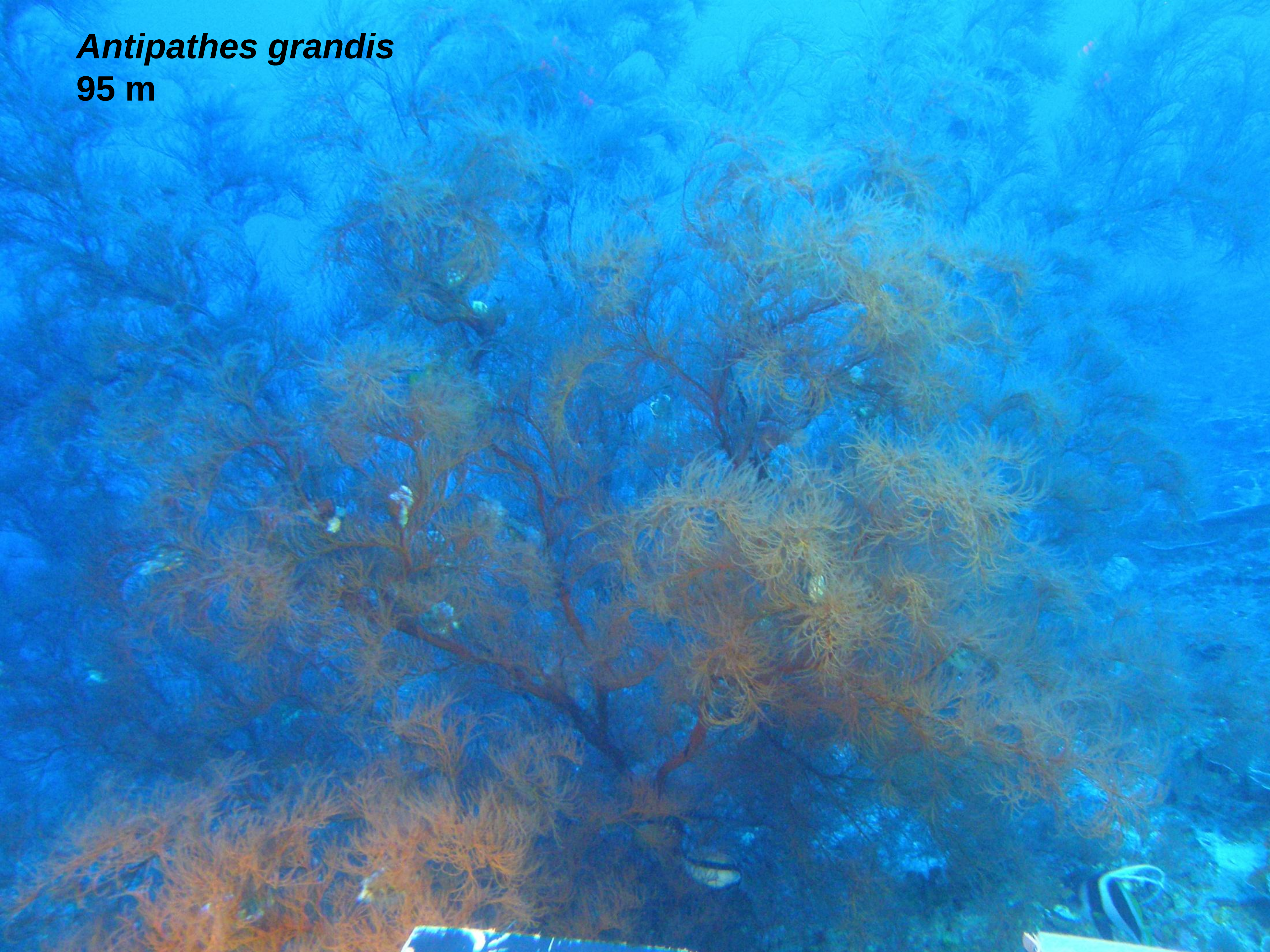

Antipathes dichotoma
25 m


Antipathes dichotoma
95 m

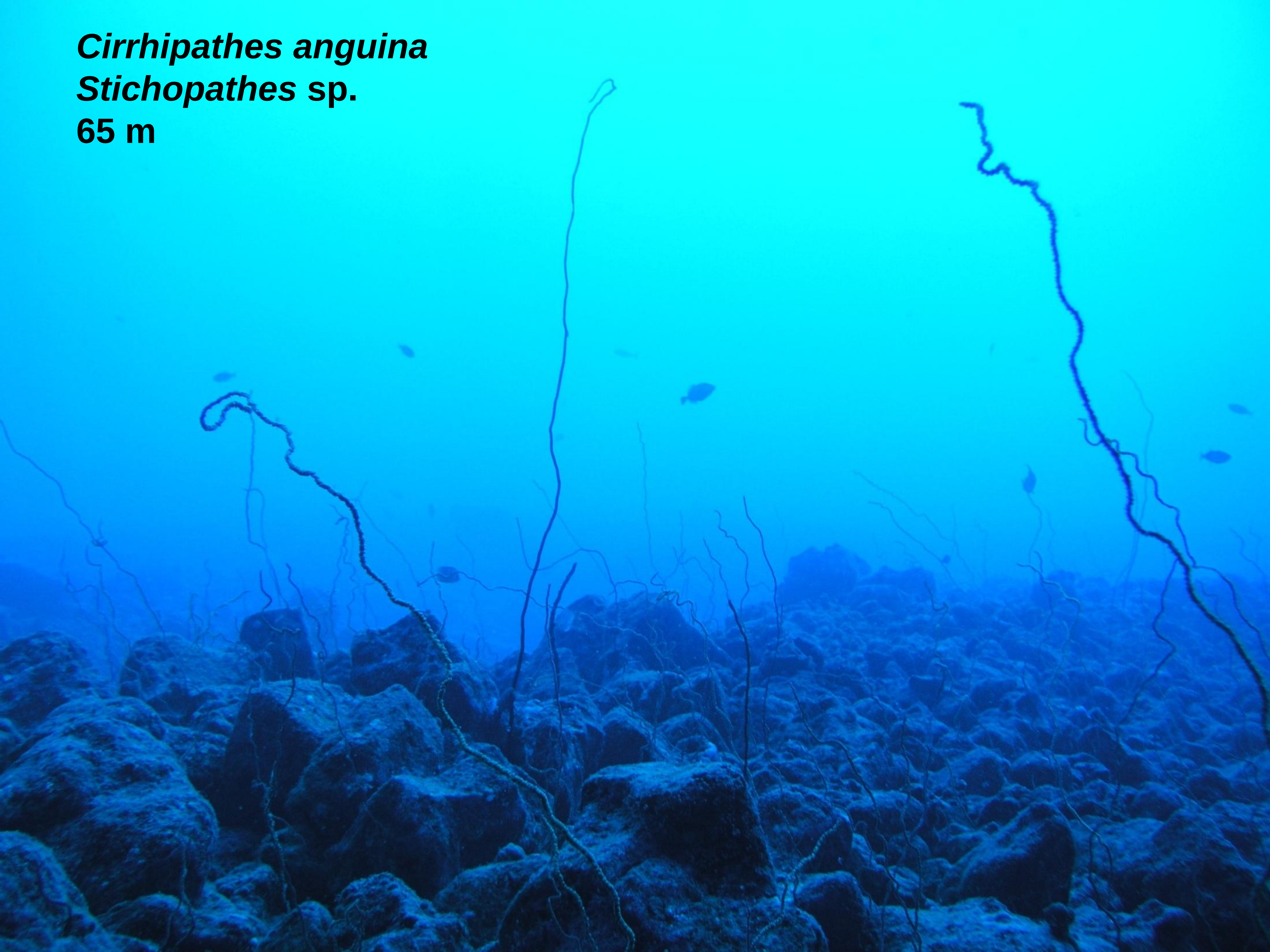

Antipathes grandis
65 m


Antipathes grandis
85 m


Antipathes grandis
90 m

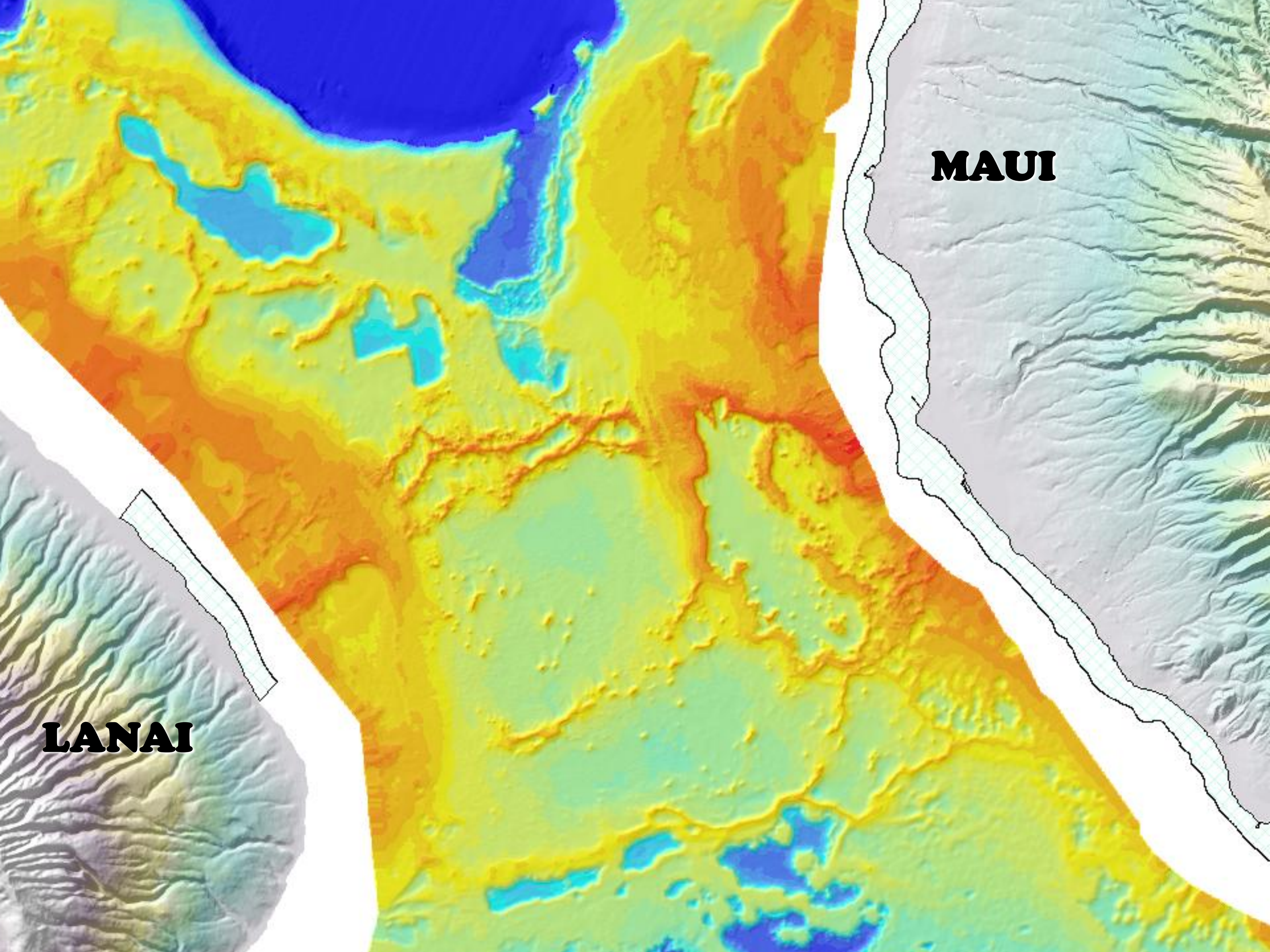

Antipathes grandis
95 m


Myriopathes ulex
25 m


Cirrhipathes anguina
Stichopathes sp.
65 m


Grigg


0"
1"


MAUI
LANAI

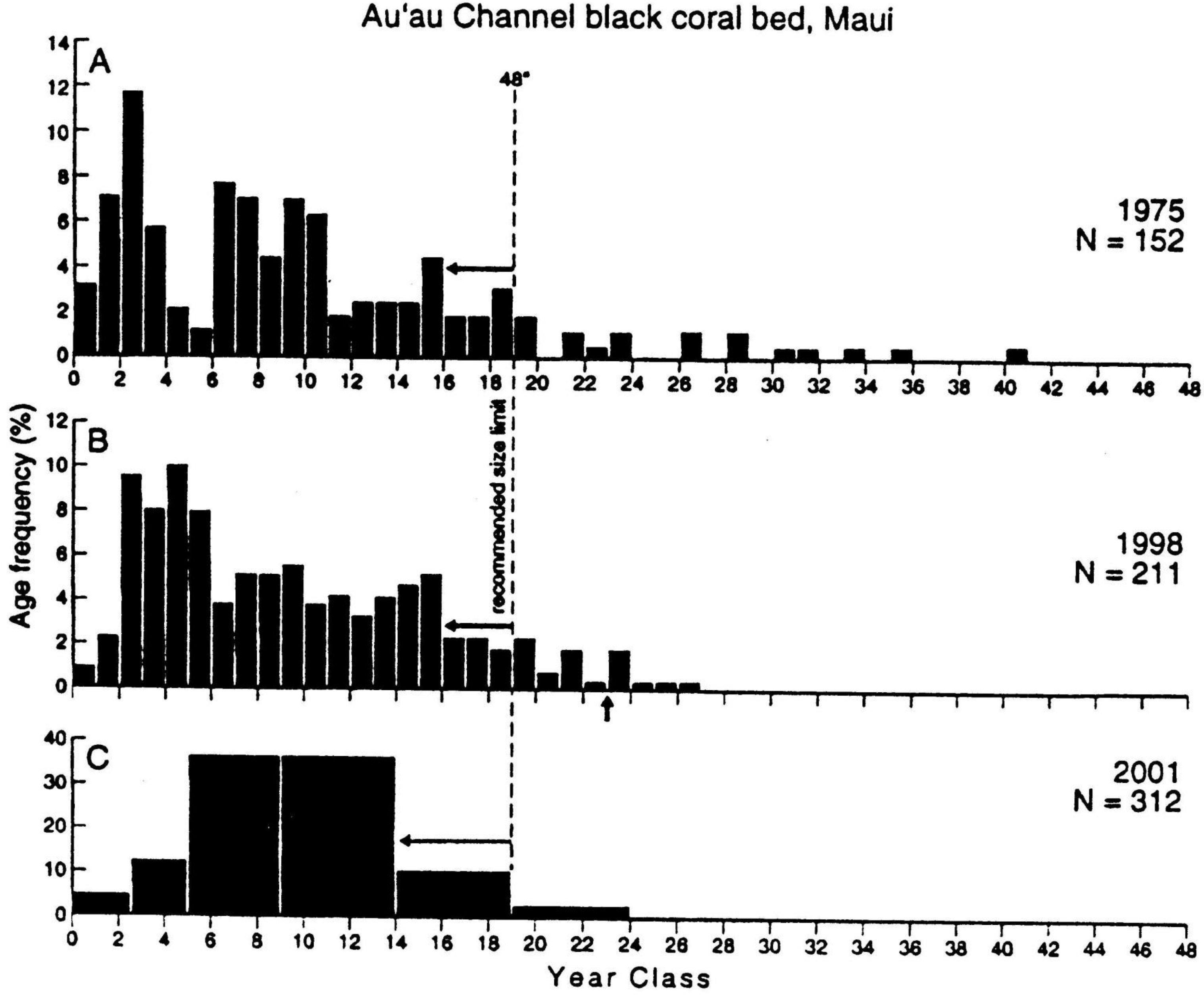
Key numbers to remember:

Maturity estimated to be
10.5 to 12 years = 67-77 cm height

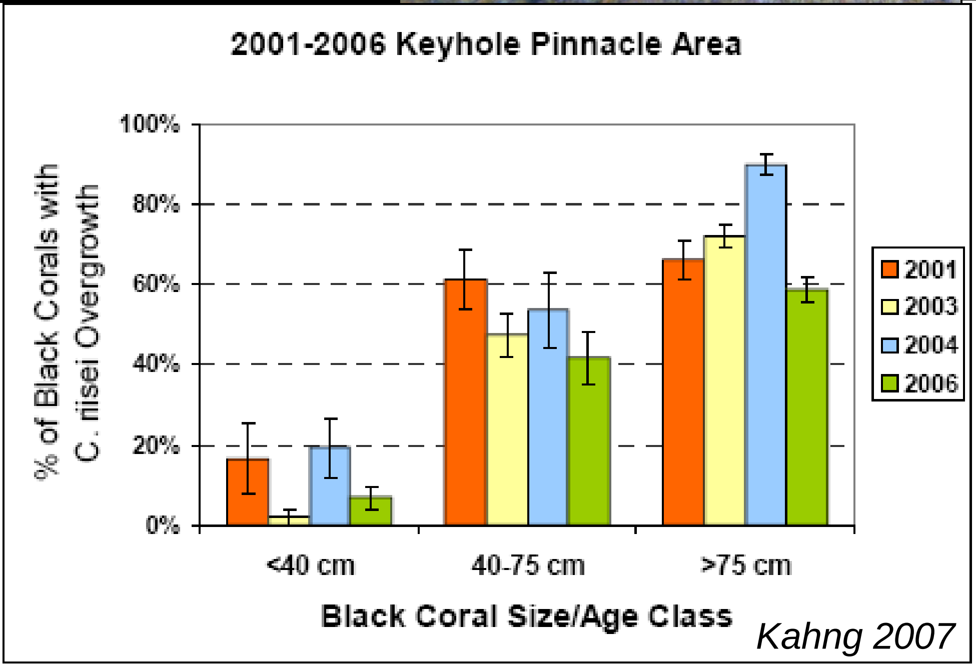
Yearly growth = 6.42 cm/year

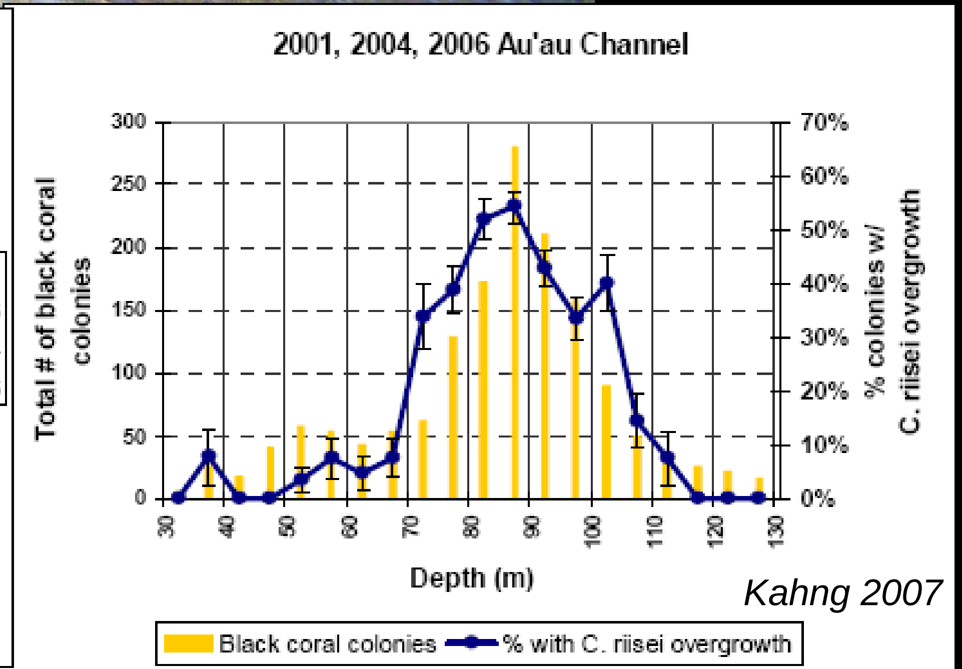
36” height = ¾” Base Diameter
90 cm = 1.9 cm = 14 years

48” height = 1” Base Diameter
120 cm = 2.5 cm = 19 years

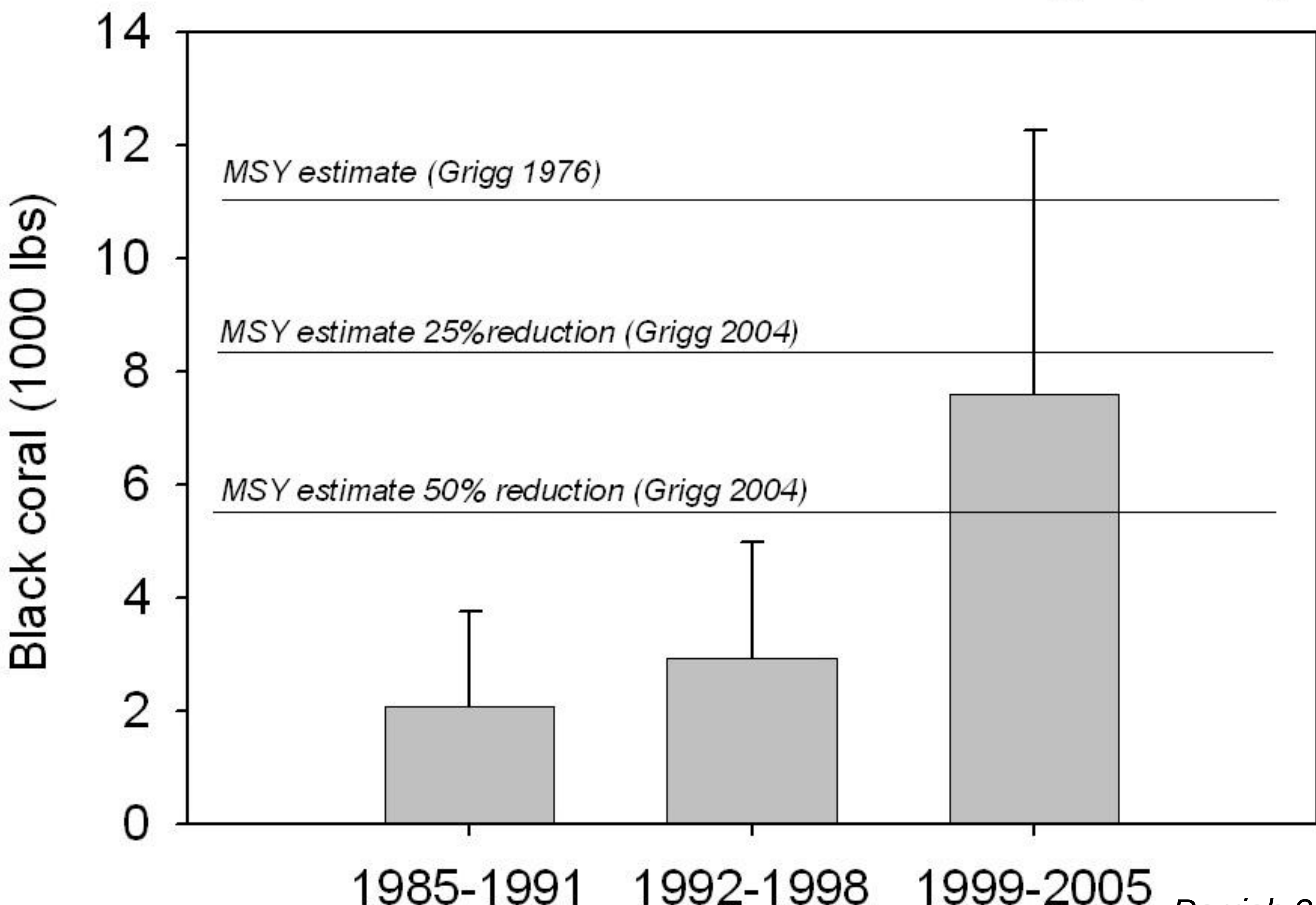

Au'au Channel black coral bed, Maui
A
48"
1975
N = 152
B
1998
N = 211
recommended size limit
C
2001
N = 312
Age frequency (%)
Year Class

Grigg 2004


2001-2006 Keyhole Pinnacle Area
% of Black Corals with C. riisei Overgrowth
100%
80%
60%
40%
20%
0%
<40 cm
40-75 cm
>75 cm
Black Coral Size/Age Class
2001
2003
2004
2006
Kahng 2007


2001, 2004, 2006 Au'au Channel
Total # of black coral colonies
300
250
200
150
100
50
0
70%
60%
50%
40%
30%
20%
10%
0%
% colonies w/ C. riisei overgrowth
30
40
50
60
70
80
90
100
110
120
130
Depth (m)
Kahng 2007
Black coral colonies
% with C. riisei overgrowth

Mean annual black coral landings (w/sd)



Parrish 2006

Threats to Resource

Carijoa invasion below 70 m

Harvesting pressure above 70 m

Potential drop in recruitment

Data Collection Method:

Grigg 1975 and 1998

- Divers using single tank with air
- Measure colonies with 1.2 meter rod
- Bottom time ranged 10 to 13 minutes

Grigg

Grigg 2001

- Submersible with 2 observers
- Use laser to measure colonies

HURL

DAR 2004

- Divers using mixed gas SCUBA
- Measure colonies with 1.2 meter rod
- Bottom time ranged 25 to 30 minutes

Assumptions of Age Frequency Analysis

Constant survival/mortality
Constant recruitment for all age groups
Sample is representative of whole population

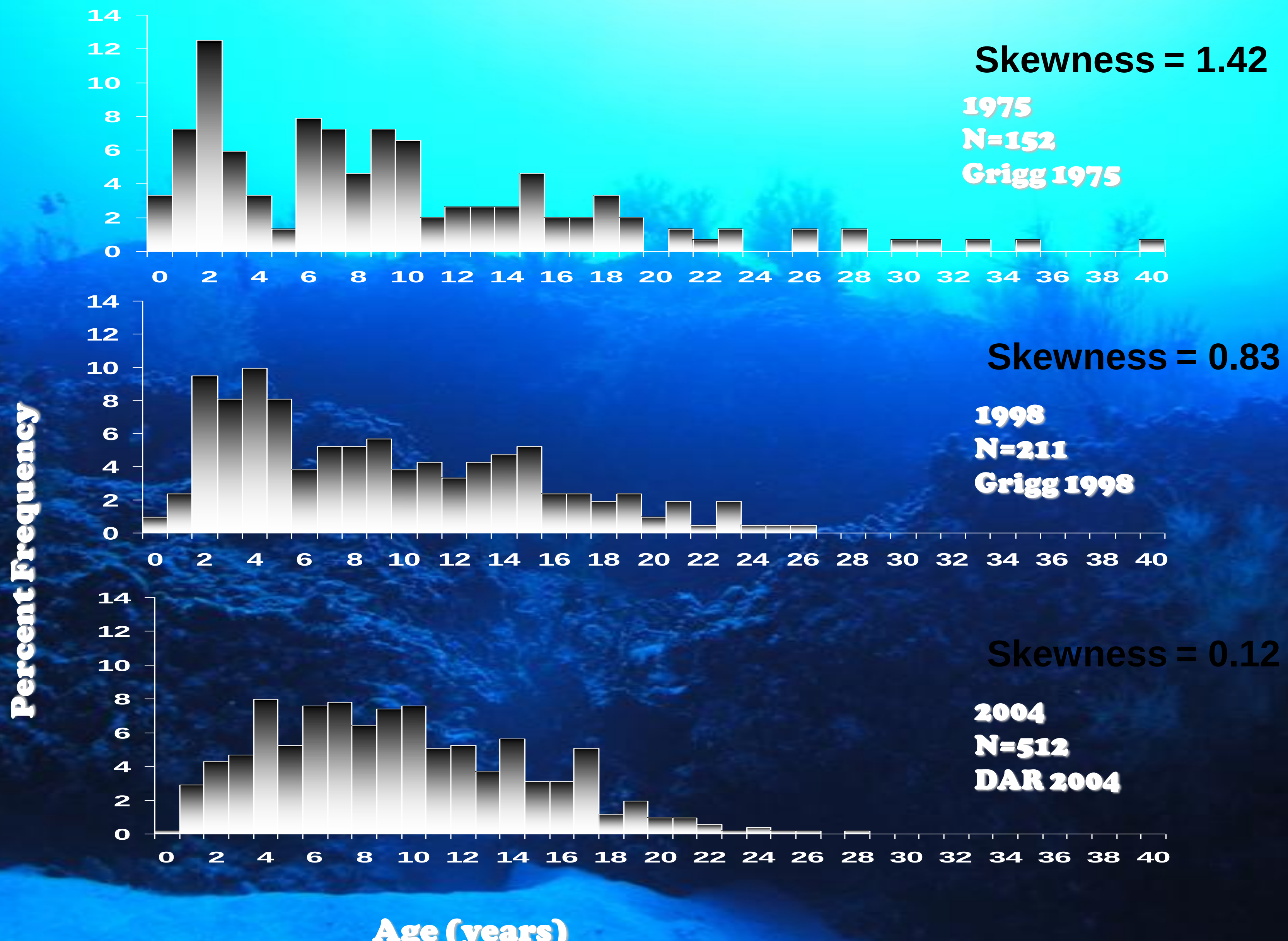
Regression Analysis:

Ages 0 and 1 were dropped

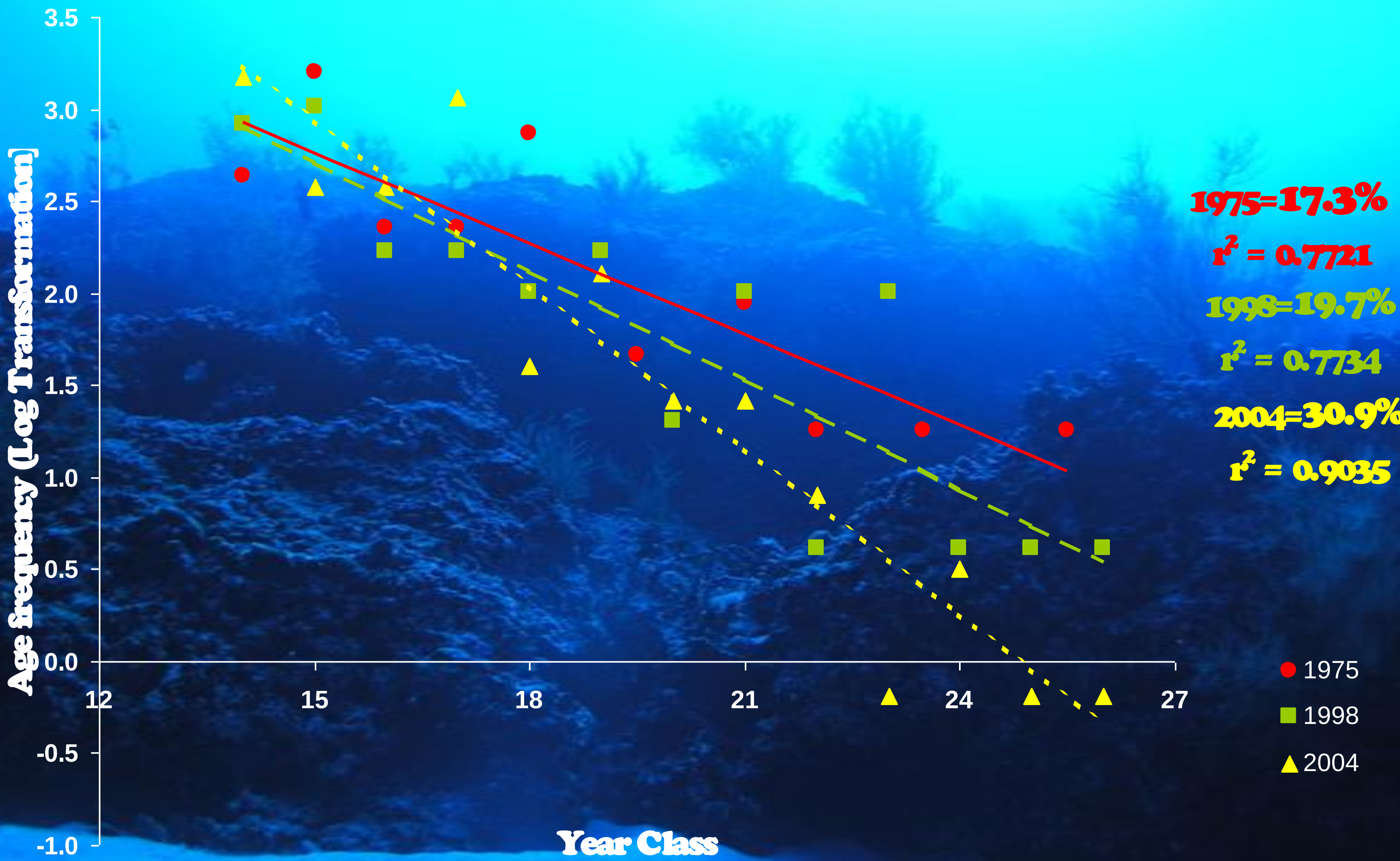
If an age class is missing individuals, that age class was averaged across 2 years

Regressions were carried out only across age classes for which there was reasonably continuous data (i.e. no more than 2 years without any individuals)

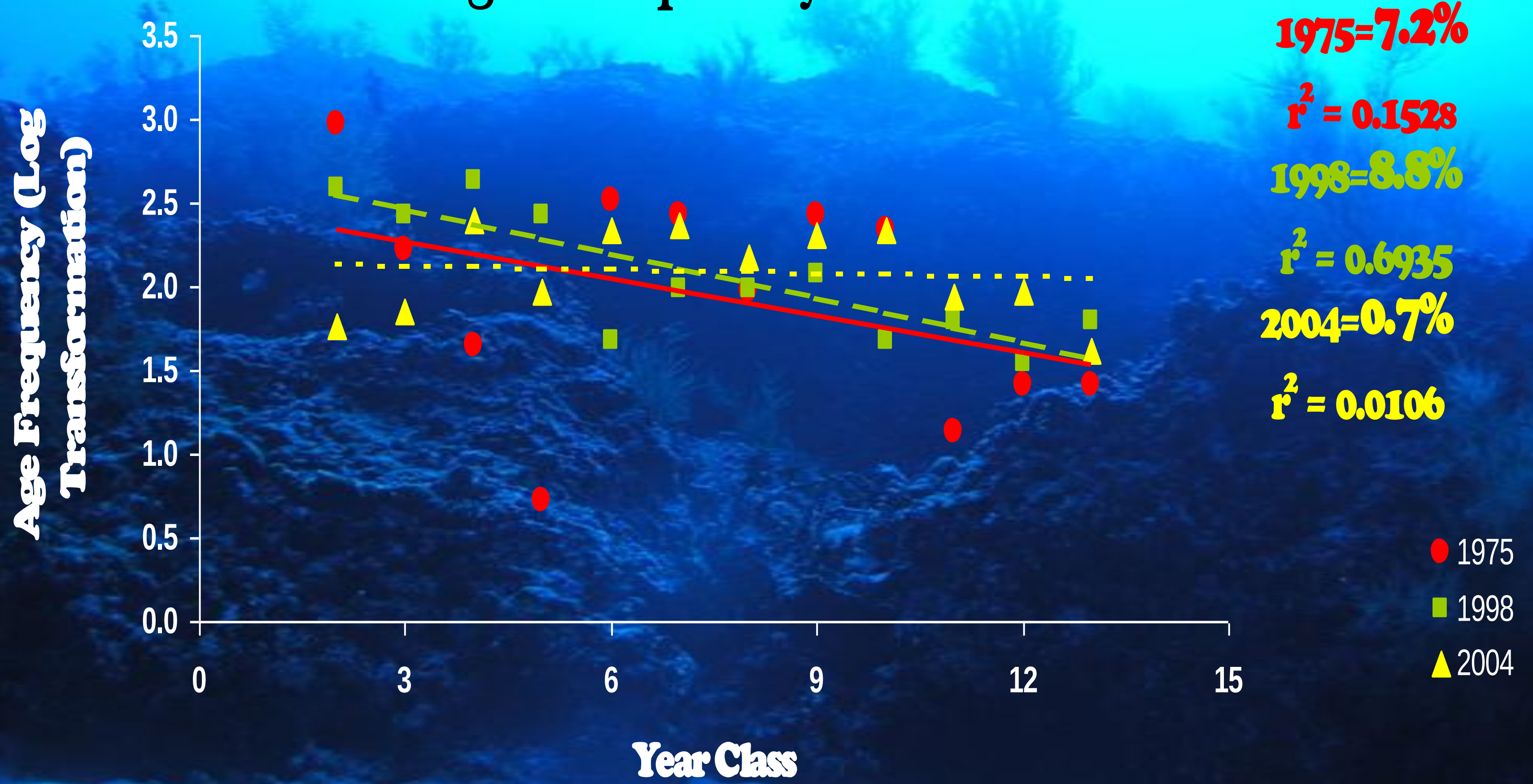
Age Frequency Distribution



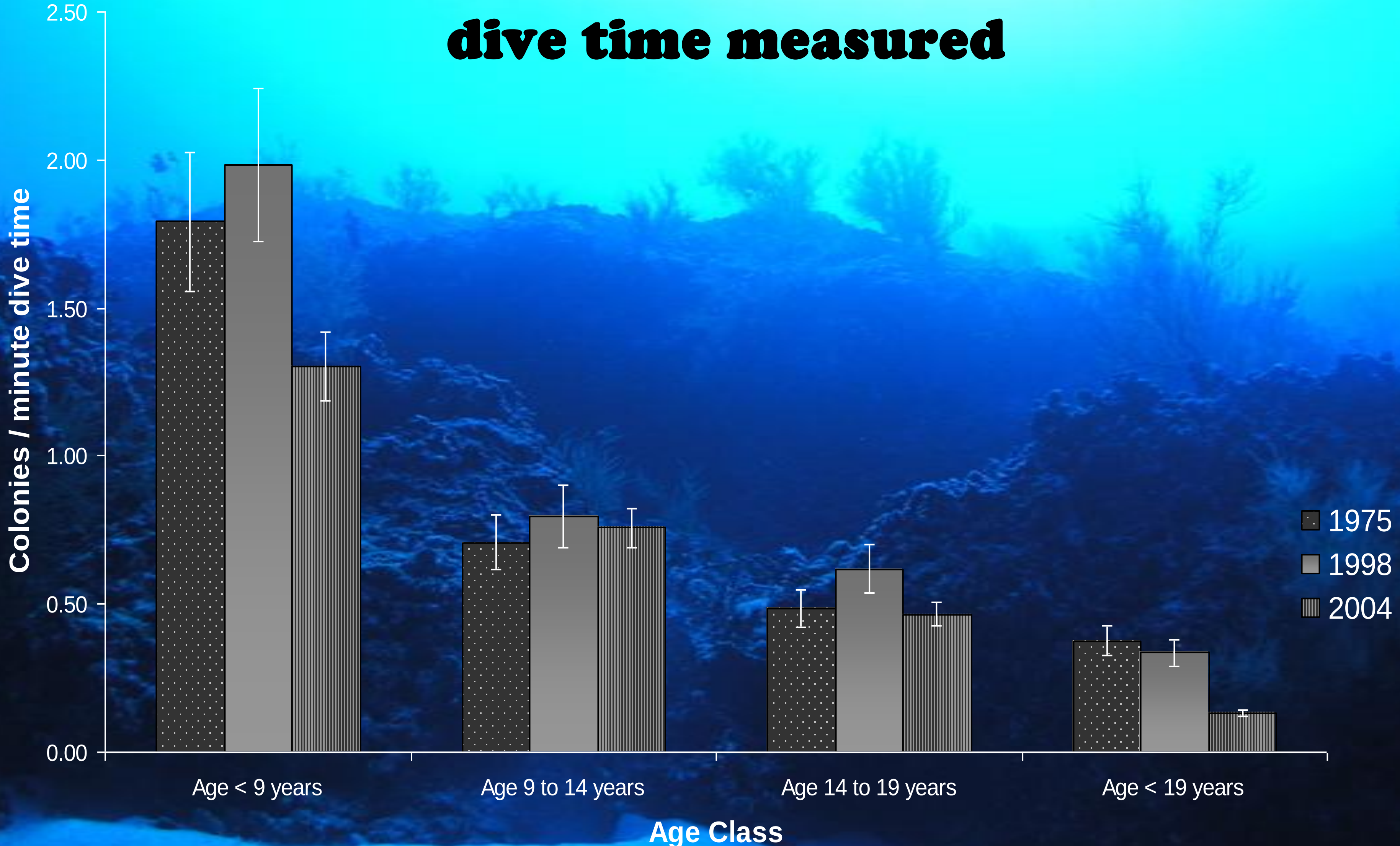
Regression of Post-Harvest Age Frequency Distribution



Regression of Pre-Harvest Age Frequency Distribution



Colonies per minute dive time measured



Current Regulations:

State of Hawaii – Minimum size of ¾" base diameter (in process of increasing to 1" base diameter)

- **Commercial Marine Fishing License**
- **Planning on adding Total Allowable Catch (TAC) and closed areas**

Federal – Minimum size of 1" base diameter or 48" height

- **Harvest Quota of 5000 kg/ 2 years**
- **Pacific Precious Coral Permit**

U.S. Fish and Wildlife Service

International Affairs Program

- Scientific Authority
- Management Authority
- International Conservation

Black Coral NDF

Black coral exports in the U.S.

- **Industry is small (3 or fewer operators)**
- **Exports limited to specimens from Hawaii**

Black Coral NDF

DSA uses the following

- **Licensing & reporting requirements**
- **Minimum size limit**
- **Maximum sustainable yield**
- **Industry information**
- **Practical harvest limitations**

Black Coral NDF

Industry Information - Applicants report

- **Weight of unworked black coral purchased (new applicant - on hand; established applicant - since last permit)**
- **Amount of unworked stockpiled coral**
- **Number of weight of processed specimens**

Black Coral NDF

Practical Harvest Limits

- SCUBA depth is limited
- Areas beyond SCUBA depth serves as de facto refugia

Black Coral NDF

- **Information confidence**

-Min. size and MSY based on peer-reviewed science

-Research is ongoing

-Industry self-reporting difficult to verify receipts to specimens

-Concept of deep water refugia reasonable although never confirmed

-Voluntary size limits after 2005 not verifiable

Black Coral NDF

Main Problems/Recommendations

- Consult with experts to obtain latest info and correctly interpret it
- Stay abreast of management and regulatory changes
- Application form - specific to coral/seahorses
- Understand the trade - trade data and products in trade

Black Coral NDF

Recommendations

- **DSA uses templates for findings (see sample)**

- different ones for plants and animals

- **New NDF for each export**
- **Permit conditions**
- **Keep electronic copy**
- **Legal acquisition - DMA**

PALAU CASE STUDY - *TRIDACNIDAE*

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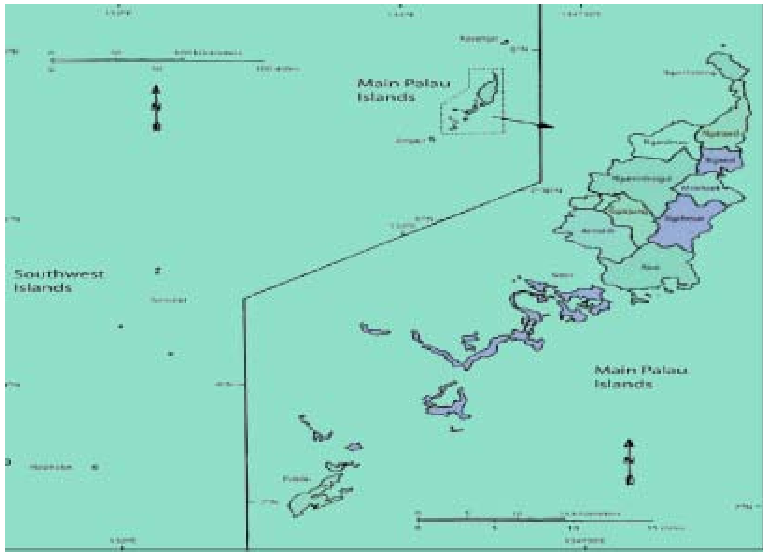
In the west central portion of the Pacific Ocean are several clusters of islands known to the world as Micronesia. Micronesia has three main island groups, (the Marianas, Marshall Islands, and the Caroline Islands) all of which comprise the former Trust Territory of the Pacific Islands. The Palau (Pelew) group lies farthest west among the Carolines which, in addition to Palau, encompasses the Federated States of Micronesia, (Yap, Chuck, Pohnpei and Kosrae).
Palau archipelago stretches over 2-8º north latitude and 131-135º east longitude. Major cities adjoining it are Manila (500n. miles northwest), Tokyo (1,900 n. miles north), Honolulu (4,450 n. miles northeast), and Sydney (3,300 n. miles south. Palau lies some 7º 30' north of the equator.

Of the 300-odd islands comprising Palau, eight are permanently inhabited. The total land area is less than 200 square miles. Babeldaob is the big island (second largest to Guam in Micronesia) which makes up the 75% of the acreage. Melekok is the provisional capital, however Koror is still the center of all government, economic and social activity where some of the 2/3 population still resides with even greater fraction of work force.

The larger islands were formed by Eocene volcanic activity and the interiors are mostly jungle. Kayangel, the northern most islands, is a coral atoll. The picturesque Rock Islands to the south are of lime-stone formation, two islets on the southeast Peleliu and Angaur are low platform and reef, with five islet groups on the southwest the Hatohobei, Sonsorol, Merrir, Helen Reef and Fanna are uplifted reef flats.



Map of the Republic of Palau Demarcating 16 States Boundaries

I. BACKGROUND INFORMATION ON THE TAXA

The Indo-Pacific family Tridacnidae comprises two genera, *Tridacnae* Brugui'ere with five species: *Tridancnae gigas* (Linne*), T. gigas* (Linne), *T. drasa* (Roding); *T. derasa* (Lamarck,), *T. maxima* (Roding), and *T. crocea* (Lamarck); and the genus *Hippopus* represented by the species *Hippopus hippopus* and *Hippopus porcellanus*. Giant clams of the family Tridacnidae have been seriously considered as maricultural candidates. The first successful laboratory rearing occurred 3 decades ago (LaBarbera, 1975; Jameson, 1976) and mass culture techniques were not demonstrated until 1982 (Heslinga *et al*., 1984b).

1. BIOLOGICAL DATA

1.1. Scientific and common names

The classification of giant clams is as follows:

Phylum:	Mollusca
Class:	Bivalvia
Order:	Veneroida
Superfamily:	Cardiacea
Family:	Tridacnidae

According to Rosewater (1965) the family is geologically young, having existed from Eocene to recent times, and apparently evolving from a cardiid-like ancestor in the Eocene. The genera *Hippopus* and *Tridacna* both arose in the early Miocene. Brief taxonomic descriptions of the seven species are presented here based on accounts by Rosewater (1965, 1982), IUCN (1983) and personal observations.

Hippopus hippopus (Linnaeus, 1758), the Horse's Hoof, Bear Paw or Strawberry Clam, reaches approximately 400 mm in length. The valves are thick, heavy and triangular in shape, often covered with reddish spots and obscured by encrustations. The mantle is a deep yellow-green, irregularly mottled at the periphery and in the center.

Hippopus porcellanus Rosewater, 1982, the China Clam, is a very recently described species. Its shell is thinner and smoother than that of *H. hippopus*, usually devoid of pigmentation, and more semi-circular in profile. The mantle is similar to that of *H. hippopus* (Rosewater, 1982), except that prominent papillae line the margins of the incurrent siphon.

Tridacna squamosa Lamarck, 1819, the Fluted Clam, reaches about 400 mm and is characterized by an elongate shell with conspicuous fluted scales on its radial ridges (Fig. 12.2B). The valves are white and occasionally tinged with orange, and the mantle yellowish green.

Tridacna gigas (Linnaeus, 1758), the Giant Clam, is the largest extant bivalve and may attain weights of over 200 kg, of which 55-65 kg is living tissue. The shell may grow to 1370 mm in length. It is white and fan-shaped with deep radiating ribs.

Tridacna derasa (Roding, 1819), the Southern Clam, is the second largest tridacnid, reaching about 500 mm in shell length. It is characterized by a low primary and radial sculpture, variable shape, massive umbonal area and smooth white shell.

Tridacna maxima (Roding, 1798), the Small Giant Clam, is a partially burrowing species that reaches about 200mm in shell length. The mantle color is highly variable, ranging from bright blue to brown.

Tridacna crocea (Lamarck, 1819), the Crocus or Boring Clam, is the smallest of the tridacnids, reaching only 150 mm in shell length. The valves are greyish white, often fringed with orange or yellow both inside and out. They are triangularly ovate in shape. Mantle coloration is predominantly blue but shows great variability.

1.2. Distribution

The present day distribution of tridacnid clams is limited to tropical Indo-West Pacific seas, although fossil forms have been found in Middle Tertiary deposits of Northern Europe (Tridacna media Pusch; T. Wolfarti Chenu) and in Lower Miocene strata in Florida (Hippopus (?)

Gunteri Mansfield) (Rosewater, 1965). Present differences in the expanse of geographical distribution among different species of Tridacnidae are not easily explained by larval behaviour. For example, the most widespread species, *T. maxima*, and the narrowly distributed *T. crocea* show similar larval life spans (Yamaguchi, 1977). It appears that unknown ecological requirements are responsible for present distributional patterns

1.3. Biological characteristics:

1.3.1. *Biological and life history characteristics of the species*

REPRODUCTION;

Tridacnid clams are protandric functional hermaphrodites which reproduce by broadcast spawning (Wada, 1954). Early growth rates are rapid (50-100 mm per year for maricultured *T. derasa* and *T. gigas*) compared to other bivalves, but the onset of sexual maturity is relatively late. Palauan *T. derasa* reach male phase maturity at 3 years post-fertilization and full maturity at 5 years (Heslinga *et al*., 1984b, and unpublished data). Wada (1942) reported that *T. squamosa* and *H. hippopus* in Palau reach full maturity at 160-200 mm and 130-150 mm, respectively, which is about 3-5 years post-fertilization. *Tridacna maxima* in Tonga reaches male phase maturity at about 55 mm (2.5 years), and 50% are fully mature at 105 mm (5 years) (McKoy, 1979). Jameson (1976) found that *T. maxima* at Guam attains full maturity at 110-130 mm.

Pheromonal factors associated with sperm and eggs act as spawning inducers in tridacnids. Stress, handling, elevated temperature and the neurotransmitter serotonin have also been implicated as stimulants, but their effectiveness depends on the ripeness of the clams (Munro and Heslinga, 1983; Braley, 1985). The spawning process has been described in detail by Wada (1954), and his account corroborated by LaBarbera (1975), Jameson (976), Gwyther and Munro (1981), Beckvar (1981) and Fitt and Trench (1981). Ejaculation of sperm lasts for several minutes to more than an hour, and is followed by a quiescent period usually lasting less than an hour. Egg release may or may not follow. Fecundity is extremely high but not well documented. Jameson (1976) estimated that a *T. maxima* specimen spawned 10 million eggs. *Tridacna gigas* and *T. derasa* might easily produce greater than an order of magnitude more, since their gonads are much larger. There is no evidence that the tridacnids are capable of producing viable offspring through self-fertilization.

A significant diel and lunar spawning periodicity has been documented for *T. gigas* at Palau, where maximum reproductive activity occurs in the late afternoon during the second and fourth quarters of the lunar month (Heslinga *et al*., 1984b). Spawning seasonality is not evident in stenothermal equatorial areas like Palau but may exist at higher latitudes (Braley, 1984).

A typical bivalve trochophore gives rise to a D-shaped veliger on day 2 post-fertilization. On day 3 feeding begins on phytoplankton and particulates in the 1-10 micron range. Most workers list the larval swimming period as 10 days or longer in small laboratory culture vessels (LaBarbera, 1975; Jameson, 1976; Gwyther and Munro, 1981; Fitt and Trench, 1981; Murakoshi, 1978; Beckvar, 1981; Fitt *et al*., 1984), but in large outdoor tanks with food provided by the Wells-Glancy method, the tridacnid planktonic period is 5 days or less, and full metamorphosis of the larval population occurs by day 7 at about 30ºc (Heslinga *et al*., 1984b, and unpublished data).

During the swimming phase and immediately thereafter, veligers ingest (but do not digest) *Symbiodinium microadriaticum* cells, which move out of the gut by an unknown mechanism before taking up residence in the mantle region (Fitt and Trench, 1981). These cells eventually multiply into millions. After settlement and substrate exploration veligers metamorphose by shedding the velum. Byssal attachment follows, though this process is reversible, and the foot remains an effective locomotory organ for at least several months. The growth of tridacnids post-settlement is rapid; maricultured *T. derasa* reach mean lengths of 5.3 mm, 10mm, 12.1 mm and 20.0mm at 3,4, 5 and 6 months, respectively. Mean sizes of 15.3 mm, 12.6 mm and 19.3 mm were reached in 5 months by cultured *T. gigas*, *T. squamosa* and *H. hippopus* (Munro and Heslinga, 1983). Maricultured *T. derasa* specimens grew at an average rate of about 50 mm per year during their first 5 years in Palau. Rapidly growing individuals increased in size at nearly double the average rate during the first 2 years (Heslinga and Perron, 1983b).

Growth rates of wild tridacnids in nature have been reviewed by Munro and Heslinga (1983). Because absolute growth rates are positively correlated with maximum size, the most promising maricultural targets are the larger 2 species, *T. gigas* and *T. derasa*. In a frequently cited study, Bonham (1965) at Bikini used radioautography to determine that 520 mm and 550 mm *T. gigas* were 9 and 6 years old, respectively. Beckvar's (1981) data suggest that wild *T. gigas* in Palau may reach 500 mm in 6 years. These are extremely rapid growth rates. It should be emphasized, though, that these data describe wild individuals that have survived intense selection during the larval and juvenile phases. In maricultural operations, where survival rates are much higher than in nature and selection intensity greatly relaxed, average growth rates may well be lower than those recorded in nature.

Patterns of mortality in the Tridacnidae are not yet well understood, but it is logical to assume that because fecundity is unusually high, average larval mortality rates must also be extreme in nature. Based on *T. gigas* population size structures, many workers have concluded that recruitment rates must be low or erratic (Hester and Jones, 1974; Yamaguchi, 1977; Braley, pers. Comm.).

Wild juvenile clams probably suffer heavy predation pressure in nature. Experiments conducted at Palau showed that maricultured tridacnids in the 10-40 mm range experience nearly instantaneous mortality when released unprotected in their natural habitat (Heslinga et al., 1984b). Predators identified so far include hermit crabs (Dardanus), various molluscivorous fishes (Monotaxis, Balistoides, Rhinecanthus), carnivorous snails (Chicoreus, Cymatium), octopus (Heslinga *et al*., 1984a, b; and Perron *et al*., 1985). Cultured *T. derasa* specimens begin to attain immunity from crushing predators at about 100mm; at 150mm there are few predators except larger octopus and perhaps certain rays that can kill them. It is commonly believed that mature *T. gigas* and *T. derasa* have no serious enemies other than man.

The lifespan of giant clams has long been a subject of great curiosity to both scientists and laymen. At this point, however, longevity estimates are still largely speculative. McMichael (1975) in Australia concluded that 240 mm *T. maxima* were 40 years old, and McKoy (1979) estimated that 250-300 mm *T. maxima* in Tonga were well over 50 years old. Hamner and Jones' (1976) data indicate that 140 mm *T. crocea* in Australia might be about 60 years old. Summerhays (1976), citing data from the Queensland Fisheries Service, estimated that Australian *T. gigas* reached 500 mm in 10 years, and that very large (1400 mm) specimens might be 200 years old.

For maricultural purposes it is already clear that the most interesting part of the giant clam life cycle is the first 5-6 years, or roughly up to the onset of full (male/female) sexual maturity. Prior to this age meat and shell weight increase at a relatively rapid rate in *T. derasa*. When maturity is reached, growth rates decline as energy is increasingly channelled into reproduction.

1.3.2. *Habitat types*

Giant clams are normally restricted in their distribution to the shallow, well-illuminated waters of coral reefs. *Tridacna gigas* is found on sand and coral rubble on the leeward side of barrier reefs, from about 1-5 m depth. *Hippopus hippopus* occurs on sandy or rubble subtrates to 10 m depth on outer reef flats; it can also be common in lagoon areas and on sea grass beds. The globular shell shape may be an adaptation which permits rolling through the surf zone (Yonge, 1980), resulting in redistribution to sandy, back reef areas. *Tridacna maxima* is found often in the high energy waters of seaward reef slopes, where its burrowing habit and strong byssal apparatus prevent dislodgement by waves. *Tridacna crocea* burrows by mechanical and chemical means into coral heads on the reef top and is found with only the mantle visible. Hamner (1978) presented a detailed account of the population biology of *T. crocea*, including an analysis of many plant-like behavioural attributes which enhance intraspecific competitive ability. *Tridacna squamosa* often occurs on coral heads or rubble substrates at 2-20 m depth, both in exposed and sheltered habitats.

All tridacnids require clean, clear water of oceanic salinity. The optimal water temperature is not precisely known but appears to be in the range of 23-30°C

1.3.3. *Role of the species in its ecosystem*
The farming of giant clams is envisaged as means of promoting biological sustainability and maintaining biodiversity.

1.4. Population:

1.4.1. *Global population size*

1.4.2. *Current global population trends*
___increasing _X_decreasing ___stable ___unknown

1.5. Conservation status

1.5.1. *Global conservation status* (according to IUCN Red List):

___Critically endangered	___Near Threatened
___Endangered	_X_Least concern
_X_Vulnerable	___Data deficient

IUCN red list assessments (1996):

T. crocea	Lower risk – least concern
T.derasa	Vulnerable
T. gigas	Vulnerable
T. maxima	Lower risk – conservation dependent
T. squamosa	Lower risk – conservation dependent
H. hippopus	Lower risk – conservation dependent
H. porcellanus	Lower risk – conservation dependent

1.5.2. *National conservation status for the case study country*

1.5.3. *Main threats within the case study country*

___No Threats
___Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
_X_Harvesting [hunting/gathering] (subsistence/commercial]
___Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
___Other_______________
___Unknown

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED.

2.1. Management measures

There is no management in place to regulate wild harvests outside conservation areas (see section 3). No exports are permitted of wild-taken clams (see section 2.3).

2.1.1. *Management history*

In the past giant clams were harvested from natural habitat and placed or pooled together in a nearby coastal area close to a community or village to only be harvested again during rough weather when family were unable to fish.

2.1.2. *Purpose of the management plan in place*

There is no management plan

2.1.3. *General elements of the management plan*

There is no management plan

2.1.4. *Restoration or alleviation measures*

The Palau Mariculture Demonstration Center (PMDC) Bureau of Marine Resources within the Ministry of Resources & Development started in 2005 a clam dissemination program to the community where to date 40 clam farms have been established consisting of more than 2 million clams disseminated. The variety of species of clams are *T. crocea*, *T. maxima, Hippopus hippopus* and *T. derasa* that make-up the most of these disseminated clams. The purpose of this program is to try and alleviate pressure of harvesting clams from the wild natural stock and also to set-aside at least 10% of clams from each farm so that they can spawn naturally in their own ranched enclosures and re-seed the nearby areas or use them as brood stock. The other objective of this program is to support food security and money making opportunity to support and improve standard of living in the community. All clams given to the farmers are free of charge.

Clam Culturing Techniques

In 1985 Palau increased its clam hatchery production of *Tridacnae derasa* to 250,000 p.a. (Heslinga and Watson 1985), however the selection of F1 for future brood-stock took place three years later, in 1989, when the clams have reached the male phase maturity. The criteria for selection of brood-stock was based on the *Symbiodinium* pigmentation color of blue green, dark green, ocean blue, and dark blue. We go back to collect wild spawners only if we want to diversify the genetic pool of our clams. The original brood-stock, derived from "a policy of using wild clams", were all placed back into the sea in "alphabetical order" close to the hatchery and other designated areas that are continued to be monitored. The founder clams are not afforded to be in the land-based tanks as they occupy much needed space for grow-out

Broodstock clams are (re)collected from the wild based on the moon phase for fecundity and are brought in to the hatchery for culture (after spawning they are returned to the wild in the same designated areas). They are brushed and scraped to rid of parasitic shells and calcareous algae. The clams are placed in the sun for an hour to stress them and then are placed in the hatchery tank where water was already prepared and warmed naturally by the sun. When the clams are spawning eggs they are placed in a styrofoam boxes with clean water where they continue to spawn eggs; sperm is collected later to manually fertilized the eggs as too much sperm will end up polluting the medium. Following the eggs being fertilized and once the free-swimming life phase has settled and metamorphosed and been counted, they are placed in the land based propagation tanks until they reach about 2.5cm. During the three months in the land-based propagation tanks they are continually thinned out as clams have the tendency to move and clump-up together where there is a possibility for their physical characteristics to be thwarted. After three months in the land-based propagation tanks, they can then be disseminated to farmers to rear in the sea in a protective cage of about 33.3 meter square. Currently Palau is using the F2 seedlings of *T. derasa, T. maxima, T.crocea*, and *Hippopus hippopus* for disseminating to farmers and export. Currently the *Tridacnae gigas* and *T. squamosa* are not being produced in our hatchery although we have the technology to produce them. No F1 specimens are exported or disseminated to farmers.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

All clams disseminated to farmers are counted and measured to get their mean sizes. The farmers are required to record mortalities in their farms including the local sales. The total mortalities and sales are deducted from the original inventory disseminated. The aquaculture personnel also conduct monitoring every six months for all the farms to asses whether the records are consistent.

2.2.1. *Confidence in the use of monitoring*

The monitoring of clam farms to assess the growth rate and to inventory the number of clams is a requirement to assist the farmers so that when they present invoices in reference to their clams sold then the total number sold is deducted from the inventory. Number of invoice and permit receipt with the number of certification and declaration forms are entered into our data base including species sizes and destination.

2.3 Legal framework and law enforcement

The inspectors are present at the airport every flight to inspect cargoes and checked in baggage. All marine resources or parts thereof to be exported or taken out of Palau are required to be declared. Falsification of declaration document warrant a fine of US$250.00 including each species failed to declare. Appendix II specimens such as tridacnid clams must be certified that they originate in Palau and that they are cultured pursuant to the CITES and that shipment is in accordance with the laws of Palau and will not be detrimental to the survival of the species in the wild, and if living will be transported in a manner which will minimize risk of injury, damage to health, or cruel treatment. The Marine Protection Act of 1994 and its Regulations prohibit exports of wild Tridacnid clams except cultured. The Act and its Marine Export Labelling Regulations mandate that all marine resources or part thereof are required to be declared by a person prior to being exported. Restricted marine resources and species stipulated in Appendix II of the CITES are required to be certified in-lieu or consistent with the CITES provisions.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. **Type of use** (origin) **and destinations** (purposes)

There are seven species of Tridacnid clams found in Palau and they have many uses. The meat is mainly used locally as food, an additional protein, and the most targeted or sought part is the abductor muscle that is sold locally in hotels and restaurants for $7.00 a pound for soup and or sashimi. The shells are used for arts & crafts. Wild clam specimens and captive-produced specimens can be used locally, however, captive-produced specimens only can be exported outside of Palau for aquarium trade and other commercialized activities. The exported captive-produced specimens are destined for Guam, Saipan, Honolulu, US Mainland, Germany, and France.

3.2. Harvest:

3.2.1. *Harvesting regime*

Harvesting for wild clams is not prohibited and there is no harvesting season; with respect to non extractive harvesting, clams are pooled in a specific frequent spot for eco-tourism and the designated conservation areas. Palau has 23 conservation areas and it's our mandate to replenish these conservation areas with cultured clams for species sustainability and diversity.

3.2.2. *Harvest management/ control (quotas, seasons, permits, etc.)*

The harvesting of wild and cultured clams is prohibited in the conservation areas. There are no quotas or seasons for harvest however non citizens are required to hold or own a collection permit if more than five marine specimens are collected in a day.

3.3. Legal and illegal trade levels

Illegal trade was never evident or practiced in Palau before and since the implementation of Marine Protection Act of 1994; due to our continued education awareness of the Act and its provisional requirements illegal trade has never been documented and is non-evident.

II. Non-detriment finding procedure (NDFs)

The CITES Article IV, paragraph 2a language is formally made part of the certification form in lieu of CITES, and Article IV, paragraph 3 is not applied because Palau Appendix II species such as Tridacnid clams can only be exported if they are cultured. Accordingly, non-detriment is achieved by restricting exports to captive-produced specimens; this culturing activity supports the conservation of the wild population through reducing harvesting pressure and by providing a source of animals for re-stocking the wild population.

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

__yes _X__no

Palau does not use the IUCN checklist in making its non-detriment findings. Palau's methodology has never been based upon the IUCN checklist and such methodology, should it be complied with, may pose a problem with us because the clam exports are cultured based on our laws (24 PNCA 1204). As it is prohibited to export Tridacnidae clams harvested from the wild, Article IV may be problematic to be used as guidelines to monitor to ensure that such species throughout its range. CITES Article IV paragraph 2 & 2a, and paragraph 3 need, to me, to be modified and not used as factor to monitor species throughout their range. Our export process indicates by its in-lieu CITES Certification form that such species for exports/shipments are in accordance with the laws of the Republic of Palau, and will not be detrimental to the survival of the species in the wild, and, if living, will be transported in a manner which will minimize the risk of injury, damage to health, or cruel treatment. Traditionally Tridacnidae clams are consumed locally. Our current practice to sustain the population is explained above that 10% of the produced clams are farmed in the 23 conservation areas and these areas are prohibited entry.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

The criteria or indicators is not applicable to us as the all Tridacnidae clam exports are cultured and to evaluate criteria and indicators as opposed to the sustainability of stocks in nature is somewhat perplexed and not clear.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

5.-6. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF AND RECOMMENDATIONS

Although the IUCN NDFs has never been applied however its applicability to our practice based on our laws is somewhat problematic and not very clear and this NDFs should be discussed further in the workshop to understand its conduciveness to our current practice.

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NDF WORKSHOP
WG 9 – Aquatic Invertebrates
CASE STUDY 2SUMMARY
Tridacnidae
Country – **Palau**
Original language – English

PALAU CASE STUDY - *TRIDACNIDAE*

AUTHOR:
Theo Isamu

Seven species of giant clams occur in the Republic of Palau. These are: *Tridacna crocea* (lower risk – least concern); *T. derasa* (vulnerable); *T. gigas* (vulnerable); *T. maxima* (lower risk - conservation dependent); *T. squamosa* (lower risk - conservation dependent); *Hippopus hippopus* (lower risk - conservation dependent); and *H. porcellanus* (lower risk - conservation dependent).

The meat of all species is used on Palau for food and may also be sold locally to hotels and restaurants; the shells are used for arts and crafts. There are no management measures in place (such as close seasons or catch limits) to regulate harvests outside conservation areas, even though this is the principal threat to the species, and there is no formal management plan. However, there are 23 designated conservation areas within which harvesting of clams is prohibited. Palau's approach to ensuring that international trade takes place without detriment to wild populations, and to enhance sustainability of domestic consumption, has been through the development and implementation of an aquaculture programme. Palau began a clam hatchery operation in 1985 focusing initially on *T. derasa*, subsequently expanding to include *T. maxima*, *T. crocea* and *H. hippopus*. Broodstock clams are collected from the wild, stimulated to spawn in land-based tanks and then returned to designated areas in the sea for monitoring and future re-use as spawners. Once clams have settled in the land-based tanks, these are reared for c.3 months (2.5cm size) when they are returned to the sea to be raised in protective cages. Since 2005, young clams have been disseminated to the community where 40 clam farms have been established; the aim of the programme being to reduce pressures on wild populations and to enhance food security and enhance living standards. Over 2 million clams have been disseminated in this way at no charge to recipients, however, it is a condition that 10% of donated clams are set-aside to spawn naturally to re-stock local areas. Clams have been produced in this way to F2 generation. Monitoring of clam farms and their stock inventories is undertaken regularly.

Palau seeks to achieve non-detriment by restricting exports to F2 clams produced by the aquaculture techniques described above, which also support wild populations by reducing harvesting pressure and by providing a source of animals for re-stocking. The IUCN approach to non-detriment findings has not been used and its application is not clear; the approach to non-detriment findings relevant to Palau's current practice requires further elaboration in the workshop.

THE GIANT CLAM PROJECT

AQUACULTURE/MARICULTURE BRANCH "PMDC"

Bureau of Marine Resources

PRESIDENT POLICY and OBJECTIVE of the GIANT CLAM PROJECT

Because of the diminishing natural stocks of giant clams, the President of the Republic of Palau, Tommy E. Remengesau Jr. stated in his Presidential Address of year 2001 that in year 2008, a total of 2 million giant clams must be planted in the waters around Palau.

The objective of this project is to expand the communities ocean based clam nurseries to :

- **establish a giant clam breeding stock to enhance natural stocks of giant clams in nearby reefs utilized in communities subsistence fishery;**
- **initiate a small cottage income generating industry for communities based on clam meat, shells and live clams;**
- **and promote management of fishery stocks through conservation.**

The project will benefit all communities involved in terms of improved nutrition, improved fisheries, additional income, establishment of an on-going income generating industry, and giant clam stock conservation. In addition, neighboring communities, through natural spreading of giant clam larvae by ocean current, will benefit by the enhancement of the giant clam resources on their reefs.

GIANT CLAM CULTURE, CONSERVATION & FARMING MANAGEMENT WORKSHOP

PMDC & DED with assistance from MCPA-BMR conducted a 1-week workshop on Giant Clam Culture, Conservation and Ocean-Based Nursery Management.

The transfer of technology to state level insure maximum production yield and help expedite project activities to reach our expected goal.

GIANT CLAM FARMS & MANAGEMENT

Number of established giant clam farms to date are 29 located in 12 States namely Kayangel, Ngarchelong, Ngaraard, Ngardmau, Ngatpang, Melekeok, Ngiwal, Ngchesar, Aimeliik, Koror, Peleliu and Helen Reef-Hatohobei.

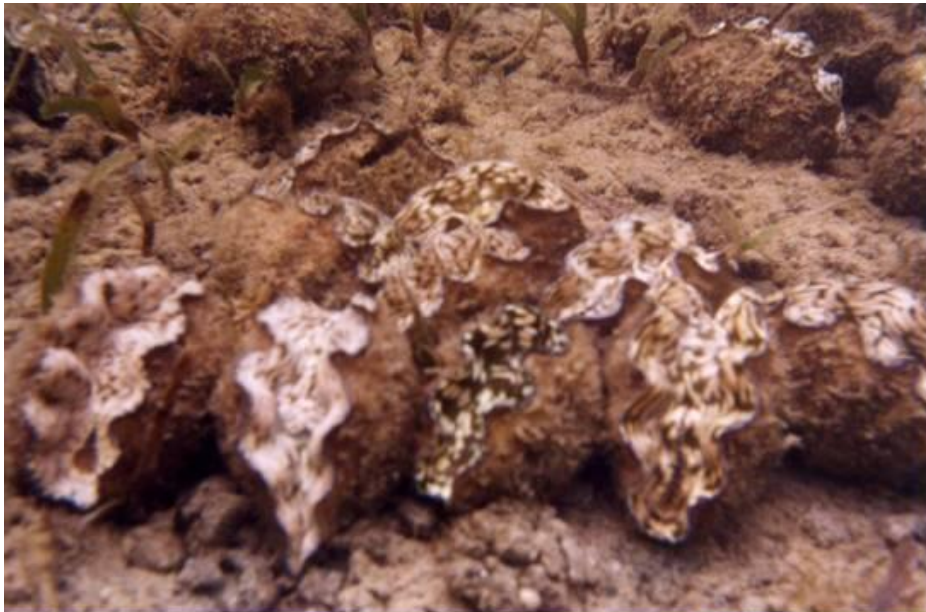
As of July 2005, these farms have been stocked with 1,003,373 seeds ranging from 2cm to 5cm (1-2.5 inches). Arrangements are made through the States offices and Aquaculture/Mariculture Branch (PMDC) of Bureau of Marine Resources of the National Government, in which States government make formal request for Aquaculture/Mariculture Branch (PMDC) to establish the farms.

To date, the State's government and/or private owners, PMDC-BMR and other assisting agency (Commerce & Trade) bore the cost of materials. PMDC-BMR provides expertise and monitor/surveys on conditions and survival for statistical purpose and free seeds/animals. Security monitoring is conducted by the states/owners.

GIANT CLAM FARMS & MANAGEMENT TABLE

ID	STATE	FARMER	% SURVIVAL	# SURVIVAL	AVE SIZE	RANGE SIZE	DATES	COMMENTS
1	NGIWAL	TITUS INACIO	89%	12,282.00	16 cm or 6.2"	14.5 - 20.2 cm	4/13-21/05	
2	NGIWAL	RUSSEL MASAYOS	92%	19,872.00	8 cm or 2.3"	4.6 - 7.0 cm	"	
3	MELEKEOK	REMERIANG TELL	88%	39,600.00	14 cm or 5.6"	10.4 - 15.9 cm	"	
4	MELEKOK	EDLEE & BERNICE	100% mortality				"	POOR MANAGEMENT
5	NGCHESAR	STATE	53%	23,850.00	18 cm or 6.7"	14.3 - 19.9 cm	"	POOR MANAGEMENT
6	KOROR	HARVEY SISIOR	97%	15,714.00	10 cm or 3.13"	6.8 - 11.3 cm	"	GOOD MANAGEMENT
7	KOROR	TIULL	92%	16,617.00	12 cm or 4.11"	7.5 - 15.2 cm	"	
8	KOROR	NGERKEBESANG	98%	1,012.00	18 cm or 6.14"	13.2 - 21.0 cm	"	
9	KOROR	NGEBEKUU	92%	29,061.00	15 cm or 5.15"	11.4 - 19.0 cm	"	
10	KOROR	BOBBY SUKRAD	50%	25,100.00	8 cm or 2.15"	5.3 - 9.2 cm	"	POOR MANAGEMENT
11	KOROR	CENTRAL NURSERY(DED)	3%	2,264.00	12 cm or 4.7"	7.4 - 15.6 cm	"	POOR MANAGEMENT
12	NGARAARD	KUABES (ALBERT SHIRO)	51%	36,720.00	17.0 cm	14.5 - 19.4 cm	"	POOR MANAGEMENT
13	NGARAARD	WILEIN BOLWAISEI	98%	18,553.00	10.3 cm	2.01 - 18.6 cm	"	
14	NGARDMAU	ALSON NGIRAIWET	100% mortality				"	POOR MANAGEMENT
15	NGARDMAU	ROADRUNNER (CYRUS)	56%	26,040.00	15 cm	13.3 - 16.0 cm	"	POOR MANAGEMENT
16	NGARCHELONG	COOP	3%	2,284.00	15.1 cm	11.0 - 17.0 cm	"	POOR MANAGEMENT
17	NGARCHELONG	BAUDISTA SATO	92%	24,472.00	8.6 cm	6.0 - 10.1 cm	"	
18	NGARCHELONG	SIOBERT SKANG	100% mortality				"	DESTROYED BY STRONG WAVE ACTION
19	NGARCHELONG	JORDAN	100% mortality				"	DESTROYED BY STRONG WAVE ACTION
20	NGARCHELONG	NGIRCHONGUIKL RULUKED SEKOUL	100% mortality				"	DESTROYED BY STRONG WAVE ACTION
21	AIMELIIK	MCVEY & BERNICE	56%	27,496.00	7.0 cm	4.6 - 10.7 cm	"	POOR MANAGEMENT
22	NGATPANG	NGIRAKESOL MAIDESIL	46%	44,482.00	16.0 cm	12.0 - 18.7 cm	"	POOR MANAGEMENT
23	NGATPANG	HIROMI NABEYAMA	44%	20,108.00	10.0 cm	7.2 - 12.3 cm	"	POOR MANAGEMENT
24	KAYANGEL	STATE		129.00			5-12-05	MONITORED BY BANDARII *
25	KAYANGEL	THOMAS OBAK		69.00			"	TRANSFERRED BY STATE
26	KAYANGEL	JOHNSON BANDARII		58.00			"	TRANSFERRED BY STATE
27	KAYANGEL	STEVENSON M.		62.00			"	"
28	KAYANGEL	INAO S.		60.00			"	"
29	KAYANGEL	REMOKET M.		29.00			"	"
30	KAYANGEL	OBEKETANG R.		90.00			"	"
31	KAYANGEL	ALFRED R.		33.00			"	"

GIANT CLAM FARMS MONITORING ON GROWTH AND SURVIVAL MANAGEMENT



NGARCHELONG COOP

PLANTED –FEB. 13, 2002
SPECIES: KISM =76,150

MONITORED – APR. 2005

SURVIVAL RATE = 3% / 2,284

AVERAGE SIZE =15.1 CM or 6.4 IN

NGARCHELONG –BAUDISTA SATO

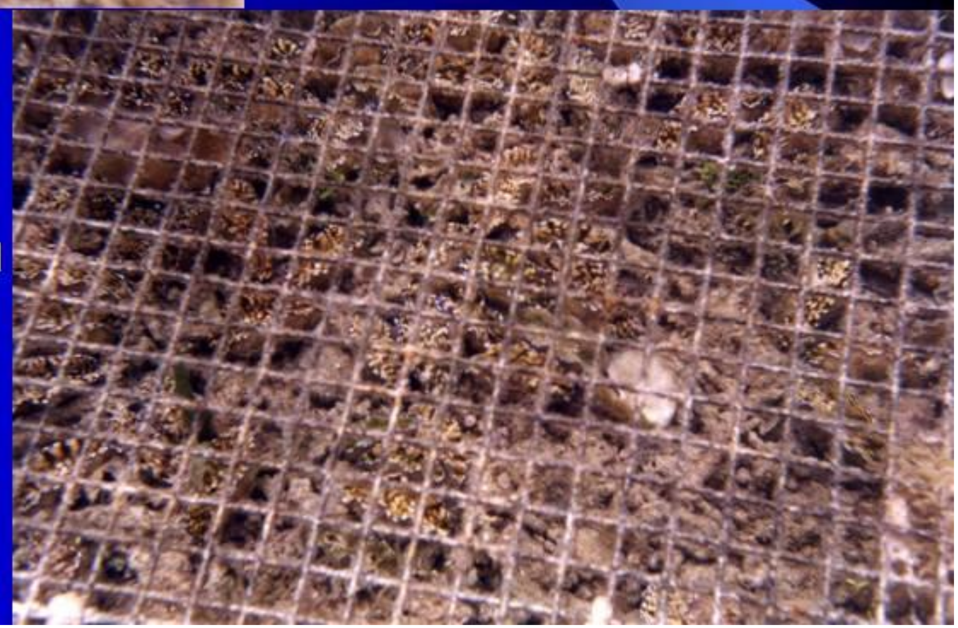
PLANTED – SEPT. 30, 2004

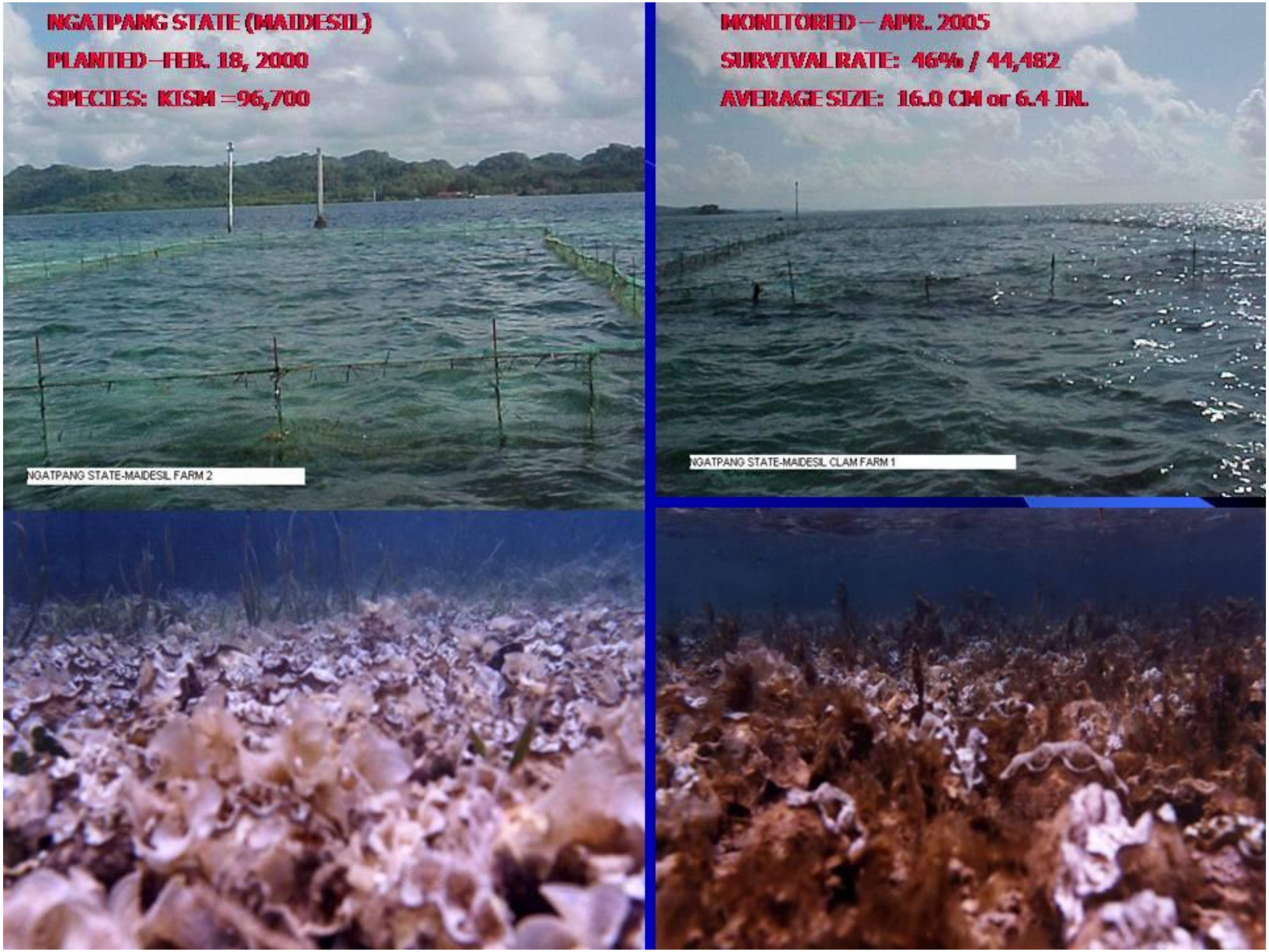
SPECIES: KISM =26,600

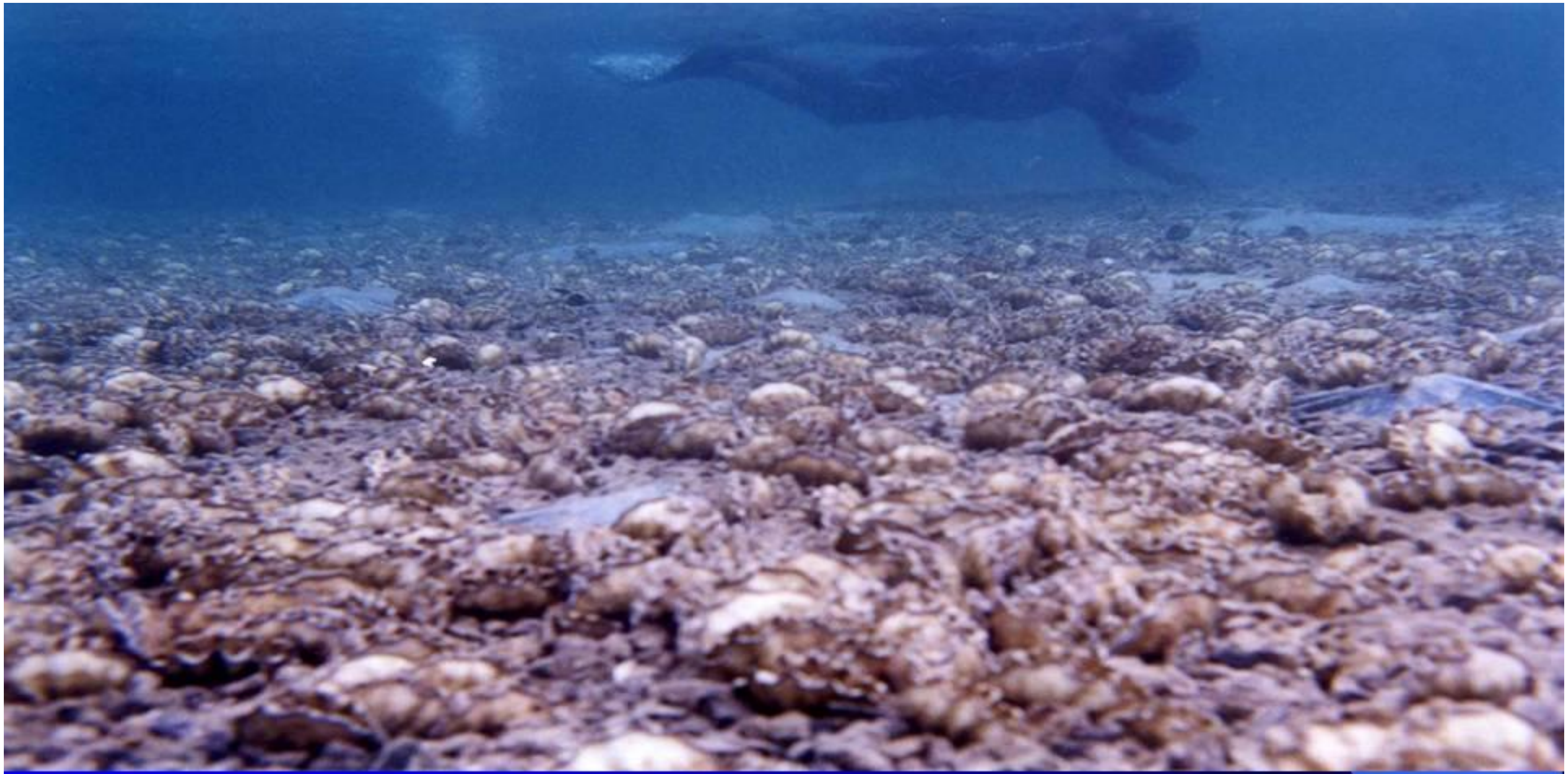
MONITORED – APR. 2005

SURVIVAL RATE = 92% / 24,472

AVERAGE SIZE =8.6 CM or 3.44 IN.




NGATPANG STATE (MAIDESIL)
PLANTED –FEB. 18, 2000
SPECIES: KISM =96,700
NGATPANG STATE-MAIDESIL FARM 2
MONITORED – APR. 2005
SURVIVAL RATE: 46% / 44,482
AVERAGE SIZE: 16.0 CM or 6.4 IN.
NGATPANG STATE-MAIDESIL CLAM FARM 1



NGATPANG STATE –RUBEANG HIROMI NABEYAMA

PLANTED DATE: JAN. 29, 2003

SPECIES: KISM =45,700

MONITORED ON APRIL 2005

SURVIVAL RATE: 44% =20,108 ANIMALS

AVERAGE SIZE: 10 cm or 4 in

NGIWAL STATE

PLANTED: AUG. 27, 2002

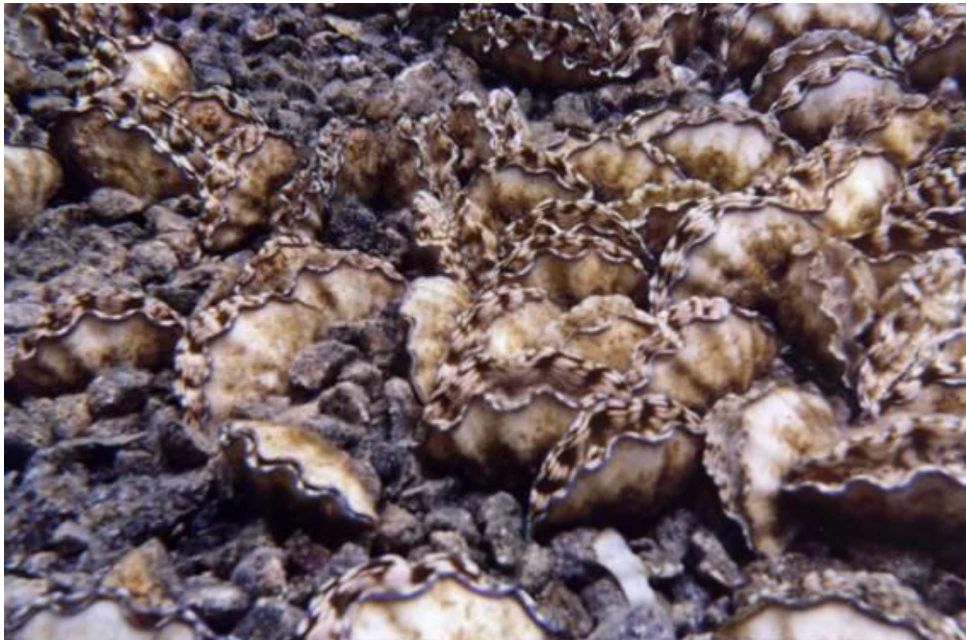
SPECIES: KISM =13,800

MONITORED ON APRIL 2005

SURVIVAL RATE: 89% / 12,282 ANIMALS

AVERAGE SIZE: 16 cm or 6.4 in

NOTE: Farm was divided and assigned to three locals for the better management. Transferred by Governor Elmis Mesubed in year 2005.



NGIWAL STATE –RUSSEL MASAYOS

PLANTED: DEC. 03, 2004

SPECIES: KISM =42,000

MONITORED ON APRIL 2005

SURVIVAL RATE: 92% =19,872

AVERAGE SIZE: 8 cm or 3.2 in

MELEKEOK STATE –REMERIANG TELL

PLANTED: OCT. 19, 2003

SPECIES: KISM =45,000

MONITORED ON APRIL 2005

SURVIVAL RATE: 88% / 39,600

AVERAGE SIZE: 14 cm or 5.6 in

NGCHESAR STATE

PLANTED: AUG. 21, 2002

SPECIES: KISM =45,400

MONITORED ON APRIL 2005

SURVIVAL RATE: 53%
27,240 # OF ANIMALS

AVERAGE SIZE RANGE:

18 cm or 7.2 in

NGARAARD STATE –KUABES CLAM FARM
(ALBERT SHIRO)

PLANTED: MAY 2002

SPECIES: KISM =72,000

MONITORED ON APRIL 2005

SURVIVAL RATE: 51% =36,720 ANIMALS

AVERAGE SIZE : 17 cm or 6.8 in

MATERIALS NEEDED

Qty	Item	Unit Price	Cost
30 pcs.	1" Rebar	10.00	300.00
30 pcs.	¼" Rebar	4.00	120.00
3 rolls	100' Plastic screen	99.00	297
4 pcs	Tarp or canvas 24'x34'	59.95	239.00
1	Boat-Yamaha 25' w/twin engine		
36 gal	Gasoline($3/gal.) TRIP 4 TRIPS	108.00	432.00
4 qts	Oil per trip 4 trips @$12	48	192.00
50,000	Clam Seeds 3-5 cm @$4	4X ($200,000.00)	0
5	Personell @$3.25/hr	$16.25*8hrs.=$130/day *4 (trips)	520.00
NOTE* From survey to construction to planting			
TOTAL COST OF ONE FARM $202,101.00			$2,101.00


•SPAWNERS COLLECTION
•SPAWNERS CONDITION
•SPAWNING

- EGG COUNTING

- LARVAL REARING

- HARVEST

•PLANTING

HATCHERY SEEDPRODUCTION CHART

Sum PRODUCED	SPECIES						
YEAR	H.hippopus	T. crocea	T. derasa	T. gigas	T. maxima	T. squamosa	Grand Total
2001	134023		99066				233089
2002			722186				722186
2003			902796	24013			926809
2004		36012	1076444		48317	107149	1267922
Grand Total	134023	36012	2800492	24013	48317	107149	3150006

PMDC ANNUAL REVENUE IN YEAR 00, 01, 02, 03 & UP TO JULY '04					
YEAR	VISITORS	SHELLS	LIVE	MEAT	TOTAL
2000	$5,636.00	$4,300.15	$9,400.00	$1,059.00	$20,395.1
2001	$4,806.00	$3,027.25	$7,338.00	$4,448.75	$19,620.0
2002	$1,648.00	$2,361.00	$5,610.00	$3,335.00	$12,954.0
2003	$991.00	$1,919.00	$2,928.00	$985.50	$6,823.5
2004	$984.00	$1,969.00	$22,291.25	$2,063.50	$27,307.7
TOTAL	$14,065.00	$13,576.40	$47,567.25	$11,891.75	$87,100.4

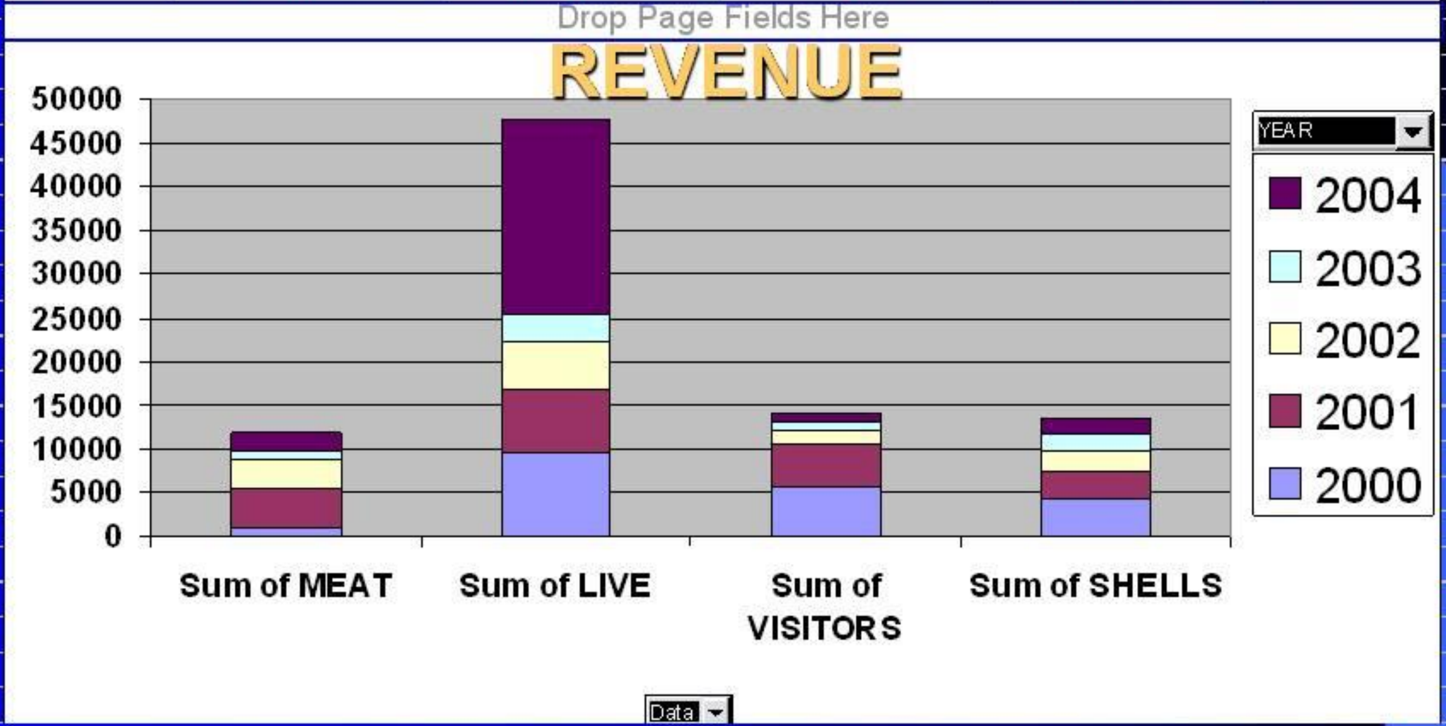


CHART-SUM OF SEEDS

Aimeliik State	49100
Hatohobei State	19500
Kayangel State	10560
Koror State	210313
Melekeok State	55600
Ngaraard State	117550
Ngarchelong State	201550
Ngardmau State	69500
Ngatpang State	157400
Ngchesar State	45400
Ngiwal State	55800
Peleliu State	17100
Grand Total	1009373

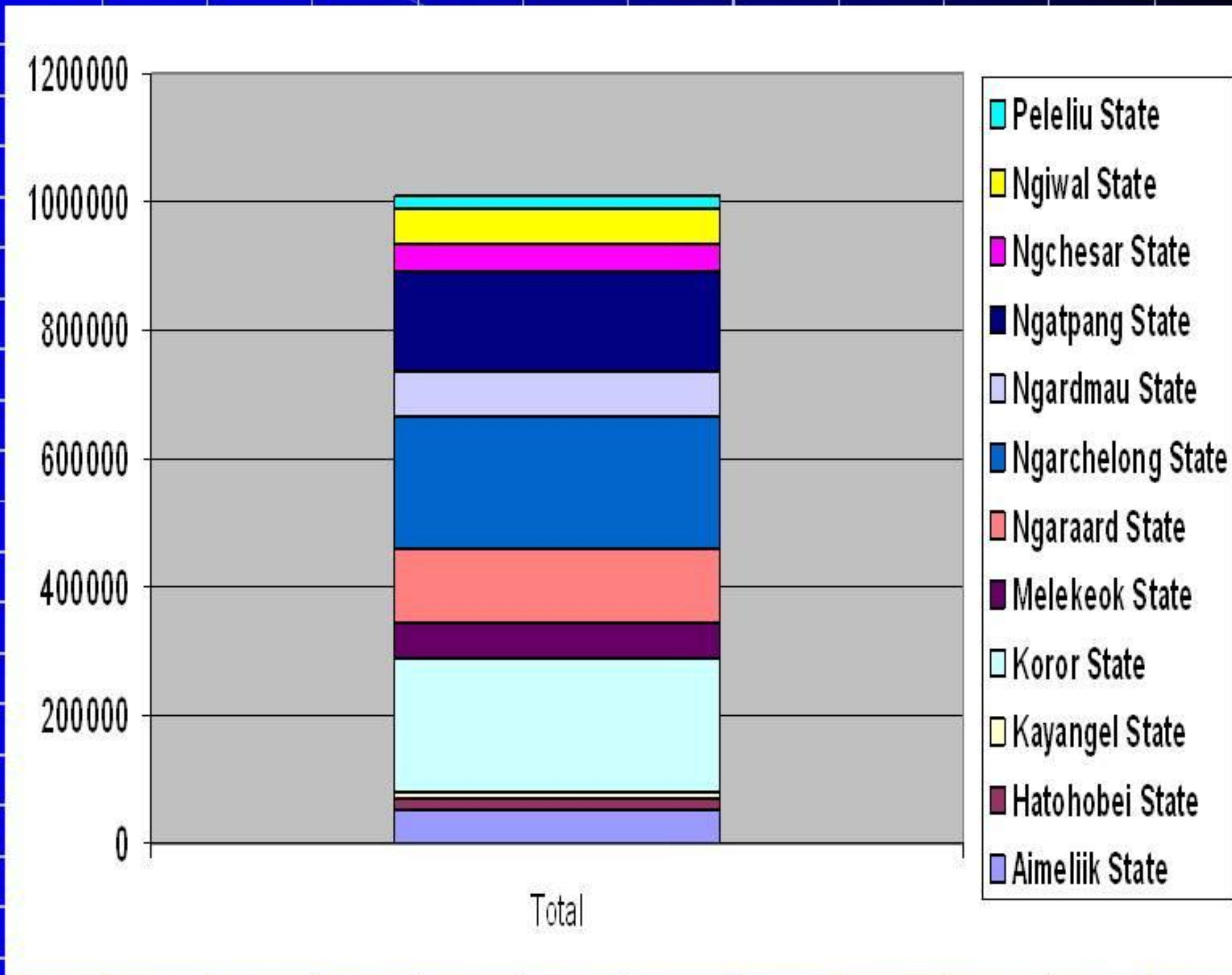
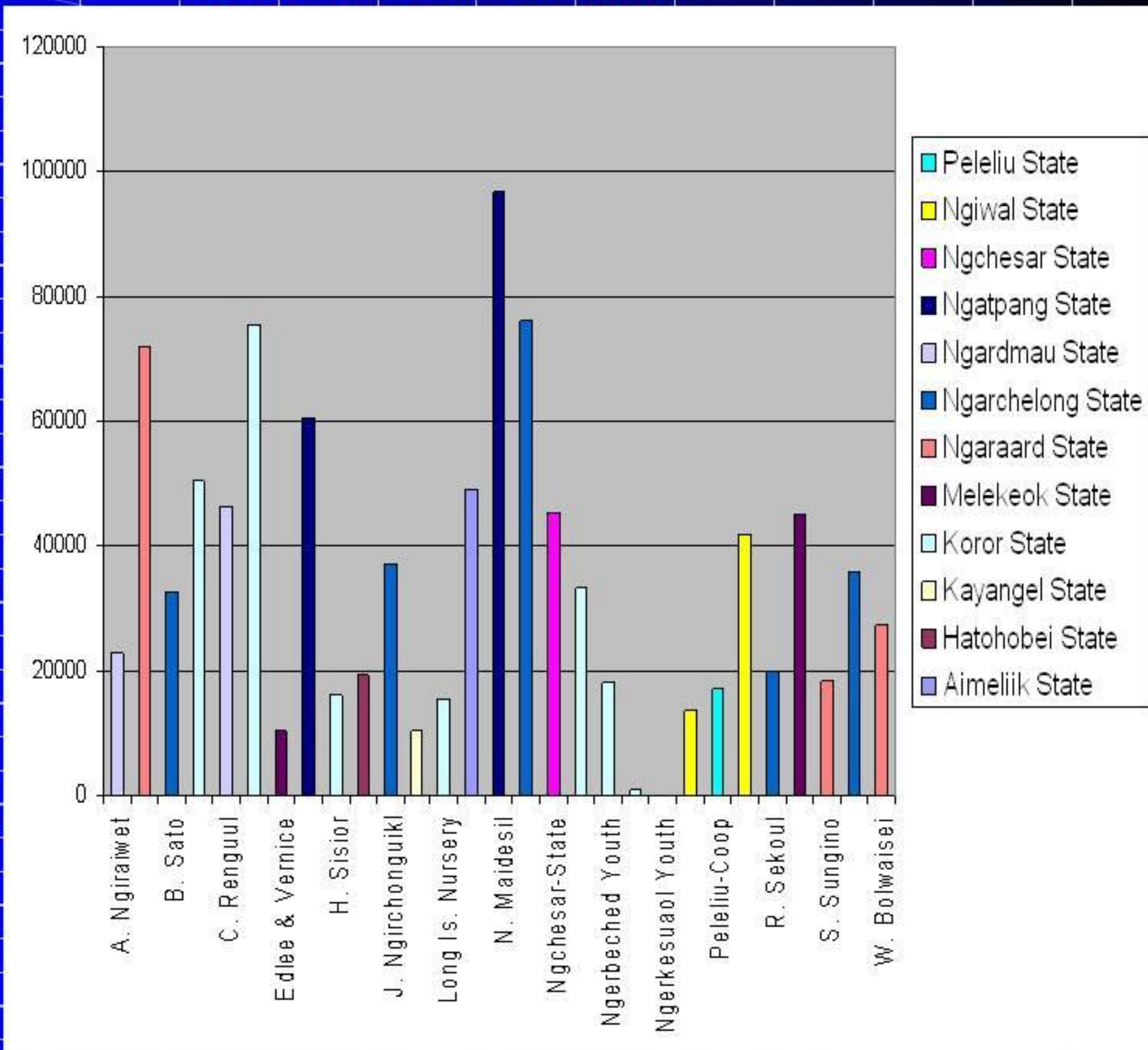
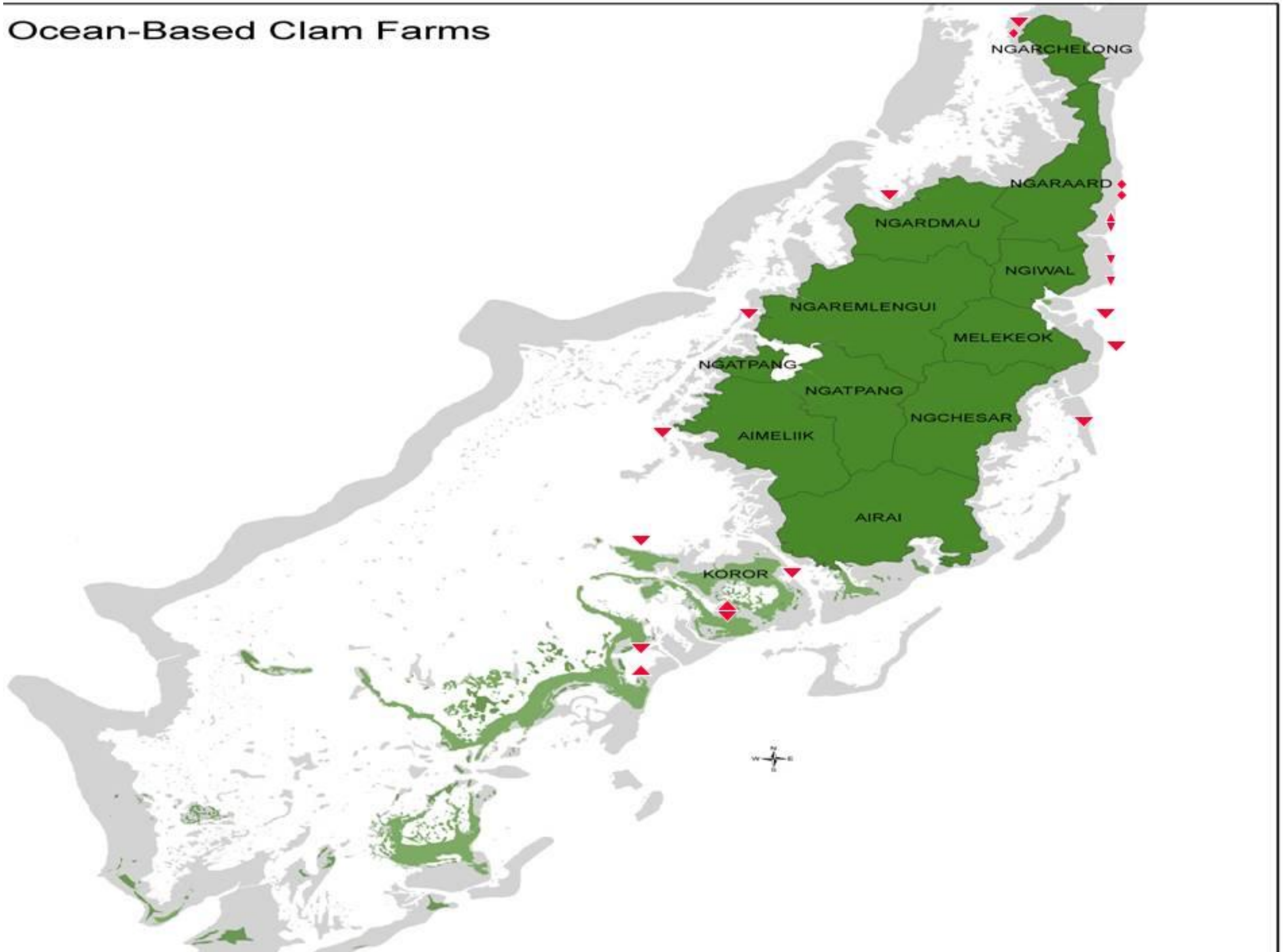


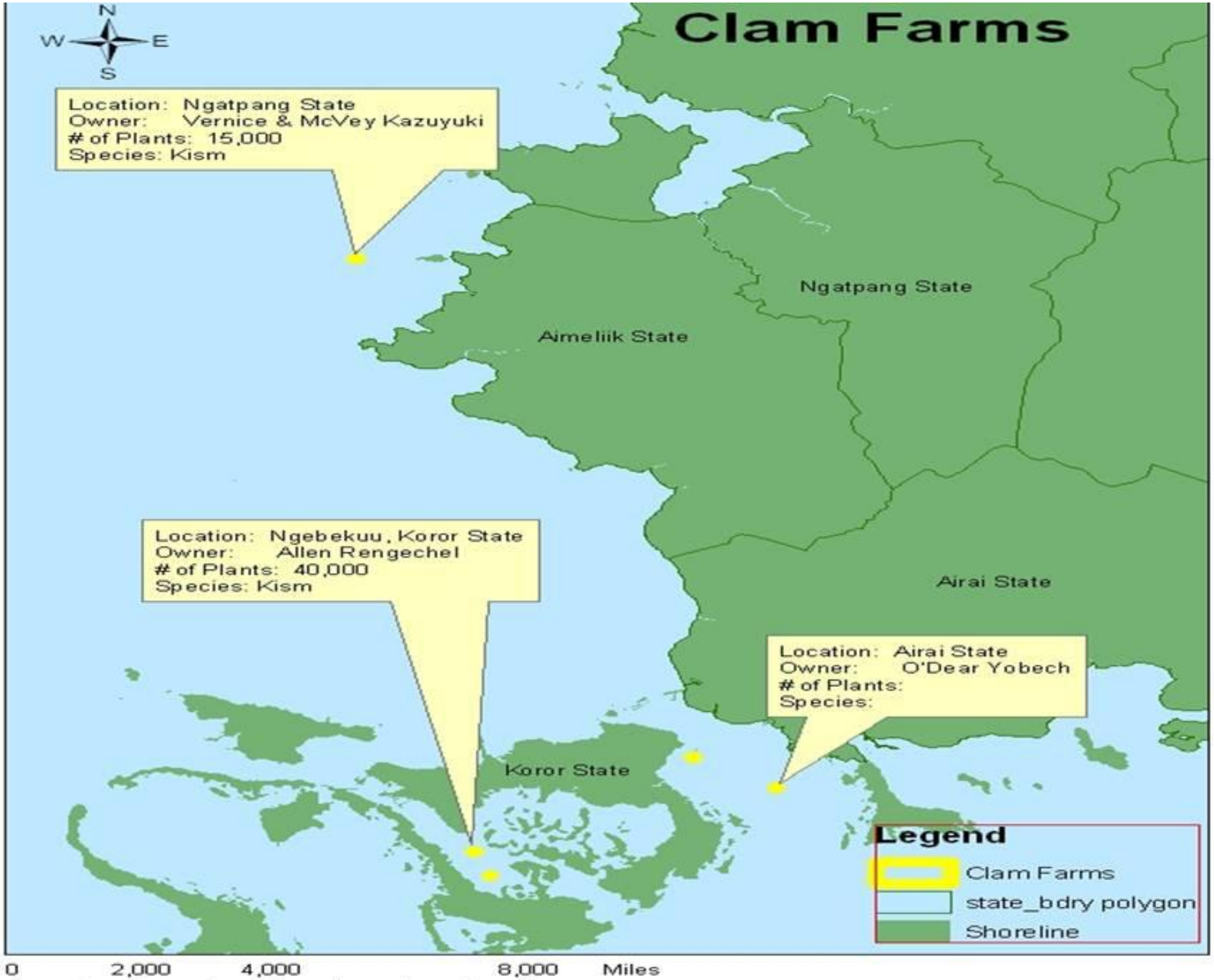
CHART-FARMERS & SEEDS

A. Ngiraiwet	23000
A. Shiro	72000
B. Sato	32600
B. Sukrad	50500
C. Renguul	46500
Central Nursery	75479
Edlee & Vernice	10600
H. Nabeyama	60700
H. Sisior	16200
Hellen Reef	19500
J. Ngirchonguikl	37000
Kayangel-Coop	10560
Long Is. Nursery	15700
Mcbay & Vernice	49100
N. Maidesil	96700
Ngarchelong-Coop	76150
Ngchesar-State	45400
Ngebekuu Farm	33339
Ngerbeched Youth	18062
Ngerkebesang Youth	1033
Ngerkesuaol Youth	0
Ngiwal-State	13800
Peleliu-Coop	17100
R. Masayos	42000
R. Sekoul	20000
R. Tell	45000
S. Sungino	18300
SFCF (Siobert)	35800
W. Bolwaisei	27250
Grand Total	1009373



Ocean-Based Clam Farms




Clam Farms
N
W
E
S
Location: Ngatpang State
Owner: Vernice & McVey Kazuyuki
# of Plants: 15,000
Species: Kism
Ngatpang State
Aimeliik State
Location: Ngebekuu, Koror State
Owner: Allen Rengechel
# of Plants: 40,000
Species: Kism
Airai State
Location: Airai State
Owner: O'Dear Yobech
# of Plants:
Species:
Koror State
Legend
Clam Farms
state_bdry polygon
Shoreline
0
2,000
4,000
8,000
Miles

CONSTRAINT

- Not enough funding
- Short staff
- Facility is not adequate to accommodate 2-3 million seeds per year
- Marketing of clam products is becoming a big problem

    -written agreement between stakeholders

    -BMR appropriate monitoring personnel (require size for local market or aquarium export, revoking of agreement and penalty)

    -National Government and local State Government support and financial assistance to cultured clam farmers.

RECOMMENDATION

- The need for PMDC to continue with ocean-based nursery and expand the program to all 16 states of the Republic of Palau depends entirely on sufficient financial support.
- It is envisioned that with enough funding, this program will create an industry that can support local communities and to protect our resources and sustain the natural marine environment for generations to come.

ANNEX 1. The Honduras conch research and management program in support of the CITES requirements for species in Appendix II

By

Nelson M. Ehrhardt
Scientist in Charge of the Conch Research Project in Honduras

The overall frame of the conch research and management program in Honduras is in response to the CITES terms of reference concerning conservation and sustainable use of species in Appendix II. Therefore, CITES aim and concept to ensure that international trade in specimens of wild animals and plants does not threaten their survival has been introduced as a protocol in the conch, *Strombus gigas*, research and management program in Honduras.

The CITES Scientific Authority in Honduras has been challenged to determine whether a particular conch export will be detrimental to the survival of the species and to define which information and parameters are relevant to determine this. The conch is the largest of the commercial marine gastropods exhibiting a complex and highly sophisticated but at the same time plastic population dynamics. This is due to a distinct geographic identity of the species, which frames growth, reproduction and recruitment according to local habitat and environmental conditions. The CITES has used the criteria of population density levels and export quantities to judge for the status of exploitation and conservation of the species in the different countries in the Caribbean region. However, it is not clear if the effects of landings are detrimental to the sustainability of the conch populations under this population density paradigm. In other words, density may or may not be related to population abundance.

Furthermore, conch cannot be aged and shell siphonal length stops at the attainment of maturity. At this time conch shells start to thicken and a wide lip is developed. That is, the direction of growth changes at the onset of maturity. The previous condition mars the possibility of estimating fishing mortality and abundance from traditional fisheries methodologies based on the age or size structure of the landings. The internal reproductive system of the conch also prevents the use of fishing mortality bench marks traditionally used in fisheries to frame the status of exploitation of fish stocks. Copulation success in *S. gigas* is related to population density levels and no fishing mortality reference points are known for this management framework. That is, it is not known what level of fishing mortality generates what level of population density that can secure reproductive success. The basic criteria for conch stock assessment methodologies and management are the first step in the efforts of Honduras to properly and responsively answer to the CITES requirements in order to formulate Non-Detriment Findings.

In 2005 the CITES authorized the Government of Honduras the use of a 210 metric ton scientific quota with the purpose of developing appropriate protocols to assess annual population densities and abundance in each of the 13 fishing banks previously reported by Honduras to the CITES as the prime localities where the species has been exploited. A systematic random sampling design with 40 replicated samples per sampling sites was adopted in each fishing ground (Figure 1). The fishing grounds were identified by knowledgeable fishers that contributed their experience and knowledge on the seasonal distribution of the conch on the Honduras Continental Shelf. The statistical sampling design is effective to map the conch resources and it generates unbiased estimates of population density as well as abundance. Given the large area of the conch distribution on the Shelf, a total of 4 vessels with 40 divers each are used in the experimental sampling. Sampling stations are set 3 nautical miles equidistant from each other. Each vessel covers 3 stations per day and each fishing bank is explored in its entirety in about 6 to 9 days. These operations are repeated every year in each season such that an entire biological cycle is attained in the database. The option to use commercial conch divers is an important consideration given their ability to detect and count conchs under extreme diving conditions. Biological samples are collected in two forms: 1) clean meat samples from which a meat weight frequency distribution is generated (Figure 2 upper panel), and 3) whole animals including the conch shell that are used to obtain morphometric data as well as data on sex, maturity and size. Protocols have been developed to statistically reconstruct the population characteristics from the samples thus generated.

So far complete assessments of the conch fishing grounds have been accomplished. An example of the density results is provided in figure 3. The population densities estimated by the experimental sampling design are well above the average reported to the CITES by all countries exporting conch in the Caribbean. Furthermore, the minimum population density of 56 individuals per hectare adopted by the CITES as the limit for acceptable exploitation is well below most densities estimated for the Honduran conch banks.

Also, Honduras is in a unique position to generate annual estimates of fishing mortality – a parameter that is rarely estimated for conch fisheries. This was possible through the development of the appropriate database and models pertinent to the species and fisheries. These estimates are presented in figure 2 (Bottom panel) for the three main fishing grounds in Honduras. These mortalities compare well with the levels of natural mortality also estimated for the species in Honduras, which resulted in 0.72 per year.

Carrying out these explorations over wide areas of the Continental Shelf requires a large number of participants as well as equipment all of which is translated in funding needs that the Government of Honduras arranged as shared investment with the stakeholders. Only through such arrangement this research work has been possible.

The project has a finite time span of four years and then it is expected that monitoring surveys will replace the ongoing massive population surveys. Those monitoring surveys in conjunction with appropriate statistics from the fisheries will be used to elucidate the status of exploitation of the conch stocks in each fishing ground. These stock assessment activities will always have to have the support and participation of the stakeholders if a successful species conservation program is desired. At this time there is a limited entry into the system

(4 vessels) based on the scientific quota assigned by the CITES; however, once the fishery is open to exports a limited entry system is being planned such that conch fishing capacities are regulated from the earliest stages after the reopening of this important fishery. With this in mind the Government of Honduras is hoping for maintaining a biologically sustainable conch resource while the fishery is economically viable. In sum, the Government of Honduras is fully aware that the conch, *Strombus gigas*, needs permanent stock assessment requirements as the only way to respond to the CITES requirement of reporting Non-Detriment Findings with the conch exports declared by the country.

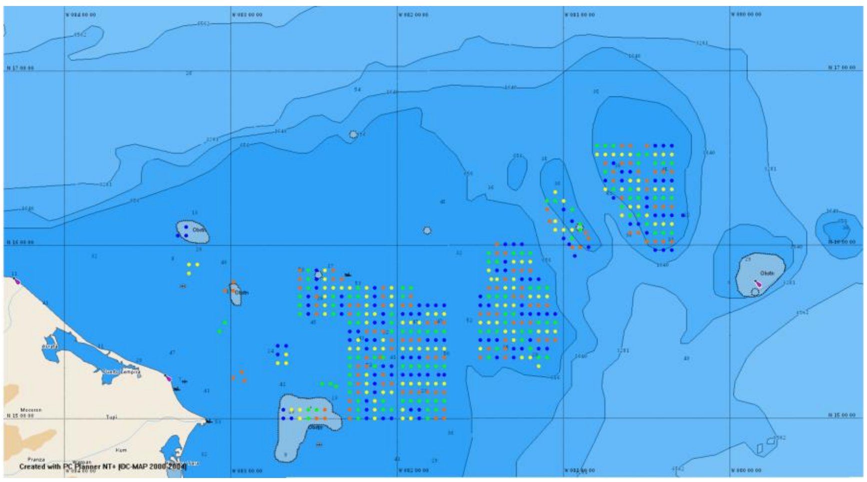


Figure 1. Distribution of the sampling stations thought the Continental Shelf where 13 conch fishing grounds are reported by Honduras to the CITES. Colors are indicative of stations allocated to the four vessels that implement the work at sea.

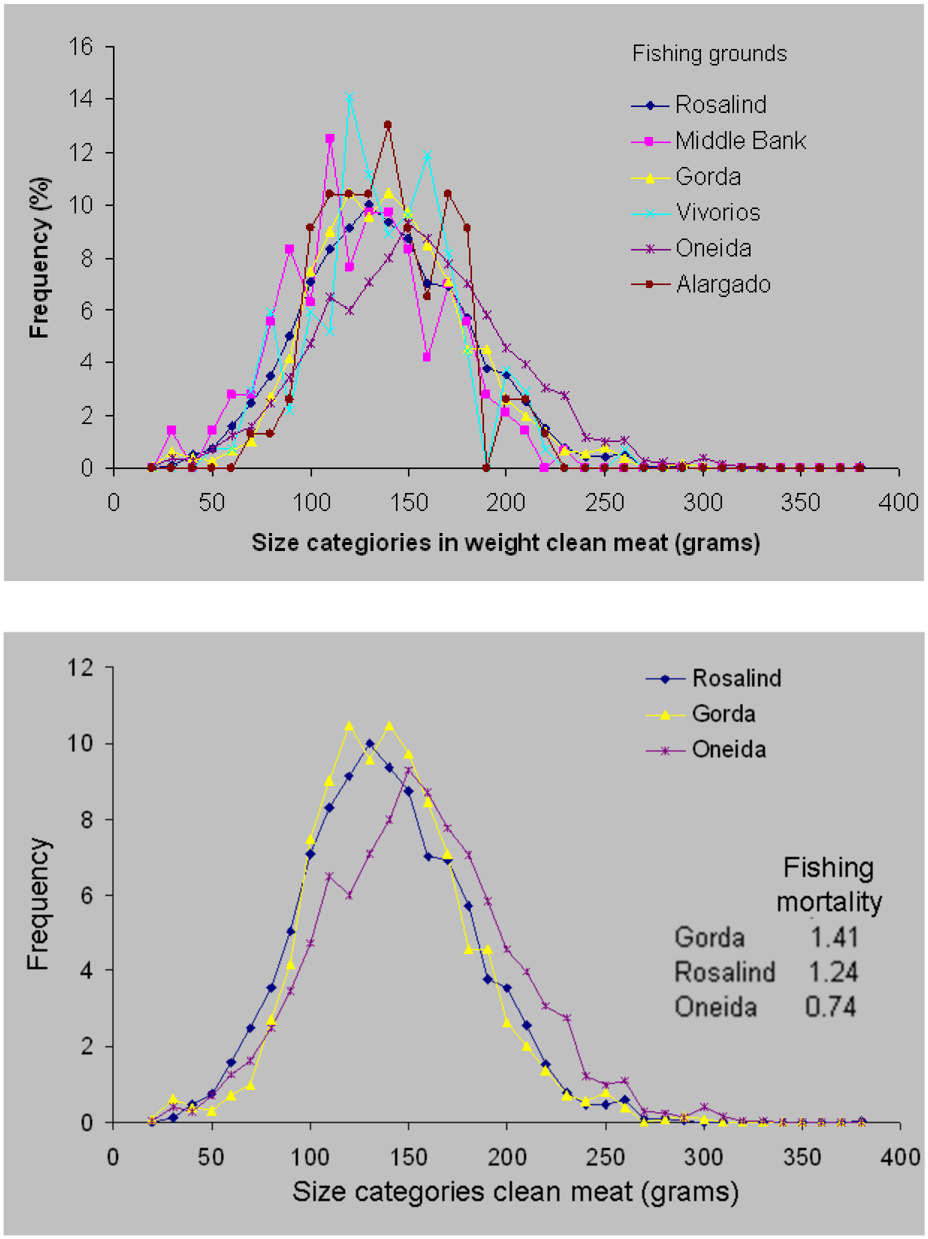


Figure 2. Upper panel. Conch size frequency distributions estimated for 6 of the largest fishing grounds in Honduras. Bottom panel. Size frequency distributions for 3 fishing grounds with estimates of fishing mortality rates.

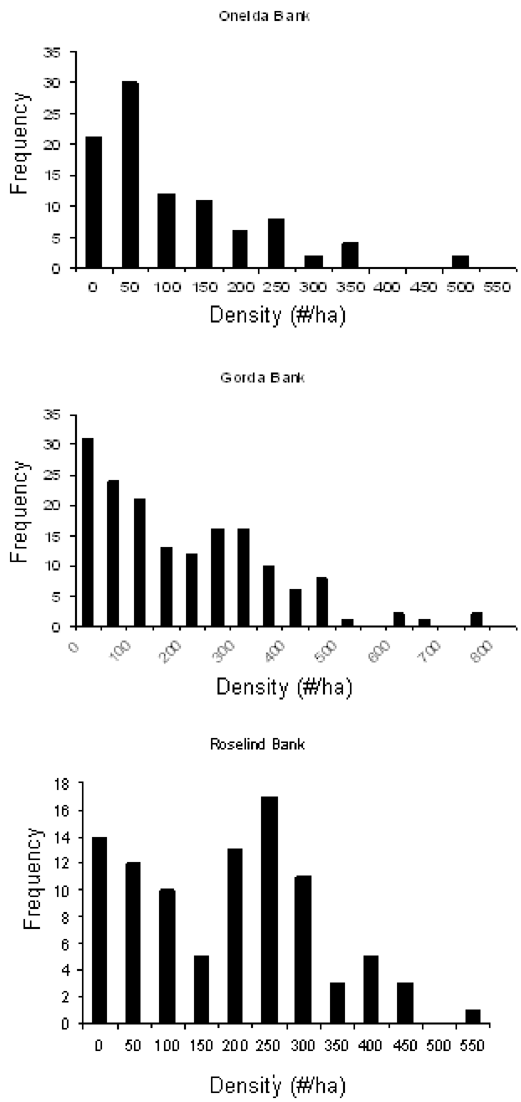


Figure 3. Frequency distribution of conch population densities in each of the three most important fishing grounds in Honduras.

NON-DETRIMENTAL FINDINGS FOR THE QUEEN CONCH (*STROMBUS GIGAS*) IN COLOMBIA

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I. Background information on the taxa

The queen conch (*Strombus gigas*) has been a highly prized species since pre-Columbian times, dating the period of the Arawak and Carib Indians. Early human civilizations utilized the shell as a horn for religious ceremonies, for trade and ornamentation such as bracelets, hairpins, and necklaces. Archeologists have also found remnants of conch shell pieces that were used as tools, possibly to hollow out large trees once used as canoes (Brownell and Stevely 1981).

The earliest record of commercial harvest and inter-island trade extend from the mid 18th century, when dried conch meat was shipped from the Turks and Caicos Islands to the neighboring island of Hispaniola (Ninnes 1984).

In Colombia, queen conch constitutes one of the most important Caribbean fisheries, it is second in value, after the spiny lobster. The oceanic archipelago of San Andrés, Providence and Santa Catalina produces more than 95% country's total production of this species. This fishery began in the 1970´s when the continental-shelf archipelagos of San Bernardo and Rosario, following full exploitation were quickly depleted due to a lack of effective management (Mora 1994).

The archipelago of San Andres, Old Providence, and Santa Catalina is located in the south-western Caribbean (11° 30′ to 16° 30′ N, and 78° 28′ to 82° 0′ W) extending over an area of 250,000 km^2. Related to the Lesser Antilles in historical and ethno-cultural terms, it has been an important and strategic Colombian territory since the 1800s and gained the status of Colombia's only oceanic department in 1991 (Article 309 of the National Constitution). The archipelago consists of three inhabited islands (San Andres, Providence and Santa Catalina), and six additional atolls in the north (Serranilla, New, Alice, Quitasueño, Serrana, Roncador), and two in the south (East-South-East and South-South-West).

The San Andres archipelago is the Colombia's northern frontier, bordering on Nicaragua, Honduras, Costa Rica, Panama, Jamaica and Dominican Republic, making a conch a transboundary species and demanding collaborative fisheries management in order to overcome current population declines. By means of bilateral treaties, Colombia shares its fish stocks with USA (Quitasueño, Serrana and Roncador), Honduras (Serranilla), and Jamaica (Serranilla, New and Alice); however few regional management measures are currently in place (Figure 1).

At present, Colombia's queen conch production is fourth in the south-western Caribbean after Pedro Bank in Jamaica, Rosalind Bank and other banks in Honduras, and around Miskitos and Perlas Keys in Nicaragua.

Experiencing a generalized decline in the wild population, the stability of this stock and traditional fishery is at risk. Several factors are responsible for the species´s critical situation: a) its preferences for sandy and shallow reef areas; b) its characteristic slow rate of movement (10 m/hour); c) the need to find mates for copulation, thus require some minimum densities for successful reproduction; d) high value markets values for its products; and e) the possible effects of global climate change for the species (at present not fully understood).

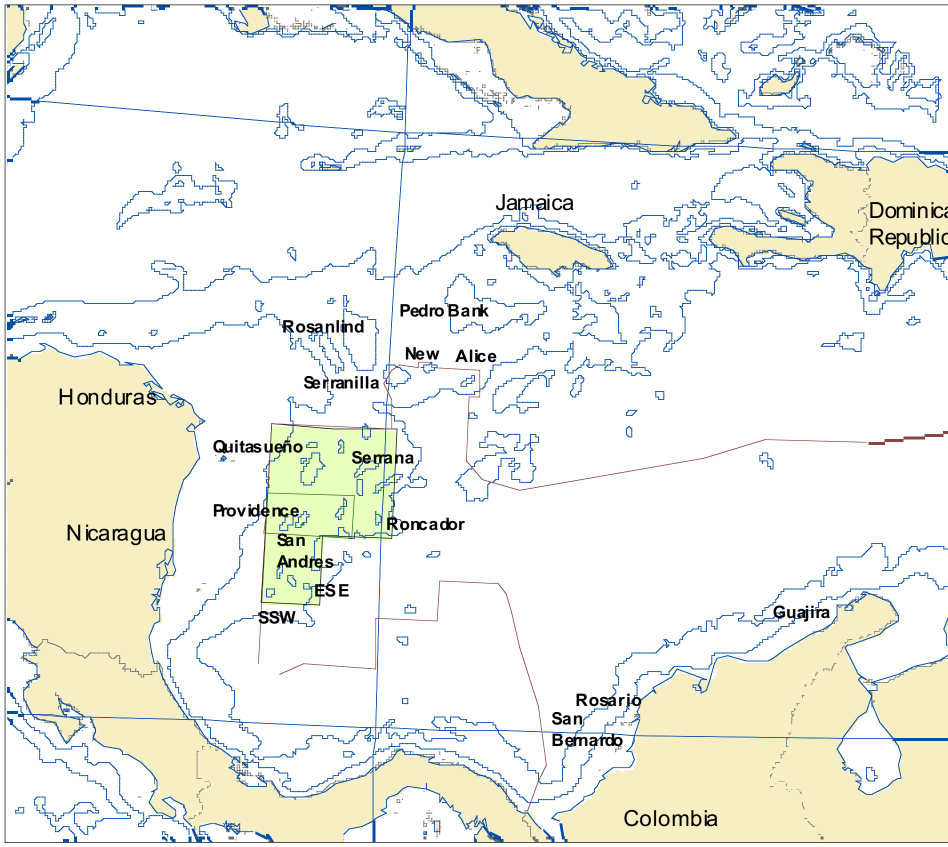


Figure 1. Location of Colombia's queen conch major fishing grounds with respect to neighboring south-western Caribbean. Brown lines denote Colombia's boundaries while green area shoes the Seaflower MPA within the San Andres archipelago.

As a consequence, queen conch was included in the CITES Appendix II in 1992. As a CITES signatory country, Colombia has made progressive improvements in queen conch fisheries management, but it has been also involved in illegal international trade. As a consequence, the queen conch fishery was closed between 2004 and 2007, and just recently re-opened, now following the principles of 1995 FAO code of conduct for responsible fisheries.

Considering the cultural relevance of queen conch and its high market value, there is strong potential for user conflicts, as well as strong incentives for poaching. This case study will describe the Colombia situation, with emphasis on the San Andres archipelago, and propose recommendations to strengthen national and international alliances needed to overcome major threats, in this manner updating information provided in the most recent Significant Review of queen conch trade conducted by CITES in 2003.

1. BIOLOGICAL DATA

1.1. Scientific and common names:

The queen conch, *Strombus gigas*, has a large lipped pink shell (25 cm or 9 inches SL), and has the highest commercial fisheries value of the six species within the western Atlantic Strombidae.

First described by Linnaeus in 1758, the species varies in common names throughout the Caribbean: caracol pala (Colombia), caracol rosa (Honduras, Nicaragua), caracol reina (Mexico), botuto o guarura (Venezuela), carrucho (Puerto Rico), cambombia (Panamá), cambute (Costa Rica), cobo (Cuba), lambi (Dominican Republic), queen or pink conch (in Caribbean English speaking countries), and lambie in the french speaking Caribbean.

FAO Species Identification Sheets separate this species from others in its family because of the large and moderately heavy shell, the outer large and thick lip with a U-shaped notch, the numerous short, sharp spires, the brown and horny operculum, and the bright pink shell with yellow borders.

1.2. Distribution

The species has been reported in Florida, Bermuda, the Bahamas, the Caribbean Islands and Gulf of Mexico, as well as the Caribbean shelves of the Central and South America (Figure 2). Seasonal migrations of adult conch have been reported in several locations. In the Bahamas, conch were observed migrating from the food rich rubble community to sand habitats for reproduction (Stoner and Sandt 1992). In the Turks and Caicos, adult conch moved from a seagrass dominated community to a sand-algal community associated with the onset of winter (Hesse 1979).

Recent scientific surveys in Quitasueño and Roncador banks, within the San Andres archipelago, identified the back-reef and the adjacent lagoon zones as juvenile nursery habitats. In addition, the deeper leeward pre-reef terrace was found to be a nursery habitat in SERRANA bank. The effects of major cuts through the forereef are believed to favor larval retention and deposition (Appeldoorn *et al*. 2003).

On the other hand, spawning areas were observed both on the north and south tips of the archipelago atolls, including the "*Acropora*" reefs in the Roncador´s lagoonal environment. Older adults were found in coral and sand-patch habitat as well as the deeper leeward reefs.

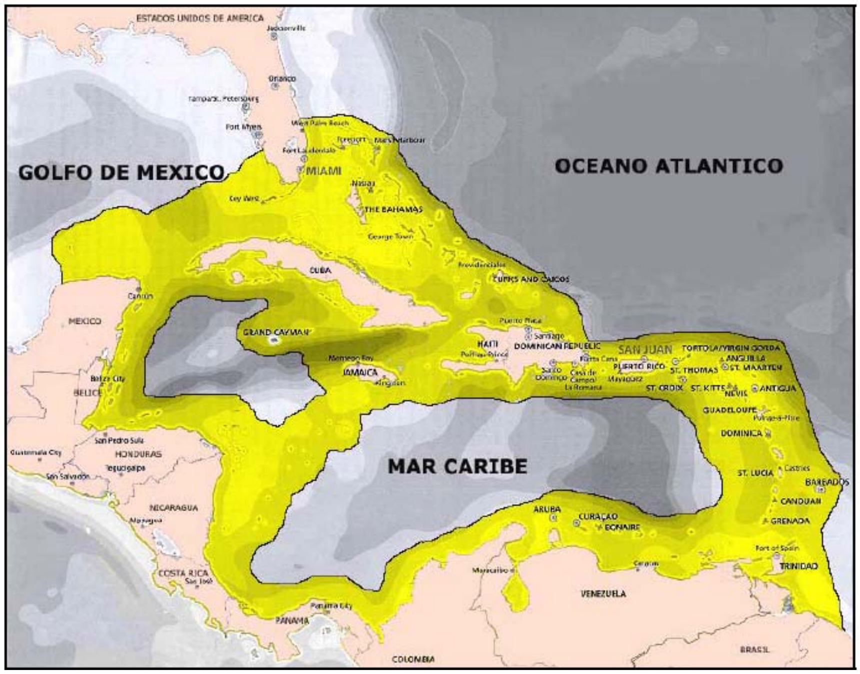


Figure 2. Queen conch distribution across the Caribbean Sea. Taken from Ávila (2004).

1.3. Biological characteristics

1.3.1 Biological and life history characteristics

Queen conch has separate sexes and internal fertilization; usually, they do not reach sexual maturity until their shell lip is fully developed at 3-4 years of age (Appeldoorn 1988). Queen conch exhibits seasonal reproduction, which varies throughout its geographic range. Typically it has 6 - 8 month egg-laying season between March and October (Davis *et al*. 1984, Davis *et al*. 1994, Stoner *et al*. 1996a). During the reproductive season, large numbers of conch will migrate towards shallow waters (10m or less) and breed in coarse sandy habitats near reefs and *Thalassia testudinum* seagrass beds (Robertson 1959, Randall 1964, D'Asaro 1965, Brownell 1977, Weil and Laughlin1984, Stoner and Schwarte 1994), making them vulnerable to exploitation.

The female lays a crescent shaped egg mass which can contain up to 1,000,000 eggs. Under optimal conditions, females can lay an average of 13.6 egg masses per season or an estimated 750,000 eggs each, or an estimate of 10.2 million eggs per season. A female conch camouflages the egg mass with sand grains to help in its survival through the three to four day incubation period.

The planktotrophic veligers resulting from the egg masses progress through a three to eight week developmental cycle while drifting in the water column. Veliger larvae eat microscopic algae that live in sea water and maybe some marine bacteria. The veliger larva has a tiny transparent shell, and once the veligers are morphologically ready (1-2 mm SL), they will respond to trophic cues and settle and undergo metamorphosis into a fully benthic animal.

The juvenile queen conch remain buried for most for the majority of first year of life, and are a nocturnal possibly as a means to avoid predation (Randall 1964, Sandt and Stoner 1992).

As herbivorous gastropods, the juvenile and adult conch feed on a variety of algae, detritus, and diatoms all commonly found in sand, seaweed, and seagrass blades (Robertson 1961).

During its early years, juvenile queen conch will add length to its shell, until it begins to form a flaring lip at approximately 2.5 - 3 years of age. Once the lip is formed, conch is a sexual mature adult. Wild populations in healthy conditions exhibit a 1:1 sex ratio (Sandt and Stoner 1992).

In the San Andres archipelago aggregations of 150-200 queen conchs have been observed within an area of approximately 30 x 100 m surrounded by a halo of open sand. Mating and pairing behavior were common within the aggregation (Appeldoorn et al. 2003).

Accordingly to Ávila (2004), conch with a shell length ?170 mm and a lip thickness >5 mm, exhibited the complete gameto-genic maturation cycle during April-September with spawning occurring in two seasons in March-April and September.

For management purposes, adults are classified into four categories as defined in Table 1.

Table 1. Definitions of adult queen conch age classes. Bold numbers in parentheses give an estimated measurement of lip-thickness measures (Taken from Appeldoorn *et al*. 2003).

Adult category	**Characteristics**	**Lip thickness (mm)**	**Picture**
Newly Mature Adult	—Flared lip starting to grow or very thin. —Periostrocum tan and clean. —Thin lip enough to allow the periostrocum to give color to the underside.	<5 - 7	
Adult	—Flared lip fully formed, minimal to moderate erosion. —Periostrocum tan but may be sand covered or with some algal growth. —Lip underside generally white with pink interior.	15	
Old Adult	—Outer lip starting to erode (as viewed from bottom). —Top of shell still well formed, but periostrocum is lost and spines have rounded moderate erosion and fouling on the outside shell. —Lip under-side may have platinum color, with darker pink interior.	30	
Very Old	—Lip is very thick and flared portion may be completely eroded away. —Outer shell is highly fouled and eroded, often resulting in a short total length. —The lip is squared off, white portion is often completely eroded and the interior is a dark pink.	>40	

1.3.2 *Habitat types*

Adult queen conch have been documented throughout their range occupying shallow seagrass beds and rubble habitats (Randall 1964, Alcolado 1976, Stoner 1994, Stoner and Schwarte 1994, de Jesús *et al*. 1999, Delgado 1999). Deep water stocks (~25-35 m) have been less documented, but suspected to be as important as shallow ones (Rathier 1993, Stoner and Schwarte 1994, Mateo *et al*. 1998).

Juvenile conchs inhabit shallow banks covered with submerged aquatic vegetation such as seagrass beds and macroalgae (e.g. *Lobophora, Halimeda*) plateaus, over bio-turbated sands (Alcolado 1976, Weil and Laughlin 1984, Stoner and Waite 1990, Wicklund et al. 1991, Stoner *et al*. 1993, Posada *et al*. 1997).

Within Colombia's archipelagos, adult queen conchs are usually seen in coarse sand, with deep water populations found over dispersed coral stratum along the leeward slope, which consists of rugose coral within a sandy matrix. Adult conchs have also been found over rodolith beds in the Bernardo and Rosario archipelago's (Gómez *et al*. 2005). On the other hand juvenile conch are commonly seen in back reef areas or in the broad reef lagoons.

1.3.3 *Role of the species in its ecosystem*

Queen conch is categorized as a specialist, being primarily an algal/detritus feeder as adults, and in large number can therefore have a major influence upon benthic productivity processes (Stoner 1989 a, b). For example, young individuals feeding on seagrass remains, seagrass epiphytes and macroalgae (Randall 1964), can play an important role in regulating the abundance of seagrass detritus and thus the overall structure of the macrofaunal communities (Stoner *et al*. 1995). Young individuals

As a key species in the scheme of marine biodiversity and shallow marine throphic dynamics, there are several predators of the queen conch, including the tulip snail (*Fasciolaria tulipa*), apple murex (*Murex pomon*), and other carnivorous species such as octopus (*Octupus vulgaris*), spiny lobster (*Panulirus argus*), old wife (*Balistes vetula*), spotted eagle ray (*Aerobatus narinar*i), tiger shark (*Galeocerdo cuvieri*, nurse shark (*Ginglymostoma cirratum*) and loggerhead turtle (*Careta careta*) (Jory and Iversen 1983, Iversen *et al* 1986).

1.4. Population

1.4.1. Global Population size

The most recent estimate of the queen conch population size within the San Andres Archipelago was obtained in 2007 from a series of scientific expeditions (Castro *et al*. in press). Surveys that replicated methods and stations from previous surveys conducted in 2003-2002 (Appeldoorn et at. 2003). A total of 282 stations in six atolls were revisited and an additional 69 stations were sampled for the first time in order to estimate population densities.

The potential population was estimated at more than 10.7 millions individuals, with 56% adults and 44% juveniles (variable by atoll) and representing by a total of 1,674 (Table 2).

In general, the population exhibited an aggregated pattern, with adult queen conch on unconsolidated coarse sands with or without rubble and over sparse and mixed coral. Juveniles occupied algal plains and back reef environments (Figure 3). Conch densities were highest at Serrana in comparison to all survey areas. High juvenile densities at this atoll were attributed to the presence of reef channels.

Table 2. Population size estimates of queen conch in the San Andres Archipelago from the 2007 surveys, excluding Serranilla, New and Alice Banks.

Archipelago atoll	Estimated No. Individuals	Mean adult density (ind/ha)	Mean % adults	Mean juvenile density (ind/ha)	Mean % juvenile	Mean Biomass mt
Roncador	513,171	110.0	25.7	83.0	74.3	716
Serrana	5,929,310	151.0	64.3	84.0	35.7	814
Quitasueño	4,008,248	37.5	77.2	11.0	22.8	91
Providence	138,542	1.8	57.0	3.3	43.0	37
San Andres				0.6		
East-South-East	84,501	8.7	51.1	8.4	48.9	6
South-South-West	55,037	5.1	59.0	3.6	41.0	9
Total	**10,728,809**					**1,674**

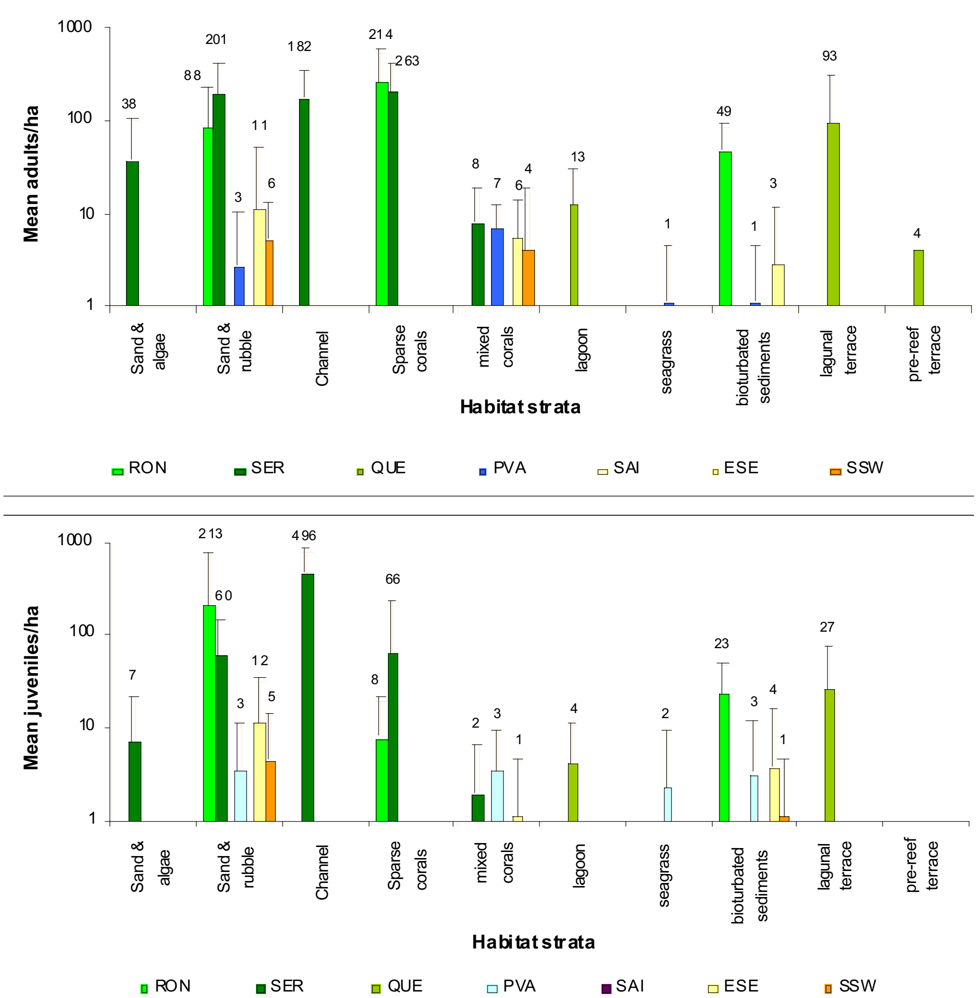


Figure 3. Mean queen conch densities across the San Andres archipelago banks (RON= Roncador, SER=Serrana, QUE=Quitasueño, PVA=Providencia, SAI=San Andres, ESE=East-South-East and SSW=South-South-West) by habitat strata. Error bars are one standard deviation.

Although isolated surveys have been conducted to estimate average densities, there are no population estimates available for conch in other areas of Colombia. For example works by Ballesteros *et al*. (2005), Garcia *et al*. (2005) and Gomez *et al*. (2005) all reported a population dominated by adults in Rosario's Islands and by juveniles in San Bernardo (Table 3). Within these archipelagos, which were declared National Parks in 1977 and extended in 1988 only subsistence fishing is allowed, however illegal commercial fishing still taken place. No data is available for other regions in Colombia.

Table 3. Estimates of queen conch population density in the Rosario and San Bernardo archipelagos. Data taken from Ballesteros *et al.* (2005), Garcia *et al*. (2005) and Gomez *et al*. (2005).

Archipelago	**Islands**	**Mean adult density (ind/ha)**	**Mean juvenile density (ind/ha)**
Rosario	Bajo Tortugas	11.4	2.9
	Tesoro	0.9	0.2
	Arena	12.8	3.2
	Overall	3.1	0.8
San Bernardo	Maravilla	3.2	12.9
	Panda	1.3	5.2
	Múcura	1.3	5.2
	Overall	1.9	7.8

1.4.2. *Global population trends*

___increasing _X_decreasing ____ stable ____unknown

TRENDS FROM FISHERY INDEPENDENT DATA

Based on fisheries independent data, it has been established that queen conch population density had exhibited progressive negative trends across the San Andres archipelago until 2003, when the fishery was closed for three years. Surveys conducted in 2007 showed a population recovery at the northern atolls (Figure 4). This closure roughly coincided with the moratorium on queen conch exports imposed on Honduras, Haiti and the Dominican Republic. This recovery was attributed to the significant reduction in fishing pressure from both legal and illegal fishers. Illegal activities from neighboring countries during that time were significantly lower in response to the CITES exports restrictions. Conch populations did not recover in Colombia central and southern atolls because artisanal fishing did not cease continued during the closure and continue to date.

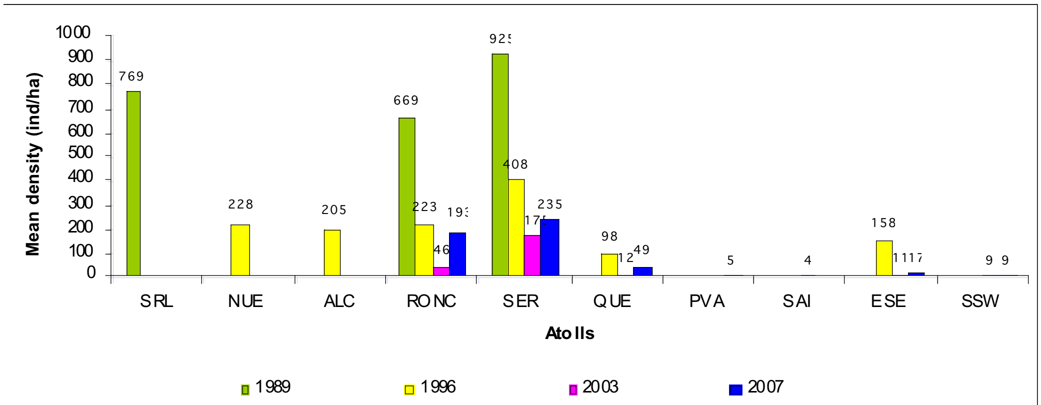


Figure 4. Historical queen conch density (ind/ha) across the San Andres archipelago (RON= Roncador, SER=Serrana, QUE=Quitasueño, PVA=Providencia, SAI=San Andres, ESE=East-South-East and SSW=South-South-West). Data labels are showed to facilitate analysis. Data obtained from Garcia *et al.* (1997), Valderrama *et al*. (1999), Appeldoorn *et al*. (2003), and Castro *et al.* (in press).

Trends From Fishery Dependent Data

Declining trends were also seen in the queen conch landings from the fishery dependent data, despite unreliable statistics during the most productive portion of the fishery trade in the 70´s (Prada and Castro in press). Delays in monitoring landings by national institutions and local ones unable to access private archives from a fleet that was dismantled in 1998 resulted in poor quality data.

Landings of queen conch meat declined from 813 m-ton in 1988 to almost half (465 m-ton in 1993) in less than a decade, to a 186 m-ton in 2000 to only 81 m-ton in 2003 (Figure 4). Declining catch in recent years also reflects the imposition of a global catch quota first fixed at 203 mt and further reduced to 96 mt in 2001, following management measures taken to counteract reductions in wild populations.

When analyzing indices of population abundance, such as CPUE, the negative trend was not evident. For instance, from 1988-1996, CPUE averaged 31 kg/day/diver, but no clear trend was observed. When better quality data became available, a reduction in CPUE from 56 to 27 kg/day/diver was reported from 1998-2002 (Figure 6).

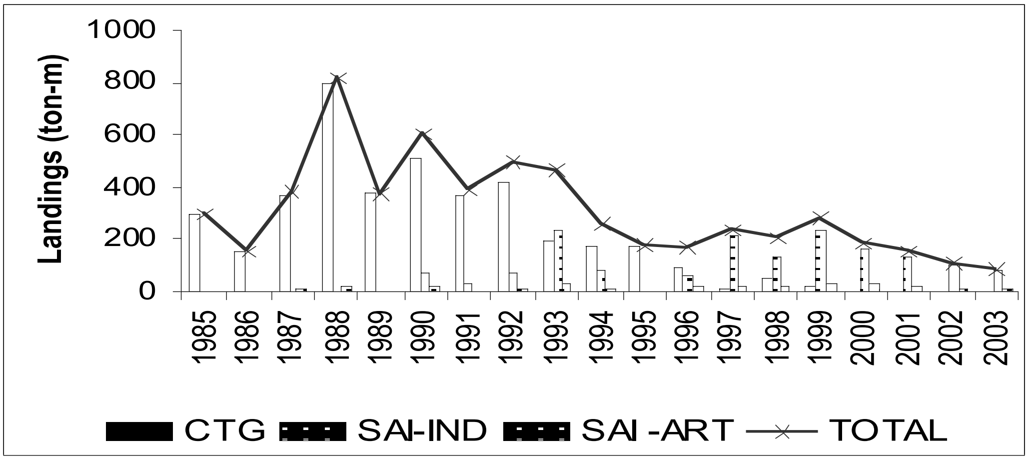


Figure 5. Landings (metric tons) of queen conch from the San Andres archipelago commercial fishery. Data from Prada and Castro in press.

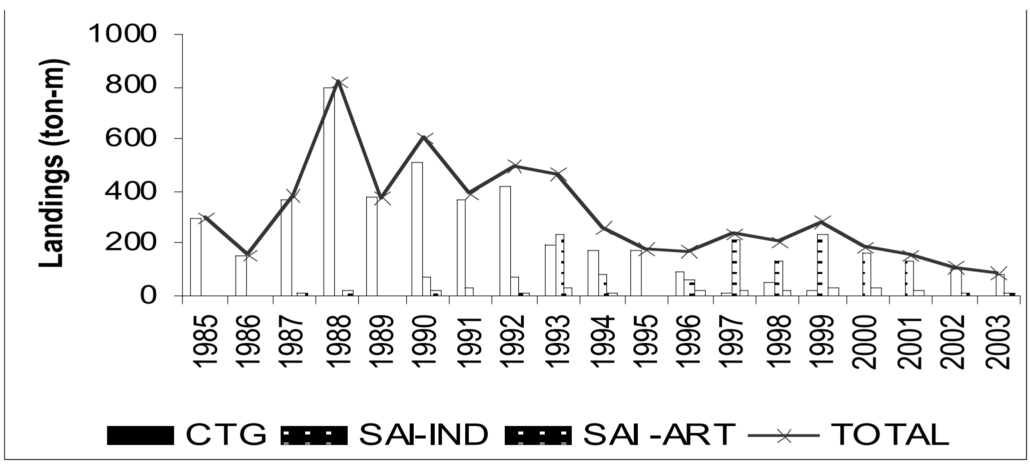


Figure 6. CPUE for the queen conch commercial fishery from the San Andres archipelago. Data from Prada and Castro in press.

Trends viewed through in fisheries dependent data are uncertain because:

1) Databases are incomplete
2) Fishing effort had not been properly standardized to account for the progressive increase in power (illegal use of autonomous diving gears or hookah; shift from sailing canoes to outboard engines)
3) Landings might not always be clean conch meat, particularly at the onset of the fishery
4) Production is not reported by atoll, thus key spatial information is missing

5) Illegal trade flows in two directions, Colombian production being sold to neighboring countries or foreign products being sold in Colombia

No substantial or quantitative information is available to estimate how the decline in queen conch populations may affect other sites in Colombia, with the exception of three isolated studies in the San Bernardo Archipelago. Goodman (1974) reported an average queen conch density of 5,778 ind/ha, which decline to 38 ind/ha in 1997 (Hernandez *et al* 1997) and to less than 3 ind/ha in 2005 (Ballesteros *et al* 2005).

In conclusion, different recent population trends were found within the geographic range of Colombian waters. While an increase is reported at Serrana, Quitasueño and Roncador atolls, a decrease was reported at Providence, San Andres, East-South-East and South-South-West atolls. Atolls further north such as Serranilla, New and Alice Banks, remain to be explored, and negative trends are expected along the continental shelf.

1.5. Conservation status

1.5.1. *Global conservation status* (according to IUCN Red List):

___Critically endangered
___Endangered
___Vulnerable
___Near Threatened
___Least concern
___ Data deficient

IUCN has not assessed.
Commercially threatened, CITES Appendix II.

1.5.2. *National conservation for Colombia*

Queen conch is a protected species in Colombia following CITES regulations and procedures. The Ministry of Environment included the species in a national red list, thus allocating funds to promote more sustainable management. CORALINA, the environmental authority within the San Andres Archipelago, selected the species as one of the key bio-physical indicators to measure MPA effectiveness.

1.5.3. *Main threats within the case study country*

___No Threats
_X_Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
_X_Harvesting [hunting/gathering]
___Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)

_X_Pollution (affecting habitat and/or species)
_X_Other: a) Seasonal river discharge introducing fresh, turbid and polluted water into the marine ecosystems, increasing vulnerability to global climate change; b) The overgrowth by the incrusting sponge, *Cliona*); c) The reduction of population density to a level where by Allee effects may affect reproduction.
___Unknown

2. SPECIES MANAGEMENT WITHIN COLOMBIA

2.1. Management measures

2.1.1. *Management history*

The first management measure for the queen conch stocks was the establishment of a permanent fisheries closure in the Quitasueño Bank and a closed season in the remaining archipelago atolls from June 1st to September 30th declared by INDERENA (Instituto Nacional de los Recursos Naturales Renovables) in 1987. A second INDERENA Resolution (17/1990) extended the closed season for an additional month, prohibited the use of scuba gear and established a minimum weight of 100g of clean meat or 225 g if an unclean. However, a legal definition of an unclean state was not included, nor were weight equivalents for inbetween states of processing. In 1991, INDERENA was replaced by a new national fisheries management institute (INPA-Instituto Colombiano de Pesca y Agricultura).

A Total Allowable Catch quota (TAC) was established in 1997 by the Comité Ejecutivo de la Pesca (CEP) with a 203 mt designated for the archipelago's fishery, and 300 mt CITES quota was established for Colombia. In 2001, the TAC for the San Andres archipelago was reduced to 96 mt. INPA was liquidated in 1998, and a new national fisheries authority, INCODER (Instituto Colombiano del Desarrollo Rural) was established.

Unique regulations for the San Andres archipelago (laws 47/1993 and 915/2004), created a new legal entity to manage the local fisheries: the Departmental Fishing Board (JDP in Spanish). INCODER transferred its functions to the JDP and its technical branch, the Fishing and Agriculture Secretariat. However, CEP is in control of national policies such as the establishment and distribution of catch quotas and determination of the closed seasons. Licensed fishers are awarded individual quotas not transferable, but valid for a specific time, and requires reporting.

In 2007, ICA (Instituto Colombiano de Agricultura) a corporation within the Ministry of Agriculture and currently the national fisheries authority replaced INCODER. A new and more collaborative management approaches are now in place in conjunction with the re-opening of the queen conch fishery in 2008.

2.1.2. *Purpose of the management plan in place*

Currently, there is no national management plan for the queen conch, although the Colombian Ministry of Environment is leading an initiative to prepare one for this important fishery. The process began in May 2008, when preliminary agreements, work assignments and the potential use of existing international tools were examined. A second meeting was held in July, 2008 to define a time table and embrace the broader stakeholder participation needed for its completion.

CORALINA drafted an action plan for the species, as part of the Seaflower MPA policies (Garcia 2005). However, while this plan has not yet been submitted for approval neither to the JDP nor the CEP, it will be used as basis for the national plan.

2.1.3. *General elements of the management plan*

The CORALINA action plan contains an introduction and seven chapters. The first three described the species as a fishery stock including information on habitat distribution and potential sources of food. A fourth chapter deals with threats to the stock and considers surveillance and enforcement issues. The fifth chapter is dedicated to the legal framework, while the remaining two chapters propose management alternatives and define conservation goals and objectives.

2.1.4. *Restoration or alleviation measures*

CORALINA in association with Harbor Branch Oceanographic Institute, Blue Dream Ltd and Fish and Farming Cooperative all supported by Wildlife Conservation Fund and the Sheila Johnson Brutsch Charitable Trust conducted a pilot project where more than 1,000 juvenile queen conch were raised and released after seven months into three MPA conservation zones (Shawl *et al*. 2007). This success project engaged artisanal currently working to increase the scope of the recovery actions. In addition, a new project is commencing soon funded by the National Petroleum Agency and the Colombian fisheries management institutions.

Conch larviculture methods for marine biology students oriented towards stock enhancement have been developed in the San Bernardo and Rosario islands (Osorio 1992), and a small scale laboratory was assembled at a facility within the Rosario National Park and is managed by a private business (CEINER).

The reopening of the conch fishery after three years of closure was preceded by innovative, participative procedures that were unique in

Colombia. Two days of negotiations and clear rules were established to reach participant consensus on the following issues: a) allocation of TAC at only two atolls following a highly precautionary scenario only in two of the Archipelago's atolls; b) reduction in industrial fishing vessels (from 8 to 5) and time at sea (from 7 to 3 months); c) 28% increase in participation of artisanal fishers in traditional industrial fishing zones; d) allow participation of artisanal fishers in monitoring landings and in research projects as alternative to offset the indefinite closure of the traditional artisanal fishing in the central and southern sections of the MPA.

2.2. Monitoring system

2.2.1. *Methods used to monitor landings*

In December 2007, institutions based in San Andres reached consensus to develop collaborative field surveys every three years to assess the condition of the queen conch stock, as well as additional habitat and biodiversity observations, incorporating an ecosystem management approach.

Fishery independent monitoring is following the Appeldoorn *et al*. (2003) protocol, in which data are acquired from diver-based visual surveys along strip-transects to cover a total area of 960 m^2 per station. Initial stations locations correspond to a random stratified sampling protocol based on eight habitat strata obtained from existing benthic maps by INVEMAR (Diaz *et al* 2000). Again this were visual surveys and no queen conch were collected during sampling.

Fishery dependent monitoring is conducted by the local fishery management authority (Secretaría de Agricultura y Pesca), and maintains the registry for 100% industrial queen conch landings in San Andres Island. There was a ≥ 70% increase in artisanal fishing reporting in 2008. Data obtained are entered into a database called SIPEIN (Sistema de Información Pesquera) created cooperatively between the Fishing and Agriculture Secretariat and INVEMAR. Starting in November 2008, additional fishery dependent data will be collected from an onboard observer program.

In the past, at least two surveys were conducted by INPA in order to assess queen conch populations (Ospina *et al*. 1997, Valderrama et al. 1999). Additional isolated efforts to monitor artisanal fishing have been conducted by CORALINA (Chiquillo 1996). Finer scale field work have been conducted by students as part of their biology degrees such as the cases of Goodman 1974, Cano 1983, Garcia 1991, Ballesteros *et al*. 2005, Gómez *et al*. 2005.

An oceanographic current model, larval supply and recruitment studies needed to understand connectivity patterns are also about to start. A complete survey to determine the queen conch genetic population diversity through 8 microsatellites is currently in progress.

2.2.2. *Confidence in the use of monitoring*

Mean density estimates from diver observations are expected to have lower confidence limits because they followed a random stratified protocol (habitat strata) and sample a large number of stations. Divers were selected from a mixed group of marine biologists with excellent diving qualifications and experienced conch fishermen working together. Lack of detailed bathymetric charts was counteracted by the availability of detailed benthic maps.

Fisheries dependent monitoring will improve in quality once the onboard observer program is initiated. However, concerns about possible interactions between these observers and illegal drug transactions by fishing vessels.

2.3. Legal framework and law enforcement

Colombia as signatory Party to CITES and abides by all international restrictions regarding international trade of queen conch. In addition, the queen conch has benefited from the creation the Seaflower MPA in June, 2005 by the Ministry of Environment (the Colombian CITES authority) and CORALINA (the local counterpart), which created a permanently closed areas to all fisheries activities, including those for queen conch. The species has been selected as one of the Seaflower indicator key species to measure the effectiveness of MPA policies.

Fishing activity is highly restricted within the Rosario and San Bernardo Islands National Park, where only subsistence fishing is allowed, and there is also an indefinite ban in effect for La Guajira area, until data on conch abundance become available.

3. UTILIZATION AND TRADE OF RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. **Type of use** (origin) **and destinations** (purposes)

Three different products are obtained from the queen conch fishery: the conch fillet, conch pearls and conch shells. Conch fillet is the most commonly traded product in international markets, with approximately 90% of the harvest being exported. National consumption of the queen conch meat was estimated in 5% of national fish production (Gallo y Valderrama 1995), but most probably this percentage has increased since then.

Conch pearls are considered jewelry, and therefore are by far the most valued of the conch products, while the conch shells are decorative pieces which are increasingly traded as souvenirs for the tourism industry.

3.2. Harvest:

3.2.1. *Harvesting regime*

The queen conch is legally harvested in Colombia by free diving. The use of any autonomous diving gear is prohibited. The fishing unit consists in one canoe and three fishermen, one operator and two divers. Conchs are collected in bags and taken to the surface, where the meat is extracted (and the pearl, if present). The meat is stored mainly in one of two levels of processing, "semi-clean" (trimmed by an additional 22% to export quality) for majority of industrial fishers, and "clean" (trimmed by an additional 15% to export quality) for most artisanal fishers.

Empty shells are usually returned to the sea, trying not to form big piles at any particular site. An industrial boat is allowed to carry up to ten canoes, but it can be less depending on the vessel size. Artisanal fishers use the same procedures, although fishing effort is not exclusively dedicated to queen conch, but also includes fish and lobster. Fishing trips for the queen conch last around a month for the industrial fleet and couple of days for the artisanal fleet.

Illegal fishing from of Colombian industrial vessels has been controlled, therefore most of the illegal harvest is conducted by divers from neighboring countries such as Honduras, Nicaragua, Jamaica and the Dominican Republic. Foreign industrial fleet utilizes SCUBA or hookahs, carry triple the number of divers and capture queen conch, lobsters, fish and turtles. The duration of illegal foreign activities fishing is quite variable, but it is expected to happen on a regular basis from a couple of days to a couple of weeks per month.

3.2.2. *Harvest management/ control* (quotas, seasons, permits, etc.)

As mentioned before, in the 2008 TAC was established of 112 mt of clean meat, distributed into 105 mt for Serrana and 7 mt for Roncador Banks. Fishing in other atolls remains prohibited. A closed conch season from April 1st to October 31th of each year has been in place for nearly 2 decades. Currently, there are 12 legal industrial licensed companies utilizing 5 vessels and employing an approximately 100 divers. Additionally, there are nearly 200 artisanal divers in 90 smaller boats registered to San Andres, Providence and Santa Catalina.

3.3. Legal and illegal trade levels:

According to the CITES national office (Vladimir Puentes, personal communication), the proportion of legal exports of conch fillet between 2000 and 2004 totaled 571.5 mt and represented an annual increased of 10%, with Miami and New York as the major destination (Figure 7). During the time of CITES export restriction imposed in Honduras and the Dominican Republic, it estimated that approximately 29.3 mt of illegally harvested queen conch was transshipped through Colombia, and in precaution a complete closure of the fishery was ordered in 2004, until better controls on illegal trade can be implemented.

A total of 6,960 conch pearls have been legally exported during 2000-2008, with an annual average of 1005 units (SD=469) in 2000-2004 and 300 units (SD=54) in 2007-2008. Major pearls importers are located in Narita (46%) and Tokyo (42%) Japan, and minor importers in Geneva (10%) and New York (2%) as presented in Figure 7.

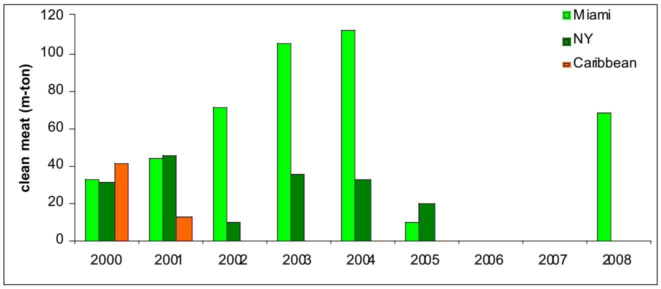
Approximately 4,112 conch shells have been legally exported during the last 8 years, with importers located in Hanoi (84%), Narita, Japan and Paris, France (6%) (Figure 7).

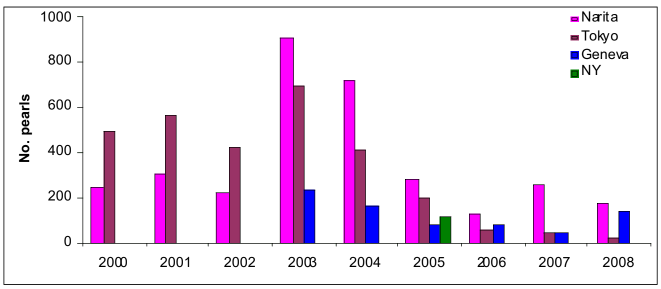
Accordingly to ICA (Instituto Colombiano Agropecuario) registries (Carlos Borda, personal communication), between the years 2000 and 2003, Colombia queen conch exports totalized more than $USD 3.2 millions with pearls accounting for 63%, conch fillets 36% and shells less than 1% (Figure 8).

Illegal conch fishing varies in time and location, and only isolated quantitative information is available. For instance, the Colombian navy, the national operational enforcement authority, estimates that there are between 3 to 7 illegal foreign vessels regularly entering to Colombian waters to fish. This fleet does not seek conch exclusively, but target lobsters with occasional captures of fish and sea turtles.

Approximately 50% of foreign illegal vessels have Honduran flags and resemble the legal Honduran fleet fishing on behalf of Colombian companies. In general, each illegal vessel acts as a mother boat, carries approximately 30 canoes, and 60 divers thought to be from Honduras, Nicaragua, Jamaica and the Dominican Republic which utilize SCUBA tanks and sometimes hookahs. Te potential number of illegal divers might be around 400 or higher (Prada et al 2004), a value that duplicate the legal divers.

The combination of diving with old and poor quality gear, fishing deep (140 feet) and frequently (up to 15 times a day) threatens serious decompression sickness and results in significant socio-economic impacts to already poor communities such as the Miskitos Indians (The NicaTimes, 2008).





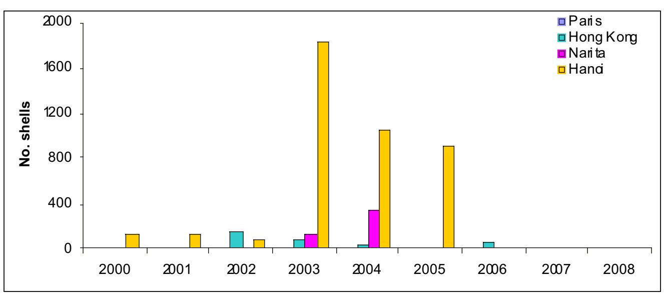


Figure 7. Colombia queen conch exports by destination. Data from Min-Ambiente (Vladimir Puentes, personal communication).

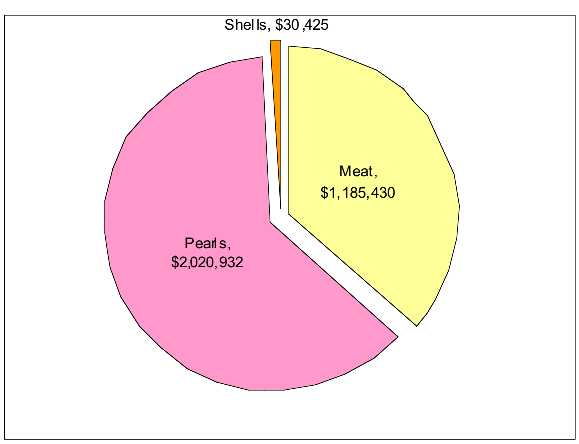


Figure 8. Value of Colombian queen conch exports during 2000 - 2003. Values expressed in US dollars. Data from Carlos Borda (personal communication).

Based on recent spiny lobster stock assessment (Nowlis *et al*. 2008), illegal conch captures may represent 2 to 14% of the illegal lobster captures (under a low and high scenarios), therefore the potential take of illegal queen conch could approximate 1.4 to 21.8 mt of clean meat. These estimates were based on the catch composition from three illegal fishing boats captured between 2005 and 2005 by the Colombian navy (Steeward Ariel, captain Jones and Tony Jr.), and assuming than only 50% of the time they were fishing in Colombian waters. Usually illegal fishing is conducted near to the country's borders, facilitating quick displacements to legal fishing grounds. Interviews from several captains of the lobster industrial fleet have confirmed the regular operation of the illegal fishing in these remote fishing areas as reported by the Colombian military authorities. The low illegal fishing scenario estimated three permanent illegal vessels, while the high illegal fishing scenario was set at 7 illegal boats, all being divers using SCUBA and belonging to an industrial fleet.

In a similar situation, Barnutty (2006) reported for the Caribbean Nicaraguan landings that unreported conch landings might be around 20% of the reported conch landings. Serious pouching by industrial vessels, mainly from Honduras, have been also reported in Pedro Bank, Jamaica taken advantages of the poor high seas enforcement, specially during the closed seasons (Aiken *et al*. 2006). Indeed, in 2003 the minister of agriculture Roger Clarke reported that conch poachers harvested about $20 million of conch from the island's waters every year and resulting in drastically reduction of Jamaica catchable quota (http://www.sidsnet.org/archives/coastal-newswire/2003/frm00076.html).

The amount of the illegal queen conch trade in the whole southwestern Caribbean region is of concern. Indeed, 2007 law enforcement personnel from the US offices of law enforcement of the US Fish and Wildlife Service and the Canadian Wildlife Enforcement Directorate prosecuted smugglers from seven countries attempting to ship 119 mts of queen conch fillets valued in more than $USD 2.6 millions (1.05 to 1.32 millions of individuals) to US and Canadian markets (Mclearn 2008). Additional substantial illegal trading is assumed to continue.

II. Non-detriment finding procedure (NDFs)

Provide detailed information on the procedure used to make the non-detriment finding for the species evaluated.

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

_X_yes ___no

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

Following are the criteria used in Colombia for NDF:

a) Clear definition of the stock including its spatial variability and benthic habitats for the various atolls of the archipelago.
b) A methodology, data analysis and evaluation protocols based on independent surveys in place. Information from landings reports utilized to complement the stock analysis.
c) Definition of a TAC introducing precautionary principles, in which only two out of nine atolls (Serrana and Roncador) are allowed to sustain fishing. In Serrana, the MSY was estimated in 130 mt, but TAC was fixed in 107 mt, discounting 18% for illegal fishing and uncertainties. In the case of Roncador, a much conservative decision was made by allocating only 10% of the 79.8 mt calculated for the MSY. Roncador is the smallest and eastern- most atoll and the area with highest coral development, thus stricter conservation measures are being developed there. The queen conch fishery will benefit by protecting the larval long-distance dispersal expected because of the dominant westerly current flow.
d) An additional precautionary approach refers to the adoption of a new and more participative decision-making in fisheries management procedures seeking the overall reduction of the fishing effort, the participation of artisanal fishers in other ways traditional industrial fishing zones, and elaboration of a proposal to improve sustainability in the queen conch pearl trade. Colombia is the first country within the south-western Caribbean than began the inclusion of NDF for the queen conch pearl international trade.
e) Promotion of participative stakeholder agreements oriented to species conservation policies and regulations.
f) Initiation of large scale stock enhancement activities and complementary research agenda allowing broad national involvement and users participation.

g) Broad educational and outreach activities involving industrial and artisanal fishermen, teachers, students, politicians and general public.
h) Promotion of international collaborative work looking for integrated management and better communication and information exchange mechanisms.

In comparison the queen conch fishery in Jamaica, by far the most productive Caribbean ground (Pedro Bank), the director of Fisheries Division at the Ministry of Agriculture Stephen Smikle, reported that the adaptive fisheries management and inclusion of CITES NDF criteria proved successful to relative stable landings. Those criteria consider the following aspects:

- Realization of compulsory stock abundance surveys (Pedro Bank – south of mainland Jamaica, is the only commercial fishing zone for queen conch) to estimate potential queen conch population and generation of a TAC recommendation annual quota. Surveys in the 1990's were carried out with financial assistance and equipment provided by the fishing industry, however since the year 2000, surveys have been government or NGO funded.
- Stock assessment combining surveys and reported (operators and captains) data carried out by fisheries managers with the participation of national and international experts. Data subjected to quality control protocols.
- Annual adjustment of the TAC based on useable MSY (maximum sustainable yield) once illegal fishing is excluded. Illegal fishing is estimated from fishermen interviews and specific workshops. In fact, TAC has been gradually reduced from 3,000 mt in 1992 to 1999 mt in 1997 to 946 mt in 2004 and 500 mt in 2005.
- Allocation of individual non-transferrable quotas to industrial fishers to operate in industrial fishing zones which are valid for a season and require reporting.
- The establishment of exclusively artisanal fishing zones, and extension of the closed season.
- The use of SCUBA and hookah is regulated.

However, Jamaica fisheries managers still face major challenges to overcome increases in the growing illegal fishing (estimated at the same level as the legal production) in remote reef banks. The inclusion of shell size and lip thickness to the existent weight regulation proved difficult to control since only meat conch is landed. All conch products exported, including those originating from the Artisanal fishers, have to meet the same standards. Exporters are forced to take products from only those artisanal operations that meet the export health standards. The cumulative impacts from major hurricanes affecting Pedro Bank such as Ivan (2004), Emily (2005), Dean (2007) and Gustav (2008) are known to be detrimental but quantitative effects are still not determined.

In a similar case, Honduras fisheries managers following recommendations from the expert Dr. Nelson Ehrhardt have addressed the NDF by determining the level of fishing mortality that affects the population density needed to secure the queen conch reproductive success. Therefore, basic criteria for conch stock assessment methodologies and management are used as the first step in order to formulate Non-Detriment Findings. In 2005, a 210 mt TAC was authorized to assess annual population densities and abundance in each of the 13 fishing banks previously identified as conch fishing grounds. At present, assessments of the conch have been accomplished and densities appears to be well above of minimum population densities adopted by the CITES as the limit for acceptable exploitation (56 ind/ha). In the near future, it is expected that monitoring surveys in conjunction with appropriate statistics from the fisheries will be used to elucidate the status of exploitation of the conch stocks in each fishing ground. See details in ANNEX 1.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

Fisheries managers have access to historical fisheries dependent and independent data, but data confidence is higher during the last decade. Field survey data are available at fine scale in the San Andres archipelago, but only dispersed data exist for other continental sites in Colombia. Assessment of queen conch populations in the Guajira area is commencing.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Funding has become available to conduct inter-institutional workshops for data analysis and technical report writing. Technical reports are under reviewed by national and international fisheries experts. Decision-making process is derived from participatory workshops, and local participation is allowed at the national level.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

With respect to population stability

- Increases in fishing effort during the month prior to the closed season (April), may have negative long term consequences since a recent studies have identified April as a month with an intense reproductive activity indicating a need to adjust the closed (Ávila 2004), or maybe a need to better determine seasonal reproductive activity.

- There are areas where conch densities are below the estimated level for reproductive success (Appeldoorn 1995), thus demanding more effective enforcement mechanisms, reduction in catch or longer closures. Conch reproductive behavior (mating, spawning) shows a marked decrease at densities below 50 conch/ha (Stoner and Ray-Culp 2000). While lacking studies on larval supply, the best alternative is to ensure viable spawning stocks are maintained throughout the fishing areas. This suggests that each bank must be managed as a separate stock.
- Low capacity and insufficient budgets to exercises the enforcement and surveillance needed to counteract levels of illegal fishing occurring in this region. Collaborative international efforts are needed to overcome political constraints and poor communication among managers.
- Potential detrimental effects from conch parasites and global climate change are not yet well understood and should be considered when designing the research agenda.

WITH RESPECT TO CONCH MEAT

- Removal of the shell before landing makes it difficult to account for important biological indicators with respect to growth and maturity (maturity is measured by morphometric characteristics of the shell). Minimum size may facilitate direct enforcement efforts, but remains dubious as a population indicator.
- The definition of an export TAC for CITES integrating the various stages of clean queen conch meat landings is needed to standardize losses and established equivalents classification to add to the regulations.
- The estimation of TAC based on surveys is expensive, thus requiring multi-source funding. Appropriate estimations also require the existence of accurate habitat maps, precise calculations of natural mortality rates and accurate determination of the spawning stock.
- Females reach larger sizes than males (Randall 1964). In the case of the San Andres Archipelago, Ávila (2004) found mature females averaging 249 mm TL and 17.5 LW mm, while males averaged 234 mm TL and 13 mm LW for males. Similar results have been reported by Márquez and Dávila 1994, Ospina *et al.* 1996, Chiquillo *et al* 1997. Therefore, having only one minimum size regulation may affect females in greater proportion than males.

- Dwarf conch have been documented throughout its range, which is not accounted for under regulations based on individual size. Small-sized stocks may result from the shallow depth, generally softer substratum, and potentially lower food concentrations in sand areas or at high density (Alcolado 1976, Martin-Mora and James 1995).
- In certain areas, the fishery may be sustained by large sub-adults and juveniles, thus perhaps selecting for smaller sizes with serious consequence for the fishery in the long run (Appeldoorn 1994).

WITH RESPECT TO CONCH PEARLS:

- Currently, there are three legal pearl traders and an unknown number of illegal ones. Legally licensed companies pay their fees based only in weight units, which is perhaps inappropriate in comparison to pearl value.
- There is no adopted protocol in place to monitor the pearl origins, therefore it has been difficult to certified whether or not it was captured on a sustainable way.
- A fishermen's perception that juvenile conch are prone to produce higher quality pearls may trigger unsustainable fishing practices.
- The small size of the pearls and their high market value encourages illegal trading including smuggling, which are difficult to control in ports and airports.

6. RECOMMENDATIONS

For population stability:

- Improve regional controls regarding illegal fishing and get consensus among managers in the south-western region to account for illegal fishing when defining TAC for CITES. Fishing characteristics in the region are relatively similar (Table 4), thus unified management approaches may be not that difficult if cooperative agreements and better communication strategies are in place.
- It may be adequate to include a minimum spawning population density as a fundamental sustainability criterion in regional conch fishery management regimes.
- Conduct regional connectivity studies to determine the level of larval supply and connectedness to maintain key "stepping stone" populations. Considering the prevailing west flowing current patterns, the protection of eastern atolls should be a priority to maintain long-distance larval supply. Such connectivity may explain the significant recovery of the queen conch populations observed in Serrana and Queena, which are down-current from Roncador, the eastern most atoll and the one with maximum densities (up to 2,250

ind/ha).

- Strengthen precautionary measures if a population is composed mostly by very old adults (perhaps low recruitment) or juveniles (reducing reproductive output). Deep water queen conch stocks may be critical to maintain spawning stocks in shallow areas.
- Promote bi-national agreements to reach consistent regional management strategies and policies, particularly in the areas with existent international treaties.
- CITES may continue acting as a dominant force in enforcement. In fact, specific enforcement workshops and better communication among managers in the South-western Caribbean region were recently identified as a priority to strengthen the functionality of a queen conch networking.
- To overcome budget limitations, a more coordinated research agenda and collaborative work should be explored to address critical knowledge gaps. Additionally, ecosystem based management requires management to determine direction and rates of change over time; thus, there is a need to agree on points of reference to control rates of extraction.

Table 4. Characteristics of the queen conch fishery in the south-western Caribbean. Data taken from: Sanchez et al. 2005, Aiken *et al*. 2006, Mateo 2008 and Eloisa Spinoza and Stephen Smikle personal communication.

Subject	Descriptor	Colombia	Nicaragua	Honduras	Jamaica	D. Republic
Overall status	Actual status	Only two areas open	conch is not directly target	export only from scientific fishing	Only two areas open	no exports permitted
	National production (ton) % exports	96 (2203), expected 112 in 2008 80-90	47 (2004), 71 (2005) 113-151 (2006) 85-75	1,359 (1991), 1,000 (2003), 210 (2007) 90	3,000 (1992), 1,999 (1997), 946 (2004), 600 (2007) 95	~580 -829 (2005) 47%?
	Estimates illegal fishing	2 to 14 mt	20% of legal reports		equal or larger than legal reports	
Surveys	stations	351 (2007)	110 (2005)	230 (2006)	63 (2007)	61 (2006)
	station sampling area (m^2)	960	2,070			1,250
	No. conch survey	19,590 (counted)	83,792 (fished)		1,398 (counted)	
	% adults	56	82		64	15
	Length shell (mm)	240-350	105-320			
	Lip width (mm)	17	19.9			5.6
	density estimates (ind/ha)	0.63 to 2,250 (2007)	50-950 (2006)		378 ind/ha (0-10 m depth); 50 ind/ha (10-30 m depth)	0.53 to 114.2 (2006)
	mean density (ind/ha)	158.8 North, 7.8 south	123.5 (204), 230 (2005)	198 (2005-.2006)	124 (1998)	53(1998)
	sex ratio (female/male)	1.03	1.17			2.25
	population size	10,728,809			75,474,652	1,076,169
Fishery	industrial vessels	5	22	13	7	40
	canoes/industrial vessel	10	40	45		5
	artisanal boats	90	70			200
	trip duration (days)	20 to 25	12 to 15	17 to 22	15 to 20	
	No. divers	8 to 20	26	40-60	10 to 20	
	CPUE	27 kg/diver/day (2003)	1.32 kg/diver/h (1987)			
	No. fishing banks	10	5	13	1	4
	extension fishing areas (km^2)	~3,200	~4,000	~10,000	~8,000	
	processing facilities	2	15		18	
Management	CITES TAC (ton)	112 (2008)	114 (2006)	210 (Scientific)	400 (2008)	n.a.
	closed season	May 1 to Oct 31	Apr 1 to Sep 30		Aug 1 to Jan 5	Jul 1 to Oct 31

FOR CONCH MEAT:

- Continue incorporating the NDF process into conch fisheries management and strengthen the international component.
- Adjust meat weight regulations to equivalent processing categories that can be accepted throughout the south-western Caribbean. Recent surveys conducted to address this concern in Honduras, Nicaragua and Dominican Republic generate baseline information to complement local information, which can be used to try and reach consensus within the region and include this criteria into the CITES TAC (Table 5).

Table 5. Description of the various types of conch meat with respect to nominal losses needed for export standards. Data from: Tewfik 1996, Smikle 1997, Galo and Earhart 2006, Barnutty 2006 and Mateo 2007.

Type of conch meat landed	Description	Honduras % losses	Nicaragua % losses	Dominican Republic % losses	Jamaica % losses
50% – 65 clean	Animal gutted and operculum removed.	44	45		12
75 - 85% clean	Additional removal of mantle, eyes, proboscis and skin.	55.8		25	28.2
100% clean	Only clean meat (except in Colombia where the operculum remains).	61.4	60	42	42.9

- Facilitate national and international discussion about potential modification of the closed season to include all spawning peaks. Perhaps compensation measures need to be allocated as well.
- Permanent closures have proved difficult to enforce, thus success is not always achieved. Therefore it might be necessary to find economic alternatives to promote reduction of fishing pressure in artisanal fishing zones.
- It may be more useful to view essential fish habitat for conch as a mosaic of habitats, and account for it when establishing marine reserves that support a full range of biological functionality (Glazer and Kidney 2004).

FOR PEARLS:

- Complete and adopt a protocol for the conch pearl trade including the following aspects: establishment of a TAC, creation of a mobilization certificate, agreements to strengthen controls by fisheries managers, appropriate fees, education and outreach programs and support for research program.

- The establishment of a TAC will consider the estimation of the adult population size and the proportion of the pearl production. In the case of san Andres archipelago estimated in 1:1,025 for a regular one (Ortegón 2006). However, not all pearls have export quality, therefore only a fraction of this amount can be set as a CITES quota. In consequence, that TAC should be a fraction of 538 pears for Serrana and 25 for Roncador. Unfortunately, not scientific information is yet available to determine what fraction would be then recommended.
- Create the pearl origin and the mobilization certificates to legal users. It might then be necessary to link the pearl trade to the fishing licensing and certification procedures. If the pearls come from unlicensed artisanal fishers, legal inspectors should certify its origin. It is expected that 100% of the conch pearls to be reported to inspectors during the following five days of the landing date. This certificate will make difficult the triangulation procedures.
- Several enforcement mechanisms will help the legal pearl trade, among them are: a) have a dedicated phone line reporting illegal activity; b) special surveillance operations at landing sites and jewelry stores; c) give ID to legal pearls traders; d) broad informative campaigns with educational materials not only about the conch pearl trade, but in general about responsible conch fisheries conducts.

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NON-DETRIMENTAL FINDINGS FOR THE QUEEN CONCH (*STROMBUS GIGAS*) IN COLOMBIA

AUTHORS:
Martha Prada, Erick Castro, Elizabeth Taylor, Vladimir Puentes, Richard Appeldoorn and Nancy Daves

The case study reports how Colombia, the fourth queen conch exporter in the Caribbean, is addressing the NDF to define its export quotas, focusing in the situation of the San Andres, Providence and Santa Catalina archipelago which provide more than 95% of the country's production. Strategies of Honduras and Jamaica are included for comparison.

Colombia uses a combination of strategies based on fishery independent surveys conducted within seven of the ten atolls comprising this archipelago to incorporate the stock spatial variability across eight benthic strata, thus clearly defining the potential extraction of conch wild populations. Fishery dependent data was also used to complement field data and be able to determine the fishery Maximum Sustainable Yield (MSY).

Currently, fishing is allowed in two atolls: Serrana a highly productive bank, and Roncador, a small and the eastern-most bank. In Serrana from the 130 mt defined as the MSY, the Total Allowable Catch (TAC) was set at 107 mt, discounting 18% for illegal fishing and uncertainties. In Roncador a more restrictive approach was followed, with only 10% of the 79.8 mt calculated for the MSY being defined as the TAC. It is expected that restriction in Roncador will benefit the queen conch fishery in the whole region by protecting the larval long-distance dispersal due to the dominance of the westerly current flow. Illegal captures were extrapolated from three illegal vessels captured in Colombian waters and interviews with experienced captains. Illegal fishery is targeting spiny lobster and queen conch may represent from 2 to 14% or 1.4 to 21.8 mt of clean meat.

Additional precautionary measures included the adoption of a new and more participative decision-making in fisheries management seeking the overall reduction of the fishing effort. Colombia also began discussion and agreements for the queen conch pearl trade, being the first country within the region to address NDF for this export product. The success of this study case lays perhaps in the wide stakeholder agreements oriented to species conservation policies and the broad educational and outreach activities involving industrial and artisanal fishermen, teachers, students, politicians and general public.

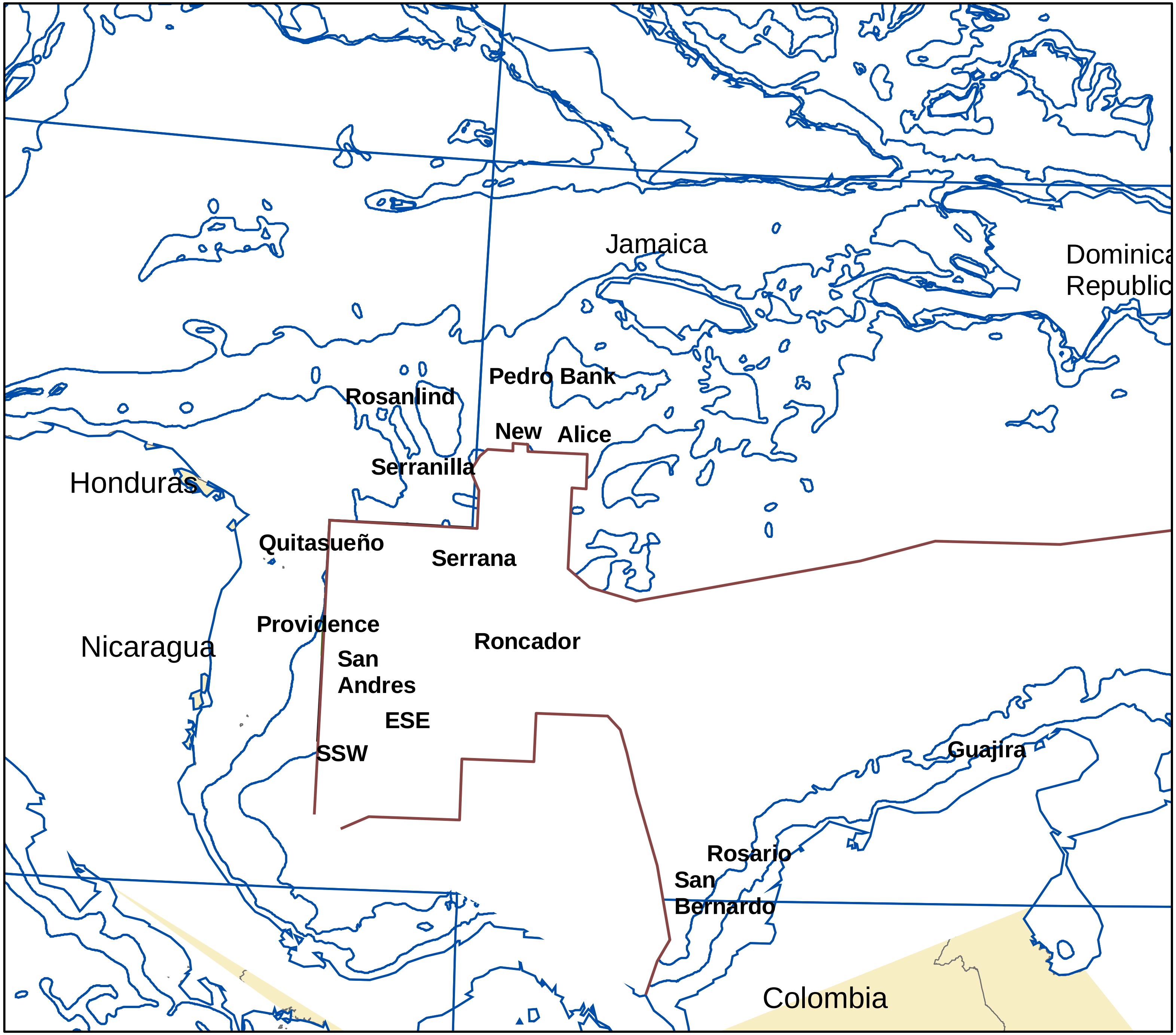
Because of the reproductive strategies of this species, management in adjacent countries can enhance or undermine the efforts of their neighbors. For this reason, Colombia has also reached out to other neighboring countries to ensure international collaborative management and to promote ways to improve communication and information exchange mechanisms. The mechanisms for making NDFs in the queen conch fishery in Colombia is compared with Jamaica and Honduras and specific recommendations are offered aimed at overcome difficulties dealing with the population stability, the conch meat and the conch pearls, that can be adopted by the countries in the southwestern Caribbean.

Non-Detrimental Findings for the Queen Conch (*Strombus gigas*) in Colombia

Martha Prada, Erick Castro, Elizabeth Taylor,, Vladimir Puentes, Richard Appeldoorn and Nancy Daves

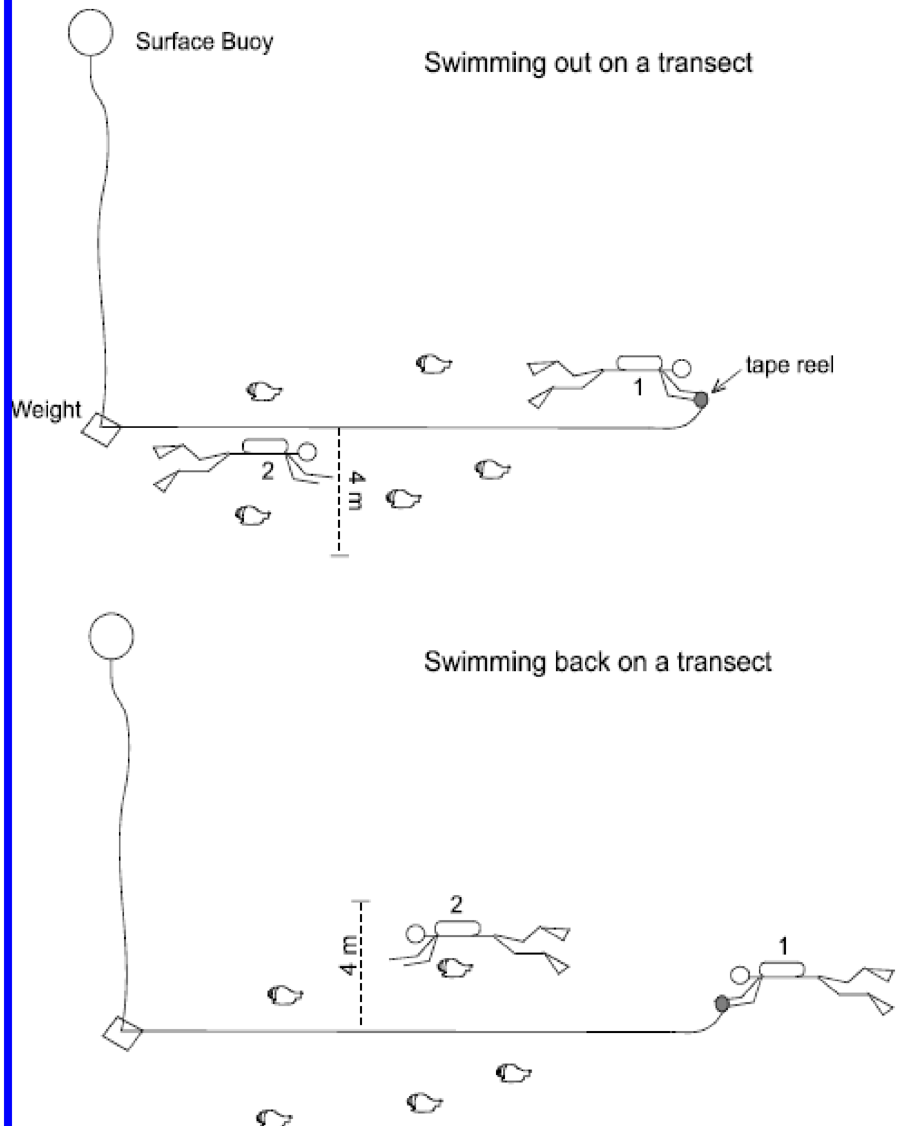
Departamento Archipiélago de San Andrés, Providencia y Santa Catalina
SECRETARIA DE AGRICULTURA Y PESCA

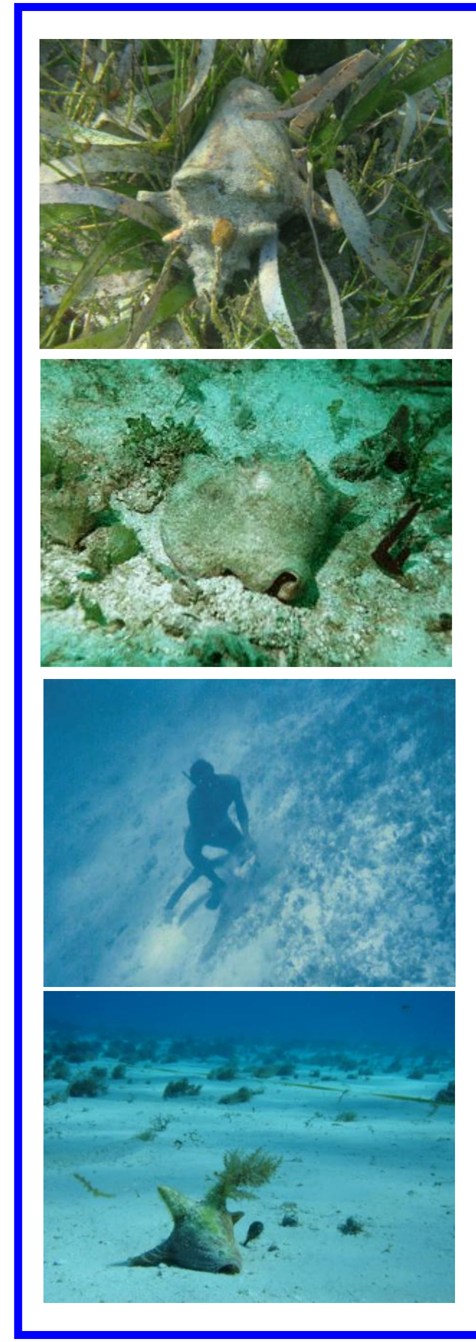
Libertad y Orden
MINISTERIO DE AMBIENTE, VIVIENDA Y DESARROLLO TERRITORIAL
REPÚBLICA DE COLOMBIA


Jamaica
Dominica
Republic
Pedro Bank
Rosanlind
New
Alice
Serranilla
Honduras
Quitasueño
Serrana
Providence
Roncador
Nicaragua
San
Andres
ESE
SSW
Guajira
Rosario
San
Bernardo
Colombia

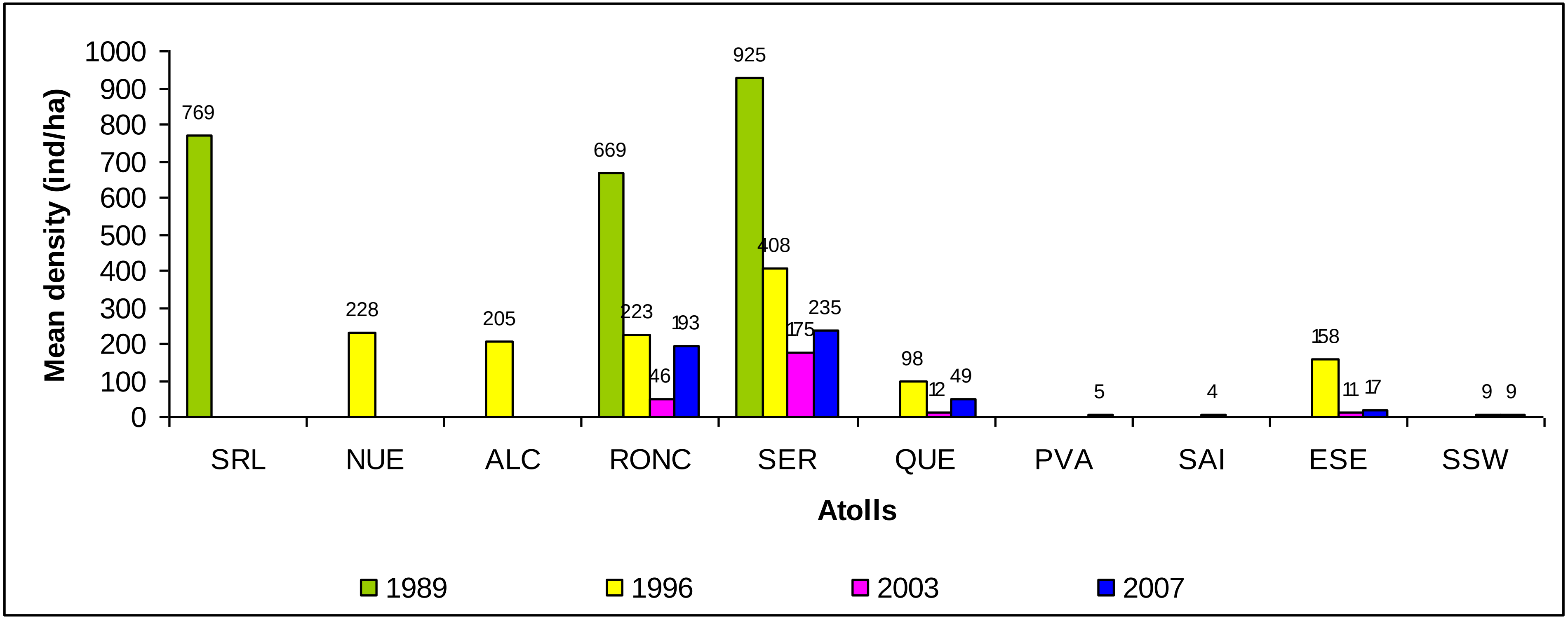
Colombia Queen Conch Population

1. 2007 scientific expeditions.
2. 282 stations six atolls revisited & 69 additional stations.
3. Methods 2003 surveys (Appeldoorn et at. 2003).
4. ≥ 10.7 millions conchs & total of 1,674 mt clean meat,
5. 56% adults & 44% juveniles (varies atoll).
6. 8 Habitat strata: sand & algae, sand & rubble, channels, sparse corals, mixed corals, lagoons, bioturbated sediments, lagunal terrace, pre-reef terrace.

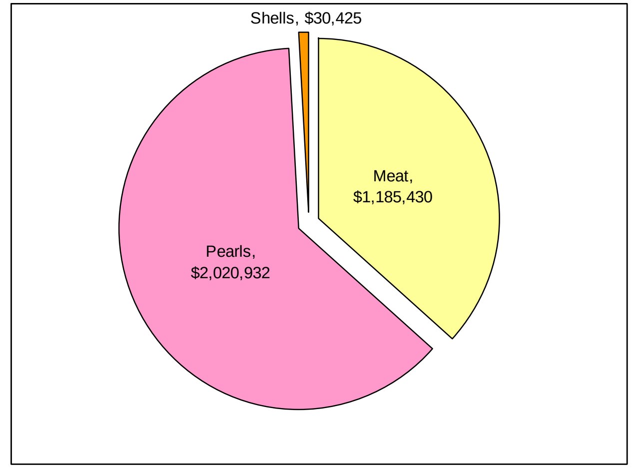

Surface Buoy
Swimming out on a transect
tape reel
Weight
1
2
4 m
Swimming back on a transect
2
4 m
1

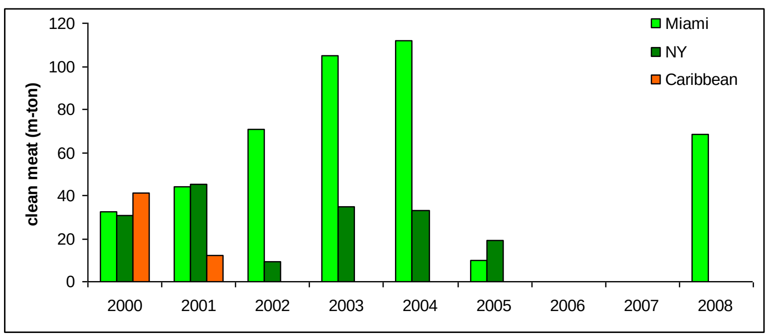


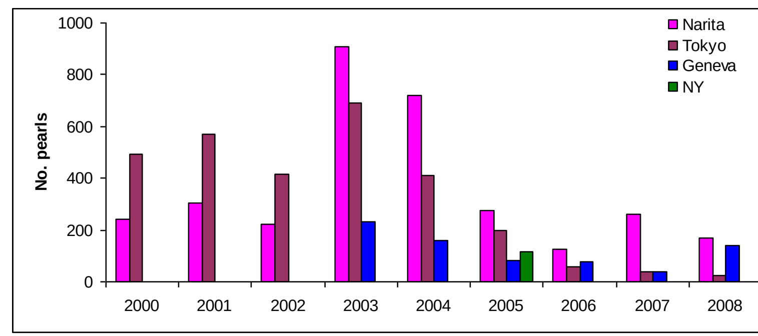
Population Trends

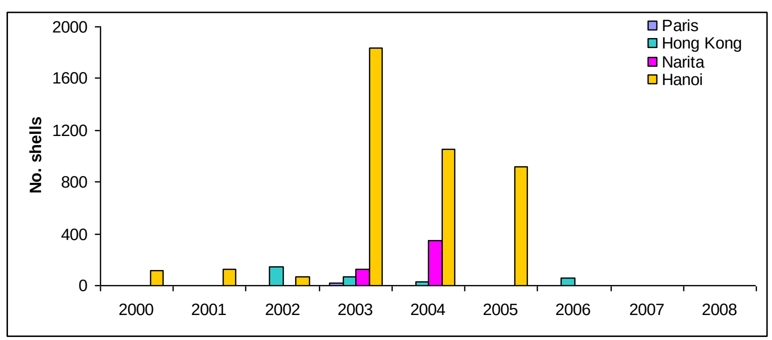


Queen Conch Products



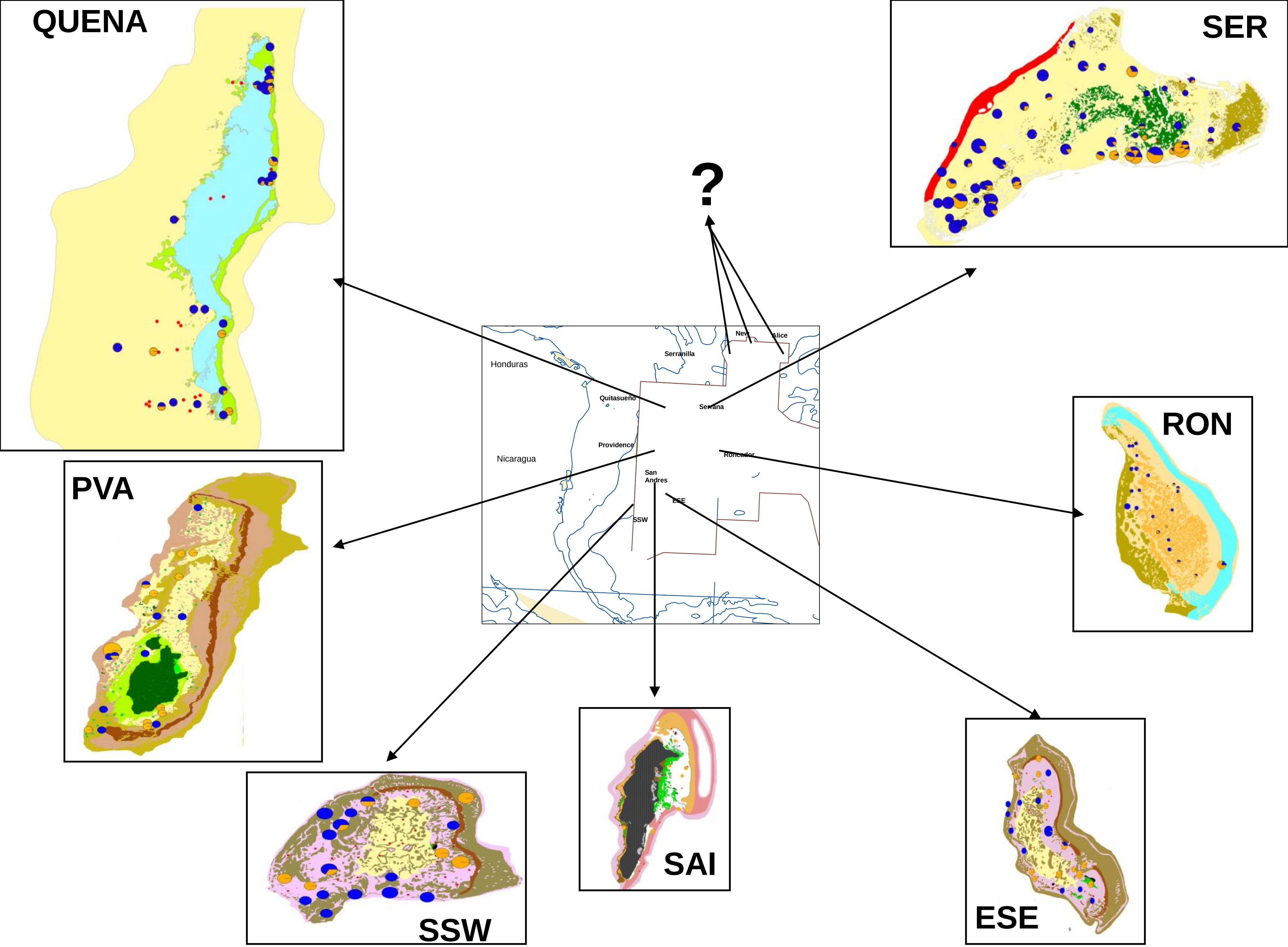






Queen Conch NDFs: Colombia

1. Stock with spatial variability & benthic habitats.
2. Methodology, data analysis and evaluation protocols.
3. Individual non-transferrable quotas to industrial fishers in industrial zones, valid one season & require reporting.
4. TAC introducing precautionary principles
   - Only two atolls fishing (Serrana and Roncador).
   - TAC Serrana 107 mt, use only 15% stock.
   - TAC Roncador 7 mt, use only 9% stock. Benefit regional larval long-distance.


QUENA
SER
?
RON
PVA
SAI
SSW
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Honduras
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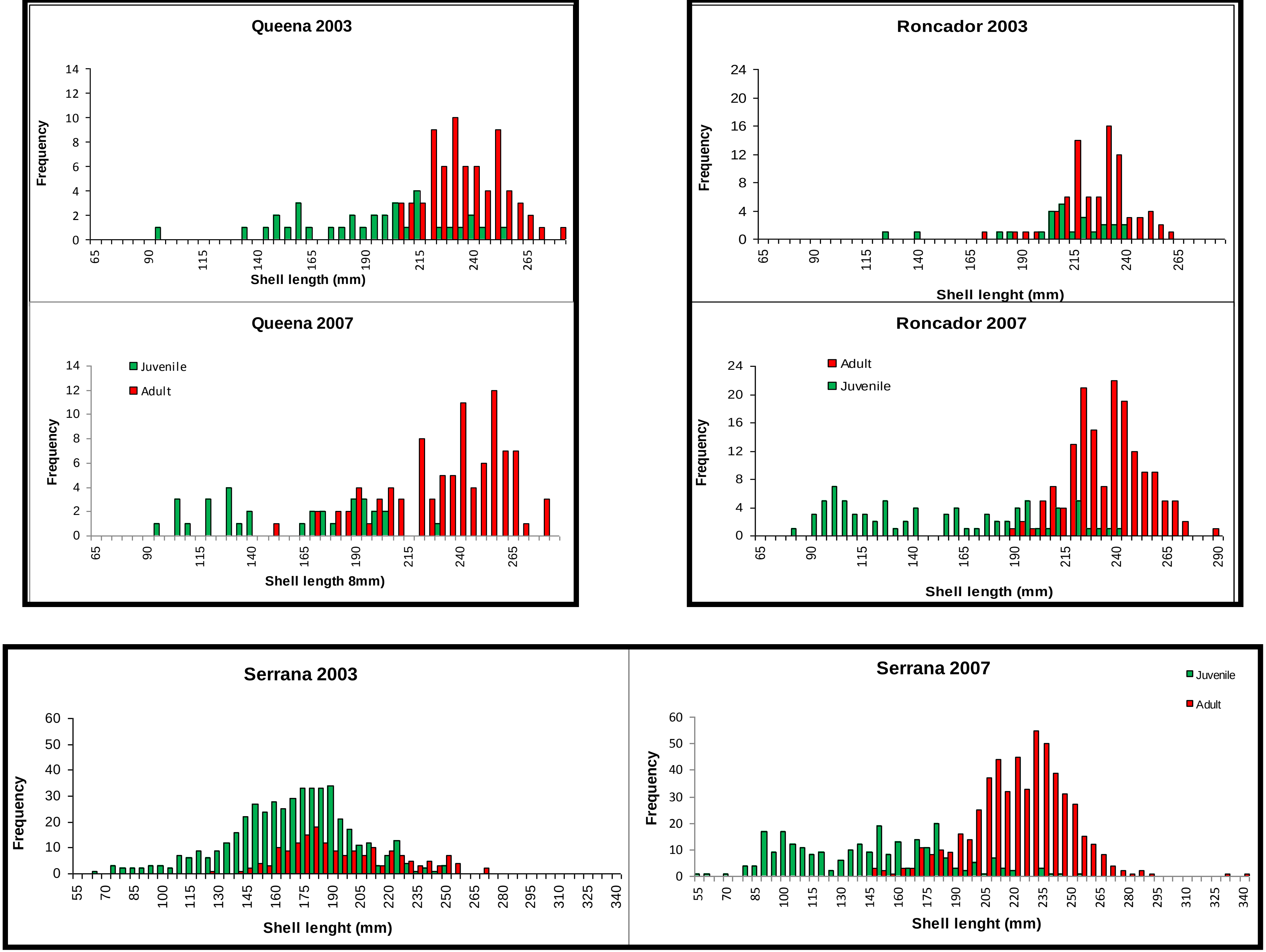
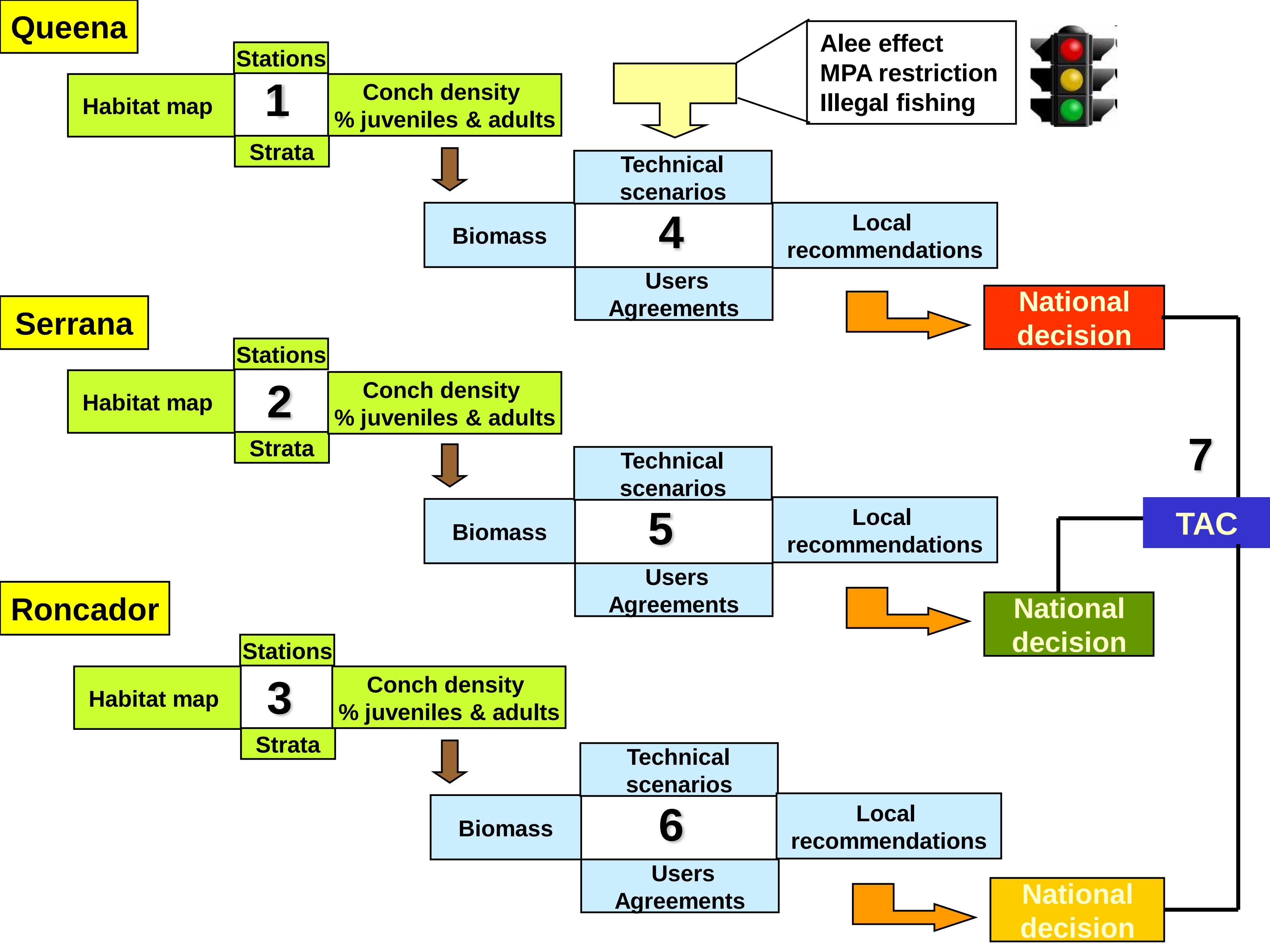
Serranilla
New
Alice
Quitasueño
Serrana
Providence
Roncador
San Andres
ESE
SSW


Queena 2003
Frequency
Shell length (mm)
Roncador 2003
Frequency
Shell lenght (mm)
Queena 2007
Juvenile
Adult
Frequency
Shell length 8mm)
Roncador 2007
Adult
Juvenile
Frequency
Shell length (mm)
Serrana 2003
Frequency
Shell lenght (mm)
Serrana 2007
Juvenile
Adult
Frequency
Shell lenght (mm)


Queena
Stations
Habitat map
1
Conch density
% juveniles & adults
Strata
Alee effect
MPA restriction
Illegal fishing
Technical scenarios
Biomass
4
Local recommendations
Users Agreements
National decision
Serrana
Stations
Habitat map
2
Conch density
% juveniles & adults
Strata
Technical scenarios
Biomass
5
Local recommendations
Users Agreements
National decision
7
TAC
Roncador
Stations
Habitat map
3
Conch density
% juveniles & adults
Strata
Technical scenarios
Biomass
6
Local recommendations
Users Agreements
National decision

Atoll	Estimated No. Individuals	Mean adult density (ind/ha)	Mean % adults		Adult Biomass	Technical Recommendation (mt clean meat)			TAC (mt)	% stock
						Precau tory	Highly Precau tory	Very high precau tory		
Roncador	513,171	110.0	25.7		80	14	7	4	7	9
Serrana	5,929,310	151.0	64.3		725	130	75	33	105	15
Quitasueño	4,008,248	37.5	77.2		667	120	60	30	0	0
Providence	138,542	1.8	57.0		37	na	na	na	na	na
San Andres										
East-South-East	84,501	8.7	51.1		6	na	na	na	na	na
South-South-West	55,037	5.1	59.0		9	na	na	na	na	na
Total	10,728,809				1,674				112	

M = 0.45 by Riter y Efanove (Sparre & Venema, 1989)

3.6 years old, 24 0 mm TL size maturation

Illegal conch Fishing

1. Spiny lobster assessment (Nowlis et al. 2008)
2. ~ 2 to 14% of illegal lobster; ~ 1.4 to 21.8 mt meat.
3. From 3 illegal Hondurans vessels (Steeward Ariel, captain Jones and Tony Jr.), assuming 50% Colombian waters.
4. Interviews experienced captains.
5. Near borders.
6. Use SCUBA (or hookah) & suffer serious decompression sickness.
7. Mother boats & ~ 30 canoes & ~ 60 divers.
8. Honduras (~50%), Nicaragua, Jamaica and the Dominican Republic.
9. Illegal divers ~ 400 (Prada et al 2004), duplicate industrial legal divers.

Queen Conch NDFs: Colombia

5. Participative decision-making to reduce fishing, broader artisanal fishers participation, better conch pearl trade.
6. Large scale stock enhancement activities.
7. Participative research agenda.
8. Educational & outreach industrial and artisanal fishermen, teachers, students, politicians and general public.
9. Promotion international collaborative management & better communication & information exchange.

Enforcement & Surveillance

1. Low capacity & insufficient funds remote areas. Require multi-source funding.
2. Landing meat difficult for bio-ecological indicators & may affect females.
3. VMS in place, but no direct access real time data. No other countries yet in place.
4. Dwarf conch may not meet minimum weights.
5. Need training and collaborative international efforts to overcome political constraints & poor communication.
6. Pearls high value, illegal trading & difficult to control ports and airports.

Queen Conch NDFs: Jamaica (Stephen Smikle)

1. Surveys (Pedro Bank) population & TAC. Surveys in 1990's by industry, since 2000 by government or NGO.
2. Assessment surveys & reports managers, national & international experts. Data quality control.
3. Annual adjustment TAC on useable MSY (exclusion illegal fishing). Illegal fishing interviews and workshops.
4. TAC reduced 3,000 mt 992 to 1999 mt in 1997 to 946 mt in 2004 and 500 mt in 2005, to 400 in 2008.

Queen Conch NDFs: Jamaica (Stephen Smikle)

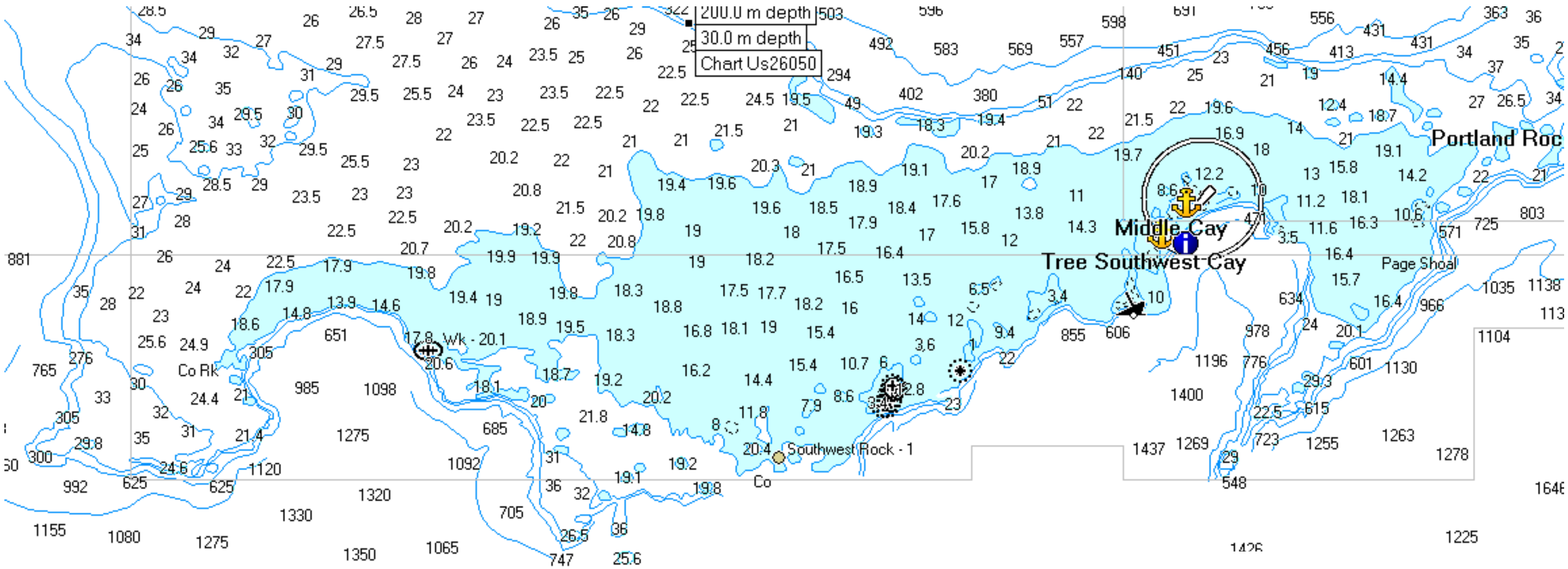
5. Individual non-transferrable quotas to industrial fishers in industrial zones, valid one season & require reporting.
6. The establishment of exclusively artisanal fishing zones, and extension of the closed season.
7. SCUBA & hookah regulated.

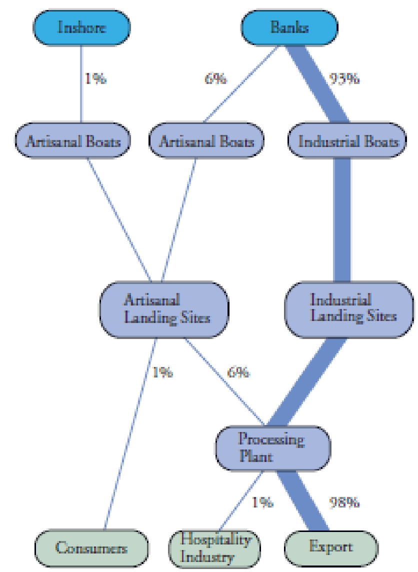
Canadian International Development Agency

CARICOM Fisheries Unit

Government of Jamaica

Pedro Bank

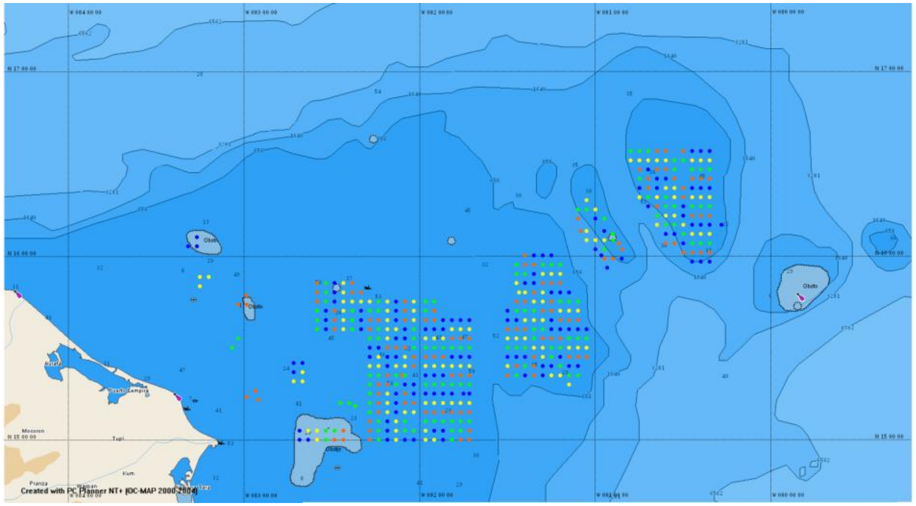


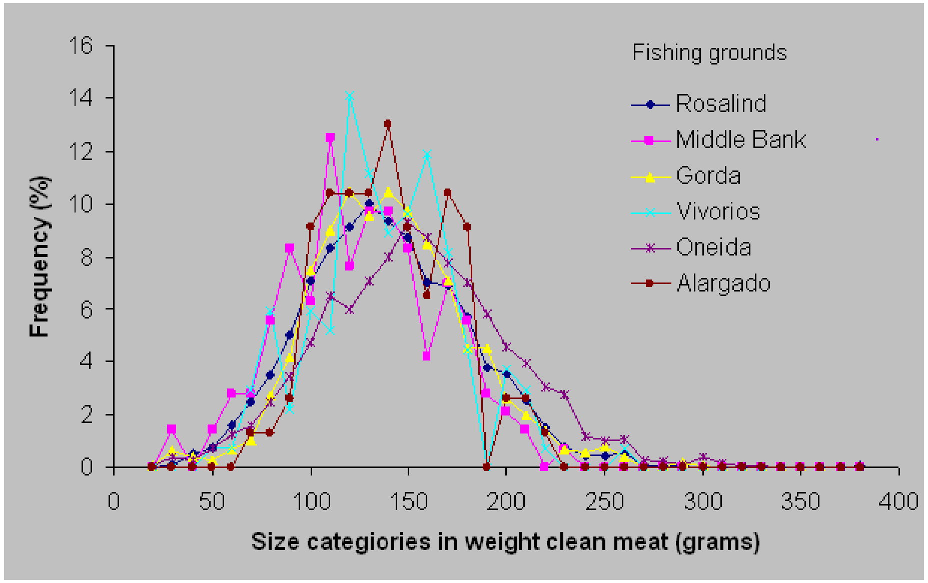


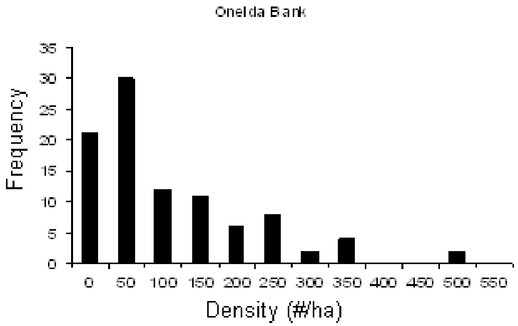
Taken from Jamaica National Marine Fisheries Atlas

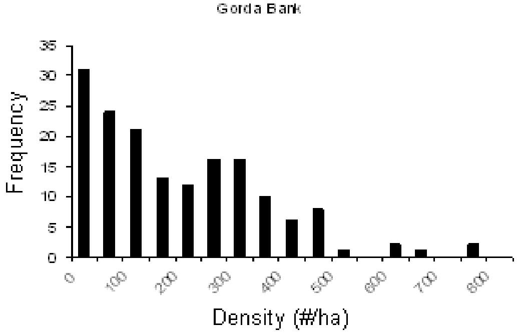
Queen Conch NDFs: Honduras (Dr. Nelson Ehrhardt)

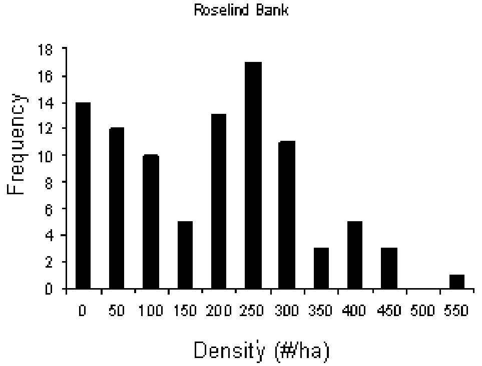
1. Determine level fishing mortality affecting population density to secure reproductive success.
2. In 2005, a 210 mt TAC was authorized to assess annual population densities in 13 fishing banks .
3. Densities appears to be well 56 ind/ha.
4. Future monitoring surveys in conjunction with appropriate statistics to elucidate status of exploitation per fishing bank.
5. Landing supervision, conch inventories processing plants & national trade control.











Taken from: Ehrhardt 2008

Subject	Descriptor	Colombia	Nicaragua	Honduras	Jamaica	D. Republic
Overall status	Actual status	Only two areas open	conch is not directly target	export only from scientific fishing	Only two areas open	no exports permitted
	National production (ton)	96 (2203), expected 112 in 2008	47 (2004), 71 (2005) 113-151 (2006)	1,359 (1991), 1,000 (2003), 210 (2007)	3,000 (1992), 1,999 (1997), 946 (2004), 600 (2007)	~580 -829 (2005)
	% exports	80-90	85-75	90	95	47%?
	Estimates illegal fishing	2 to 14 mt	20% of legal reports		equal or larger than legal reports	
Surveys	stations	351 (2007)	110 (2005)	230 (2006)	63 (2007)	61 (2006)
	station sampling area (m^2)	960	2,070	2,094		1,250
	No. conch survey	19,590 (counted)	83,792 (fished)	(fished)	1,398 (counted)	(counted)
	% adults	56	82	70	64	15
	Length shell (mm)	240-350	105-320			
	Lip width (mm)	17	19.9			5.6
	density estimates (ind/ha)	0.63 to 2,250 (2007)	50-950 (2006)	28-511 (2005)	378 ind/ha (0-10 m depth); 50 ind/ha (10-30 m depth)	0.53 to 114.2 (2006)
	mean density (ind/ha)	158.8 North, 7.8 south	123.5 (204), 230 (2005)	198 (2005-.2006)	124 (1998)	53(1998)
	sex ratio (female/male)	1.03	1.17	1		2.25
	population size	10,728,809			75,474,652	1,076,169

Subject	Descriptor	Colombia	Nicaragua	Honduras	Jamaica	D. Republic
Fishery	industrial vessels	5	22	13	7	40
	canoes/industrial vessel	10	40	45		5
	artisanal boats	90	70			200
	trip duration (days)	20 to 25	12 to 15	17 to 22	15 to 20	
	No. divers	8 to 20	26	40-60	10 to 20	
	CPUE	27 kg/diver/day (2003)	1.32 kg/diver/h (1987)			
	No. fishing banks	10	5	13	1	4
	extension fishing areas (km^2)	~3,200	~4,000	~10,000	~8,000	
	processing facilities	2	15		18	
Manage ment	CITES TAC (ton)	112 (2008)	114 (2006)	210 (Scientific)	400 (2008)	n.a.
	closed season	Jun 1 to Oct 31	Apr 1 to Sep 30		Aug 1 to Jan 5	Jul 1 to Oct 31

Recommendations: Population stability

1. Regional control illegal fishing & useable MSY for TAC.
2. Minimum spawning population density in management.
3. Regional connectivity studies larval supply & connectivity.
4. Strengthen precautionary approach if dominance very old adults (low recruitment) or juveniles (reduce reproductive output).
5. Deep water stocks critical to stocks in shallow areas.
6. Promote bi-national agreements to regional management strategies and policies.
7. Coordinated research and collaborative management to ecosystem based management. Need to agree on reference points.
8. CITES may continue acting as a dominant force in enforcement.

Recommendations: Conch Meat

1. Adjust meat weight regulations to equivalent processing categories accepted south-western Caribbean.
2. Facilitate national and international discussion about closed season to include all spawning peaks. compensation measures need to be allocated.
3. Find economic alternatives to promote reduction of fishing pressure in artisanal fishing zones.
4. Introduce essential fish habitat when establishing marine reserves.

conch meat landed	Description	Honduras % losses	Nicaragua % losses	Dominican Republic % losses	Jamaica % losses
50% - 65 clean	Animal gutted and operculum removed.	44	45		12
75 - 85% clean	Additional removal of mantle, eyes, proboscis and skin.	55.8		25	28.2
100% clean	Only clean meat (except in Colombia where the operculum remains).	61.4	60	42	42.9

Recommendations: Conch Pearls

1. Adopt protocol: TAC, mobilization certificates, strengthen controls, appropriate fees, education & outreach & research.
2. TAC will consider adult population & proportion pearl production. San Andres archipelago 1:1,025 (Ortegón 2006). But, fraction export quality.
3. Need link trade with fishing licenses. Require 100% pearls reported.
4. Strength enforcement mechanisms: a) dedicated hot line; b) special operations at landing sites & jewelry stores; c) ID to legal traders; d) informative campaigns & responsible conch fisheries conducts.

NON DETRIMENT FINDING FOR CITES-LISTED *CORALS* IN THE QUEENSLAND CORAL FISHERY

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I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names

Please see Table 1 for CITES-listed species/genera collected in, and sometimes exported from, the fishery.

1.2. Distribution

Based on the best available information (Roelofs and Silcock, 2008), all but four CITES-listed species/genera collected in the QCF have widespread distribution throughout the Indo-Pacific region. One of the four genera, *Dendrophyllia*, has a comparatively more restricted distribution, though it is commonly found throughout the West Pacific. Two other genera/species (*Duncanopsammia axifuga* and the genus *Balanophyllia*), while found throughout the West Pacific have the potential to be locally rare. The mussid *Acanthastrea lordhowensis* is thought to be regionally endemic.

1.3. Biological characteristics:

1.3.1 *General biological and life history characteristics*

Corals can be divided into two very distinct groups, based on whether or not they have a symbiotic relationship with tiny algae called zooxanthellae. *Zooxanthellate* corals derive much of their energy source from the photosynthetic products of the microalgae, consequently they require habitats with at least some exposure to light. *Azooxanthellate* corals do not have this symbiosis and can live in darker habitats – relying solely on catching plankton or absorption of nutrients from the water column for food.

There are several different genetic strains of zooxanthellae that appear to confer different levels of thermal tolerance to the corals that harbour them. Evidence is emerging that suggests corals can switch zooxanthellae to suit their particular environmental conditions (Baker, 2001) – how this process works exactly and the role that it might play in improving resilience to localised events such as increased sea surface temperatures (the main risk factor for coral bleaching) is yet to be understood.

Corals can also be divided into *hermatypic* (reef-building) or *ahermatypic* (non-reef building) types. This division prompts some debate but for the purpose of this report, the term hermatypic will be used to describe corals that contribute significantly to the calcium carbonate reef matrix, regardless of whether they are zooxanthellate or not (Schumacher and Zibrowius, 1985). Most are in fact zooxanthellate.

Corals have a wide range of reproductive and growth strategies and many species exhibit considerable flexibility in response to stress or particular environmental conditions. Only the hard corals collected in this fishery will be discussed in this report. For colonial species of hard coral there is a blurring between growth and reproduction. Coral polyps are grouped together in a limestone formation – they grow via continual calcification (accretion). Polyp density is maintained in the growing colony by continual division of polyps (particularly the polyps at the tips of branching corals or the leading edge of other growth forms).

Depending on conditions, most corals can reproduce both sexually and asexually. *Asexual reproduction* can be via *fragmenting, budding, polyp bail out* (a stress response involving just the polyps), *polyp expulsion* (occurs in apparently healthy coral and includes both the polyp and part of the skeleton), and *asexually brooded planulae* (competent larvae). *Sexual reproduction* can be equally plastic under different conditions. Corals are generally either *hermaphroditic* (both sexes in the same colony) or *gonochroic* (different sexes in different colonies)

—some corals e.g. *Porites porites* can switch sex. There are two main reproductive strategies— *brooding* or *broadcast spawning* (which can vary also in response to environmental conditions). Brooders are usually hermaphrodites and self fertilise. Broadcasters release eggs and sperm into the water column – they can be hermaphroditic or gonochroic. The slight majority of corals appear to be primarily hermaphroditic, broadcast spawners (Borneman, 2001).

Life history traits are frequently grouped as being either 'r' or 'k' strategies. For corals – *'r' strategists* are often the 'pioneer' species (e.g. the acroporids and pocilloporids) – corals that reproduce frequently, in large numbers (but with high mortality rates for the offspring), have shorter lifespans and small to medium colony sizes. The *'k' strategists* are frequently brooders and put energy into longterm growth (e.g. the faviids and *Porites* species). These species have large, long-lived colonies, less frequent sexual reproduction and lower juvenile mortality rates. However, most corals sit somewhere in between these two extremes (Borneman, 2001). In most species of hard corals, sexual maturity is reached between 3-5 years old and for most species, the onset of reproductive activity appears to be closely related to colony size, area and branch length – depending on the species (Borneman, 2001).

Given the plasticity of most life history characteristics, vulnerability indices have been generated for species in this fishery based on environmental and ecological factors (accessibility/ habitat/ ecological niche/ distribution/ susceptibility to bleaching/ relative abundance on the Great Barrier Reef) that influence their potential vulnerability to harvesting activities. This was used as a pre-assessment tool for a subsequent ecological risk assessment of the QCF (for full details see Roelofs & Silcock, 2008). The results for the CITES-listed hard corals collected in this fishery can be seen in Table 1. It is interesting to note that of the 52 genera/species collected in the fishery, 31 have a low susceptibility to bleaching.

1.3.2. *Habitat types*

Please refer to Table 1 for details. Of the 52 CITES-listed genera/species collected in the QCF, 10 are listed here as habitat specialists (that is they have a limited or defined niche). These are: *Plerogyra, Catalaphyllia, Heteropsammia, Caulastrea, Diaseris, Cycloseris, Montipora, Symphyllia, Scolymia* and *Trachyphyllia.*

Several of these genera are either solitary corals (e.g. *Cycloseris*, or are routinely found in relatively great abundance in deeper, more turbid, inter-reefal areas. The rest of the genera are identified as habitat generalists and are found in a wide range of habitats and depths –

more commonly on reefs than off. Based on the information in Table 1, 12 of the 52 CITES-listed genera/species found in the QCF are readily accessible (that is, they are found in depths less than 5-10m). With the exception of the genera *Diaseris* and *Montipora*, these are not the same genera as those that are habitat specialists (listed above).
Broad habitat types for each species/genus were included in the Vulnerability Assessment.

1.3.3 *Role of the species in its ecosystem*

A broad range of coral species is collected in this fishery —some species are hermatypic. These tend to be either fast growing species— such as the acroporids and pocilloporids, or the slower growing 'massives' such as the poritids, plus there are several other genera that contribute in various ways to constructing the fabric of a coral reef.

However, there are many other species that, while they are found on coral reefs, are more commonly described as ahermatypic corals. Some species in this group are free-living e.g. fungiids, while others are more likely to form colonies (or live as clusters of individuals) in inter-reefal waters – generally these are sandy or muddy environments, sometimes with some semi-submerged hard (rock) substrate present. Little is known about the explicit ecosystem function of these species, other than they contribute to the biodiversity of the system and, at a smaller scale than true reef-building coral species, provide habitat for other species. Some species are able to survive well across a range of habitats. See Table 2 for a summary of the reef-building status of hard coral genera/species in the QCF. The majority of the species exported in any quantity[1] from this fishery are ahermatypic (12/19 species).

Inter-reefal habitats have traditionally received minimal research attention so little is known about the ecosystems they support. Because most coral scientists focus on reef communities and particularly the reef building or fast growing species of coral, other species that are infrequently encountered on coral reefs have, in the past, been labelled as rare. In many cases this apparent rarity is belied by anecdotal reports that these same species can be extremely prolific in specific kinds of inter-reefal habitats (see section 1.3.2.)

On the Great Barrier Reef, recent research on the habitat impacts of the otter trawl fishery has produced thousands of hours of towed video transects of the seafloor (Pitcher *et al*., 2008). While this research was unrelated to the coral fishery it has provided insight into the

[1] More than 100 pieces over two years.

nature of the various inter-reefal habitats and does corroborate the existence of extensive beds of ahermatypic corals – however the footage needs further spatial and taxonomic analysis if it is to be used quantitatively for estimating stock status of various species in the Queensland coral fishery.

1.4. Population:

1.4.1. *Global Population size*

This is difficult to estimate given current lack of published information on actual regional stocks of each species across all habitats in the area. Results from a recent assessment of the conservation status of 845 zooxanthellate hard coral species[2] provide a valuable means of setting priorities for biodiversity conservation at a coarse global scale. Of the 704 species with sufficient information to attempt a classification under this risk-based framework, 32% were classified as having an elevated risk of extinction, due, primarily, to global loss of coral reef habitat.
However, the approach does have limitations that include:

- Application to ahermatypic[3] corals. Many species that occur regularly in the aquarium trade, and appear to be found in greatest abundance in inter-reefal areas are not generally considered hermatypic. Note, on the Great Barrier Reef, coral reef extent represents only about 6% of the total area (~20,724km^2) – the rest is composed of a range of inter-reefal habitats. Because scientists and other divers (except the aquarium collectors) rarely go to these places (due, in part, to scientific diving depth regulations, turbidity, and for recreational users – lack of interesting 3-D structure), independent corroboration of these anecdotal accounts of extensive inter-reefal stocks of several species has been, and remains, difficult in most parts of the world.
- Inability to use 'local knowledge'. The IUCN approach relies heavily on scientific expertise and published information – most of which does not cover the species in the aquarium trade in any detail. Currently, this approach does not appear to incorporate regional, unpublished "local" (non-scientific) knowledge into the consensus process, although the methodology could allow it to do so.

[2] This study used the IUCN Red List criteria, current information on global hard coral cover and reef extent, and the best available scientific consensus to adjust this physical proxy at a species level (based on specific life-history characteristics and known vulnerability to various disturbances e.g. bleaching, COTS etc.) to classify the conservation status of a significant number of hard coral species. For details see Carpenter et al., (2008).

[3] non-reef building corals – as previously defined.

It is worth noting that coral reefs are naturally dynamic places and coral cover varies enormously at both temporal and spatial scales, even on relatively healthy reefs (see data from the Australian Institute of Marine Science Long Term Monitoring Program[4]). Therefore, care needs to be exercised in making assumptions when using information on reef-based coral cover.

There is no doubt that coral reef ecosystems are particularly vulnerable to various forms of disturbance and the cumulative impact of poor water quality, coastal development, anchor and diver-related damage from high levels of recreational use and the removal of critical components of the ecosystem due to assorted fishing activities. However, assumptions that published results from sometimes relatively small coral cover surveys (potentially targeted around known damaged sites at reefal habitats) represent a good regional picture may result in a significant underestimate of coral ecosystem health and indeed individual species status at a regional scale. It may also have implications for making a CITES non-detriment finding at either a species or (multispecies) fishery level for a region.

1.4.2 *Current global population trends*

___increasing __X__decreasing __X_stable (regional scale) ___unknown

It is difficult to generalise across the broad range of species used in the aquarium trade. Based on current available information, at a global scale, coral cover and reef area appear to be declining. However, at a regional scale, some places (like the Great Barrier Reef) appear to be relatively stable[5].

Actual status of any given region depends on recent incidence of disturbance (e.g. COTS, bleaching, coral disease, cyclones) and relative resilience of the ecosystem in the face of other cumulative pressures (e.g. how diverse the ecosystem is, how intact the trophic structure is given local fishing pressure, what impact coastal development has had, plus relative coastal water quality given historic and current land use practices etc).

The real concern is: given the range of current predictions for climate change impacts on coral reef ecosystems (including increased sea surface temperature and increased ocean acidification – what state will regional coral reef ecosystems be in, in 10-20 years time? The

[4] http://www.aims.gov.au/source/research/monitoring/pdf/status-report-08-20080616.pdf.

[5] Compared with other reefs; noting the dynamic nature of coral reefs and previous comments about a general lack of information on inter-reefal habitats in global coral ecosystems.

opportunity before us is to determine how the CITES framework can be strengthened (and integrated with other international conventions) to empower people to improve local scale stewardship and thus ensure that coral ecosystems are more resilient to future threats.

1.5 Conservation status

1.5.1 *Global conservation status* (according to the IUCN Red List)

___Critically endangered	_X__Near Threatened
_X_Endangered	_X__Least concern
_X_Vulnerable	_X__Data deficient

CITES –listed species collected in the QCF range from 'least concern' to 'endangered', and some are data deficient (see Table 2). Species that are frequently exported from the QCF are mostly listed as near threatened under the IUCN *classification. Where only genera are identified (the second part of the Table)* in the QCF the full range of IUCN listings are provided. Four genera in this section include listings of endangered (EN) and one genus includes a listing of critically endangered (CR). This result requires further investigation, however it is unlikely that these classifications are true for the Great Barrier Reef region (see Roelofs, 2008).

1.5.2. *National conservation status for the case study country*

All Scleractinia (hard corals) plus Helioporidae (blue corals), Milleporidae (fire corals), Stylasteridae (lace corals) and Antipatharidae (black corals) are listed under Appendix II of CITES, and, therefore are covered by the *Environmental Protection and Biodiversity Conservation Act* (the primary Australian environmental legislation and the legal instrument to give effect to CITES obligations).

In the Great Barrier Reef Marine Park (GBRMP) and World Heritage Area, the *Great Barrier Reef Marine Park Act* and *Regulations* list all corals (all species of the classes Anthozoa and Hydrozoa) as no-take, except via a permit. This position is consistent with State Marine Park Legislation (see 2.1.3.).

1.5.3 *Main threats within the case study country:*

___No Threats
_X_Habitat Loss/Degradation (human induced- coastal development & inshore habitat loss)
___Invasive alien species (directly affecting the species)
___Harvesting [hunting/gathering]
_X_Accidental mortality (e.g. e.g. anchor damage/ship groundings)

___Persecution (e.g. Pest control)
_X_Pollution (affecting habitat and/or species –water quality and sediment load from land-based activities)
_X_Other: Climate change (bleaching/flooding/acidification/sea level rise/increased Sea Surface Temperature (SST)/coral disease)
___Unknown

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1. Management measures

2.1.1. *Management history*

- Coral has been collected for various reasons from the Great Barrier Reef for more than 100 years.
- Historically (at least between the 1840s and the beginning of World War II) thousands of tonnes of coral were mined and removed from nearshore waters, along with considerable quantities of coral sand (this was mostly done under a rudimentary permitting system). Generally, the coral was crushed (and sometimes burnt) to produce lime to fertilise the adjacent acid sulphate soils that were farmed extensively (along much of the Queensland coast) for sugar cane; some was used as a setting agent to manufacture raw sugar. Prior to 1900, coral was used for construction (refer to Daley, 2005 for historic details and evidence of extensive modification of nearshore reefs and coral cays and islands during this period).
- As tourism developed on the Great Barrier Reef – considerable quantities were souvenired by visitors, from popular locations. Some coral was transplanted also, to improve amenity values around at least one of the early tourist resorts (Daley, 2005).
- Significant research collections were made and sent to museums and research institutions around the world – particularly pre-1960 (Bowen and Bowen, 2002). In modern times, researchers continue to collect coral from the GBR for research purposes, under a permitting system.
- A ‘fishery’ has been regulated since 1932 by the State of Queensland (Harriott, 2001). It has been limited entry and quota-based since 1997.
- Up until the 1990s the vast majority of the coral collected in the fishery was the fast growing acroporid and pocilloporid species favoured for the ornamental trade. Over the last 20 years advances in aquarium technology (and reductions in the cost of aquarium equipment) have shifted the market focus towards small colourful species

of coral (often the large-polyped/solitary hard corals and, increasingly, the soft corals, zooanthids and corallimorphs) and coral rubble/rock for the live aquarium trade.

- In 1975, the Australian government established the Great Barrier Reef Marine Park (GBRMP) via legislation and set up the Great Barrier Reef Marine Park Authority to manage the conservation, sustainable use, understanding and enjoyment of all the natural resources within the marine park boundaries. At this time all mining, including oil and coral mining, was banned in the marine park.
- The GBRMP covers an area of 345,400 km^2, of which around 6% is coral reef habitat[6]. Since its establishment, a system of zoning has been progressively implemented to ensure that all activities in the GBRMP (e.g. tourism, recreation, fishing, shipping, etc) are managed, based on their relative levels of impact. The zoning system includes substantial representative areas that are no-take, and in some cases, no-entry. Currently about 33% of the marine park is closed to all forms of fishing – this includes a minimum of 20% protection for each of the total area of some 70 bioregions (unique benthic habitats). The Australian and State governments work together to implement the day-to-day compliance framework for these multiple layers of management.
- In 2000, closure of the coral fishery was considered, following calls from the tourism industry. Detailed investigation (including an independent review – see Cartwright *et al.*, 2002) identified that the fishery was poorly understood and management arrangements were inadequate, based on current practices (noting the shift to species of coral used in aquaria) but there were no sustainability grounds for closure[7]. The outcome was that over about four years, managers from the GBRMPA, the DPI&F and the EPA worked closely with the fishers and other interested parties to completely restructure the management arrangements for the fishery.
- The policy giving effect to the new arrangements was implemented in July 2006 by the DPI&F. All catch information presented in this report relates to the new management arrangements. The policy framework for the coral fishery allows for adaptive management

[6] The remainder includes significant inter-reefal areas and a range of other habitats.

[7] It is important to note that while management arrangements were out of step with collection practices by the 1990s, corals were still afforded protection on the GBR through the following management: no recreational take and commercial collection that was restricted to a small number of operators in shallow, site-specific areas with a small fixed quota per location.

and in early 2008, a review of the new policy was completed, based on 18 months of detailed logbook data. As a consequence of the review, some changes have been recommended and these are currently going through a process of public consultation prior to implementation.

- At the time the Coral Policy was implemented, the new arrangements for the fishery were assessed also under the national Environmental Protection and Biodiversity Conservation Act[8] and given export approval, for the first time since hard corals were listed under CITES. This EPBC Act 'sustainable fisheries' assessment process is also the legal instrument by which the CITES NDF assessment is completed (See Table 3 and http://www.environment.gov.au/coasts/fisheries/publications/pubs/guidelines.pdf for more details). The sustainable fisheries assessment process is risk-based and intended to promote adaptive management, based on sound information.

2.1.2 *Purpose of the management plan in place*

Coral collection in the GBRMP operates under multiple management layers – consequently, to address this item, the stated purpose of each is listed individually below. However, to understand the management arrangements, the layers should be regarded as an integrated package.

State Management arrangements – see http://www2.dpi.qld.gov.au/extra/pdf/fishweb/coralreefpolicy.pdf for details of the current version of the policy *(DPI&F Policy for the Management of the Coral Fishery[9])*:

- To provide for ecologically sustainable use of coral – particularly to ensure that a precautionary approach is taken to the risk of localised depletion[10] if all collection was concentrated in a given area and to ensure that not all the 200 tonne quota is taken as "live" coral (the species favoured in the aquarium sector of the fishery)
- Reduce conflict with other user groups
- Enhance potential export opportunities

[8] This legislation (Part 13A of the *EPBC Act*) is used to meet CITES obligations – the Act also provides an assessment framework for every Australian Fishery that exports native product and every fishery that interacts with national listed protected species, regardless of whether product is exported or not. National standards have been developed to guide the ecologically sustainable management of fisheries.

[9] The Coral Policy has recently been reviewed, minor amendments have been recommended and these proposals are currently out for public comment.

[10] Now termed 'ecologically unsustainable harvest'

GBRMPA arrangements (permits issued jointly with the State EPA) and jurisdictional framework:

- To ensure that the natural resources of the marine park are conserved, that any use is ecologically sustainable (and equitable), and that the ecosystem is understood and enjoyed
- That cross jurisdictional arrangements are well integrated and complementary
- To ensure that all use of coral is monitored (because hard coral is listed under CITES and hence is addressed under the *EPBC Act*) – the collection may only occur via permitting, which carries with it reporting requirements.[11] For this reason, no recreational (unpermitted) take is allowed in the GBRMP.

2.1.3 *General elements of the management plan*
In combination, the current range of multi-jurisdictional and non-legislative management arrangements is as follows:

- Under both the GBRMP and State marine park legislation, all take of coral must be done under a permit. Permits can be issued for the purpose of a limited entry fishery; for conducting research; dredging shipping channels/removal for permitted works in the marine park; and limited coral transplantation to improve amenity value for site-based tourism activities). Permit applications for other purposes will be assessed on a case-by case basis but are unlikely to be granted. This means there is no 'as of right' (recreational) take of coral in the GBRMP World Heritage Area. The State Environmental Protection Agency (EPA) and the Great Barrier Reef Marine Park Authority (GBRMPA), have a collaborative assessment and permitting process for coral collection for the purposes previously identified.
- Under the Queensland *Fisheries Act and Regulations* coral is defined as a 'fish' and can be collected via a limited entry fishery (using Hookah or SCUBA gear) and recreationally (where only a snorkel may be used). Because recreational collection is prohibited in all marine parks including the GBRMP, there are very few areas where recreational Limited entry —59 licences (however there are only about 24 operators in the GBRMP as several hold multiple licences—this means that the overall "footprint" of the fishery is very small).
- Limits on the number of boats and collectors that can operate under a licence at any given time

[11] Note also the early history of coral mining/souveniring on the GBR – the introduction of the GBRMP was partly to ensure that such a level of these activities never occurred again.

- Collection by hand or handheld implements (e.g. hammer and chisel) only
- Catch reporting via mobile phone, prior to landing (to enable compliance checks on arrival in port and to allow real-time quota debiting to minimise quota slippage)
- Detailed logbook reporting, to the level of dive site.
- Catch and catch composition is monitored collaboratively by managers to the level of reef (dive sites if necessary) and to the best taxonomic resolution available through the logbooks. Noting that many species of coral require microscopic examination to finalise identification - species have been grouped to the finest resolution that is possible/reliable through field-based identification. This ensures that fishers are more likely to complete the detail required in the logbook, which, in turn, allows managers to have confidence in the quality of the fishery-dependent information. However, this approach does not, in all cases, achieve the level of reporting specified under CITES
- A comprehensive Ecological Risk Assessment (ERA) tool that takes account of accessibility, vulnerability to disturbance, life history characteristics and collection pressure, then calibrates against local and scientific knowledge systems and provides a risk ranking collection can occur in Queensland.

COMMERCIAL FISHERY

- Total Allowable Catch (TAC) of 200 tonnes per year. This TAC is further split into: 70% can be taken as coral rock/rubble or fast growing coral species (acroporids or pocilloporids only) and 30% taken from all other coral species. The 30% cap includes species that may be relatively uncommon, or have more complex life history characteristics that could make them vulnerable to high levels of collection. It also includes soft corals, zooanthids, corallimorphs and other species that are not CITES-listed. It is worth putting the scale of collection in this fishery in perspective - 1 tonne of live rock represents approximately 25m^2 (equivalent to the size of one car parking space at a shopping centre). Normal functioning coral reef systems produce significant quantities of live rock due to natural processes every year (see ecological risk assessment for live rock in: Roelofs, 2008). Harvest of live hard corals in the QCF represents a miniscule fraction of what naturally accretes in a year on the Great Barrier Reef.
- Defined fishery area (between latitudes 10o41'S and 24o30'S) that amounts to 345,400 km^2 of coral reef ecosystem (Figure 3). Subject to GBRMP zoning rules – around 60% of this area is available to

collectors. Two areas of relatively concentrated collection within the GBRMP have been further defined (see Figures 4 & 5)[12]. Review reference points (of 43 tonnes and 36 tonnes respectively) have been established for each of these areas to provide a transparent tool to assess fishery performance and, if needed, a mechanism to further constrain catch to minimise the risk of localised depletion.

- with respect to depletion for each species of coral collected in the QCF. The first iteration in late 2007 indicated that one genus of hard coral was ranked as moderate risk (*Montipora*)[13] – everything else emerged as a low vulnerability risk. It is intended that this assessment will be reviewed as more information becomes available. The report describing this assessment is currently being finalised and will be publicly available from the DPI&F website in the near future. This tool will be explained in detail at the workshop.
- A Performance Measurement System (PMS) – this harvest strategy tool is currently under development. This will prescribe review reference points and response frameworks to ensure that species identified with any risk rating (in this case, low risk) and export species are closely monitored spatially and temporally. Other species can be monitored as required. The PMS will be reviewed regularly. This tool will be explained in detail at the workshop.
- An Environmental Stress Response Plan – also in development. Essentially this is a cross cutting tool that grew out of a localised, but extensive, bleaching event on the Great Barrier Reef and subsequent public concern about whether coral collectors might be further impacting already damaged reefs. It is designed to assist managers, fishers and the public to take a transparent, structured, objective approach at a local scale (over and above existing management measures) whenever a significant disturbance event occurs. Note disturbance can be caused by a range of factors such as bleaching, freshwater incursions, flooding, cyclone damage and Crown of Thorns starfish (COTS) infestations. It relies on recognised external monitoring programs (such as the GBRMPA's 'Bleachwatch' (http://www.gbrmpa.gov.au/corp_site/key_issues/climate_change/management_responses/bleach_watch2.html) and "Eye on the Reef" type programs, (e.g. http://www.gbrmpa.gov.au/corp_site/doing_your_bit/become_involved_and_help_protect_the_reef) to identify

[12] Aquarium trade collection requires land-based holding facilities and good access to air freight. Historically, collectors have focussed their efforts around places where suitable habitat is found close to the coast and to major urban centres with reasonable sized airports.

[13] Note this genus is not a dominant catch component; however it will be monitored closely over time.

the extent of the problem and therefore trigger the response plan. Depending on the severity of the impact, a range of possible actions (including various levels of voluntary non-collection and temporary regulatory closures) and timeframes are identified in the response plan. Importantly, the mechanisms to monitor the situation and review actions are also defined – so in the event of reef recovery, voluntary or mandatory actions can be removed in a timely manner. This tool will be explained in detail at the workshop.

- In addition, the fisher's representative body Pro-Vision Reef Inc. has compiled a Code of Conduct that identifies their current approaches to best practice collection and voluntary response plans for various levels of disturbance (the Approach taken in developing the Environmental Stress Response Plan complements this initiative). This is part of a comprehensive industry-developed stewardship approach that ultimately will form the backbone of an auditable accreditation program. Another industry initiative is currently being trialled - a pilot monitoring program that tracks anemone numbers and densities and monitors recovery of bleached corals in the vicinity of coral collecting dive sites.

2.1.4. *Restoration or alleviation measures*

RESTORATION

No *fishery-focussed* restoration measures are required at this time. The level of take is miniscule relative to the area of reef (and inter-reefal) habitats available to collect from, noting that more than 30% of the fishery area is protected in a comprehensive network of no-take zones as well. It is important to acknowledge that coral ecosystems do exhibit considerable natural variation in species composition and per cent coral cover at a range of spatial and temporal scales. Based on information from the Australian Institute of Marine Science Long Term Monitoring Program the majority of reefs in the GBR are in reasonable condition, though this fluctuates at a regional scale over time and depends (primarily) on the status of COTS and coral disease in the area (http://www.aims.gov.au/source/research.monitoring/pdf/status-report-08-20080616.pdf). Current management measures for the GBRMP are focussed on maintaining ecosystem health and minimising the impact of use to ensure that under current conditions, restoration is not needed.

However, if required, site-based tourism programs do have limited access to strictly controlled coral transplantation permits. This process has been set up to deal with situations when the amenity value at designated tourism sites deteriorates (for a range of reasons including

COTS outbreaks) and small-scale transplantation is deemed to be the most appropriate and least impacting solution (as opposed to relocating the program to another undamaged location). This approach has been used only rarely, is extremely costly and has a strict management framework in place to ensure that it is a last resort after other measures have been explored. Guidelines have been developed to ensure that donor areas (must be within 500m of the recipient site and on the same reef to prevent translocation) have healthy levels of coral cover to begin with and will be minimally impacted by removal of coral for the recipient site (http://www.gbrmpa.gov.au/corp_site/key_issues/tourism/management/policies/coral_transplantation).

ALLEVIATION

This is an area that is likely to receive increasing attention as the effects of climate change become more apparent (e.g. increased frequency and severity of bleaching). As previously mentioned, at the policy level – the GBRMP is managed for ecosystem resilience. This approach is embedded in legislation and all operational procedures. To explicitly address climate change concerns a broad-based vulnerability assessment has been completed based on the best available scientific information (Johnson & Marshall, Eds., 2007) and a GBRMP-wide Climate Change Action Plan has been developed (http://www.gbrmpa.gov.au/__data/assets/pdf_file/0012/22620/climate-change-action-plan.pdf).

Over the next 12-18 months, a specific Fisheries and Climate Change Action Plan is expected to be developed and implemented for the GBRMP region. The Environmental Stress Response Plan outlined in Section 2.1.3 is an early step on that pathway, where the focus is firmly on empowering people to be part of the solution. It is anticipated that this approach will be a powerful and practical tool to assist with balancing ecosystem and human needs, at a local scale. The Environmental Stress Response Plan will be an iterative process that evolves as more knowledge comes to hand. It is likely also that there will be increasing focus on developing better relationships between different sectors in the community and generating local agreements/partnerships to address specific local impacts and compliance issues.

At a global scale, Australia strongly supports the call for significant reductions in global carbon emissions as a critical step for improving the long-term prospects for the environment – including the fate of coral ecosystems. Federal government planning is in place to introduce a national carbon-trading scheme by 2010, to contribute to the global process.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

As outlined under 2.1.3, for the first time there is comprehensive spatial information on catch. A detailed logbook was developed with support from the fishers and this is used as a proxy for a monitoring program. Nearly two years of data are now available and it is likely that the logbook will retain a similar level of detail under the reviewed Policy.

Presently, there is no capacity for formal fishery-independent monitoring although several community-based monitoring programs (e.g. Reefcheck) are being considered. The main problem lies in developing appropriate user-friendly (low cost) methodology that addresses the wide-range of species and their spatial diffusion on reefs as well as the species that are abundant in patches of inter-reefal habitat (that is often deep and/or turbid). Analysis of existing towed video footage of the seafloor is being considered to generate a baseline to describe at least some of these inter-reefal habitats.

A small pilot project is currently underway for fishers and other members of the community to monitor the distribution and abundance of a few species of anemones (that have been identified in an ERA as being particularly vulnerable to bleaching and relatively uncommon) at one high-use location that was heavily bleached in 2006. At the same time some fishers are keeping 'Bleachwatch' records to track recovery at specific dive sites over time (see section 2.1.3).

2.2.2. *Confidence in the use of monitoring*

Because the new management arrangements were developed from the bottom-up, in partnership with stakeholders (fishers, managers, and compliance officers) and in consultation with various sectors of the general public, there is wide acceptance of the new approach. In turn, this fosters stewardship and an increasing interest in peer regulation is emerging. Many fishers are keen to support effective compliance to protect their good reputations and develop a global marketing edge based on stewardship and best practice.

Prior reporting the catch greatly assists compliance capacity to monitor catch components and quota compliance at the time of offloading.

In some high use areas of the GBRMP, community partnerships are developing where local 'eyes and ears' (across several sectors including fishers) are contributing to the management knowledge base on reef health. This includes information on local bleaching, COTS outbreaks and other disturbances to coral habitat, as well as general compliance matters.

2.3. Legal framework and law enforcement

See previous discussion at sections 1.5.2, 2.1.2 and 2.1.3. Hard corals are listed on Appendix II of CITES; as native species they are subject to export control under national environmental protection legislation (*EPBC Act and Regulations);* listed as no-take species unless a permit is held, under GBRMP legislation and defined as a 'fish' under State Fisheries legislation. Primary enforcement for both fisheries and marine park legislation is done by officers from the Queensland Boating and Fisheries Patrol, and supported by compliance staff from the GBRMPA and the State EPA.

At a national level, the *EPBC Act and Regulations* are the legal instruments for implementing and enforcing Australia's obligations as a signatory under international environmental agreements such as CITES. All export and import of hard coral is subject to *EPBC Regulations*. Because coral is defined as a fish under fisheries legislation in the three States or Territories in which coral is found in Australia (in Queensland, Western Australia and the Northern Territory), determination of an NDF to allow export is made at a State fishery level, based on the management arrangements, during the *EPBC* sustainable fisheries assessment process outlined under section 2.1.1. Live rock is collected also in limited quantities from the Coral Sea region by two aquarium fish collectors – the Coral Sea fishery is a small, mixed sector, offshore fishery managed by the Australian Government, (Note - live rock product currently supplies the domestic market only).

As previously described, all Australian fisheries that export product require assessment against national guidelines for ecosystem-based management. This is a process of continuous improvement based on the best available information. The guidelines aim to ensure that rigorous and transparent assessments are conducted in close cooperation with fisheries agencies, the various fishing sectors and the broader community. Reassessment of each fishery occurs every 3-5 years and usually results in acknowledgement that good progress has been made since the last assessment and that an export accreditation is granted. However, because <u>some</u> corals are CITES-listed, an NDF is required under CITES – the *EPBC* assessment process provides the NDF but in addition, individual export permits are required for every shipment from an accredited fishery like the QCF to ensure that all product trade is monitored. Export permits are applied for as required and then acquitted following shipment.

Compliance for the *EPBC* export process is as follows: Australian Customs officers check product/paperwork at point of departure. Desktop audits are periodically conducted on permitted exporter's records and occasionally site visits/audits are completed on land-based components of the business (sometimes in conjunction with the Australian Federal Police). On-water compliance is addressed through compliance mechanisms established for the specific fishery management arrangements.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. **Type of use** (origin) **and destinations** (purposes)

For the last two quota reporting years, only half of the quota has been collected and most of this (79 tonnes) was taken as wild-caught, hand-collected, loose 'live rock' for the domestic market. Strong local market demand, low product value and high transportation costs currently preclude this from being exported. The remaining catch of 24 tonnes (also wild caught and hand collected) was split between:

- Supplying the domestic and export live aquarium markets through the careful selection of small, high quality, colourful specimens from a wide range of taxa (13 tonnes). Size and beauty are all important which means that much of the population at any given site is unsuitable and therefore not collected. The majority of the hard corals collected in this sector are large-polyped, solitary, not generally considered to be hermatypic and often found in inter-reefal habitats. A significant proportion of this catch includes soft corals, zoanthids and corallimorphs – none of which are CITES-listed.
- Supplying the domestic and export ornamental and interior design, markets (11 tonnes) – collection is focussed on a limited number of larger/heavier pieces of mainly fast growing, abundant, reef building corals (e.g. acroporids, pocilloporids, *Turbinaria* species and *Heliopora coerulea*).
- Medical Research: a small quantity of unknown species of hard corals is used to supply domestic research into bone grafting/repair – few details are currently available.

A taxonomic comparison of the number of pieces collected versus the number of pieces exported can be seen at Figure 6. Export species/genera represent a limited range of the species collected in the fishery. It is also evident that many key target species are not CITES-listed species.

The main export destinations for Queensland coral are the USA, the UK, the Netherlands and France (see Figure 7); around 21,000 pieces were exported from the QCF over the last two years.

When considering the role of trade and whether it helps or hinders the ecological status of coral ecosystems it is important to acknowledge the potential educational and conservation value of tropical marine aquaria in raising public awareness about the intrinsic importance of corals and their current plight. Very few people get to dive/snorkel on coral reefs yet first-hand experience brings understanding and appreciation. Without this, the motivation to bring about the change necessary to look after coral ecosystems is unlikely.

Several hundred million people visit public aquaria every year (Bartley, 2000) – countless more will be exposed to private aquaria – all are moved by the experience. When the organisms on display have been collected (or grown) in an ecologically sustainable manner and there are appropriate ecological and conservation messages provided at point of sale or display, this medium can be a powerful tool for improving the resilience of coral ecosystems into the future[14].

A further benefit from the ecologically sustainable collection of coral for use in aquariums is the huge, mostly unpublished, knowledge base held by aquarists. Most of the corals grown in aquaria have received little scientific attention. It may well be that our understanding of critical processes in coral reef ecosystems (and the role that species from deeper water 'refugia' can play) can be substantially improved by accessing this information on species from inter-reefal habitats.

To date, all coral from the QCF is wild-caught, however various separate research endeavours are exploring aquaculture options for a number of species. The current research is mostly focussed around anemones (such as *Heteractis quadricolour*) that are relatively uncommon in the wild, found in shallow water and prone to bleaching.

3.2. Harvest:

3.2.1. *Harvesting regime*

Harvesting is done by hand or hand-held implement such as a hammer and chisel. Depending on the species, it is either fully extractive (e.g. solitary/free living species or small colonies of coral are completely removed) or is "non-extractive" in the sense that generally only a small portion of a large colony is removed – over time this would normally regrow. Again, depending on species – the demographic seg-

[14] In Range States with few economic opportunities, ecologically sustainable aquarium collection could represent one of the few viable options. If the system can be organised to reward the collectors and not the middle-men – this too would be a driver for reef stewardship.

ment that is harvested is likely to be smaller solitary/free living individuals (which presumably equates to less mature/juvenile members of the population). For colonial species – small, perfectly shaped colonies are generally targeted for fast growing species (e.g. *Acropora* or *Turbinaria* species – again, juvenile or subadult stages) or else small segments from much larger colonies (e.g. *Duncanopsammia axifuga*) are removed – in this case a significant portion of an adult colony is left to regrow.

A current industry initiative is to document best practice harvest strategies (for a range of species) within a code of conduct. An independent research project is planned to put some scientific rigour into testing these best-practice assumptions.

For most sectors in this fishery freight costs are a driving factor in determining what is collected – Australia is a large and geographically isolated country so the majority of product is airfreighted to all markets (domestic and export). This means that packing 'live' product in 20kg polystyrene boxes is an industry standard – consequently, it is more cost effective to pack multiple small pieces per box than to pack a larger, single piece of either live rock or live coral.

The exception to this approach is the pieces collected for the ornamental market. Here coral is collected and treated (bleached) close to the point of collection and then transported by road, dry, at a later date to the domestic wholesale market, and by sea or air to international markets. CITES personal baggage permits are frequently used by retail clients to take a limited number of individual purchased pieces of coral to their home country for their personal use.

Corals are collected by divers using Hookah or SCUBA. The use of hand held implements such as a chisel and hammer aids the targeted selection of specific pieces and reduces the incidence of damage to neighbouring corals. Live rock is collected as loose pieces, by hand.

The combination of Australian commercial diving rules and fishery management arrangements (including significant reporting requirements), spatial closures under the GBRMP zoning plan, the market demand for small perfect pieces of coral and the frequent vagaries of weather means that there are significant limitations to what is actually collected from the GBRMP. Even though collection occurs year-round, only about half the quota was collected in each year since the new management arrangements were introduced. Vessel size ranges from small (<10m) boats used for day trips to large vessels (>20m) capable of travelling to the outer shelf of the Great Barrier Reef.

Additional harvest – as previously noted, there is limited harvest available for coral transplantation for amenity improvement at significant fixed-operation tourism sites (though the management focus is firmly on maintaining the health and resilience of the site in the first place). Coral is taken for research purposes under permit only – applications are assessed by all three management agencies on a case-by-case basis. Distribution of collection tends to be associated with island-based research stations (there are four main research stations on the GBR). It is estimated that total research collection in any given year would not exceed 10 tonnes. Research permits also carry reporting requirements but linkage of the two permitting systems is done only on a qualitative basis at present. Export of research specimens does occur, however it is permitted individually and the quantities are very small.

Coral is periodically removed from the GBRMP for the purpose of dredging shipping channels and developing port facilities. This activity is managed via permits issued by GBRMPA and the EPA – specific details are assessed via a rigorous environmental impact assessment framework (sometimes with public consultation – depending on the scale of operations) on a case-by-case basis and permitted and supervised accordingly. While this form of harvesting is not factored into the fishery management arrangements it is managed to minimise localised impact to the ecosystem.

3.2.2. *Harvest management/ control*

Collection occurs year-round, though access to most collection areas is very weather dependent. See sections 2.13 and 3.2 for details.

3.3. Legal and illegal trade levels:

A total of 20,931 pieces of coral were legally exported from the QCF during the period July 2006 to May 2008.

Recreational take of coral (for use in personal aquaria) and indigenous take for cultural purposes is thought to be minimal in Queensland and is unlikely to constitute a significant illegal trade concern. Souveniring of beach-washed coral by local residents and tourists is an ongoing and, to date, unquantified problem. Beach-washed coral is regularly confiscated from passengers (departing from Australian ports) on entry into adjacent international ports such as Auckland, in New Zealand.

Small coral fisheries exist in two other States in Australia – the Northern Territory (NT) and Western Australia (WA). The amount taken in each of these is fairly limited, ~2.8 tonnes of live rock and ~5.1 tonnes of hard coral in WA[15] and about 1 tonne of coral and 0.5 tonne of live rock in 2006 in the NT. To date, there has been no export record-

[15] These are draft figures for 2007.

ed from the Northern Territory and 15,770 pieces of coral have been reported as exported from Western Australia (in the period July 2006 –May 2008). The level of souveniring from these regions is unknown.

The Northern Territory has significant inhibitors to expansion of the coral fishery – large tidal range, turbid water and healthy crocodile populations, and a recent court decision awarding indigenous title to the majority of the coastal foreshores.

Western Australia has a very different geomorphology than either Queensland or the Northern Territory. Large tracts of sub-fossilised coral rubble dunes run parallel to, and inland from, large sections of the coast and the current reef systems, while each is quite extensive they are more geographically discrete\ than reefs on the GBR. WA has a small quota-based fishery and is currently developing new management arrangements for the wild catch – in the meantime the collection of *Catalaphyllia jardinei* has been banned in one of the collecting areas. Consultation on a coral aquaculture discussion paper is still underway.

II. NON-DETRIMENT FINDING PROCEDURE (NDFS)

The following section outlines the process used to evaluate hard corals when making a non-detriment finding for corals taken in the QCF; to minimise repetition, relevant information from earlier sections is cross-referenced here.

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

No – the explicit radar plots recommended under the IUCN checklist were not used to make the NDF. The IUCN checklist is intended to be completed at a species level – yet there are more than 350 species of hard coral found on the GBR – of these, 52 genera/species are routinely collected and a further 23 are exported in some numbers (the remainder are exported infrequently or not at all). The Australian sustainable fisheries assessment (see sections 2.11 and 2.3) satisfies the intent of the NDF framework. According to the 2006 assessment (and associated recommendations placed on the Queensland Coral Fishery by the Australian Government, http://www.environment.gov.au/coasts/fisheries/qld/coral/assessment.html) the management arrangements, practices and processes being established meet or exceed the NDF checklist. Explicit species-level management is not considered necessary at this time because the package of management arrangements is so precautionary.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

Please see Table 3 for an outline of criteria, parameters and indicators used to assess the fishery and how these relate to the NDF guidelines. The process used for making the NDF for the QCF complements the 'Addis Ababa Principles and Guidelines for Sustainable Use of Biodiversity' described in Rosser (2008).

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

The main source of data for making and reviewing the NDF assessment is detailed logbook information, supported by an Ecological Risk Assessment (ERA). The ERA is an adaptive management tool that is to be reviewed regularly and as new information comes to hand. A literature review and expert advice is used to compile the biophysical information that underpins a vulnerability assessment. Following this, an expert consensus workshop (using scientific, local and management knowledge) is convened to ground-truth the information for different regions on the GBR and conduct an ecological risk assessment (see also comments at 2.1.3).

While not specific to the species in the coral fishery, nor to most of the collection areas, coral cover and general reef health information from the Australian Institute of Marine Science Long Term Monitoring Program (http://www.aims.gov.au/docs/research/monitoring/reef/reef-monitoring.html) was also considered to provide a broad contextual measure of reef health and resilience at the scale of regions and the GBR as a whole. Broad results from the recent Seabed Biodiversity Study (Pitcher et al, 2008) provided an assessment of relative levels of protection (no-take zoning) of different habitats in the GBRMP and demonstrated (qualitatively) that considerable areas of inter-reefal habitat do, in fact, support substantial stocks of some key species in the coral fishery.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

While mindful that data is mainly fishery-dependent, the system has several important checks and balances:

- All decision-making is risk-based (where the risk framework meets or exceeds the Australian risk-assessment standard). Under this framework, expert consensus is sought from local knowledge holders, scientific experts and managers to ground truth information that is fed into decision-making.
- The TAC is very small relative to the standing stock in the fishery area (the whole GBRMP); quota is direct debited on landing catch

via an at-sea telephone reporting system. This mechanism allows compliance officers to target inspections if they wish to meet the boat as it arrives in port and inspect catch prior to landing (to validate data records).

- More than 33% of the GBRMP is closed to all fishing; further areas are completely or partially inaccessible either due to weather or depth.
- Managers have a close working knowledge of the fishers and their practices – most practices are tightly driven by economics or relatively consistent market demands. Understanding these drivers helps ensure that managers are conversant with new practices as they evolve and allows for an adaptive management approach to ensure that best practice is maintained.
- Management arrangements were developed from the ground-up with fishers over a considerable period of time. Because of this partnership between management, fishers and compliance officers, arrangements are pragmatic, achievable and enforceable.
- Partnership has resulted in a greater sense of ownership and a greater willingness for personal stewardship.
- About 70% of the catch is live rock, which is very easy to monitor and carries a low environmental risk on the GBR.
- Logbook information is mapped and monitored collaboratively across three agencies, at very fine spatial scales – catch composition can be tracked against individual fishers if necessary. Export information is broadly tracked against catch data, noting that much of the market is domestic.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

- The species-level NDF checklist does not readily “fit” a complex multi-species group like coral. The huge number of species, the diverse life history features from one species to the next and the considerable plasticity and variation within a species, contribute to this problem.
- Corals listed under CITES do not just include live or recently dead coral – the issue of coral-derived rock (live rock) and whether it is modern (weeks to hundreds of years old and captured by CITES definitions) or whether it is fossilised (and therefore exempt from CITES) has yet to be effectively resolved. Because live rock is not currently exported from this fishery, this issue has not been addressed in detail in this report.
- Coral taxonomy provides another level of complexity to the NDF process. Many coral species cannot be identified to species level

reliably in the field even by experts. This drives the level at which data can be collected through logbooks – which in turn determines to what level export records are accurate. While the CITES framework provides some concessions on species level reporting for trade purposes (acknowledging the problem) – our experience with this fishery suggests it does not go far enough. Consequently the integrity of export records – at least for some species groups will be compromised.

- Units of measure for monitoring and reporting how much coral is removed at point of collection present further problems. Many species of coral are highly 'plastic' depending on whether their polyps are inflated or retracted so accurate weighing is next to impossible – this presents a significant compliance challenge. Depending on species, it may be more useful to report figures and for others, volume. In almost all cases, conversion factors will be required. To complicate things, export trade figures are only given as numbers which conveys no information about total volume and can be misleading (100 pieces could represent a few kilograms or it could represent a few tonnes).
- The question of scale – with respect to making an NDF. Clearly removing coral from a one metre square area will likely result in significant localised depletion. However, at what scale does this actually become important for the health of the coral ecosystem? When does concentrated removal of any fisheries resource begin to affect the ability of the natural system to bounce back? This is a global fisheries issue for which there does not appear to be any adequate working definition of 'localised depletion' and few effective tools to address the problem.
- The question of ecosystem function - with respect to making an NDF for corals. At what scale does removal begin to significantly compromise ecosystem function – given that many of the corals in trade are not reef building and that, providing biodiversity is maintained, there is likely to be considerable functional redundancy or at least overlap, within an ecosystem.
- The question of relative biodiversity - the GBR is fortunate to be one of the southern-most extensions of the 'Coral triangle'[16] (Figure 8). The GBR also represents an extraordinary latitudinal range of highly connected reefs, inter-reefal habitats and shoal grounds, which currently confer reasonably high levels of ecosystem resilience. This is not the case for most coral reefs where natural diversity is much

[16] The Coral Triangle is the global hotspot of coral biodiversity.

reduced to begin with (and likely further modified by significant anthropogenic impacts). On the GBR, species mix varies at small spatial scales and some high disturbance areas (e.g. inshore, shallow, bleaching and flood-prone) do have reduced biodiversity and are impacted from anthropogenic activities. However, compared with the global situation, the GBR coral ecosystem is in relatively good condition.

- The question of cumulative impact – under CITES the main point of leverage revolves around what can be traded and ensuring that trade doesn't significantly impact on population status at a species level. However, in most parts of the world it is very likely that the amount of coral removed for the aquarium and curio trade is small relative to the combined impacts of poor water quality (from land use practices), coastal development, destructive fishing practices and industrial scale removal for the construction and agricultural (production of lime) industries. Overlaid on this is the prospect of significant climate-induced changes. The CITES framework does not, at this stage, explicitly address these matters.

6. RECOMMENDATIONS

- Noting that species of coral are rarely collected in isolation, it is recommended that consideration is given to how the preceding matters might be better addressed under a coral-specific, ecosystem-based NDF framework. From our experiences with the QCF – it is suggested that a risk-based, adaptive management framework is a relatively simple, yet pragmatic solution to the complexities outlined.
- That tools such as the ERA, the PMS and the Environmental Stress Response Plan developed for the QCF, could be customised to suit individual range states or regional collections/fisheries. A more consistent and risk-based framework would give CITES scientific and management authorities greater capacity to evaluate and compare coral NDFs across range states.
- To ensure that any risk assessment methodology uses all available information (including scientific, management and local knowledge) together with a process for regular, transparent review. This is an effective mechanism to ground-truth knowledge on the many habitats and species for which very little information is published.

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The ongoing development of management and stewardship arrangements documented in this report would not be possible without the trust and collaboration that has been built and maintained amongst stakeholders over a long period of time – while the list of people involved is too long to include here, they know who they are! It is particularly important to acknowledge the enormous role that the fishers have played in this process, in sharing their knowledge and large amounts of their time to talk through issues and help find practical solutions to challenging problems. The late Vicki Harriott's research report on the coral fishery was another important milestone

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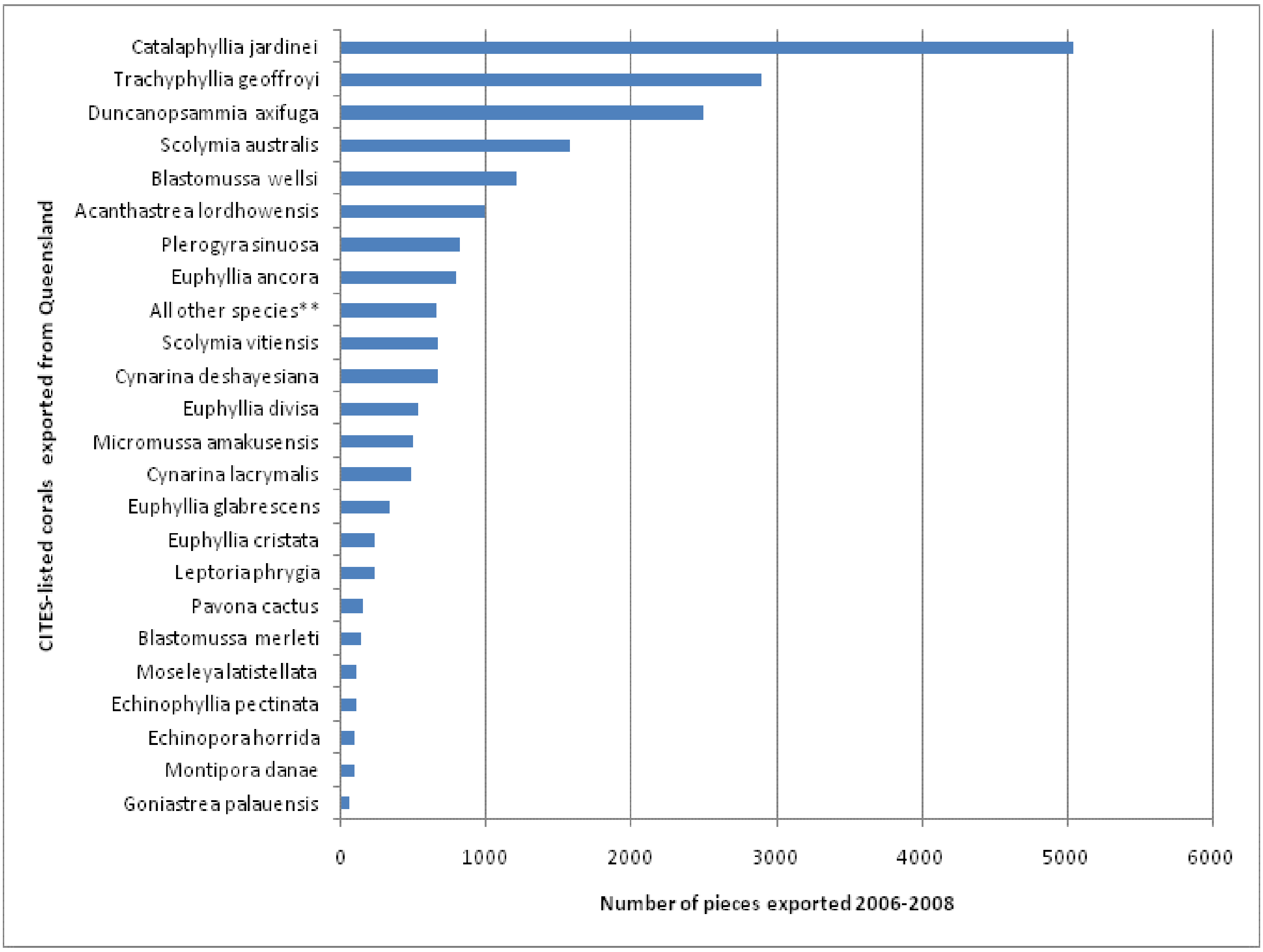


Figure 1: Species of CITES-listed coral exported from the Queensland Coral Fishery from July 2006 to May 2008. Note: All other species** = 47 different species where less than 50 pieces per species have been exported during this period. *(Source DEWHA CITES section export figures, 2006-2008)*

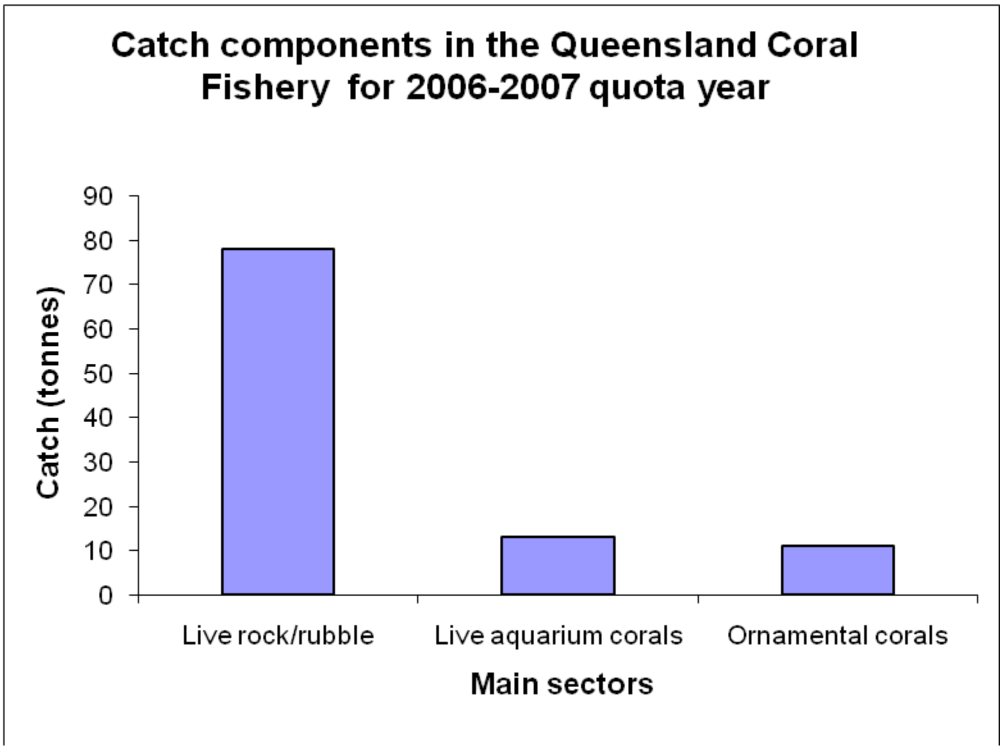


Figure 2: Catch components and market focus for the 2006-2007 quota-reporting year for the Queensland Coral Fishery *(source DPI&F 2008 Annual Status Report*).

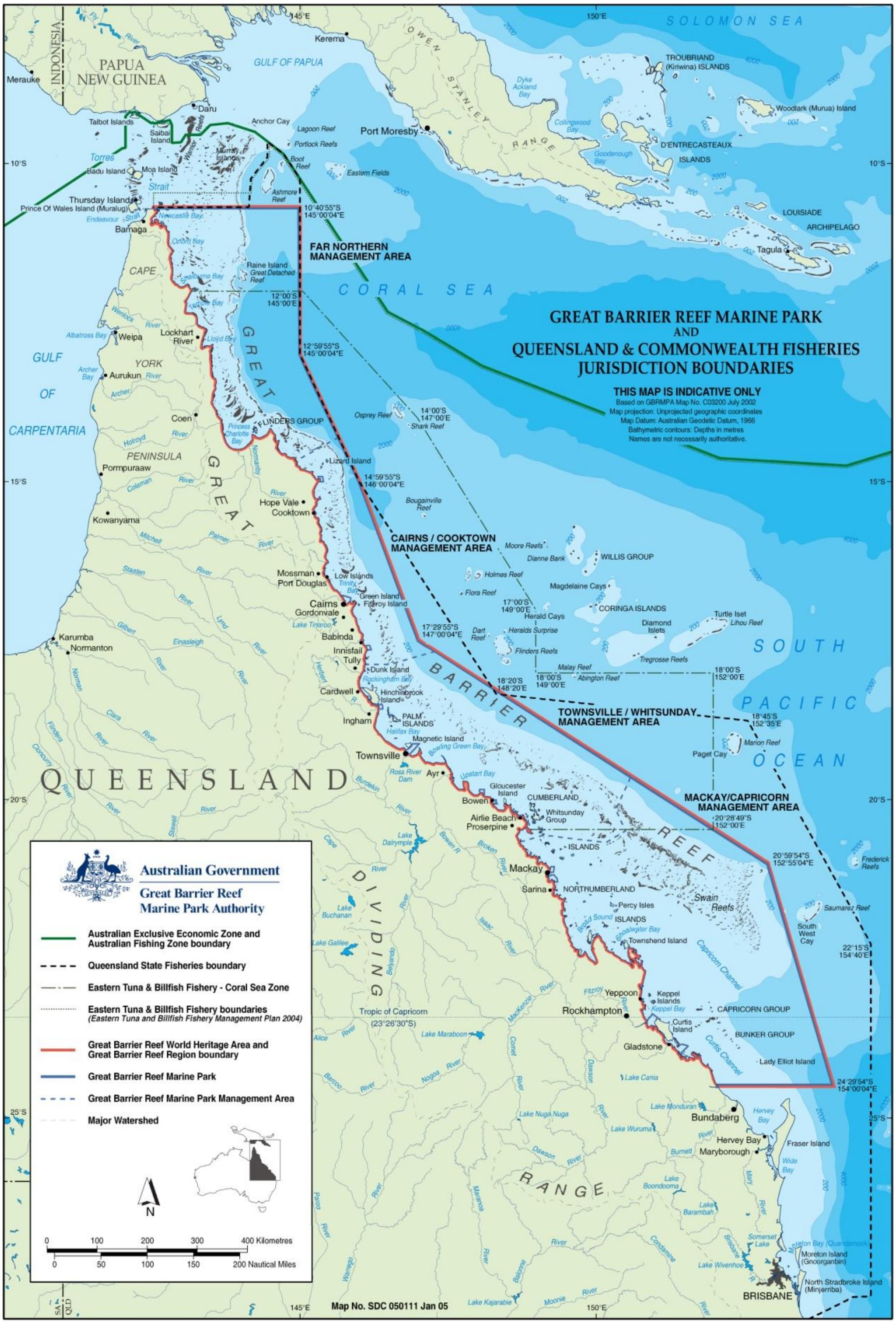


Figure 3: The Queensland Coral Fishery Area has the same prescribed boundary as that for the Great Barrier Reef Marine Park. (Note two permits exist for small collection areas just south of the GBRMP specifically to supply two public aquaria – see *Policy for the Management of the Coral Fishery* for details)

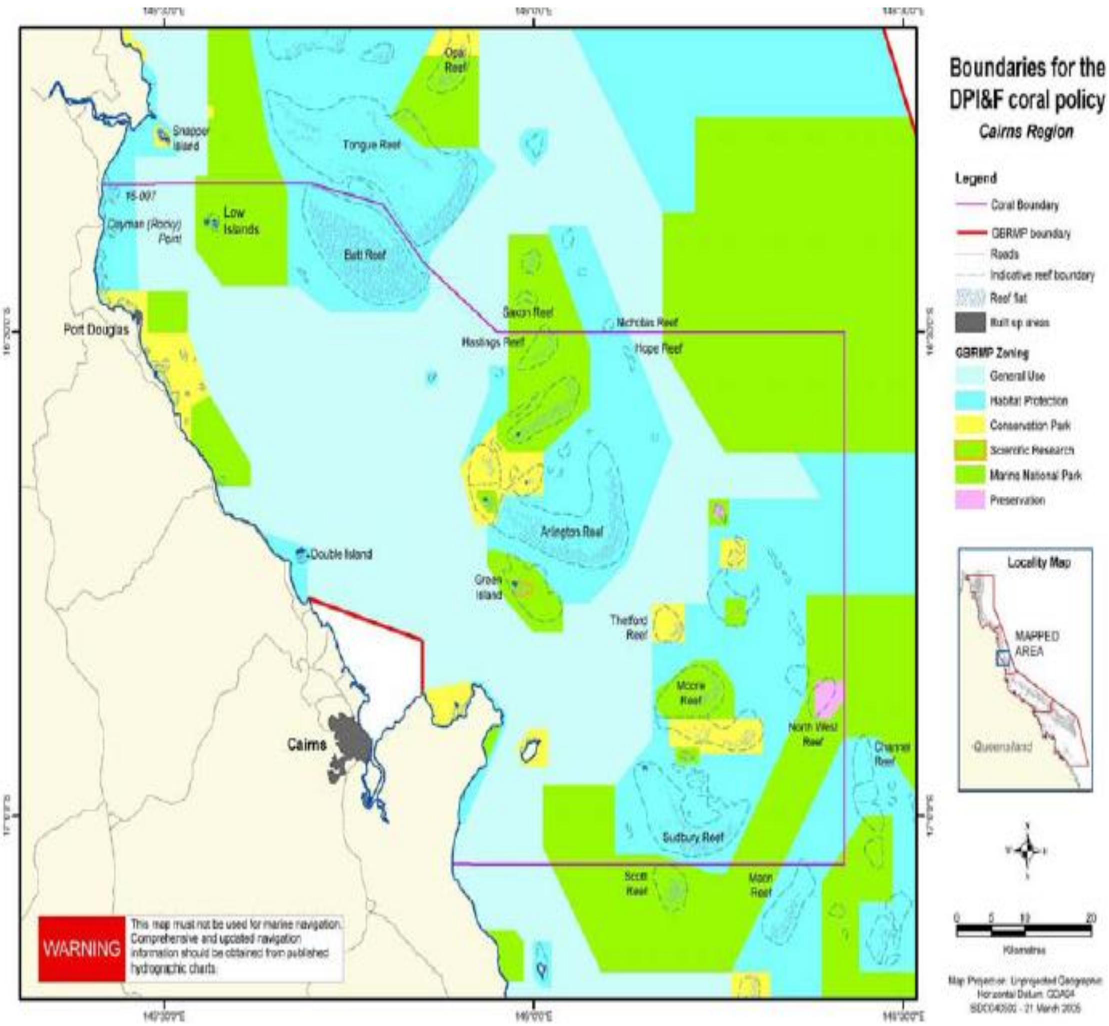


Figure 4: Boundary of the Cairns Region as defined under the DPI&F *Policy for the Management of the Coral Fishery.*

Figure 5: Boundary of the Keppel region as defined under the DPI&F *Policy for the Management of the Coral Fishery*.

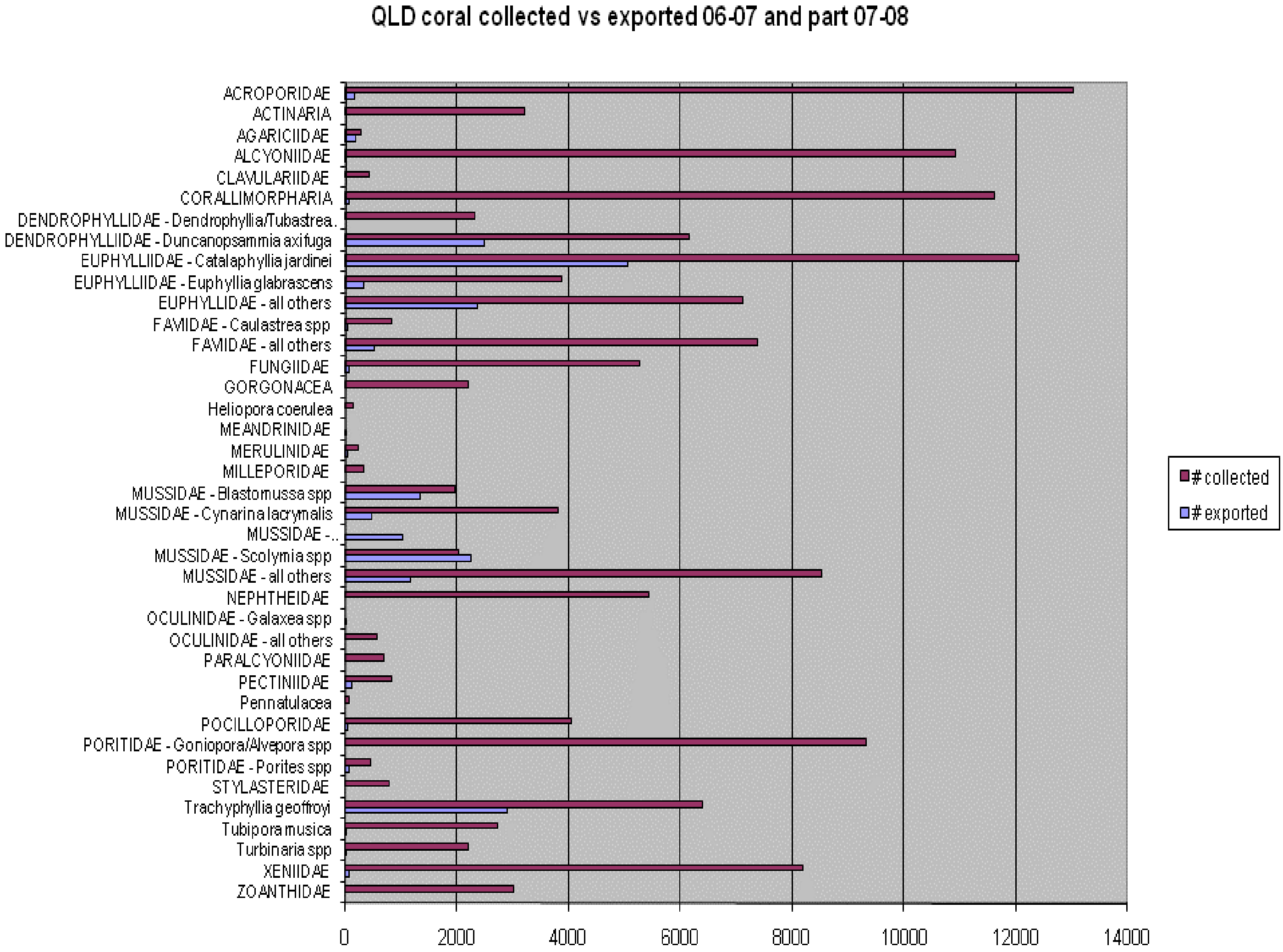


Figure 6: A comparison of number of pieces of coral collected vs. number of pieces exported by species/genus for July 2006 to May 2008.

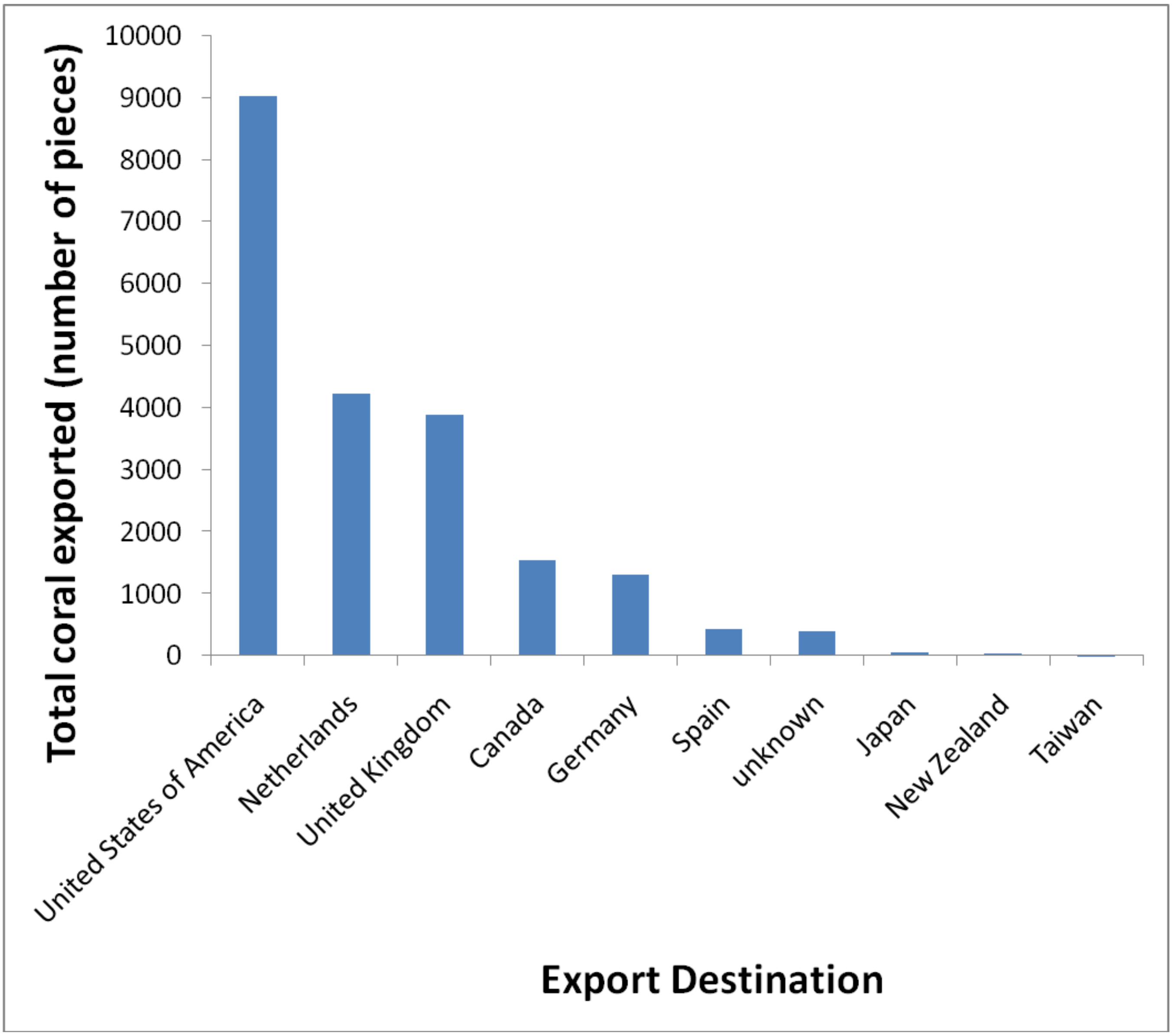
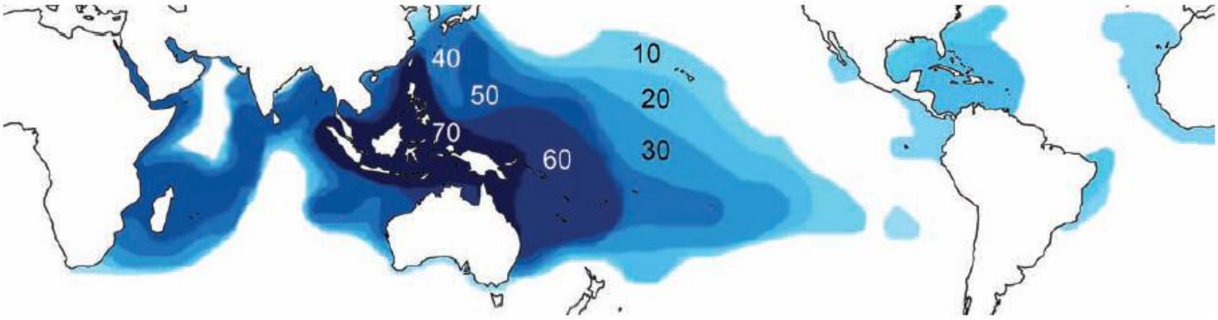


Figure 7: Export destination and quantity of coral from the Queensland Coral Fishery during the period July 2006 to May 2008.



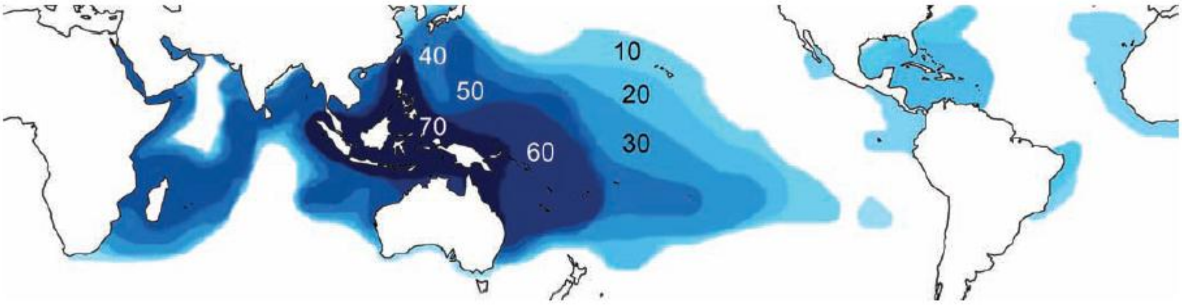


Figure 8: Map indicating global trends in coral biodiversity. The Great Barrier Reef is located at the southern-most extension of the 'Coral Triangle' - the global hotspot for coral biodiversity. (Source: *Hutchings, P.A. and Kingsford M.J. (in press). Chapter 13: Biodiversity. In: The Great Barrier Reef: Biology, Environment and Management. CSIRO Publishing.)*

Table 1. Vulnerability rankings for CITES-listed coral taxa harvested in the Queensland Coral Fishery as at the end of 2007 (taxa in orange are moderately vulnerable). See Roelofs and Silcock, (2008) for a full explanation of the scoring for the five vulnerability indices. Dist = distribution; VAR = Vulnerability Assessment Rating. Categories for VAR are as follows: Very low = <2 (these taxa are not vulnerable to harvesting activity in the QCF); Low = 2-2.99 (These taxa are at low risk from QCF harvesting activity; Medium = 3-3.99 (these taxa have characteristics that make them moderately vulnerable to harvesting by the fishery; High = 4-5 (these taxa have characteristics that make them highly vulnerable to over harvesting by the fishery). * Some taxonomists classify these genera as belonging to the Family Euphillidae.

Order	Family	Genus	Species	Common name	Dist	Eco-niche	Bleaching	Access	Abundance	VAR
Scleractinia	Acroporidae	*Acropora*		Staghorn coral	1	2	5	4	2	2.8
Scleractinia	Acroporidae	*Montipora*		Velvet coral	1	4	5	4	2	3.2
Scleractinia	Caryophyllidae	*Catalaphyllia**	*jardinei*	Elegance coral	1	4	2	3	3	2.6
Scleractinia	Caryophyllidae	*Euphyllia**	*glabrascens*	Torch coral	1	2	2	3	3	2.2
Scleractinia	Caryophyllidae	*Euphyllia**		Branching hammer coral	1	2	2	3	4	2.4
Scleractinia	Caryophyllidae	*Physogyra**		Bubble coral	1	2	2	4	2	2.2
Scleractinia	Caryophyllidae	*Plerogyra**		Bubble coral	1	4	2	3.5	4	2.9
Scleractinia	Dendrophyllidae	*Dendrophyllia*		Cup corals	2	2	2	2.5	4	2.5
Scleractinia	Dendrophyllidae	*Duncanopsammia*	*axifuga*	Whisker coral	3	2	2	2.5	4	2.7
Scleractinia	Dendrophyllidae	*Tubastrea*		Daisy coral	1	2	2	3	2	2
Scleractinia	Dendrophyllidae	*Turbinaria*		Cup coral	1	2	2	4	2	2.2
Scleractinia	Dendrophylliidae	*Balanophyllia*		Flower coral	3	2	2	3	4	2.8
Scleractinia	Dendrophylliidae	*Heteropsammia*		Button coral	1	4	2	3	2	2.4
Scleractinia	Faviidae	*Caulastrea*		Trumpet coral	1	4	3	3.5	3	2.9
Scleractinia	Faviidae	*Favia*		Moon coral	1	2	3	3	2	2.2
Scleractinia	Faviidae	*Favites*		Moon coral	1	2	3	3	3	2.4
Scleractinia	Faviidae	*Goniastrea*		Honeycomb coral	1	2	3	4	2	2.4
Scleractinia	Faviidae	*Leptastrea*		Star coral	1	2	3	4	3	2.6
Scleractinia	Faviidae	*Leptoria*		Maze coral	1	2	3	3.5	2	2.3
Scleractinia	Faviidae	*Montastrea*		Moon coral	1	2	3	3	3	2.4
Scleractinia	Faviidae	*Moseleya*		Corallimorph coral	1	2	3	3.5	4	2.7
Scleractinia	Faviidae	*Oulophyllia*		Moon coral	1	2	3	3.5	3	2.5
Scleractinia	Faviidae	*Platygyra*		Maze coral	1	2	3	3.5	4	2.7
Scleractinia	Faviidae	*Plesiastrea*		Star coral	1	2	3	3.5	3	2.5
Scleractinia	Fungidae	*Fungia*		Disk coral	1	2	2	3	3	2.2

Scleractinia	Fungiidae	*Cycloseris*		Domed mushroom coral	1	4	2	2	4	2.6
Scleractinia	Fungiidae	*Diaseris*		Diaseris	1	4	2	4	2	2.6
Scleractinia	Fungiidae	*Heliofungia*		Tentacled mushroom	1	2	2	4	2	2.2
Scleractinia	Fungiidae	*Polyphyllia*		Slipper coral	1	2	2	3.5	2	2.1
Scleractinia	Merulinidae	*Hydnophora*	*actinoformis*	Carpet coral	1	2	4	3.5	3	2.7
Scleractinia	Merulinidae	*Merulina*		Ruffled coral	1	2	2	3.5	2	2.1
Scleractinia	Mussidae	*Acanthastrea*		Starry cup coral	1	2	2	4	4	2.6
Scleractinia	Mussidae	*Blastomussa*		Pineapple coral	1	2	2	4	4	2.6
Scleractinia	Mussidae	*Cynarina*		Button coral	1	2	2	2	4	2.2
Scleractinia	Mussidae	*Micromussa*		Micromussa	1	2	2	4	5	2.8
Scleractinia	Mussidae	*Mussa*		Spiny flower coral	1	2	2	3	4	2.4
Scleractinia	Mussidae	*Scolymia*		Doughnut coral	1	4	2	3	4	2.8
Scleractinia	Mussidae	*Symphyllia*		Lobed brain coral	1	4	2	3.5	4	2.9
Scleractinia	Occulinidae	*Galaxea*		Galaxy coral	1	2	2	3	2	2
Scleractinia	Pectinidae	*Pectinia*		Lettuce coral	1	2	3	3	4	2.6
Scleractinia	Pectiniidae	*Echinophyllia*		Encrusting coral	1	2	3	3	2	2.2
Scleractinia	Pectiniidae	*Mycedium*		Elephant ears	1	2	3	3	2	2.2
Scleractinia	Pocilloporidae	*Pocillopora*		Cauliflower coral	1	2	5	3.5	2	2.7
Scleractinia	Pocilloporidae	*Seriatopora*		Birds nest coral	1	2	5	3	3	2.8
Scleractinia	Pocilloporidae	*Stylophora*		Finger coral	1	2	5	3	2	2.6
Scleractinia	Poritidae	*Alveopora*		Daisy coral	1	2	2	2	4	2.2
Scleractinia	Poritidae	*Goniopora*		Flowerpot coral	1	2	2	3	2	2
Scleractinia	Poritidae	*Porites*		Boulder coral	1	2	2	3	2	2
Scleractinia	Siderastreidae	*Pavona*		Leaf coral	1	2	2	4	4	2.6
Scleractinia	Stylasteridae	*Distichopora*		Miniature fan coral	1	2	2	3	4	2.4
Scleractinia	Trachyphyllidae	*Trachyphyllia*	*geoffroyi*	Open brain coral	1	4	2	2.5	3	2.5
Antipatharia	Antipathidae	*Cirrhipathes*		Black coral	1	2	2	3	2	2

Table 2: Reef building status and IUCN conservation status of hard corals exported from the Queensland coral fishery (species list as at mid 2008). Other CITES-listed genera/species collected for the domestic market are included for comparison. The range of IUCN classifications is included when only a genus is identified. CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, LC = least concern, DD = data deficient. Hermatypic = reef building; ahermatypic = not a main contributor to the reef matrix.

FAMILY	**GENUS/SPECIES**	**IUCN Conservation status**	**EXPORT QUANTITY**	**REEF BUILDING STATUS**
Caryophyllidae	*Catalaphyllia jardinei**	VU	5047	ahermatypic, soft bottom
Trachiphylliidae	*Trachyphyllia geoffroyi*	NT	2899	ahermatypic, solitary, free living
Dendrophyllidae	*Duncanopsammia axifuga*	NT	2497	ahermatypic, soft bottom
Mussiidae	*Scolymia australis*	LC	1577	ahermatypic, solitary
Mussiidae	*Blastomussa wellsi*	NT	1212	Ahermatypic
Mussiidae	*Acanthastrea lordhowensis*	NT	986	Hermatypic
Caryophyllidae	*Plerogyra sinuosa* *	NT	820	? hermatypic
Caryophyllidae	*Euphyllia ancora**	VU	793	Ahermatypic
Mussiidae	*Scolymia vitiensis*	NT	672	ahermatypic, solitary
Mussidae	*Cynarina deshayesiana*	NT	663	ahermatypic, solitary, free living sometimes
Caryophyllidae	*Euphyllia divisa**	NT	527	Ahermatypic
Mussidae	*Micromussa amakusensis*	NT	492	Hermatypic
Mussidae	*Cynarina lacrymalis*	NT	486	ahermatypic, solitary, free living sometimes
Caryophyllidae	*Euphyllia glabrescens**	NT	338	Ahermatypic
Caryophyllidae	*Euphyllia cristate**	VU	233	Ahermatypic
Faviidae	*Leptoria Phrygia*	NT	228	Hermatypic
Siderastreidae	*Pavona cactus*	VU	155	Hermatypic
Mussiidae	*Blastomussa merleti*	LC	133	Hermatypic
Faviidae	*Moseleya latistellata*	VU	103	Hermatypic

Pectiniidae	*Echinophyllia pectinata*	DD	99	Hermatypic
Acroporidae	*Montipora danae*	LC	92	Hermatypic
Faviidae	*Echinopora horida*	NT	92	Hermatypic
Faviidae	*Goniastrea palauensis*	NT	52	Hermatypic
Faviidae	*Caulastraea furcata*	LC	49	Ahermatypic
Mussidae	*Lobophyllia hemprichii*	LC	35	Hermatypic
Poritidae	*Porites vaughani*	LC	30	Hermatypic
Agariciidae	*Leptoseris explanata*	LC	30	Hermatypic
Fungiidae	*Heliofungia actinoformis*	VU	27	Ahermatypic
Occulinidae	*Galaxea fascicularis*	NT	24	?hermatypic
Fungiidae	*Cycloseris cyclolites*	Not listed	24	ahermatypic, solitary
Merulinidae	*Hydnophora exesa*	NT	22	Hermatypic
Tubiporidae	*Tubipora musica*	NT	22	?hermatypic
Acroporidae	*Acropora nobilis*	LC	20	Hermatypic
Acroporidae	*Montipora digitata*	LC	20	Hermatypic
Poritidae	*Porites cylindrica*	NT	20	Hermatypic
Acroporidae	*Acropora yongei*	LC	20	Hermatypic
Fungiidae	*Fungia fungates*	NT	16	ahermatypic, solitary
Pocilloporidae	*Seriatopora hystrix*	LC	15	Hermatypic
Dendrophylliidae	*Turbinaria reniformis*	VU	15	Hermatypic
Mussidae	*Isophyllia sinuosa*	LC	12	?hermatypic **
Dendrophylliidae	*Turbinaria peltate*	VU	11	Hermatypic
Faviidae	*Favites abdita*	NT	10	Hermatypic
Merulinidae	*Hydnophora microconos*	NT	10	Hermatypic
Poritidae	*Porites nigrescens*	VU	10	Hermatypic
Occulinidae	*Galaxea astreata*	VU	10	Hermatypic
Faviidae	*Favia pallida*	LC	10	Hermatypic
Faviidae	*Platygyra daedalea*	LC	10	Hermatypic
Siderastreidae	*Pavona varians*	LC	10	Hermatypic

Acropoidae	*Montipora tuberculosa*	LC	10	Hermatypic
Pocilloporidae	*Pocillopora verrucosa*	LC	10	Hermatypic
Pocilloporidae	*Seriatopora caliendrum*	NT	10	Hermatypic
Pocilloporidae	*Stylophora pistillata*	NT	10	Hermatypic
Merulinidae	*Merulina ampliata*	LC	10	Hermatypic
Pectiniidae	*Mycedium elephantotus*	LC	10	Hermatypic
Fungiidae	*Fungia scutaria*	LC	8	ahermatypic, solitary
Pocilloporidae	*Pocillpora eydouxi*	NT	7	Hermatypic
Faviidae	*Favia speciosa*	LC	5	Hermatypic
Caryophyllidae	*Euphyllia paraencora**	VU	4	Ahermatypic
Mussidae	*Lobophyllia hatai*	LC	4	Hermatypic
Faviidae	*Australogyra zelli*	VU	4	Hermatypic
Faviidae	*Plesiastrea versipora*	LC	2	Hermatypic
Meandrinidae	*Ctenella chagius*	EN	2	Hermatypic
Mussidae	*Lobophyllia pachysepta*	NT	2	Hermatypic
Mussidae	*Symphyllia agaricia*	LC	1	Hermatypic
Caryophyllidae	*Physogyra lichtensteini**	VU	1	?hermatypic
Faviidae	*Diploastrea heliopora*	NT	1	Hermatypic
	Other CITES-listed coral collected in the fishery			
Acroporidae	*Montipora*	DD,LC - EN		Hermatypic
Dendrophyliidae	*Balanophyllia*	DD		Ahermatypic
Dendrophyliidae	*Dendrophyllia*	Not listed		Ahermatypic
Dendrophyliidae	*Heteropsammia*	LC, NT		ahermatypic, solitary
Dendrophyliidae	*Tubastrea*	Not listed		Ahermatypic
Dendrophyliidae	*Turbinaria*	LC-VU		Hermtypic
Faviidae	*Favia sp*	LC-VU		Hermatypic
Faviidae	*Favites*	LC-VU		Hermatypic
Faviidae	*Leptastrea*	LC-VU		Hermatypic
Faviidae	*Montastrea*	LC-VU		Hermatypic

Faviidae	*Moseleya sp.*	VU	Hermatypic
Faviidae	*Oulophyllia*	LC-NT	Hermatypic
Fungiidae	*Diaseris*	Not listed	ahermatypic, solitary
Fungiidae	*Heliofungia*	VU	ahermatypic, solitary
Fungiidae	*Polyphyllia*	LC-NT	ahermatypic, solitary
Helioporidae	*Heliopora coerulea*	VU	Hermatypic
Merulinidae	*Merulina*	LC	Hermatypic
Milliporidae	*Millipora*	DD, LC-EN,CR	Hermatypic
Mussiidae	*Micromussa*	DD, NT	Hermatypic
Mussiidae	*Mussa*	LC	hermatypic**
Pectiniidae	*Echinophyllia*	DD, LC or VU	? hermatypic
Pectiniidae	*Pectinia*	DD, NT-EN	? hermatypic
Poritidae	*Alveopora*	NT-EN	ahermatypic - usually soft bottom
Poritidae	*Goniopora*	NT	ahermatypic - usually soft bottom
Siderastreidae	*Pavona*	DD, LC-VU	Hermatypic
Stylasteridae	*Distichopora*	Not listed	Ahermatypic

* Note - Note some taxonomists identify these species as belonging to the Family Euphyllidae

** Note - supposed to be Atlantic genera

Table 3: Provides a comparison of the relevant elements of the suite of management tools for the Queensland Coral Fishery against the broad criteria of the *EPBC* Guidelines for the Ecologically Sustainable Management of Fisheries, and the CITES IUCN guidelines for making a Non Detriment Finding for the Coral Fishery. Further details on the explicit requirements for an *EPBC Act* sustainable fisheries assessment can be found at:
http://www. environment.gov.au/coasts/fisheries/publications/pubs/guidelines.pdf

EPBC Guidelines, broad criteria. In each case the regime should:	Relevant elements of the Queensland Coral Fishery:	Relevant CITES NDF guidelines:
Be documented, publicly available and transparent	○ *Policy for the Management of the Coral Fishery* (describes key components of the management arrangements, history and practices in the wild caught fishery) http://www2.dpi.qld.gov.au/extra/pdf/fishweb/coralreefpolicy.pdf *Other management policies and guidelines will be available online when finalised*	• 1.2, 1.5, 1.6 Type of harvest ○ Degree of control ○ Demographic segment removed ○ Level of harvest ○ Reason for harvest ○ Commercial destinations • 2.11 Management history • 2.12 Management Plan or equivalent • 2.13 Aim of harvest regime in Management Plan • 2.14 Quotas
Be developed through a consultative process providing opportunity to all interested and affected parties, including the general public	○ Coral Policy developed from the bottom-up over a 4-year period ○ 30-day public consultation period and targeted consultation for final introduction of State management policies ○ 30-day public consultation on fishery management submissions for *EPBC* sustainable fisheries assessments	
Ensure that a range of expertise and community	○ The Harvest Management Advisory Committee (Harvest MAC) supports the dive-based fisheries including coral – membership	

interests are involved in individual fishery management committees and during the stock assessment process	includes representatives from fishers, managers (DPI&F, GBRMPA & EPA), science, conservation, compliance and an independent Chair with fisheries management experience ○ Issue-specific Working Groups set up under the Harvest MAC are expertise-based (often subsets of the MAC)	
Be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements are measured	• Overarching fisheries and marine park legislation provides strategic objectives • *Policy for the Management of the Coral Fishery* – gave effect to fishery restructure – identifies operational fishery objectives, fishery area, quota, species caps, spatial review points • *Ecological Risk Assessment* – guides development of performance criteria based on relative risk • *Performance Measurement System* – (in development) identifies key criteria for monitoring and auditing fishery performance to ensure effective ecosystem-based management • *Environmental Stress Response Plan* – (in development) provides a tool to address exceptional local circumstances through an objective, transparent, performance-based framework • *GBRMP Climate Change Action Plan* – broad strategic framework to manage the marine park for resilience • GBRMP fisheries and climate change action plan – (in development) will provide fishery-specific strategies & objectives to prioritise and measure effectiveness of actions.	• 2.12 Management Plan or equivalent • 2.13 Aim of harvest regime in Management Plan • 2.14 Quotas • 2.1 Biological characteristics • 2.2 Ecological adaptability • 2.3 Dispersal efficiency • 2.4 Interactions with humans • 2.5 National distribution • 2.6 national abundance • 2.7 National population trends • 2.9 Major threats • 2.21 Use compared with other threats • 2.15 Harvesting in protected areas
Be capable of controlling the level of harvest in the fishery using input and/or output controls	○ Overarching fisheries legislation prescribes many of the input controls ○ *Policy for the management of the Coral Fishery* – prescribes remaining input and output controls; prescribes detailed logbook reporting, real-time quota reporting ○ GBRMP legislation including *2003 Zoning Plan* defines zoning	• 2.12 Management Plan or equivalent • 2.15 Harvesting in protected areas • 2.19 Methods used to monitor harvest • 2.24 Proportion strictly protected from harvest

	system, including ~33% no-take zones ○ Licences and permits specify operational conditions at an individual level	
Contain the means of enforcing critical aspects of the management arrangements	○ Legislation, policy, licence and permit conditions (including logbook and quota reporting functions) are enforced through compliance officers (from mainly DPI&F but also GBRMPA and EPA) ○ Compliance activities are prioritised based on comprehensive risk assessments ○ Increasing focus on stewardship incentives and establishment of third-party audit processes; increasing partnerships with local communities – enhances compliance with voluntary management measures	• 2.8 Quality of information • 2.10Illegal trade or harvest • 2.12 Management Plan or equivalent • 2.16 Harvesting in areas with strong resource tenure or ownership (note not strict legal ownership – rather increasing co-management approach at regional scale) • 2.18 Confidence in harvest management • 2.20 Confidence in harvest monitoring • 2.22 Incentives for species conservation • 2.23 Harvest in areas with open access (note very limited recreational take outside marine park boundaries – not true open access) • 2.25 Effectiveness of strict protection measures • 2.26 Regulation of harvest effort
Provide for the periodic review of the performance of the fishery management arrangements and the	○ *EPBC Act* fisheries assessment process is one of continuous improvement. Periodic review of export approval occurs every 12 months as part of the annual reporting requirement of export accreditations. Reassessments occur every 3-5 years depending on	

management strategies, objectives and criteria	the outcome of the previous assessment. However, export accreditation can be for less than 3 years if a fishery exhibits sustainability concerns that need to be addressed in the short term. o Legislation can be reviewed as needed (cumbersome process) o *Policy for the management of the Coral Fishery* – designed to be adaptive, reviewed as needed (new information to hand or a reference point triggers further management action) and relatively easy to amend quickly o Policy objectives and actions designed to be responsive o *Environmental Stress Response Plan* – adaptive management to address externalities e.g. climate change impacts	
Be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates	**Fishery-specific:** o Explicit fine spatial scale (individual dive sites) monitoring of catch and effort data to finest possible taxonomic resolution o *Ecological Risk Assessment* o *Performance Measurement System* o *Environmental Stress Response Plan* o Industry initiative to monitor a few species at small (regional) scale in response to coral bleaching in the area o Cross matching coral export data with fisheries catch data **Other broad scale GBR-wide monitoring mechanisms:** o AIMS Long Term Monitoring Program for coral cover on the GBR o GBRMPA 'Bleachwatch' and 'Eye on the Reef' Programs o ReefCheck and other community-based under water surveys o Water Quality monitoring program (extensive Commonwealth and State government bilateral agreement for the GBR) o Monitoring tourism and recreational use o Permitting all use of coral in the GBRMP	• 1.23 Incentives for habitat conservation • 2.19 Methods used to monitor harvest

Require compliance with relevant threat abatement plans, recovery plans, the *National Policy on Fisheries Bycatch* and bycatch action strategies developed under that policy	○ Not applicable, no relevant threat abatement or recovery plans for coral on the GBR ○ Not applicable – no bycatch in this fishery	
Comply with any relevant international or regional management regime to which Australia is party	See CITES NDF Guidelines listed in column 3 of this Table	See above listings

NON DETRIMENT FINDING FOR CITES-LISTED *CORALS* IN THE QUEENSLAND CORAL FISHERY

AUTHORS:
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Commercial-scale coral collection occurs in three parts of Australia – the Northern Territory, Western Australia and Queensland. This report provides a case study of the management history and arrangements for the Queensland Coral Fishery (QCF); limited contextual information is provided on the other two fisheries. A small licensed fishery has existed in Queensland on the Great Barrier Reef since 1932, though large quantities of coral were removed prior to that, mainly for the production of lime. In its current form, the QCF is a small, limited entry, quota-based fishery that operates almost exclusively in the Great Barrier Reef Marine Park (GBRMP) and World Heritage Area (WHA).

The GBRMP is the southern extremity of the Coral Triangle – the global hotspot for coral biodiversity. It covers an area of 345,400km^2 and includes a large range of both reefal and inter-reefal habitat types. There are more than 350 species of hard coral on the Great Barrier Reef. Of these, 52 genera/species of CITES-listed corals are regularly collected in the QCF - to date, about 23 of these species have been exported in any numbers. The vast majority of the catch for the QCF is live rock, none of which is currently exported. The reminder of the catch is composed of a diverse range of coral and coral-like species including hard and soft corals, zooanthids, and corallimorphs – many of which are not CITES-Listed. The fishery predominantly supplies the domestic and international live aquarium markets, though a small proportion of the catch goes to the ornamental coral market.

Collection of the small quota (200T per annum) is managed under a comprehensive multi-jurisdictional framework. This report documents the approach taken in the QCF to:

- Integrate multi-jurisdictional management under a risk-based, adaptive management framework to address the particular concerns regarding a coral fishery operating in a multiple-use marine park and WHA
- Work collaboratively with fishers and the community to develop key elements of the management arrangements and generate practical solutions to often intractable problems
- Meet the CITES Non Detriment Finding requirement for hard corals
- Consider how to manage for cumulative impacts (including climate change) and encourage and support stewardship initiatives to promote ecosystem resilience

It is hoped that the lessons learned through this process may assist with improving the global capacity to make consistent, risk-based NDF assessments for coral given the current poor fit between an extremely diverse and taxonomically complex group and a system originally intended for single species assessments. It is noted that a range of factors (other than just collection) affect the conservation status of corals, including cumulative impacts from coastal development, water quality, destructive fishing, industrial scale removal of coral and, into the future, climate change impacts resulting from increasing sea surface temperature, sea level rise and ocean acidification. It is proposed that further consideration should be given to strengthening the CITES framework and seeking integration with other international conventions to more explicitly address these matters.

Queensland Coral Fishery - Case Study

Australian Government

Great Barrier Reef Marine Park Authority

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Developing the 'toolbox'

Australian Government
Great Barrier Reef Marine Park Authority

- Shared story – participatory, collaborative
- Many years, much discussion
- Pragmatic work in progress

Effective Conservation = good information AND <u>changing people's behaviour</u>

Acknowledgements

Australian Government
Great Barrier Reef Marine Park Authority

- **Management:** DPI&F, GBRMPA, EPA
- **Compliance:** QBFP, DDM
- **Science:** AIMS, JCU, Museum, CQU, independent consultants
- **Industry:** Peak body + ~ 6 key operators
- **NGOs:** WWF (limited)
- **General Public:** various open consultation periods
- **Ultimate Arbitor:** DEWHA (EPBC fisheries assessment + NDF)

Overview

Australian Government

Great Barrier Reef Marine Park Authority

- Context – relevant to making an NDF
- Current Management Status
  - Legislative component
  - Adaptive component
- Catch & export status
- Making the NDF – risk-based approach
- Details of adaptive management tools
- Problems
- Recommendations

History of coral removal on the GBR

Australian Government

Great Barrier Reef Marine Park Authority

- Coral mining from late 1800s, for horticultural use (lime)
- Early “scientific” collection (museums & private collections)
- Substantial tourism souveniring of curio corals (from early 1900s)
- Commercial collection/fishery (regulated since 1932)
- Until 1990s focus on curio market
- Increasing public perception issues re removal of curio coral
- Improved technology from late 1980s + cheaper equipment = increasing shift to aquarium market

History of coral removal on the GBR

Australian Government
Great Barrier Reef Marine Park Authority

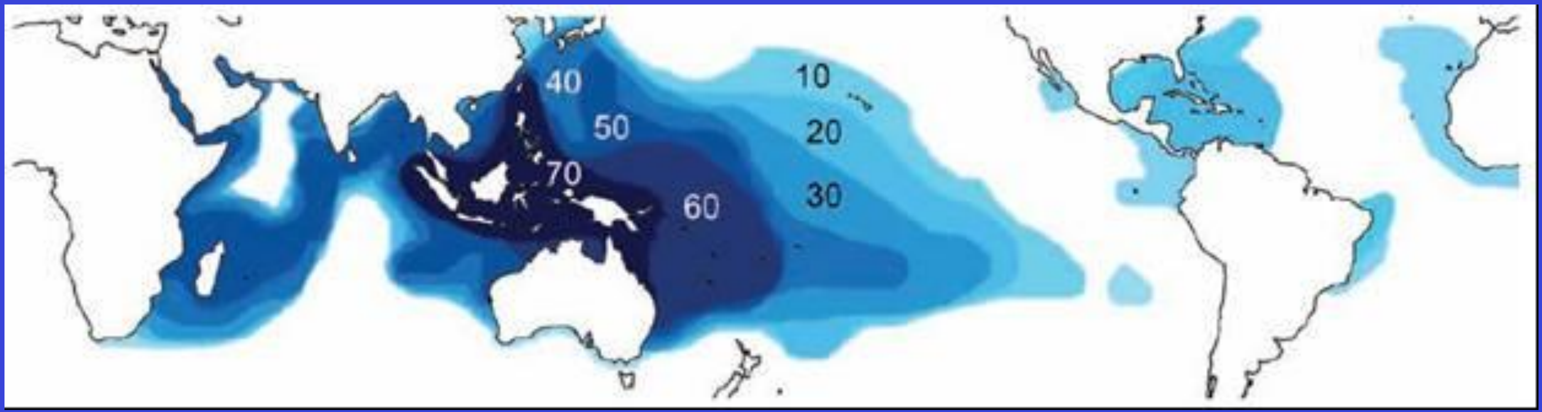
- GBRMP established 1975, largely to prevent proposed oil mining (& prevent return to coral mining)
- Gradual development of Marine Park management toolbox
- Tourism calls to close coral fishery ~2000
  - Independent Review found no sustainability grounds; but management outdated

Response = collaborative development of current coral policy

GBRMP & global coral biodiversity

Australian Government
Great Barrier Reef Marine Park Authority

Source: Hutchings & Kingsford (Eds) 2008



- The Coral Triangle – centre for global coral biodiversity
- On GBR – ~70 genera of hard coral & more than 350 species

Australian Government

Great Barrier Reef
Marine Park Authority

What is the GBRMP?

- World Heritage Area marine park
- Over 2000 km of coast
- Large latitudinal range
- Area > 345,000 km^2
- 33% closed to all fishing
- ~ 70 unique benthic habitats
- ~ 6% = "coral reef"
- Lots "inter-reef" & shoals
- Oceanography complex
  - connectivity good?

Basic biology

Australian Government
Great Barrier Reef
Marine Park Authority

Corals - difficult to generalise!

- >350 hard coral species on GBR- huge range of behaviour
- Zooxanthellate vs azooxanthellate
- Hermatypic vs ahermatypic
- Sexual reproduction – brooders vs broadcast
- Asexual reproduction – fragmentation, budding, polyp bailout/expulsion, brooded planulae
- R vs K strategies

Some coral species show enormous plasticity

Habitat types and ecosystem role

Australian Government
Great Barrier Reef Marine Park Authority

Habitats

- Most QLD CITES-listed species are habitat generalists
- 10 species are habitat specialists – many common in deeper ‘off reef’ areas – not so accessible
- 12 are also very accessible (mostly these are habitat generalists)

Ecosystem role

- Hermatypic corals – contribute substantially to coral reef matrix, provide habitat, food, increase biodiversity
- Ahermatypic corals – often inter-reefal, some role as habitat , food & biodiversity . Major export species = ahermatypic

Current knowledge base

Australian Government
Great Barrier Reef Marine Park Authority

- **Published Science** = mostly ‘coral reef’ habitats, mostly shallow/common species hard corals
- **Aquarists** = unusual/’rare’ species, more often deeper/turbid water coral species – some information anecdotal or in grey literature
- **Collectors** = inter-reefal habitats and species – mostly anecdotal unpublished information

Current management

Australian Government
Great Barrier Reef Marine Park Authority

Basic Rules (multi-jurisdictional)

- Fishery area = GBRMP WHA
  - 33% no-take + extra areas too deep or exposed
- Limited entry, small (59 licenses/ 24 operators)
  - Limits on number of boats & divers
  - Hand collection (hammer/chisel)
  - Detailed catch (logbook) reporting (species/location)
- No recreational take of coral in GBRMP
  - All other removal of coral requires permit – strict guidelines applied

Current management

Australian Government
Great Barrier Reef Marine Park Authority

Basic Rules (multi-jurisdictional)

- Quota (200 T per year)
  - Real-time quota debit (phone–in system prior to landing)
  - Good compliance framework
- Quota cap
  - 70% live rock & fast growing corals (2 genera)
  - 30% all other types of coral
  - Quota review reference points for 2 main collection areas (defined spatial boundaries)

Current management

Australian Government

Great Barrier Reef Marine Park Authority

Natural limits on effort

- Diving safety regulations – limits time at depth > 10m
- Weather - significantly limits all effort
- Strong market drivers focus effort
  - Private aquaria = small pieces rock & coral - colour, shape important
  - Primary transport = air freight (20 kg boxes + economics)

Current management

Australian Government
Great Barrier Reef Marine Park Authority

Adaptive, risk-based management framework

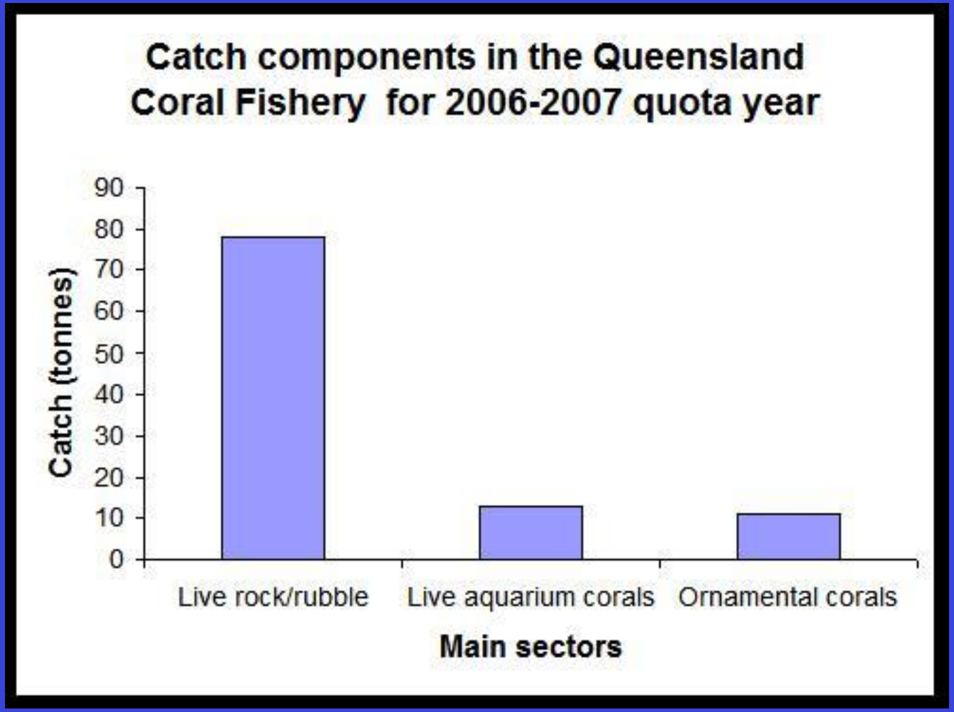
Focus = ecological sustainability & resilience

- Collaborative fine-scale catch monitoring
- Review reference points for high use areas
- Iterative Vulnerability Assessment (VA)
- Iterative Ecological Risk Assessment (ERA)
- Iterative Performance Measurement System (PMS)*
- Environmental Stress Response Plan*
- Industry stewardship initiatives*

Current Catch

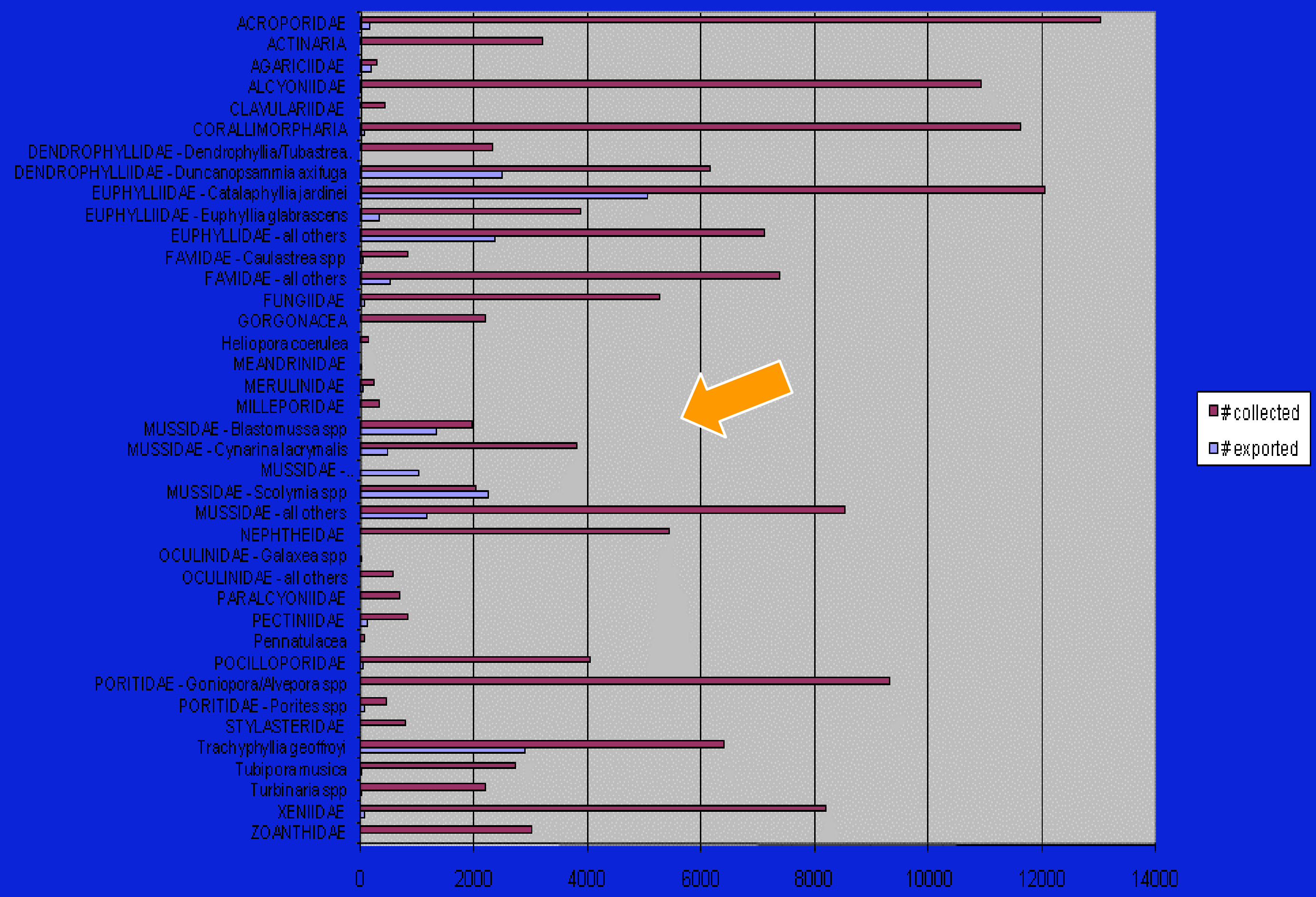
Australian Government
Great Barrier Reef Marine Park Authority

- Only ½ quota collected
- Live rock → domestic market
  - 1 Tonne = $25m^2$
- Ornamental
  - Mainly *Pocillopora* & *Acropora*
  - Some export
- Aquarium
  - Not all CITES-listed!
  - Mix of hard/soft corals, corallimorphs, zooanthids etc.
  - Some export



Number collected vs exported July 2006- May 2008

Australian Government
Great Barrier Reef Marine Park Authority



Current status of the fishery

Australian Government

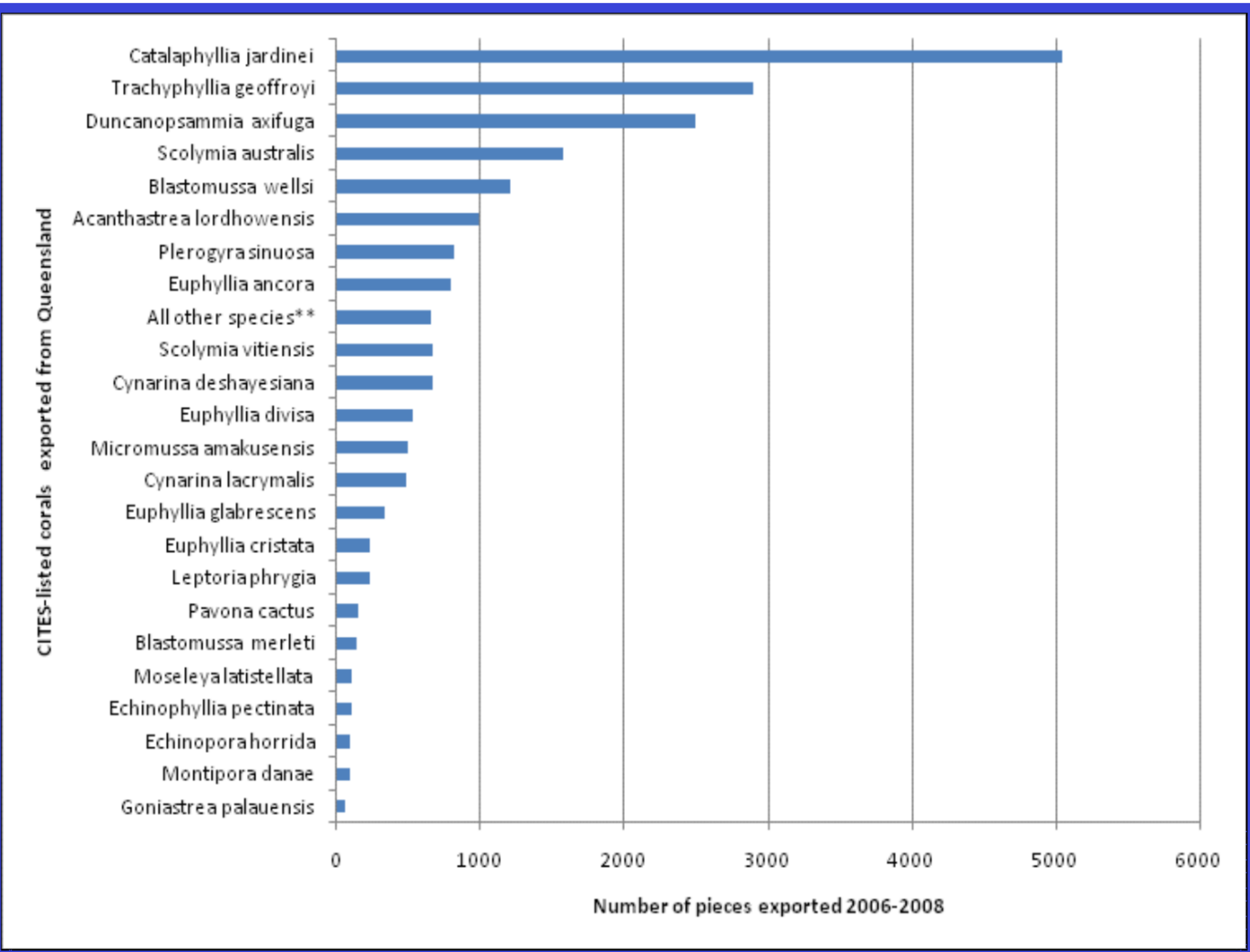
Great Barrier Reef Marine Park Authority

CITES-listed Catch/Export information

- 52 CITES-listed genera/species fished
- 48 widespread distribution, 4 mainly West Pacific, some locally rare
- 23 exported (>100 pieces in 2yrs)
- Total export ~21,000 pieces
- Exported species = most not ‘reef builders’

Current status of the fishery

Australian Government
Great Barrier Reef Marine Park Authority



Species of CITES-listed coral exported from the Queensland Coral Fishery from July 2006 to May 2008.

Note: All other species** = 47 different species where less than 50 pieces per species have been exported during this period.

(Source DEWHA CITES section export figures, 2006-2008)

Making an NDF

Australian Government
Great Barrier Reef Marine Park Authority

- Coral doesn’t fit CITES easily
- QLD started from scratch, built from bottom-up (2003-2006)
  - Fishers initially hostile
  - No reliable catch data
  - Limited scientific information on target species
  - No export*

Making an NDF

Australian Government
Great Barrier Reef Marine Park Authority

- Existing national adaptive risk-based fisheries framework (*EPBC Act*) = used this for NDF
- Stepwise approach
- Incorporated all available information
- 2008 = 2 yrs data; participatory/collaborative management
- Now time to review adaptive components

Tools – Vulnerability Assessment

Australian Government
Great Barrier Reef Marine Park Authority

- Simple flexible structure
- Identifies key issues & species
- Quantify factors that make species vulnerable to harvest
- Pre-assessment tool for ERA

- Taxa list generated from collectors stock lists
- Desk-top study
- Vulnerability = average across ranks
- To be reviewed when more info available

Tools – Vulnerability Assessment

- **Accessibility** (1-5 scale, 1= very limited)
- **Habitat/ecological niche** (2 = generalist & 4 = specialist)
- **Distribution** (1-5 scale, 1= widespread)
- **Susceptibility to bleaching** (2-4 scale, 2 = low)
- **Abundance** (1-5 scale, 1= very common)

Australian Government
Great Barrier Reef Marine Park Authority

Tools – Vulnerability Assessment

Australian Government

Great Barrier Reef Marine Park Authority

Vulnerability risk categories for coral taxa in the QCF

Vulnerability Risk	Average score from criteria	Description
Very Low	<2	These taxa are not vulnerable to harvesting activity in the QCF.
Low	2–2.99	These taxa are at low risk from QCF harvesting activity.
Medium	3–3.99	These taxa have characteristics that make them moderately vulnerable to over harvesting by the fishery.
High	4–5	These taxa have characteristics that make them highly vulnerable to over harvesting by the fishery.

Of 52 genera/species assessed, only 1, *Montipora* emerged as a moderate risk, all other CITES-listed genera were a low vulnerability risk

31 had a low susceptibility to bleaching

Tools – Vulnerability Assessment

Australian Government
Great Barrier Reef Marine Park Authority

RESULTS

- Of 52 genera/species assessed, only 1, *Montipora* emerged as a moderate risk, all other CITES-listed genera were a low vulnerability risk
- Note also:
  - 31 had a low susceptibility to bleaching
  - 10 habitat specialists (*Catalaphyllia, Caulastrea, Cycloseris, Diaseris, Heteropsammia, Plerogyra, Montipora, Scolymia, Symphyllia, Trachyphyllia*)
  - 12 were readily accessible (no over lap except *Diaseris & Montipora*)

Tools – Ecological Risk Assessment

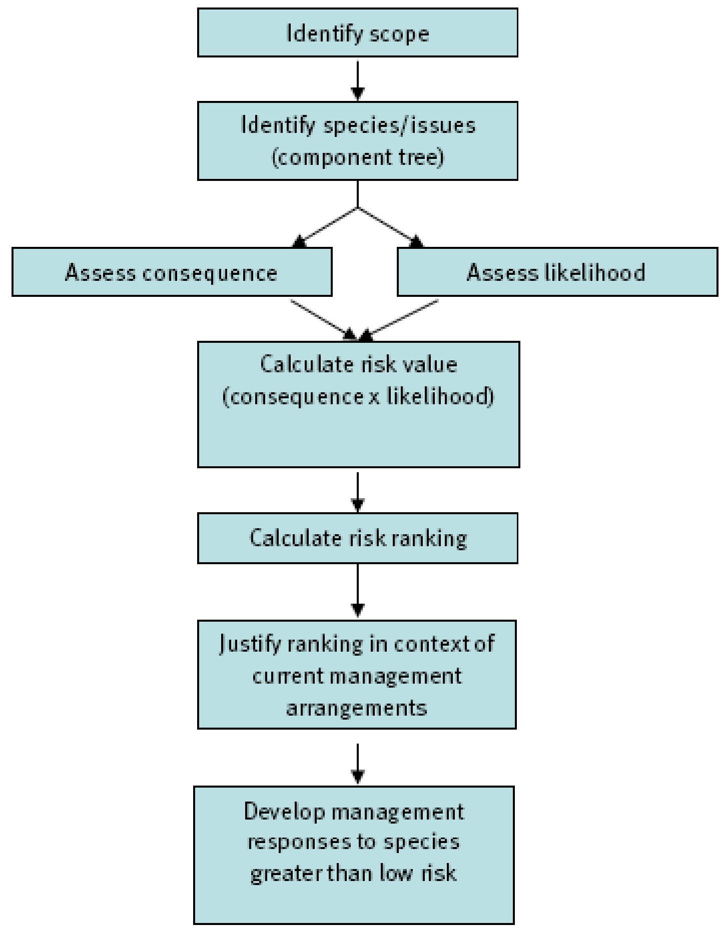
Australian Government
Great Barrier Reef Marine Park Authority

- Provides formal assessment of effects of fishery on harvested species = risk
- VA used to develop scope & issues & ‘component tree’
- ERA relies on best available expertise, incl. managers, scientists & fishers
- Because VA identified few species at, or above, low risk experts agreed to include all current/likely export species and live rock

- **Recording expert rationale and known strands of evidence for every step of the risk assessment is CRITICAL**

Tools – Ecological Risk Assessment

Australian Government
Great Barrier Reef Marine Park Authority



Tools – Ecological Risk Assessment

Australian Government
Great Barrier Reef Marine Park Authority

Table 3. Risk matrix – numbers in cells indicate risk value, the colours/shades indicate risk rankings (see Table 4 for details). Adapted from Fletcher et al. (2002).

Likelihood		Consequence					
		Negligible	Minor	Moderate	Severe	Major	Catastrophic
		0	1	2	3	4	5
Remote	1	0	1	2	3	4	5
Rare	2	0	2	4	6	8	10
Unlikely	3	0	3	6	9	12	15
Possible	4	0	4	8	12	16	20
Occasional	5	0	5	10	15	20	25
Likely	6	0	6	12	18	24	30

Tools – Ecological Risk Assessment

Australian Government
Great Barrier Reef Marine Park Authority

Table 4. Risk ranking definitions. Adapted from Fletcher et al. (2002).

RISK		Reporting	Management Response
Negligible	0	Short Justification Only	Nil
Low	1-6	Full Justification needed	None Specific
Moderate	7-12	Full Performance Report	Continue Current Management Arrangements
High	13-18	Full Performance Report	Changes to management required
Extreme	19-30	Full Performance Report	Substantial additional management needed urgently

Tools – Ecological Risk Assessment

Australian Government
Great Barrier Reef Marine Park Authority

- No taxa collected in the fishery came out with a rank greater than ‘low risk’
- ERA to be reviewed in 3 years (or as needed if substantial new information available)
- ERA provides transparent mechanism to identify monitoring & research needs

- Experts agreed to keep watching brief on harvest rates of all species

Tools – Performance Management System

Australian Government
Great Barrier Reef Marine Park Authority

- Becoming a std fisheries tool in Australia
- In development for coral fishery
- Establishes objectives, KPIs (e.g. rates of change) & management responses (e.g. adjust quota units)
- Provides formal & transparent process to review catch data
- Relies on best available data/information relevant to objectives
- Involves stakeholders, has public reporting requirements

Tools – Stress Response Plan

Australian Government
Great Barrier Reef Marine Park Authority

- In development…..
- Outlines harvest strategy to adopt when reefs show evidence of stress (bleaching due to several causes)
- Links to existing and well respected monitoring programmes
- Aims to promote resilience through transparent, non-emotive, timely responses
- Allows for continuum from voluntary moratorium at local scale to temporary spatial closure
- It is hoped this will be a pilot for a more inclusive approach to managing local access by all users to “stressed” areas of reef

Tools – industry stewardship

Australian Government
Great Barrier Reef Marine Park Authority

- Compiling comprehensive Code of Conduct, incl. documenting harvest strategies
- Looking to co-fund grant-based research on best practice
- Forward planning to develop certification programme – 3rd party auditable
- Pilot monitoring programme – integrate with community capacity to ground-truth results in shallow areas
- Attending conferences to share knowledge with other sectors (+ engage with Coral-list)

Problems

Australian Government
Great Barrier Reef Marine Park Authority

- Taxonomy/life history plasticity – doesn’t fit CITES framework,
- Taxonomic issues compromises quality/accuracy of data
- Units of measure - #s alone is misleading
- Question of spatial scale and ecosystem function in diverse systems
- Trade is tip of the iceberg – cumulative impact from other processes more important?
- Can’t ignore social and economic factors – they drive human behaviour
- Fossil coral???
- Scientific movement of coral?

Recommendations

Australian Government
Great Barrier Reef Marine Park Authority

- Ecosystem-based NDF framework for coral - single species rarely collected in isolation
- Adaptive & risk-based – rarely have good info on species & habitats
- Need a ‘”toolbox” and stakeholder participation - need transparency & buy-in
- Incorporate best available “expert” information & regular review – converging lines of evidence

Global Perspectives

Australian Government
Great Barrier Reef Marine Park Authority

Context

- Recent global & local shift to live aquarium corals
- Entire aquarium industry worldwide > US $15 billion
- 100's of millions of people visit public aquaria annually
- Est. 10% of households in many countries have private aquaria

Coral collection opportunities:

- Education
- Economic
- Research
- Medical

NDF WORKSHOP CASE STUDIES
WG 9 – Aquatic Invertebrates
CASE STUDY 5
Stony corals
Country – **INDONESIA**
Original language – English

EVALUATION OF NON-DETRIMENT FINDING FOR TRADE IN *STONY CORALS* FROM INDONESIA.

AUTHORS:
Suharsano
A.W. Bruckner

I. BACKGROUND INFORMATION ON THE TAXA

1. BIOLOGICAL DATA

1.1. Scientific and common names

Species considered in this cases study are known by the common name "stony coral". This included the order Scleractinia, which is represented by 17 families, 109 genera and more than 800 species of corals. Indonesia is located within the center of biodiversity with some 590 described species of coral, belonging to 82 genera (Veron, 2002; Best *et al*, 1989; Hoeksema, 2006; Wallace *et.al*. 2000). Because of the high diversity of corals, and ongoing taxonomic revisions, it is not possible to name all coral species, let alone to include the synonymy, since many coral taxonomists are still in disagreement. Only a portion of the stony corals found in Indonesian waters are currently being extracted for international trade. These are listed in Table 1. (Note: all table and figures see appendix 1). Beside scleractinian coral, two other anthozoan corals, Heliopora (blue coral) and Tubipora (organ pipe coral) are listed There is also one group of hydrozoan corals in two families, the Stylasteriidae (Stylaster and Distichopora spp.) and Milleporidae (Milleopra; fire coral).

1.2. Distribution

Indonesia has the largest and most extensive coral reefs ecosystem in the world. These are estimated to cover some 87,500 square km or 14% of the total area of corals reefs found worldwide. Coral reefs extend nearly 5000 kilometers from east to west and 1,800 kilometers from south to north. The highest diversity of corals occurs in insular Southeast Asia, in the western Pacific Region (Equatorial west Indo-Pacific, from Sumatra and Java, Indonesia in the Southwest, Sabah and the Philippines in the north west; and Papua New Guinea in the north east) with diversity diminishing rapidly along latitudinal gradients.

It is difficult to clarify the distribution of coral species in Indonesia one by one, but in general coral species appear to be distributed relatively evenly throughout the Indonesian waters (Suharsono, 2008). Nearly all Indonesian coasts are covered by coral reefs, except for the east coast of Sumatra, the north coast of Java, south coast of Kalimantan and the south coast of Papua. Many coral species are very abundant, occurring in a wide variety of habitat types extending from shallow nearshore locations to deeper offshore shelf edge reefs; other species have a restricted distribution, occupying specific habitat types where they may occur at a low density. The dominant species in nearly all Indonesian waters are respectively *Acropora, Montipora* and *Porites*. As an example of corals distribution in Indonesia, research in Raja Ampat, Papua identified 456 coral species of 77 genera (Veron, 2002). In Derawan Island, East Kalimantan, some 444 species occur and in Banda Island, 330 species (Suharsono *et al*., 2003). Coral distribution, as well as genera and species distribution in Indonesia can be seen in Figures 1, 2 & 3.

Most corals harvested to supply international markets come from areas relatively close to Java Island, Nusatenggara and Sulawesi, while those from other areas are as yet not utilized. At least some studies suggest that harvested areas can still support collection at the same levels as they did historically, based on the premise that the targeted species still exhibit the same size frequency distribution and the same number of reefs are being targeted (Suharsono, pers. Obs.)

Coral reefs with abundant coral cover about 250.000km^2 of the earth surface. Coral reef (in red) always have coral, but zooxanthellate corals occur beyond the latitudinal range of reef (in blue)

The number of genera of reef corals occuring in various tropical regions (After"Distribution of Reef Building Corals' J.E.N. Veron. Oceanus, Vol 29. No. 2, p.27, 1986. Copyright ©1986 Woods Hole Oceanographic Institution)

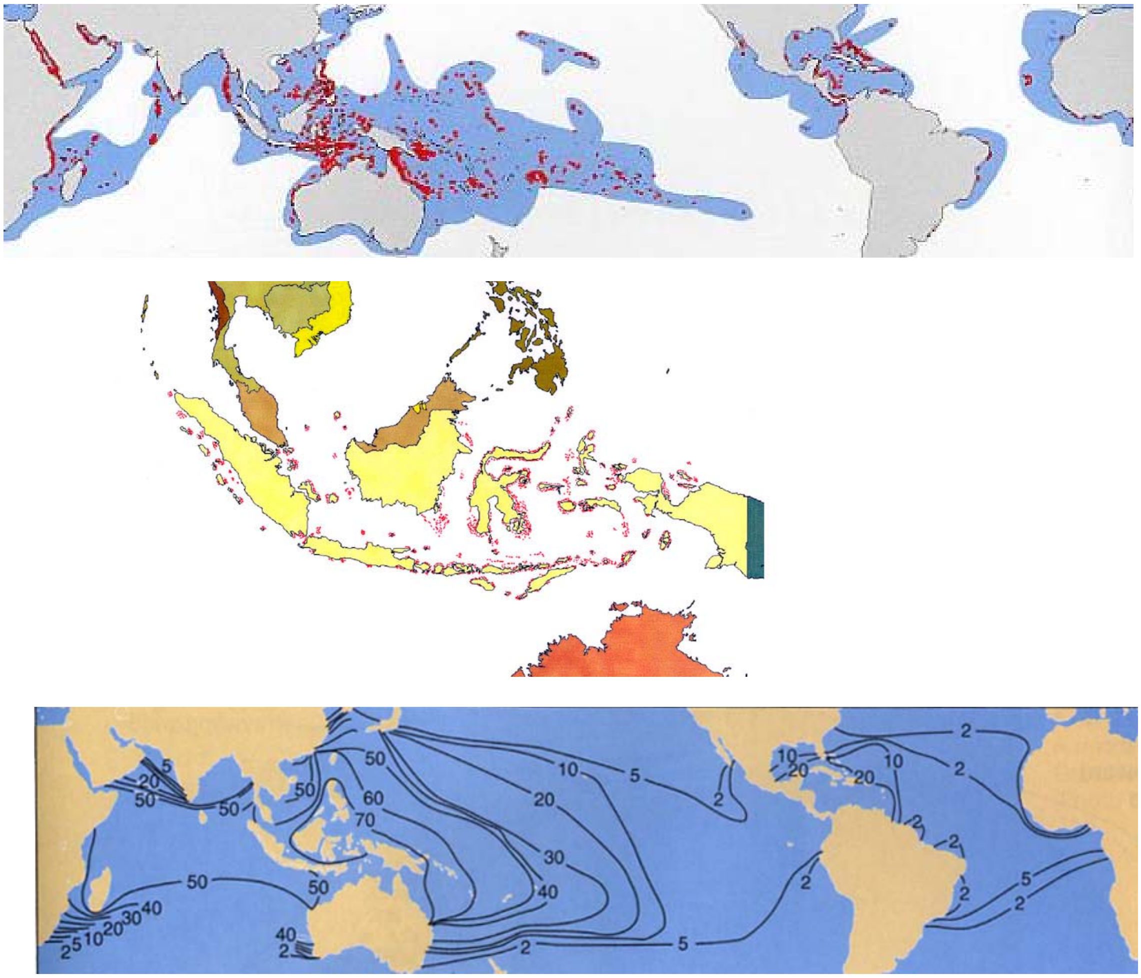


Figure 1. Coral reefs distribution in Indonesia.

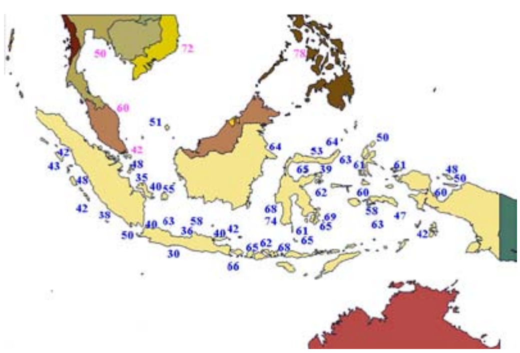


Figure 2. Distribution of coral genera in Indonesia. Total 82 coral genera found in Indonesia.

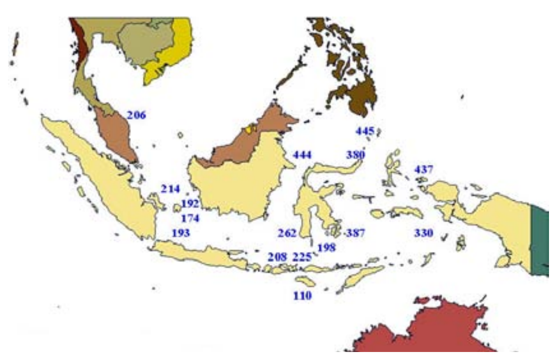


Figure 3. Distribution of coral species in Indonesia. Total 590 coral species found in Indonesia.

1.3. Biological characteristics

1.3.1. *General biological and life history characteristics of the species*

Corals grow and develop properly in clear water with optimal temperature between 28 – 30°C and salinity of 32-34%o. Vertical distribution of living corals in western Indonesia ranges between 1 – 20 m, while in the middle and eastern Indonesia they can grow in the depth of 40m. Corals are differentiated into ahermatypic and hermatypic types. While the hermatypic corals is further sub-divided into reef building coral and non-reef building coral.

Stony corals include two classes of Cnidarians (Anthozoan and Hydrozoans) that secrete calcium carbonate skeletons. All Cnidarians have a sac-like body cavity (coelenteron) with a single opening which serves as mouth and anus. The opening is surrounded by tentacles with stinging cells. The body wall has two layers separated by a jelly like mesoglea. The animal (called the polyp) is sedentary and may be solitary and almost all coral are colonial, with individual polyps connected to each other via a series of tubes. Polyps range in size from less than 1 mm to more than 250 mm.

Some of the Indonesian coasts do not support coral growth because they are located close to big river mouths. River waters decrease the salinity and increase the turbidity of sea water, reducing the amount of sunlight available for photosynthesis by the symbiotic zooxanthellae within the coral tissue. High rates of sedimentation near river mouths also will smother and kill corals, unless they have a well developed ciliary mucus system.

Corals have occurred throughout most shallow marine environments surrounding Indonesia for million of years, especially those living around the Sulawesi Sea and the Banda Sea. In contrast, coral reefs found in the Java Sea and the Natuna Sea, particularly those growing in the Sunda Shelf and Sahul Shelf, only became established about 8000 years ago, during a period of rising sea level once shallow coastal areas were inundated with sea water.

Corals are invertebrates with simple body structure in tubular form, measuring between some millimeters to a few centimeters depending on the species. Corals may have separate sexes, while many exhibit both male and female reproductive structures (hermaphrodites). Recent research indicates that corals can also reverse the sex or sex-change (Loya *et al* 2008). Some species of corals exhibit mass spawning events once or twice per year; these corals release egg/sperm bundles into the water column for external fertilization. Other corals are known as brooders, where the female takes up sperm from the water, fertilizes the eggs internally, which develop into plalulae larvae before being released. carry out external fertilization by releasing the eggs and sperms into the water. Corals that are known as brooders release well developed larvae that tend to settle on the bottom within hours to days, relatively close to the parent, while externally fertilized larvae require many days to weeks to develop, before settling on the bottom. Larvae from broadcast spawners can be transported great distances before settling and recruiting to a reef.

Corals can reproduce sexually as well as asexually. Asexual reproduction occurs by fragmentation, budding and 'blurbing'. Branching corals usually propagate from detached branches that have been broken via physical disturbance (high wave action, ship groundings) or bioerosion; these branches can reattach to the bottom and regrow into a new colony. Fragmentation is also done in solitary coral of genus *Diaseris* and *Zoophylus* which after reaching certain size they will fragment. Budding is commonly carried out by corals of the Family Fungiidae which are mostly solitary corals; under stress these corals often develop buds which can form new individuals. Branching corals of the Genus *Goniopora* also carry out propagation activities by 'bail out' that is by fragmentation of the polyp through forming small lump which then separates from the mother to become an individual of its own.

Corals that live in subtropical seas sexually reproduce once a year in the dry season, immediately before or after the full moon (up to 5-7 days after the full moon) in a tightly controlled mass spawning event. Brooding corals in Indonesia may reproduce all year round, with a peak reproductive event in August. Some corals, such as the brooding species *Pocillopora damicornis* can produce 300-500 larvae per day/colony. This species will mature at about 2 years when it achieves a minimum size of 10-15 cm in diameter. Spawning occurs in the night prior to the full moon at the time of low tide (Munasik 2008, Rudi 2006). They spawn or release the larvae at night to minimize the risk of predation. Spawning occurs during low tide to maximize possibilities of fertilization. The fertilized eggs and larvae float on the surface of the water, and are transported by water currents. Planulae may float for hours to days (or even weeks in some cases) until they become competent and identify a suitable hard substrate, upon which they will settle and attach to the substrate. As soon as the coral larvae find a proper place, they will begin to metamorphose into a polyp and begin depositing skeletal elements. Some larvae have symbiotic algae in their tissue which came from the parent, while others must acquire the zooxanthellae from the water column.

Larvae of coral usually attach to crevices, cracks and other sheltered locations to avoid predation. While settlement and survival rates are highly variable, depending on a number of factors such as the species, suitability of the substrate and habitat and other biotic and abiotic pressures. Most broadcast spawners release million of gametes, however very few of these survive settle onto the reef and recruit into the population (<<1% survival), while brooders tend to have higher settlement success. In one study from Indonesia, settlement on ceramic (terra cotta) tiles placed at an angle was fairly high, namely 18 juvenile/month/m^2 (Rudi 2006). Coral require substrates that are free of macroalgae, dense turfs and sediments. Because they are sessile and attached, they compete heavily for the limited available space, either through rapid growth and overtopping or direct interactions (competition and aggression).

The growth of coral varies depending on the species and growth form, with reports ranging from mm/year for corals that are massive, submassive and meandroid, and up to about 20 cm/year for branching and plating corals. Many of the massive corals found in Indonesia are reported to increase in size by 0.5 to 2.5 cm/year while branching corals such as *Acropora formosa* and *A. grandis* can grow up to 20 cm/year. For example, in the Seribu Islands, branching corals exhibited linear branch extension rates of 5 – 20 cm/year (Sadarun 1999). Individual colonies can continue to grow indefinitely, reaching sizes of meters to tens of meters in height/diameters; in some cases, especially the slow growing massive corals like Porites, individual colonies can live hundreds of years.

1.3.2. *Habitat types*

In general, corals grow in habitats with a hard bottom, clear water and continuous, flowing currents. In Indonesia, most other corals occur on fringing reefs, barrier reefs, atolls, and patch reefs. There are however, a number of commercially important corals that live in soft bottom habitats. For example, *Catalaphylia, Nemenzophyllia, Diaseris, Goniopora*, and *Trachyphyllia* prefer grassbeds, algal flats and sandy or mud bottom habitats in either shallow or deep water. Many coral species, especially the ones with big polyps, can survive in turbid water. One example of a widespread and common coral found near mangroves and river mouths is *Galaxea*. Result of research on corals that live in turbid places indicated that they have undergone natural adaptation by changing the RNA/ DNA ratio (Bak and Meeters 2000).

There are many distinct habitat types in Indonesia. It is thought that this high variability is one factor that has led to the unusually high coral diversity found in the area. For example, habitats include areas with substrates covered by fine sand while others have dead coral rubble substrates. The outer portion of the reef may slope gradually or near vertically to a depth of 300 m or more, and often there are overhangs, caves and other features. Coral can grow in relatively enclosed bayments and also in the open sea around oceanic reefs.

Some species, as well as certain genotypes within a species may be more adapted to high currents and wave action, such as many of the branching corals that occur on reef flats and reef crest on outer barrier reefs or oceanic islands. Other corals prefer calm, protected locations including back reef environments. Corals in the genus Pocillopora and Acropora prefer an open area with high to moderate wave energy. Many of the corals in the genus Porites and Goniopora prefer protected areas.

Corals can also be differentiated in terms of their need for sunlight. Some species of coral prefer an open place/shallow area with full sunshine, therefore they are called sun-loving while others such as Cynarina, Blastomussa and Plerogyra, live in protected areas at the back of big coral colony or live in a deeper part (shade loving coral)

1.3.3. *Role of the species in its ecosystem*

Corals have an important role in the ecosystem. In the food cycle corals act as primary producers as well as the primary consumers. Most corals live symbiotically with zooxanthellae, which are single celled "algae" (dinoflagellates) that produce lipid and carbohydrates through photosynthesis which is shared with and directly utilized by the coral for their growth. In addition to that coral also catch zooplankton, small fish, phytoplankton and detritus as supplementary food sources. The importance of zooplankton depends on the species, with larger polyp corals relying more heavily on plankton.

Conversely, coral polyps are the food source for many marine animals (known as corallivores) such as the sea star *Acanthaster planci*, the gastropod *Drupella* and some species of fish such as the butterfly fish and parrotfish.

Corals also are the major factor responsible for building reefs and providing refuge for other coral reef organisms. The coral skeleton serves a place for other animals to lay eggs, to serve as a nursery ground, a temporary home, and a feeding ground for its associated animals. Physically, coral with its hard skeleton functions as the main support of the reef ecosystem. The strong structure of coral reef functions as wave breaker and to attenuate the current. Corals also produce land as their skeletons are broken during storms and they accumulate and become cemented in place. For human life coral is used as building material, food sources and medicinal material as well as for tourism.

1.4. Population:

1.4.1. *Global population size*

Population size constitutes the most difficult question to answer. Firstly, most corals form colonies and only a small proportion of corals are solitarily individuals, making it difficult to determine the total number of individual animals or “polyps”. Secondly, it is very difficult to estimated global population size of individual species, as coral reefs contain multiple species and include some that are dominant and others that can be rare overall or in certain locations. The existing corals in Indonesia amount to some 590 described species. In Indonesia these 590 species may occur over an area of over 8 million hectares. Thirdly, the distribution of one coral species can be random, clumped or patchy, and multiple species will usually occur together, making it impossible to estimate the overall size of a population of individual species over broad areas. Furthermore, one species of coral can be difficult to find in one place while it is very abundant in another. Some examples of this include various species of *Fungia, Diaseris* and *Trachyphyllia*. One attempt at determining the distribution, abundance and the population structure of corals in Indonesia is summarized in Suharsono and Giyanto (2006) and in Suharsono (2008).

There are many methods that have been applied to estimate abundance and distribution of corals. One of the most simple approaches involves an estimate of the percent cover of corals which has been done in some locations in Indonesia at the level of growth form, genus and less frequently species. These estimates have been made using the Line Intercept Transect (LIT), belt transects or various photographic methods.

One of the most widely used approaches in Indonesia is to estimate the “condition” of reefs. For example, the Research Center for Oceanography-LIPI has conducted annual or biannual assessments of reef condition in numerous locations. Their recent surveys from the end of 2007 represent surveys in 77 localities distributed all over Indonesia, with 908 stations. These results identified only 5.51% of Indonesia’s reefs as being in very good condition, 25.11% in good condition, 37.33% in moderate condition and 32.05 % in bad condition (Table 2).

To estimate abundance of corals, and to determine levels that could be harvested sustainably, coral cover and abundance by growth form are both inadequate measures. Coral cover will not provide any meaningful information on the numbers of colonies, while growth form fails to identify even the abundance of individual genera, as multiple genera may have the same growth form. There has been an increased interest in applying protocols from the western Atlantic to Pacific reefs which involve at minimum observations on the number of colonies of individual genera within a given area, reported by size or size class. For example, Bruckner and Borneman (2006) used this approach to categorize the population dynamics of corals within Indonesia's largest collection area. They completed belt transects through all major habitat types and along depth gradients. These data provided quantitative information on the total numbers of each taxa and their size frequency within each habitat type. This was then extrapolated to estimate the total abundance through the collection area by calculating the area of each habitat type and multiplying it by the abundance/unit area of each taxa.

While it is not possible to provide quantitative data on the total number of each coral taxa within Indonesia, most studies have identified large declines in coral condition, both through measures of losses of living coral cover, and mortality of individual corals. What is interesting is that all countries in the southeast Asia region (Philippines, Vietnam, Malaysia and Singapore), with exception of Indonesia and parts of Thailand, reported high rates of decline from 1994-2004. Indonesia was the only country that showed improvements in reef condition across the board since 1999, with a shift from most reefs having less than 25% cover in 1999 to many more that have 25-50% cover in 2004 (Wilkinson, 2004). Other reports provide a less than rosy picture. For instance, in the past 50 years the proportion of degraded reefs increased from 10% to 50%. Western Indonesia, which is the most populated and the area with most of the coral fisheries is in much worse condition than eastern Indonesia (Burke *et al.*, 2002).

Table 2. status of coral reefs condition in Indonesia. Data ware taken from 77 locations and 908 stations all over Indonesian water.

Location		No.Of Location	Excellent	Good	Fair	Poor
West	35	362	5,52	27,07	33,98	33,43
Central	27	274	5,11	30,29	44,89	19,71
East	15	272	5,88	17,28	34,19	42,65
Indonesia	77	908	5,51	25,11	37,33	32,05

1.4.2. *Current global population trends*

___ increasing _X_ decreasing ___ stable ___ unknown

Valuation of coral reefs from 1993 to 2007 indicated that to certain extent the coral condition in Indonesia were getting better. It was apparent that coral reefs in bad condition tend to decrease, corals in moderate condition were increasing, while corals in good condition were more or less constant (Figure 4)

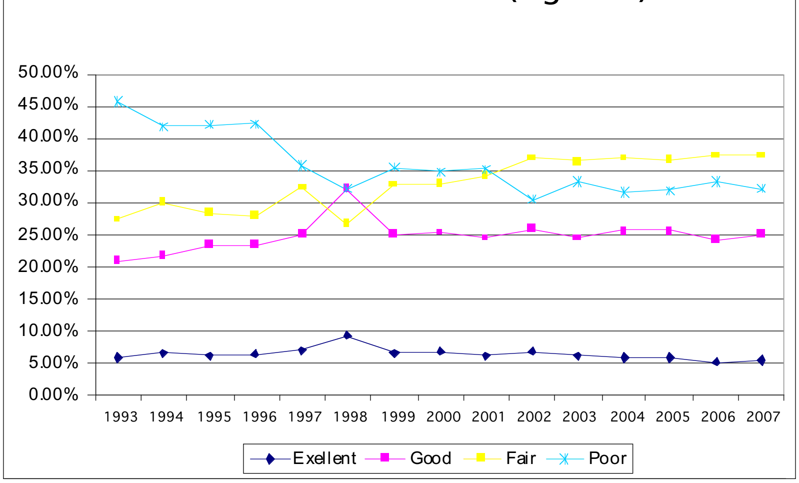


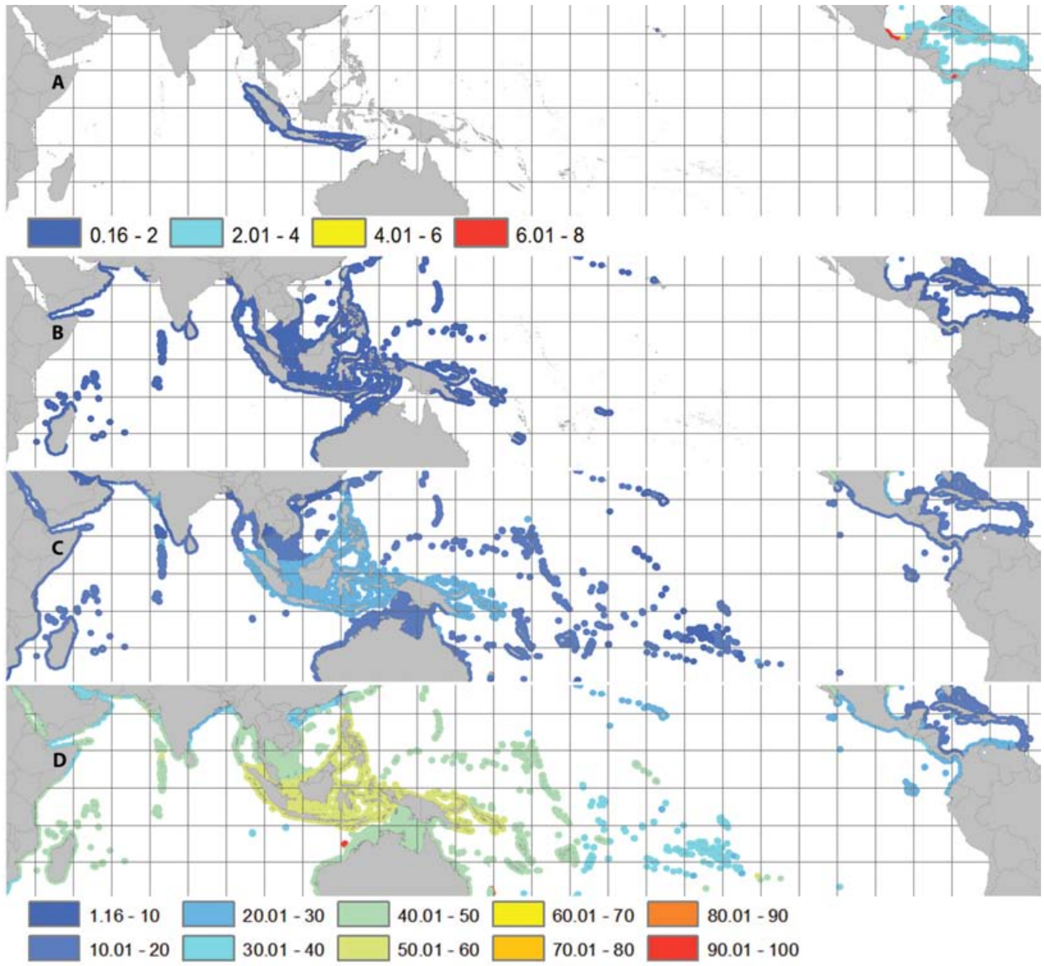
Figure 4. Grapic of trend of coral reefs condition in Indonesia from 1993-2007.

1.5. Conservation status:

1.5.1. *Global conservation status* (according to IUCN Red list).

____Critically endanger	__X_Near threatened.
__X_Endangered	____ Least concern.
__X_Vulnerable	__X_Data deficient.

The conservation status of 845 zooxanthellae reef building coral species were assessed using IUCN Red List criteria in 2007. 141 species were data deficient of the remaining 704 species were categories with elevated risk of extinction including 231 in the threatened categories. The highest proportion of vulnerable and near threatened coral species were found in the epicenter of marine biodiversity (in the Indo-Malay-Philippine Archipelago), the Coral Triangle Species in the families Euphyllidae, Dendrophylliidae and Acroporidae are particularly at risk with more than or close to 50% of species in a threatened category.



a) Critically Endangered species as percent of total species in area, b) Critically Endangered and Endangered species as percent of total species in area, c) species in all Threatened categories (Critically, Endangered and Vulnerable) as percent of total species in area, and d) species in Threatened and Near Threatened categories as percent of total species in area. Calculations are based on a cell size of 10 km2. Data and Figure from

1.5.2. *National conservation status for the case study country*

The Indonesian government gives very serious attention to coral reefs since their condition in some locations have undergone very serious degradation, which has been most dramatic near large population centers, but also includes large losses in remote locations presumably from climate change impacts (e.g., bleaching events). Despite that, in general, the coral condition in Indonesia is still relatively good (Figure 5)

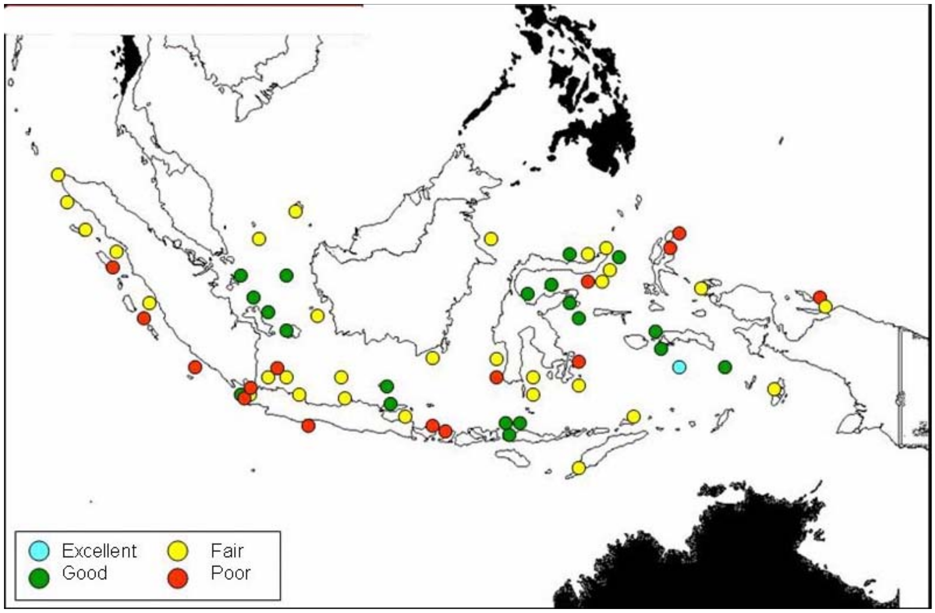


Figure 5. General coral reef condition in Indonesia.

1.5.3. *Main threats within the case study country*

___ No threats.
_X_Habitat loss/ Degradation (human induced)
____Invasive species (directly affecting the species).
_X_Harvesting.
____Accidental mortality (e.g. bycatch).
____Persecution (pest control)
__X_Pollution.
__X_Other climate change (elevated sea water temperature, disease, tsunami, COTs).
____ Unknown.

The main causes of coral degradation in Indonesia are the result of human activities and localized impacts from natural factors. In the 2002 Reefs at Risk Assessment human activities threaten over 85% of Indonesia's reefs. The principle threats to these reefs are overfishing and destructive fishing, which threatens 64 and 53% of Indonesia's reefs, respectively. Both sedimentation and coastal development threaten about 20% of the country's reefs. Among the most egregious of the destructive fishing practices, bombing is a common practice by subsistence fishermen, while cyanide is used to target large groupers for the Live Reef Food Fish trade and thousands of species of aquarium fishes. Coral reefs adjacent to large cities have been subjected to serious degradation due to high pollution of household and industrial wastes. In 1983 and 1998 Indonesia experienced increase of sea water temperature in the waters of Natuna, Java, Bali, Lombok and Sunda

Straits. Increase of sea water temperature of 3-4°C can bring about massive coral death of 80 – 90% (Brown and Suharsono 1990, Suharsono 1999). Significant coral mortality was also associated with the 1998 bleaching event, but coral recovery from this event seems to be well on the way. There have also been localized impacts from outbreaks of crown-of thorns and Drupella snails, which have largely impacted branching corals. There are also recent reports on increases of coral diseases in Indonesian waters.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1. Management measures

2.1.1. *Management history*

The Research Center for Oceanography has been monitoring the coral reef condition in Indonesia since 993. These studies have demonstrated linkages between coral degradation and human activities as well as to natural factors. Worried by the continuing degradation of coral reefs, various discussions, seminars and workshops have been organized to develop a program of saving the Indonesian coral reefs. In 1998 such a program was developed and named the COREMAP (Coral Reef Rehabilitation and Management Program). To execute the program, a National Policy Strategy and Action Plan for Coral Reefs was constructed. COREMAP Program are composed of three phases namely initiation phase (3 years), acceleration phase (6 years), internalization (6 years)., and was started in 2000. Currently the program is in Phase 2 and is implemented in 6 Provinces and 15 Districts in Indonesia (see COREMAP).

Indonesian Government is a developing country with serious interests in protecting and conserving coral reefs. For example, they have allocated about US $ 105 million to manage coral reefs over the last 9 years. In 2007 the Government also launched the program of Coral Reef Triangle Initiative which involves 6 countries, namely Indonesia, Malaysia, Papau Gunea, the Philippines, Timor Leste, and Solomon Islands.

In response to the CITES Appendix II listing of corals, Indonesia has developed specific guidelines for sustainable utilization of coral resources. These were developed in coordination with management authority (Directorate general for Forest Protection Conservation), Scientific Authority (Indonesia Institute of Science) and ICRWG (Indonesian Coral Reef Working Group). This includes a quota first implemented in 1997, which is now broken down by species for each province where collection is allowed (Table 1).

2.1.2. *Propose of the management plan in place*

The objective of COREMAP is to balance the management between intensity and different uses based on available scientific data and carrying capacity of the environment, to enhance the standard of living of coastal communities who are dependant on coral resources, and to develop cooperative coral reef management systems involving all parties.

2.1.3. *General elements of the management plan*

There are five main components in the COREMAP program which are identified in the National Policy Strategy and Action Plan. These include: Research and Monitoring, Institutional Strengthening, Community Based Management, Law Enforcement and Surveillance, Public Awareness an Education.

Coral harvest for international trade is currently allowed in 11 provinces, but it must occur outside protected areas and tourism areas. In addition, coral is supposed to be taken at levels below the regeneration rate for each species, and at a specific size (e.g. 25 cm for fast growing species and 15 cm for slow growing corals). These guidelines also recommend that collection only occur in sites where population assessments have occurred and monitoring is undertaken to ensure sustainable utilization. Along with specific methods of coral removal, coral collection sites are under a minimum of a four year rotation period.

Quota setting. The quota lists the allowable harvest by species/genus for each of the 11 collection areas, and the allowable exports which are about 90% of the allowable collection, to take into account mortality and discards during collection. The quota for coral harvest is currently established using available information on reef accretion rates, rates of coral growth, condition of reefs from sites where monitoring has occurred, and estimates of reef area. Initially, a total quota was established at 1,000,000 colonies between 15-25 cm in diameter, which represented 0.00035% of the total coral reef area in good to excellent condition. The quota was based on the assumption that reef accretion rates range from 1 to 1.5 cm per year, growth rates are from 2.5-30 cm per year and harvest occurs only on about 30% of the reefs in Indonesia, specifically those in good to excellent condition (Suharsono,1999). The quota is subdivided among individual taxa (to the species level, or in some cases to genus) for each of 11 provinces.

The quota allocated for 2001 included over 925,000 live corals, 950,000 pieces of reef substrate with attached soft corals and 450 metric tons of live rock. The quota for 2008 is listed in Table 1. In addition to the quota, there is a ban on the export of coral skeletons.

2.2. Monitoring system

Research to understand the coral reefs was done initially in a selected area which is considered representative of the coral reefs in the area. The initial approach involved a rapid assessment to determine the general condition of the coral reef. This was later supplemented with permanent transects that are reexamined annually, to determine the baseline and amount of change over time.

2.2.1. *Methods used to monitor harvest*

The permanent transect are monitored each year using a Line Intercept Transect. The area to be monitored annually are located in 15 Districts in West Sumatera (Northern Pagai , Southern Nias, Siboga); East Sumatra (Natuna, Batam, Riau and Lingga); South Sulawesi (Selayar and Pangkep); Southeast Sulawesi (Buton and Wakatobi); Papua (Raja Ampat and Biak and East Nusatenggara (Sikka).

2.2.2. *Confidence in the use of monitoring*

Application of LIT method has met the international standard and is done by qualified researchers so that the result of monitoring in each locality is scientifically justifiable. Comprehensive reports of the results of monitoring of all locations are kept in the library of CORE-MAP –LIPI.

2.3. Legal framework and law enforcement

There are at least 5 Acts that can be used to base the management of coral reefs in Indonesia. These are Act no 5 of 1990 on conservation of the living environment and its ecosystems; Act No 23 of 1997 on Management of Living Environment; Act No 31 of 2004 on Fisheries; Act No 32 of 2004 on Local Autonomy; and Act No 27 of 2007 on Management of Coastal Area in which all included coral reefs to be properly managed. In addition to that there is a Government Regulation No 8 of 1999 which regulate the utilization of biota; and this regulation appointed PHKA as a management authority while LIPI as scientific authority.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED.

3.1. **Type of use** (origin) **and destination** (purposes)

Stony corals are harvested for building materials and road construction, in Lombok and Bali for production of lime, the domestic ornamental industry and also for international trade as curios and aquarium specimens.

Indonesia has been the world's largest coral exporter since 1993. Currently only live coral may be exported; trade in skeletons (recently killed and bleached coral) for curios has been prohibited since 1998. The Indonesian Government gives only export permission for live coral, so that coral can only be used for aquarium ornamentation and not for other purposes.

While all exports were historically wild-harvested corals, over the last three years there has been a large expansion in Indonesia of coral farms that are producing colonies for export from fragments of a donor colony. The Indonesian government , through the management authority and scientific authority, is developing a policy to gradually phase out wild harvest, with all exports ultimately being obtained through coral mariculture. While this is currently being done in a wide variety of ways, some of which are more environmentally friendly. For example, some "farmers" t remove an entire colony which is broken into pieces that are attached to a substrate and then exported. Other farmers have collected a "mother" colony of a species of interest, they fragment only a portion of the colony and allow the mother colony to grow back. The fragments are attached to substrates and allowed to grow to a marketable size before being exported. Once the maricultu-re effort is deemed successful, Indonesia proposes to prohibit wild har-vest.

While hundreds of individuals collect coral, only AKKII (the Indonesian Coral Shell and Ornamental Fish Exporters Association) members are allowed to legally export wild-harvested corals and farm-raised corals.

3.2. Harvest

3.2.1. *Harvest regime*

Coral harvesting occur throughout the year with peaks depending on market demand. Harvesting is lowest during summer season and hig-hest during the winter season, from November until Christmas. Corals are exported commonly to Europe, United States and Japan. The current proportion of export between wild-harvested corals and mari-cultured corals is supposed to be 60:40, but currently this ratio is clo-ser to 80:20.

Presumably, research is conducted in each location where harvest is allowed to determine sustainable levels. The approach used to achie-ve this is based on data from the Line Intercept Transect and the Belt Transect. These two methods are used for two different types of coral habitats, namely the LIT is used for reef building coral assemblage (e.g., those corals found on reefs), while Belt Transect is used for corals in which the larger proportion of the population are non reef building species (e.g., those corals found in grassbeds and soft bottom habitats). Example of result and the research method is presented in a paper entitled: "A formulation approach to quantify the abundance of coral genera" by Suharsono and Giyanto (2006). In short the result of this method provides a value for each species. The values range between 5 – 20 and coral that have the total abundance value of 17 –20 can be commercialized and those that have a value 5 – 10 (harvest prohibited) must be left undisturbed.

Harvesting of coral from nature must be carried out by trained fishermen. It must be done with great care since it involves live coral. The fishermen will do just that, since dead corals are not saleable. Usually coral harvesting by fishermen is based on order from the importers. Fishermen will do the harvesting when an order from the importer is received including verification of the species wanted.

3.2.2. *Harvest management*

Harvest management is based on the decree of the Minister of Forestry No: 447/Kpts- II/2003 concerning administration directive of harvest or capture and distribution of the species of wild plant and animal species. In this ministerial decree is included regulation and custom of harvesting, quota allocation, capture location, utilization of specimen of wild animals, permit of harvest or capture, permit for foreign commercial utilization, permit for foreign transport of wild animal, coordination and the role of the community, the role of non government organization, the role of association, control of harvest of the wild specimens, information system and data base, law enforcement and sanctions etc.

The management of coral harvesting also involve Non-Government Organizations as a control agent and in this case include in the Indonesian Coral Reef Working Group (ICRWG) which consists of non-government organization, relevant government institutions such as the Department of Marine Affairs and Fisheries, National Development Planning Agency, Department of Commerce, Directorate General for Forest Protection and Nature Conservation (PHKA), Indonesian Institute of Sciences. ICRWG also issued a guide book on "Pattern of Sustainable Use of Ornamental Coral". This book is expected to guide sustainable use of coral, enhance the welfare of the fishermen and the state of foreign exchange, and safeguard sustainable coral reefs.

To facilitate management and control of coral trading, the Indonesian Government requires all exporters to unite in an

Association called AKKII (Indonesian Coral, Shell and Fish Association). The performance of AKKII is unrelated to that of the government but they have the duty to control, manage, and to watch its members for sustaining coral trading without causing coral degradation.

3.3. Legal and illegal trade levels

Legal trade through quota mechanism follows that of the CITES, and the Exporters who belong to AKKII presumably obey the regulation controlled by the management authority. The possibility of existing illegal trade is believed to be very unlikely since it is controlled by the exporting countries as well as by the importing countries of CITES members.

Corals that are reported to be exported illegally form Indonesia largely involve misidentifications relating to the taxonomical problems. For example the scientific name of *Wellsophyllia* was believed to be *Trachyphyllia* or vice versa, so that the export transaction was considered not valid (illegal). Some NGOs suggest there is considerable smuggling that may occur to the non CITES member country, but the government of Indonesia believes illegal trade to CITES member countries is very small. All exporters that are members of AKKII are discouraged to become involved in illegal trade, since they can be banned from trading forever if caught.

II. Non-detriment finding procedure (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS:

__yes _X__no

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

The criteria used to ascertain the NDF is the decrease in total number and measurement of the exported coral species. To date the amount exported for each coral species is relatively small compared to the existing potency. As a matter of fact there is no problem to meet the quota of export. The size of each coral species (which is controlled), which is used as an indicator for the NDF, does not show any significant decrease. In addition to that monitoring is done during harvest time to observe the condition of the coral reefs.

Apart from the above, Indonesia also applies the principle of sustainable used, among others:

- The location of coral harvesting is outside conservation area, tourism area, protected areas by the Local Government, agreed tradi-

tional areas of local community;
- Size of the harvested coral are between 5 -20 cm;
- Coral harvesting in one location can be done only after its abundance has been evaluated by SA and ICRWG;
- Collecting of coral must be done with care without destructing the targeted coral or other biota in the surrounding area that are not the target;
- Coral harvesting must be done by trained fishermen
- The amount of coral collected must be based on the quota which was decided by the Supreme Court (MA) Issuance of permit and extension of permit needs a verification, field monitoring and evaluation.
- Field monitoring is done once a year in the collection site to obtain information in deciding the quota;
- Monitoring is to be done by the MA and SA starting from collection site up to the exporting site;
- Collection and division of quota is based on province and diversified for each province in order to prevent concentrated harvesting in one location
- Export permission is not given for recently dead coral. Permit is given only for live corals, this is to push fishermen and exporters to be more careful so as not to suffer from loss. Handling living coral need real care starting from the time of collection up to the hand of exporters so that they will remain in good condition.
- The policy to permit export of living coral only is also intended to prevent smuggling of coral.
- All exporters and fishermen are required to execute coral transplantation. The portion of coral quota from nature will be decreased and those from transplantation will be increased and at the appropriate time there will be no corals taken from the wild.

3. MAIN SOURCE OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

The main data was evaluation of export realization, field data resulting from monitoring which was collected by means of LIT and Belt Transect and was analyzed whether or not there is a decrease in the number and measurement, and is there any change in state of the abundance of one species of coral, for instance from the status of commercialization or to be prevented from being commercialized.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

The quality and quantity of data collected, from the stand point of the amount are quite sufficient since the monitoring is done in the location of coral harvesting for export and is always done by researchers and staff coming from the NGO who are best qualified. While data that come from export realization can also be answerable to the management authority as well as to that of exporter association.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

The listing of an entire order, e.g. the Order Scleractinia in the CITES is very unusual. This may have first been done due to difficulties in identifying individual coral species, but this approach presents difficulties for CITES authorities in exporting and importing countries, and for enforcement officers. Recently, a revision of the listing focused on improving identification requirements by identifying those corals that could be identified to species, those that only needed to be identified to genera and those that could be reported to order. While this clarified reporting requirements for live corals and it offered a viable way to differentiate reef substrate and live rock from coral, it still presents many difficulties because of taxonomic difficulties and the extensive expertise required to correctly identify corals.

Because individual species vary in abundance, and some are very common, not all species "qualify" for listing. While Indonesia feels these should not be included, this is largely a response to their similarity (e.g., look-alike criteria). Without listing all corals, it is likely that many more shipments would be confiscated due to questions about identification on permits.

In terms of making a NDF, the great number of species of corals and the large extent of coral reefs in the Indonesian sea presents difficulties when conducting stock assessment studies for each species and to carry out monitoring of each species. The uniqueness of reef corals as colonial and not individual, animals and their differing biological characteristics from other biota, further complicate the making of an NDF.

6. RECOMMENDATIONS

It is necessary to evaluate the current list of corals included in CITES Appendix II to select species of corals which are threatened with extinction due to trade. While it would not be feasible to exclude common corals from CITES, those that are indeed threatened should be considered for Appendix I.

The necessary evaluation from the CITES Animals Committee is needed to evaluate the status of coral mariculture (especially with respect to source codes reported on CITES permits), given the success of artificial propagation especially for branching corals. Coral harvesting from nature should be gradually minimized and the time will come when all targeted coral will be successfully cultured by way transplantation, then coral harvesting from nature will be prohibited. As currently required, all corals should be reported as wild. This presents difficulties when evaluating sustainability, especially if a large proportion of these are not being directly pulled from the reefs.

Identification of corals in trade presents large problems to customs and wildlife inspectors. More emphasis is needed on identification training and adoption of standards for reporting.

Determination of a sustainable quota: a quota is one mechanism for ensuring that a resource is utilized sustainably, but it must be based on science. The quota should reflect the total amount of each taxon coming out of the water, and not the amount of coral that is exported, as this does not reflect the numbers that died during collection and subsequent handling. In addition, the quota should be established for each geographic collection area, based on the condition of the reef, the abundance of the targeted coral, the extent of other reef uses, and impacts from natural and anthropogenic disturbances that may affect survival of targeted taxa. The quota must also take into account life history strategies, such as rates of growth, recruitment rates, and population demography. Various quantitative data, such as the abundance, size frequency distribution, growth rates, mortality and recruitment, in combination with the total area occupied by a targeted species and the area under collection pressure, can provide an initial estimate of the potential yield of each taxa under different levels of collection.

A classical fisheries model was modified for precious corals by Grigg (1984) and was also applied to stony corals to estimate the maximum sustainable yield for *Pocillopora verrucosa* in the Philippines (Ross, 1984). This model involved a calculation of the biomass that could be harvested, based on an assessment of the standing crop in the harvested area, the growth rate, and the instantaneous rate of recruitment and natural mortality. For sustainable harvest, the model requires that the corals obtain a minimum size (age) to allow for reproduction, which in the case of *Pocillopora* was estimated to be 18 cm (6 years). This type of model may be suitable for branching corals, especially those harvested for curios, as these taxa are generally harvested at a large size. However, it may not be applicable to the other species that are not so widespread, they exhibit slower growth rates and much lower rates of reproduction. In addition, the average size of most corals collected for the aquarium trade is small and often pre-reproductive.

As a first step in developing a model applicable to Indonesia, Bruckner and Borneman (2006) assessed the largest collection area in

Indonesia, off Spermonde. This involved 1) a determination of the total number of different habitat types and their aerial coverage within the Archipelago; and 2) total number of each taxa found within the region and their size structure, as determined from the abundance and diameter of stony corals identified per unit area (from belt transects), multiplied by the area occupied by each taxa, to determine how many were available for harvest. They then established a conservative level (% of the population) that could be removed, considering the life history of each taxa and the actual size distribution. This ranged from 1-10% of the population, with higher numbers for the faster growing corals that were very common and are known to recruit well. These numbers were then compared to the existing harvest quota for the Spermonde Archipelago, to determine whether the quota was sustainable or it had the potential to result in overexploitation. Ultimately, it was determined that Indonesia coral collectors were removing from <1-96% of the population of each taxa on an annual basis. Recommendations were made to reduce the level of harvest of certain taxa currently under high collection pressure (based on the field data and empirical life history data), while other species were identified that could be collected at higher levels to make up for the loss in revenue associated with reduced collection pressure. This work also suggested that the proposed level of off-take (a certain percentage of the population) was only an interim measure, and follow-up monitoring would be needed to verify that this was sustainable and an adaptive management approach may need to be incorporated to reduce or increase that percentage based on the responses of the population, and considerations of some of the other threats affecting the population.

An alternative, and much simpler approach from that proposed by Bruckner and Borneman (2006) is included in Suharson and Giyanto (2006). A formulation approach to quantify the abundance of corals developed by Suharsono and Giyanto (2006) can be considered to obtain basic information necessary in determining the potency and condition of coral to set quota for coral trade. The line intercept transect and the belt transect method has been used to calculate the total value for each coral based on the number of occurrence, the genera dominance, the size of the colonies and the coral coverage in each study area was assigned scale, weight and value. A total value range from 5 -20 and the assignment abundance category of coral is 17-20 very common, 14-16 common, 11 – 13 uncommon, 8 – 10 rare, 5 -7 very rare. Coral categorized as very common can be harvested, coral categorized as common can be harvested with caution, coral categorized as uncommon has harvests which are limited, coral genera classed as rare and very rare are not permitted to be harvested.

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Annex

Table 1. List species of quota coral for export 2008. There is 78 species of scleractinian coral and 4 species non scleractinian coral.

A. Scleractinian

Family	Province											
/ Species	Lampung	Jabar	Banten	Babel	Jateng	Jatim	NTB	NTT	Sulsel	Sultra	Sulteng	Totals
Pocilloporidae												
Pocillopora damicornis LINNAEUS	500	250	250	500	250	500	250	500	500	1000	500	5000
P. verrucosa ELLIS & SOLANDER	200					1000	300	500	1000	1000	1000	5000
Seriatopora hystrix DANA	500	200	200	500		200		400	500	500	500	3500
Stylophora pistillata ESPER	500	600		200	300			400	500	500		3000
Acroporidae												
Acropora spp.*	3000	3000	1000	3000	3000	3000	2000	4000	6000	5000	7000	40000
Montipora spp.	2000	1000	1000	2000	2000	1000		1500	3000	3000	1500	18000
Fungiidae												
Herpolitha limax (HOUTTOYN)	200	200		200				500	700	200		2000
Fungia fungites (LINNAEUS)	1500	500	500	500	500	500	1000	1000	1000	1500	1500	10000
F. moluccensis VAN DER HORST	500	500		1000	500	500		500	2500	1000	500	7500
F. paumotensis STUTCHBURY	500	750		750		500	500	1000	1000	1000	1000	7000
Fungia spp.*	1000				2000					1000		4000
Heliofungia actiniformis (QUOI & GAIMARD)	7000	5000	3000	8000	2000	5000	1500	3000	8000	5000	2500	50000
Polyphillia talpina LAMARCK	1500	700		300	500	1500		1000	3000	1000	500	10000
Oculinidae												
Galaxea astreata (LAMARCK)	300	300		300	500	700		500	1000	1000	1000	5600
G. fascicularis (LINNAEUS)	2000	1500	500	2000	1000	1500	1000	1000	2500	2500	2500	18000
Mussidae												
Blastomussa wellsi WIJSMAN_BEST	750	500		500				500	1000	500		3750
Symphyllia agaricia EDWARDS & HAIME		200		500					500	300		1500
Symphyllia sp.	200			500					500			1200
Lobophyllia corymbosa (FORSKAL)	2000	500	1000	2000	1000	1000	1000	2000	2000	2000	500	15000
L. hemprichii (EHRENBERG)	500	1000		1500	1000	1000		1500	2000	2500	2000	13000
Cynarina lacrymalis (EDWARD & HAIME)	1000	500	250	1000	500	500	500	500	1500	500	500	7250
Scolymia vitiencis (BRUGGEMANN)	500	300		200	300	200		500	1500	500	500	4500
Acanthastrea echinata	200	200		300					300			1000

Family	Province											
/ Species	Lampung	Jabar	Banten	Babel	Jateng	Jatim	NTB	NTT	Sulsel	Sultra	Sulteng	Totals
Merulinidae												
Merulina ampliata (ELLIS & SOLANDER)	200	300		500	1500	0		750	1250	1000	500	6000
Pectinidae												
Pectinia lactuca (PALLAS)	200	200		200	200	200		450	450	300	300	2500
Caryophylliidae												
Euphyllia glabrescens (CHAMISSO & EYSENHARDT)	1000	2000	1000	2500	4000	2500	500	1500	3000	3000	3000	24000
E. divisa	2000							500				2500
Euphyllia cristata CHEVALIER	5000	3500	1500	3500	6000	3000	1000	2000	4000	4000		33500
E. ancora VERON & PICHON	5000	3000	1000	3000	7500	2500		2000	3000	3000	3000	33000
Nemenzophyllia turbida HODGSON & ROSS	4000	0							5000	5000		14000
Plerogyra sinuosa DANA	4000	2000	2000	2500	2000	3000	1000	2000	4000	3500	2500	28500
Physogyra lichtensteini (EDWARDS & HAIME)	1500	1000	500	1000	2000	1000		1000	1000	1000	1000	11000
Catalophyllia jardinei (SAVILLE-KENT)	2000	2000		1000	500	1000	500	5000	2000	8000	4750	26750
Dendrophyllidae												
Turbinaria peltata (ESPER)	3500	2500	500	1000	1000	1500		2500	2000	1500	1000	17000
T. mesenterina (LAMARCK)	4000	3000	500	1500	1000	500	1000	1500	4000	1000	1000	19000
Dendrophyllia fistula (ALCOCK)	3500	1000	500	1000	1000	1500	1000	3500	4000	3000	1000	21000
Tubastrea aurea	1000	500		500	500	500		1000	2000	1000	500	7500
Poritidae												
Porites spp.	6000	5000	2000	3500	4000	3000	2500	4500	5500	3500	16000	55500
Goniopora lobata EDWARDS & HAIME	5000	4000	2500	5000	3000	2550	2000	3000	6000	7500	7000	47550
G. minor CROSSLAND	5000	4000	2000	5000	3000	2500	2000	4000	6000	7500	7000	48000
G. stokesi EDWARDS & HAIME	5000	4000	2000	5000	3000	2500	2000	4000	6000	7500	7000	48000
Alveopora spongiosa	0	0		0	0	250		150	150	200	300	1050
Faviidae												
Caulastrea echinulata (EDWARDS & HAIME)	2000	1000		1000	1000	500		1500	2000	1000	1000	11000
C. tumida MATTHAI	2000	2000	500	1000	1500	1000		2000	2000	1000	1000	14000
Favia pallida (DANA)	500	500		1000	500	500		750	750	500		5000
Favia spp.*	1000				1000							2000

Family	Province										
/ Species	Lampung	Jabar	Banten	Babel	Jateng	Jatim	NTB	NTT	Sulsel	Sultra	Sulteng	Totals
Favites abdita (ELLIS & SOLANDER)	500	500		1000	500	500		750	750	500	500	5500
Favites chinensis	1000	1000	500	1000	500	500		1000	1000	1000	500	8000
Goniastrea pectinata (EHRENBERG)	200	300		200	300	200		200	500			1900
G. retiformis (LAMARCK)	100	500		100	300							1000
Hydnophora exesa (PALLAS)	2000	500	500	1000	1000	1500	1000	1000	2000	1000	1000	12500
H. microconos (LAMARCK)	1000	500		500	1000	500		1500	500	500	500	6500
H. rigida (DANA)	500	0		500	500	500	500	1000	500	500	500	5000
Montastrea annuligera (EDWARDS & HAIME)	500	300		200	200	300			1000	500	0	3000
M. valenciennesi (EDWARDS & HAIME)	500	500		200	300	500			1000	500	500	4000
Montastrea spp.		500										500
Diploastrea heliopora (LAMARCK)				500								500
Cyphastrea serailia (FORSKAL)		500										500
Echinopora lamellosa	500											500
												0
Trachyphylliidae												0
Trachyphyllia geoffroyi (AUDOUIN)	8000	6000	1000	7500	3000	3000		5000	7000	5500	5000	51000
Wellsophyllia radiata (PICHON)	1000	500		1000				1500	5000	1000		10000

B. Non Scleractinian Coral

Heliopora coerulea DE BLAINVILLE	500	1000				500		500				2500
Tubipora musica LINNAEUS	1000	1500		500	500	500		1000	1500	1000	1000	8500
Millepora spp.	500	500		300	200				500			2000
Disticopora spp.									1000	500		1500

839050

C. Unidentified Scleractinian

Substrat (unidentified scleractinian)	150000	150000	100000		150000	100000		150000	100000			900000 pieces
Base rock (unidentified scleractinian) live rock	150000	100000	50000		100000	50000						450000 kg

EVALUATION OF NON-DETRIMENT FINDING FOR TRADE IN *STONY CORALS* FROM INDONESIA.

AUTHORS:
Suharsano and A.W. Bruckner

Indonesian stony corals are harvested for building materials and road construction, in Lombok and Bali for production of lime, the domestic ornamental industry and also for international trade as aquarium specimens.

The conservation status of 845 zooxanthellae reef building coral species were assessed using IUCN Red List criteria in 2007. While 141 species were data deficient, the remaining 704 species were found to have an elevated risk of extinction, including 231 in the threatened categories.

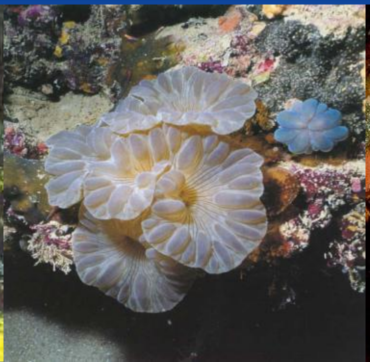
In response to the CITES Appendix II listing of corals, Indonesia has developed specific guidelines for sustainable utilization of coral resources. These were developed in coordination with management authority (Directorate General for Forest Protection Conservation), Scientific Authority (Indonesia Institute of Science) and ICRWG (Indonesian Coral Reef Working Group). This includes a quota first implemented in 1997, which is now broken down by species for each province where collection is allowed.

Coral harvest for international trade is currently allowed in 11 provinces, but it must occur outside protected areas and tourism areas. In addition, coral is supposed to be taken at levels below the regeneration rate for each species, and at a specific size (e.g. 25 cm for fast growing species and 15 cm for slow growing corals). These guidelines also recommend that collection only occur in sites where population assessments have occurred and monitoring is undertaken to ensure sustainable utilization. Along with specific methods of coral removal, coral collection sites are under a minimum of a four year rotation period.

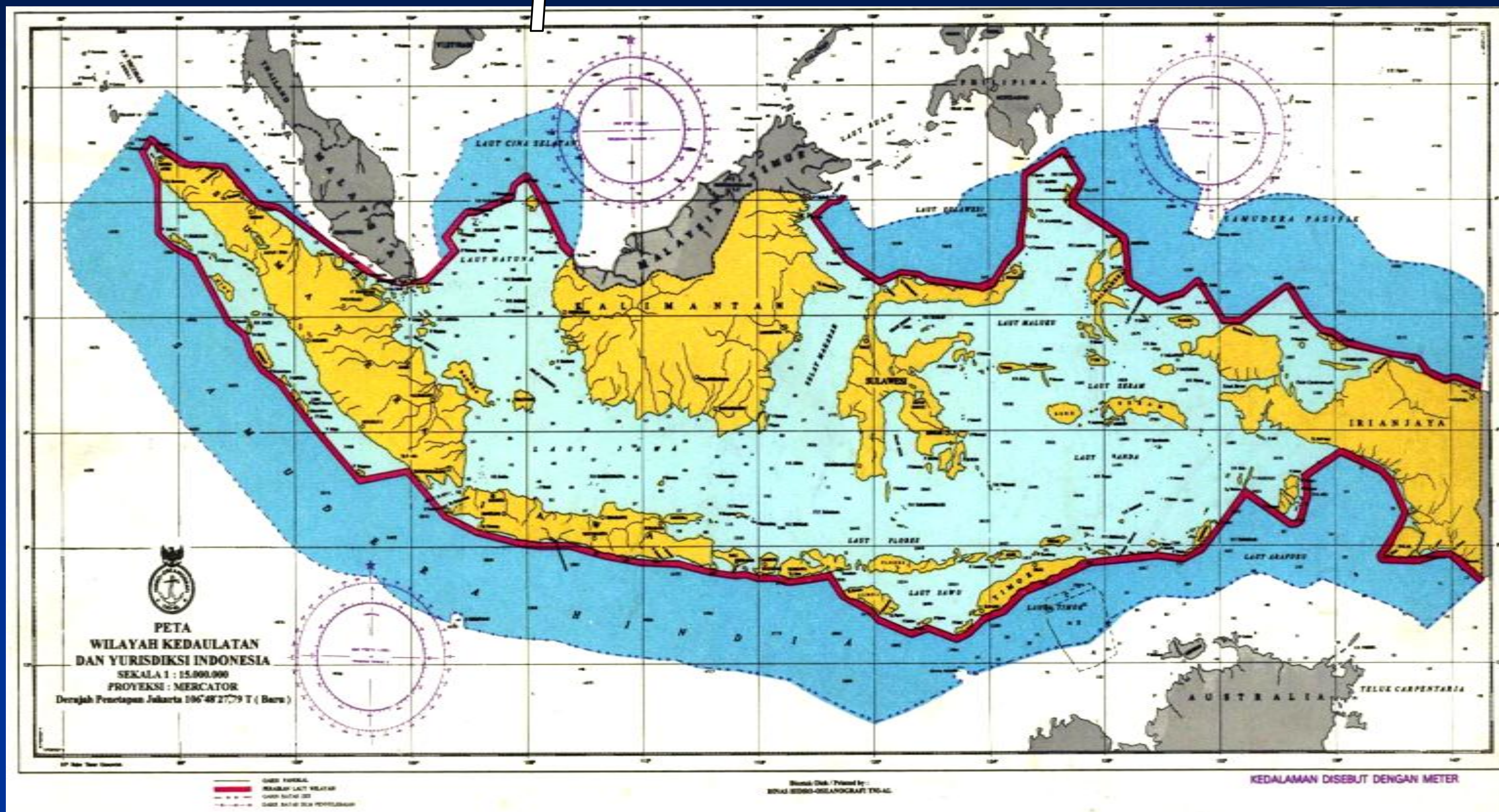
The quota lists the allowable harvest by species/genus for each of the 11 collection areas, and the allowable exports which are about 90% of the allowable collection, to take into account mortality and discards during collection. The quota for coral harvest is currently established using available information on reef accretion rates, rates of coral growth, condition of reefs from sites where monitoring has occurred, and estimates of reef area.

While hundreds of individuals collect coral, only AKKII (the Indonesian Coral Shell and Ornamental Fish Exporters Association) members are allowed to legally export wild-harvested corals and farm-raised corals.

Evaluation of Non-detriment Finding for Trade in Stony Coral from Indonesia

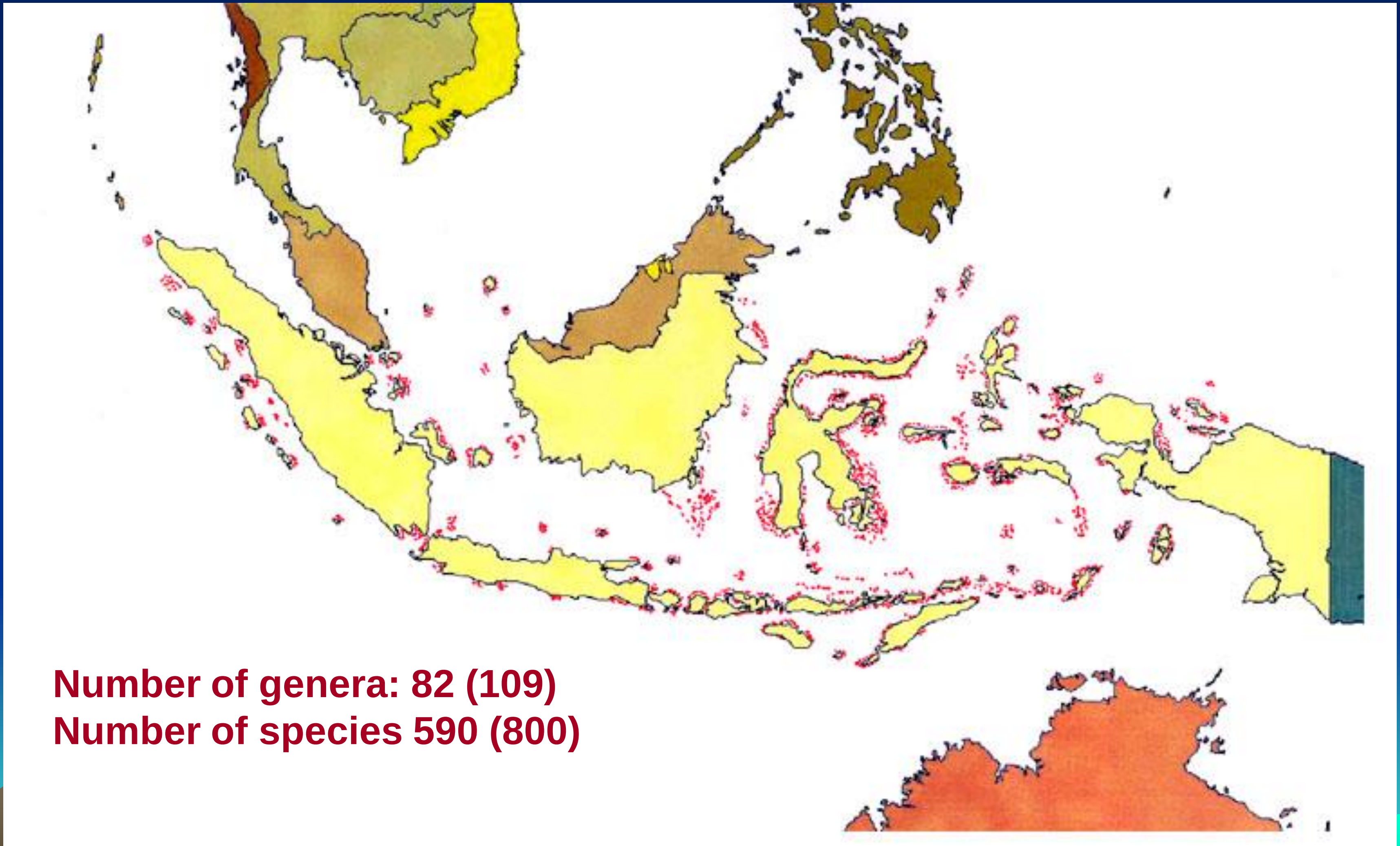




Map of Indonesia



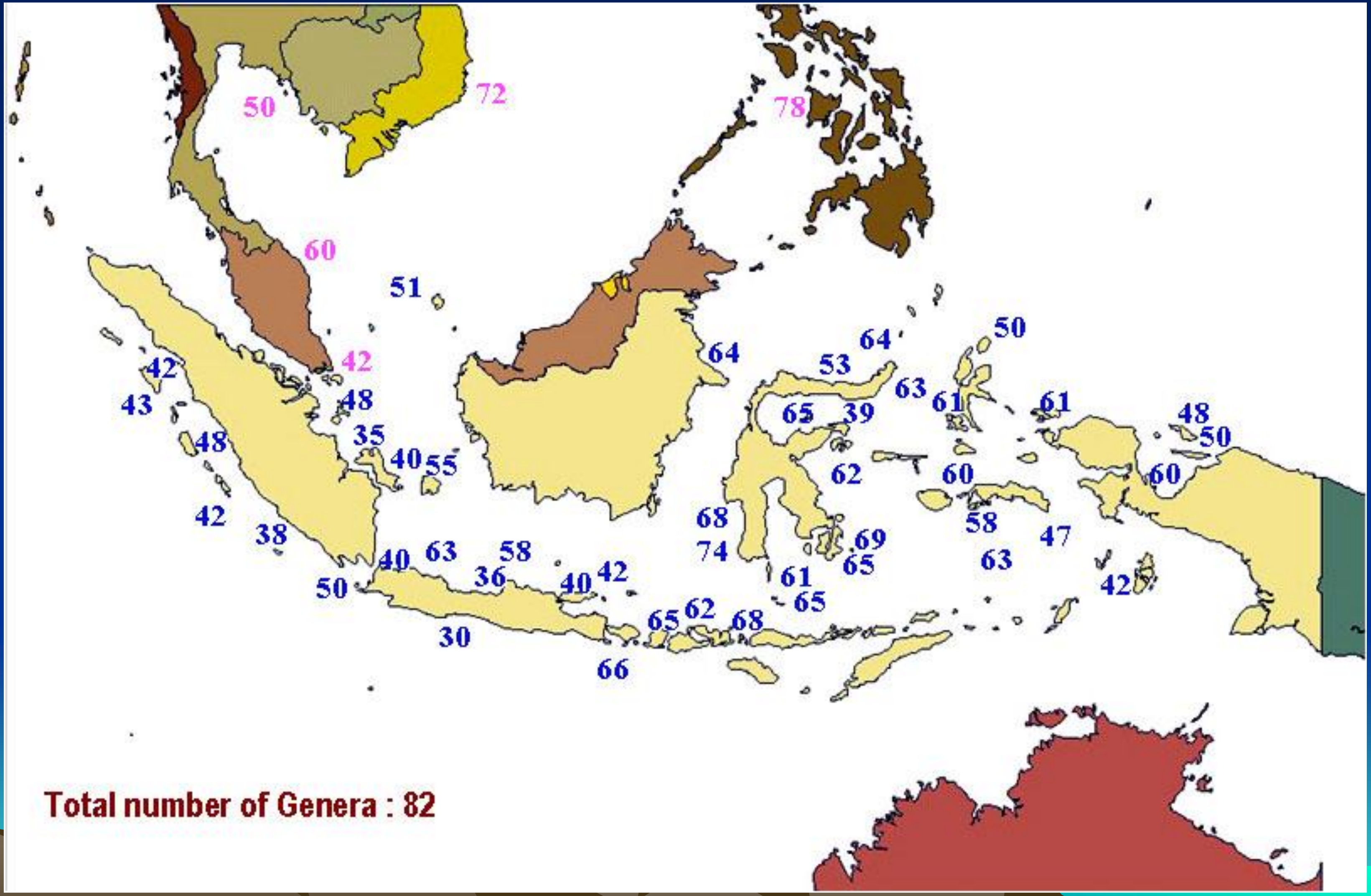
1. Length east-west : 5,100 km
2. Wide north-south : 1,800 km
3. Area : 10,8 million km^2
4. Number of island : 18,100.
5. Coral reef area : 87,500 km^2 =14% of the world

Coral Reef Distribution in Indonesia

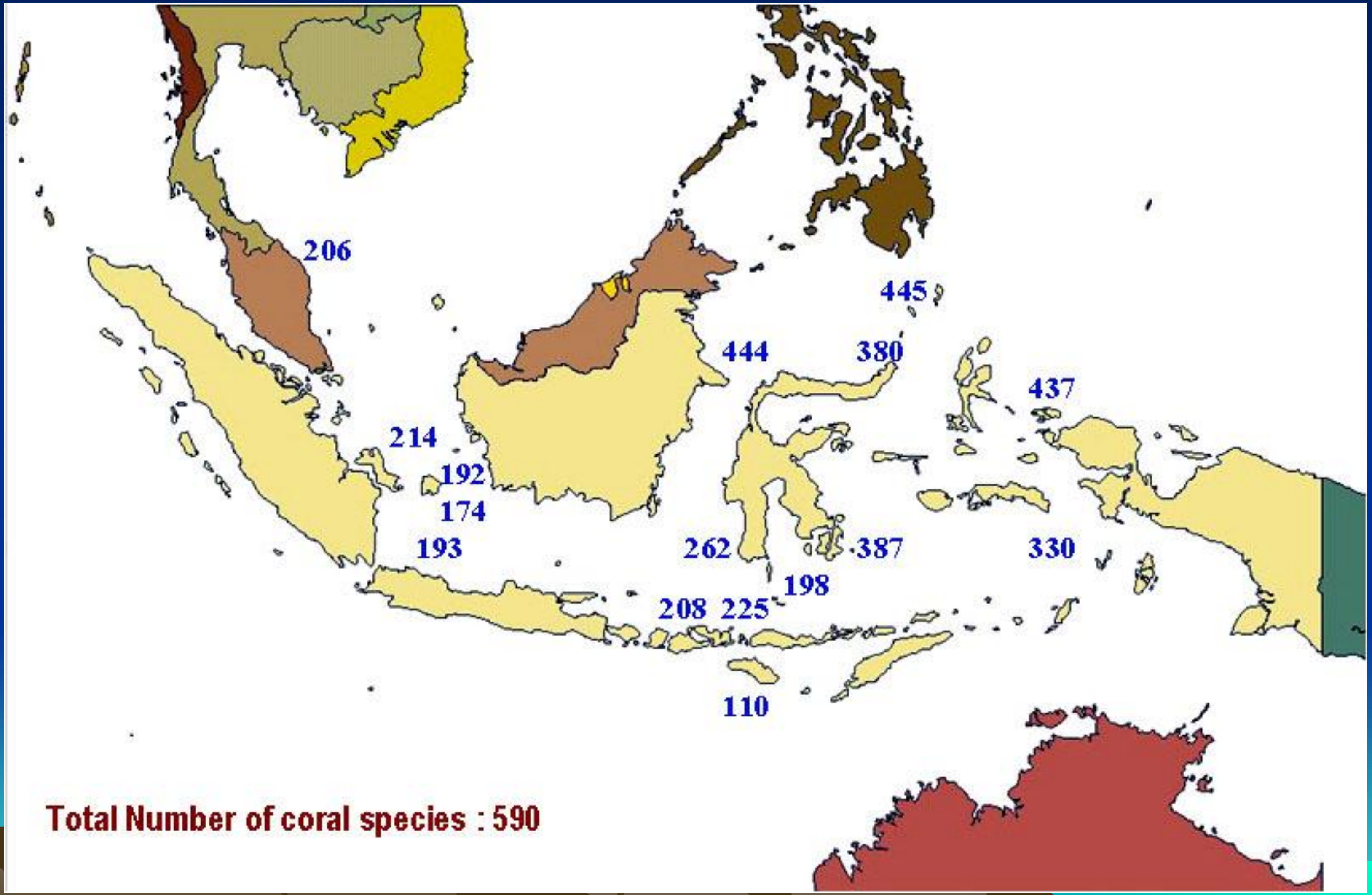


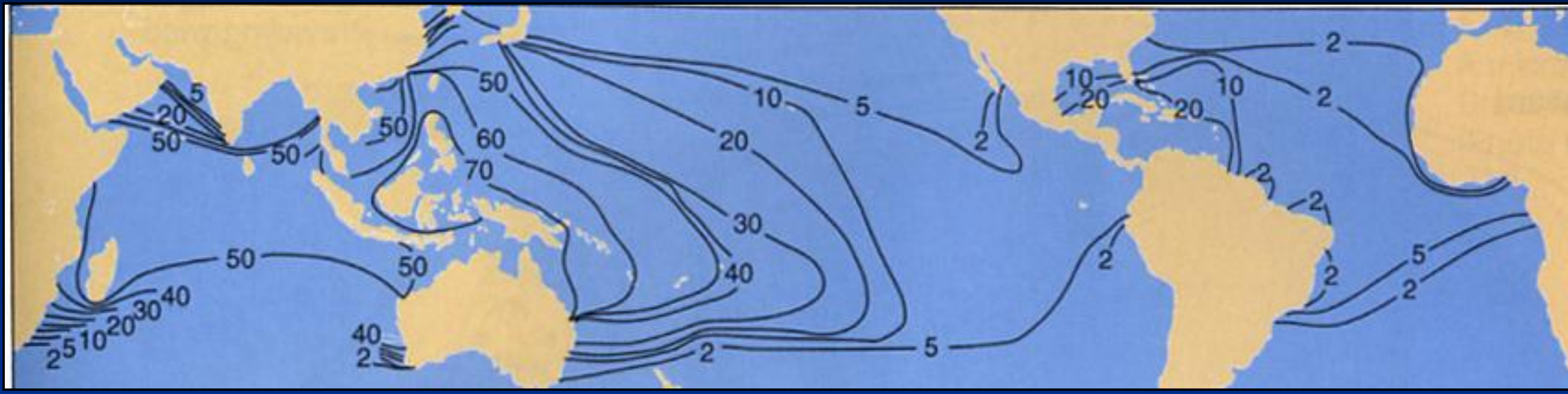
Number of genera: 82 (109)
Number of species 590 (800)

Distribution of Coral Genera in Indonesia



Distribution of Coral species in Indonesia





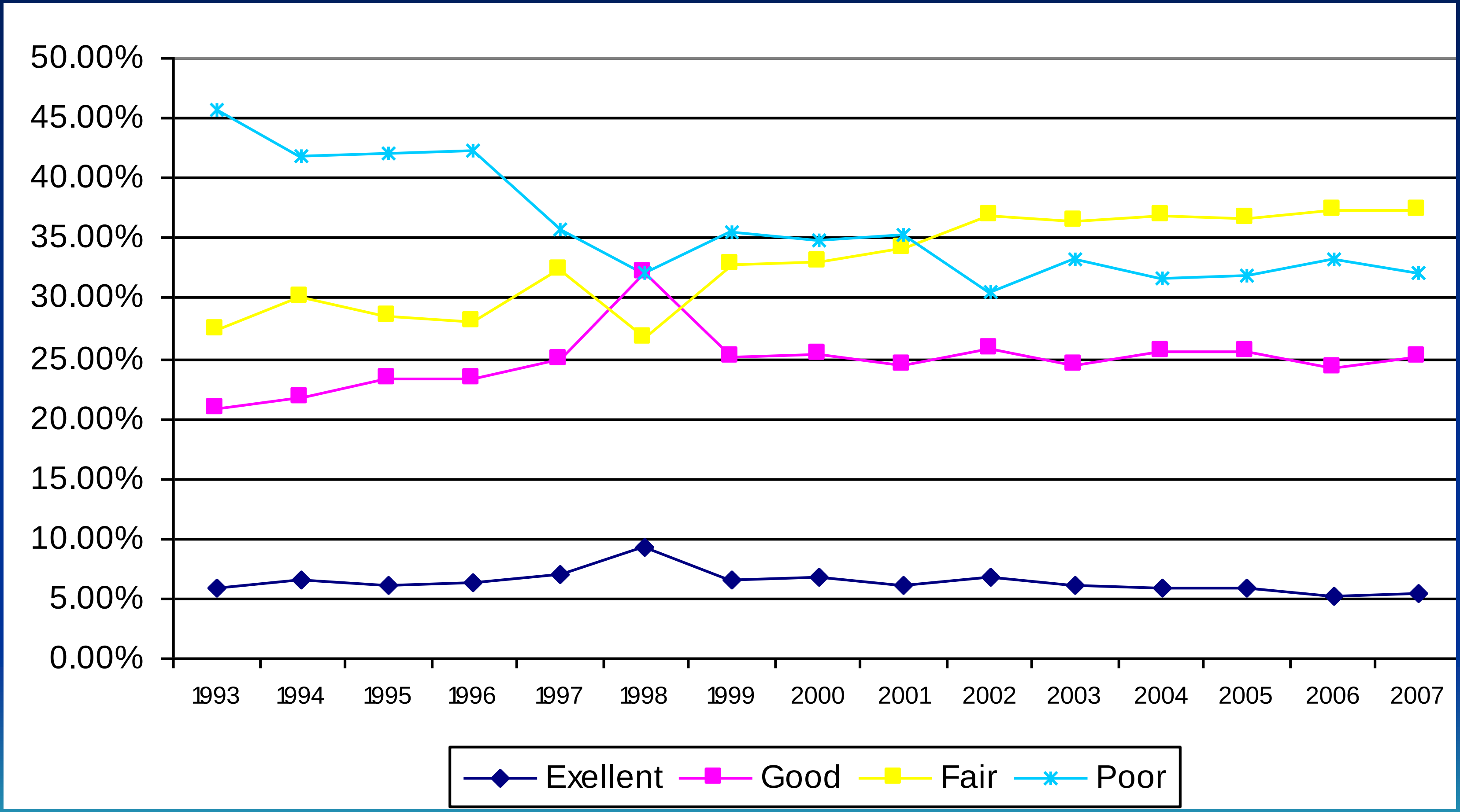
The number of genera of reef corals occuring in various tropical regions
(After"Distribution of Reef Building Corals' J.E.N. Veron. Oceanus, Vol 29. No. 2, p.27, 1986.
Copyright ©1986 Woods Hole Oceanographic Institution)

Status of Coral reefs condition in Indonesia

Location		No. of Location	Excellent	Good	Fair	Poor
West	35	362	5,52	27,07	33,98	33,43
Central	27	274	5,11	30,29	44,89	19,71
East	15	272	5,88	17,28	34,19	42,65
Indonesia	77	908	5,51	25,11	37,33	32,05

Data were taken from 77 locations and 908 stations all over Indonesian waters

Graphic of trend of coral reefs condition in Indonesia from 1993-2007



Coral biology

Reproduction :

1. Sexual : male, female, hermaprodite.
2. Asexual : propagation, bail out, budding, break out.
3. Spawning or brooding (1 – all year around).

Growth :

2 – 25 cm / year. (depend on species)

Main threat of coral reefs

1. Boming to catch fish.
2. Cyanide fishing for live fish.
3. Pollutant from land base activities.
4. Bleaching event (natural disasster)




Management plan

- COREMAP : Res & monitoring, Institutional strengthening,Community based management, Law enforcement and Public awareness.
- Coral taken at levels below the regeneration rate for each species.
- Harvest taken in several area.
- Export coral for live coral only.
- Export of live coral from nature gradually minimized subsitute by transplantation corals.
- Quota setting.

Quota setting

TV= SoC + RF + RD + HC

SoC = Size of Colony
RF = Relative Frequency
RD = Relative Dominance
HC = Hard coral cover

Criterion for Decision Making

Interval TV	Criterion	Action taken
17-20	Very common	Harvest allowed
14-16	Common	Harvest allowed with caution
11-13	Uncommon	Harvest limited
8-10	Rare	Harvest strictly limited
5-7	Very rare	Harvest prohibited

Note: TV=Total Value

Non detrimental finding measure

- The amount exported for each coral species is relatively small compared to the existing potency.
- The size of each species did not show any significant decrease.
- Condition of coral reefs are monitored yearly.

- Coral harvested outside conservation area,tourism area, and protected area.
- Size of the harvested coral are between 5 -20 cm.
- Coral harvest can be done after its abundance evaluated by SA, MA and ICRWG.
- Collecting of coral must be done with care and by trained fishermen.

- The amount coral collected based on the quota set up by MA.
- Field monitoring is to be done once a year by SA, MA and ICRWG.
- Collection and division of qouta is based on province and deversified for each province in order to prevent concentrated harvesting in one location.

- Permit is only given for living coral. This is to push fishermen and exporter to be more careful. This is also intended to prevent smuggling of coral.
- All exported and fishermen are required to executecoral transplantation.
- The portion of coral quota from nature will be decrased and those from transplantation will be increased.

Recommendation

1. To select species of corals which significantly to include in the Appendix II of CITES
2. The Animal Committee is needed to give the status of coral transplantation
3. To socialize coral identification for the custom
4. Determination of a sustainable quota

Euphyllia divisa

Euphyllia glabrescens

Euphyllia paraancora

Goniastrea favulus

Heliofungia actiniformis

Hydnopora rigida

Montipora danae

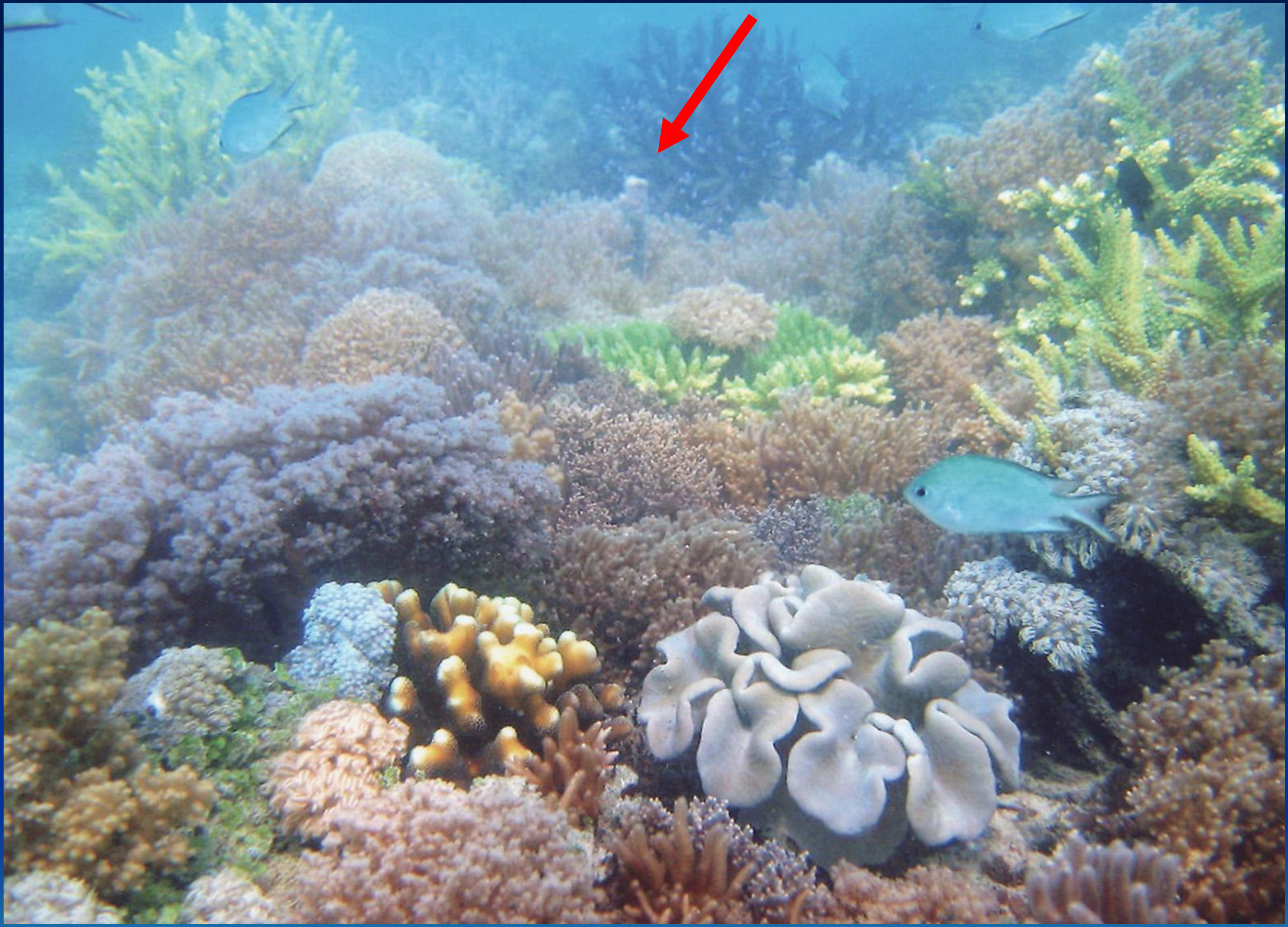
Montipora delicatula

Montipora foliosa

Seriatopora hystrix

Trachyphyllia geoffroyi

Tubipora musica



Thank You