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Development of fisheries management tools for trade in humphead wrasse, *Cheilinus undulatus*, in compliance with Article IV of CITES

Final Report of CITES Project No. A-254 undertaken by the International Union for the Conservation of Nature and Natural Resources - World Conservation Union/Species Survival Commission (IUCN/SSC) Groupers & Wrasses Specialist Group and led by Dr Yvonne Sadovy.

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FINAL REPORT
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IUCN Groupers & Wrasses Specialist Group
Submitted by Yvonne Sadovy

Photo: P. L. Colin

IUCN
The World Conservation Union
Groupers & Wrasses Specialist Group

TABLE OF CONTENTS **Page No.**

Introduction

In October, 2004, the Humphead wrasse (also known as the Napoleon fish or Maori wrasse in English), *Cheilinus undulatus*, was listed on CITES Appendix II because of concerns that it was actually or potentially threatened by exploitation, especially for the international live reef food fish trade (LRFT). This species will be referred to in this report as the Humphead wrasse, HHW or *Cheilinus undulatus*.

Under the CITES Appendix II listing, exporting countries need to establish Non-Detriment Findings (NDF). The CITES Secretariat contracted the IUCN Groupers & Wrasses Specialist Group to assist a key exporting country (Indonesia) in developing NDF for the HHW. The work involves trade and underwater visual census surveys. All surveys have now been completed and are summarized and annexed to this report. Several related meetings have been held, including two initial preparatory meetings in Jakarta (Feb. 17th, and March 22nd, 2005), a trader meeting in Hong Kong SAR on January 13th, 2006, and a 2-day workshop in Jakarta to present data collected, address data gaps, and plan for the next steps (February 14-15, 2006, funded by TRAFFIC-SEA). An international workshop to discuss possible regional application of the NDF approach to be developed in Indonesia is being planned for June, 2006. IUCN is collaborating with FAO to develop a stock assessment that can be discussed as the basis of NDF in Indonesia. Key activities and outputs of this work are outlined in this report with full details in Annexes I and II.

IUCN is working in close collaboration with the CITES Management and Scientific Authorities of Indonesia. Pending finalization of the Humphead wrasse stock assessment, the government of Indonesia has introduced an interim annual export quota of 8,000 animals. Hong Kong SAR has not implemented the CITES Appendix II listing as of June 2006, pending new legislation, but held a workshop in January 13th, 2006, to advise and consult with traders in preparation of implementation by end 2006.

Objectives

1. To provide relevant tools and information to the CITES Scientific and Management Authority in a key exporting country that can assist in developing or improving its fisheries management of *Cheilinus undulatus* for international trade, in monitoring impacts of harvest and trade, in adapting management accordingly, and in establishing scientifically based and sustainable levels of exports in compliance with Article IV of the Convention;

2. To give practical advice on enhancing collaboration between CITES authorities and local, national and regional stakeholders in Indonesia;

3. To develop generic advice on the making of non-detriment findings for trade in *Cheilinus undulatus* and the establishment of harvest and export quotas;

4. To assist a key exporting country in setting up a model management programme for harvesting and trading *Cheilinus undulatus* in a non-detrimental, sustainable manner;

5. To collaborate with a key exporting country to convene a meeting for major exporting range States key and importing countries to share experiences in the fisheries management of *Cheilinus undulatus*, evaluate and learn from the model management programme mentioned in paragraph 4 above, develop a regional management and conservation strategy for the species, identify regional

opportunities and needs regarding the conservation and fisheries management of *Cheilinus undulatus*, and improve regional collaboration and communication in this regard, and to collaborate with the CITES Secretariat in securing external funding as necessary to organize the international meeting mentioned in paragraph 5 above.

Executive Summary

The Humphead Wrasse *Cheilinus undulatus* is an important example of a valuable commercially important coral reef fish. In October 2004, *C. undulatus* was listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on the basis that wild populations were experiencing current and projected declines due to unsustainable harvest, in particular for the international trade in live reef food-fish.

Indonesia is the major exporter of this species and is also at the centre of its geographic range. Hence the status of wild populations of Humphead Wrasse in Indonesia is important for the species' global status.

The project entitled "**Development of fisheries management tools for trade in Humphead Wrasse *Cheilinus undulatus*, in compliance with Article IV of CITES**", was led by the IUCN Grouper and Wrasse Specialist Group under contract to the CITES Secretariat. The compilation of trade data (Annex I) combined with an Underwater Visual Census survey (UVC) of wild population status and biological characteristics (Annex II), will contribute to the design of methodologies to conduct "non-detriment findings" (NDF) to allow for sustainable harvest and export levels of *C. undulatus*. One additional survey has been completed (IUCN/GWSG, 1996), and two additional surveys are pending for later 2006 to provide the necessary field data. A stock assessment that can form the basis for developing the NDF, will be completed by end October, 2006, in time for quota allocation in 2007 in Indonesia.

For the trade surveys, five administrative jurisdictions in Indonesia (Bali, South Sulawesi, North Sulawesi, Jakarta and North Maluku) were surveyed between June and August 2005 to assess the trade of *C. undulatus*. Formal and informal interviews were conducted with 94 individuals representing a selection of Indonesian government authorities, traders, and fishermen. Professionals who might have had information about the trade such as aquarists and dive operators were also consulted wherever possible. Surveys were also conducted in Hong Kong SAR, the major destination of Humphead Wrasse (HHW) exported from Indonesia, to provide additional information. Most of the major traders in HHW between Indonesia and Hong Kong SAR were interviewed.

For the UVC surveys, a methodology suitable to survey a large wide-ranging fish was developed and validated, and three locations were selected for initial UVC surveys. The locations were selected to represent one each of a heavily fished, lightly fished and medium fished situation to provide size and density data for the stock assessments required to establish Non-Detriment Findings (NDF) for the Humphead wrasse. In all cases, the natural densities of fish were low (less than 1 fish per hectare), compared to other locations where the species occurs; few large fish were found in heavily fished areas where only juveniles and small adults were present. Given the large coral reef area in Indonesia, three additional surveys are planned (one was completed in April 2006 and two more will be completed by end of 2006) and have been funded. The purpose of the underwater surveys is to obtain a sufficiently comprehensive set of natural fish size and abundance data for stock assessment that can be used to develop NDF.

To develop an appropriate stock assessment for the Humphead wrasse that can be applied in developing NDF, collaboration was established with the Marine Resources Service of the Food and Agriculture Organization of the United Nations (FAO). Data from the trade and UVC surveys are being integrated into a yield per recruit stock assessment, specially adapted for a hermaphroditic species because some Humphead wrasse change sex. These analyses will form the basis of the NDF model to be discussed at the international workshop scheduled for June, 2006, (see below) and are intended to assist Indonesia in developing an export quota, or other suitable measures, to ensure that the species is exploited sustainably.

To plan the trade and UVC surveys with the Indonesian government, gather additional data, discuss findings, raise awareness of the listing and address related issues, several meetings and workshops were conducted, and an international workshop is now scheduled for June, 2006. On February 17th and March 22nd 2005, planning meetings were held in Jakarta with all relevant government departments in attendance. A workshop was held in Hong Kong SAR on 13th January 2006, to provide information to, and seek feedback from, traders in HHW, and a workshop was organized (by TRAFFIC-SEA) on 14-15 February, 2006 in Jakarta to provide an opportunity for Indonesian government authorities to share further information from national and provincial jurisdictions on Humphead Wrasse population status, harvest methods and trade. An international workshop will be held in June, 2006, to discuss regional issues in relation to the CITES App II listing of the HHW and to discuss the possibility of adopting a similar NDF model to that being developed for Indonesia in all exporting countries in the region.

The following perspectives were derived from this research [for abbreviations and acronyms, see Annex I]:

Policy Framework and Agency Responsibility

- Although there already exist law/regulation/decree for HHW, the policy framework for management of harvest, domestic trade, and export of HHW are not yet sufficiently implemented to be effective. Since there is no comprehensive document that describes all the regulations governing the industry, stakeholders are sometimes confused about existing legislation. Regulations governing HHW harvest and trade, and inter-agency responsibility and co-ordination for monitoring compliance with fisheries and CITES regulations are not well understood. This confusion was common to fishermen, collectors, exporters and even sub-sections within the Department of Marine Affairs and Fisheries (DKP), and its provincial arm, the KDKP.

- The CITES Appendix II listing for HHW came into force in January 2005, and there has not been sufficient time to distribute information to all regions in Indonesia, especially when the areas are remote. Dissemination of information is made harder by the current shift in Indonesia from a centralized to a regionally autonomous system of governance. The implementation and enforcement of Fisheries regulations for export of the species since January 2005 should have been conducted in collaboration with the CITES Management Authority of Indonesia, which is under the Ministry of Forestry. However, the survey team observed that provincial offices of DKP and the provincial offices of the CITES Management Authority of Indonesia, the BKSDA, did not seem to be in contact at all. Many officers also cited a lack of formulation and dissemination of new regulations since international trade in HHW came under the purview of CITES.

- There is currently a lack of a comprehensive and structured protocol describing the methods by which enforcement authorities are to monitor, enforce, and issue permits with regards to HHW trade. There is also a lack of co-operation between PHKA, BKSDA, and DKP with the relevant enforcement and monitoring departments i.e. DKP Quarantine, and Customs.

- Hong Kong SAR's legislation to implement CITES does not currently cover Humphead Wrasse, so it does not currently require a CITES export permit to accompany HHW cargoes arriving in the SAR. The CITES MA of Hong Kong SAR was not aware that Indonesia had introduced an annual export quota of 8000 specimens for 2005 and 2006.

Available Trade Data and Value of the Trade

- Fisheries export data held in provincial offices were often unavailable to researchers, and when revealed were largely inconclusive or incomplete. Different agencies had different data sets, over differing periods of time and with varying degrees of specificity regarding Humphead Wrasse.

- Data collated by DKP Budidaya (Ministry of Marine Affairs and Fisheries, Mariculture Division) at central level, however, revealed that during the period 2001-2005, recorded exports of HHW by 24 exporters totalled 108,241kg. Considering the legal export limits for *C. undulatus* in Indonesia is restricted between 1-3kg, this equates to a range of 36,080 to 108,241 specimens exported over five years. However, this recorded export volume was only 36% of the total allocated quota for that 5-year period (298,250kg).

- A national export quota of 8,000 fish was set for 2005 in Indonesia, the first year of CITES implementation for HHW. Data collected by the Indonesian CITES Management Authority in 2005 showed that 5320 live specimens of *C. undulatus* were reported as exported from Indonesia under CITES permits in 2005. By comparison, DKP Budidaya figures for the same year total only 1600kg, which indicates between 533 and 1600 specimens in legal export trade during the same calendar year.

- Discrepancies exist between reported exports from Indonesia and reported imports into Hong Kong SAR. (the major importer of HHW globally). Comparison of DKP Budidaya export data from Indonesia with import data in Hong Kong SAR strongly suggests that significantly more fish were imported to Hong Kong SAR in 2005 than were reported as exported from Indonesia: at least 11,000 kg imported compared to <2,000 kg reported as exported by DKP Budidaya records. In terms of numbers of fish, 11,000 kg would probably represent at least 11,000 fish since many fish below 1 kg appear to be included in export cargoes. Hong Kong SAR's import data also contrasts with Indonesia's CITES export quota for 8,000 specimens for 2005, of which 5320 live specimens were recorded as exports by Indonesia's CITES Management Authority.

- For the first time, Hong Kong's Census and Statistics Department (CSD) data show Singapore as a major exporter of Humphead Wrasse to Hong Kong SAR. Singapore is not a known producer country for HHW, and does not allow export of its native wildlife, so the HHW are likely re-exports from other range States (e.g. Malaysia and Indonesia). Singapore CITES Management Authority has not issued any permits for import, export or re-export of Humphead Wrasse since the CITES Appendix II listing came into force in January 2005.

- Data collected by DKP regarding exports in the period 2001-2005 show that the 108,241kg recorded exports had an export value of USD1,391,441, which equates to an average of USD12.86 per kg. Over the five year period, average prices per kg ranged between USD10.96 per kg (2002) up to USD36 per kg (2005). The data indicate that the reported HHW export trade has been worth an average of at least USD278,288 per year to Indonesia over the past five years.

- According to interviews, the price for HHW in the export trade chain in Indonesia ranges between USD6-80 per kg for live fish, with the highest price for live HHW in the trade chain obtained by collectors and exporters. Even though local consumption is likely far less significant than the export trade in terms of volume and frequency, the restaurant consumer pays the highest price for HHW compared to all other fish species available (USD76-125 per kg) in Indonesia.

Sources and Market Destinations

- Export figures compiled by central DKP Budidaya show 24 exporters currently active in Indonesia, 100% of which report Hong Kong SAR as a destination for their exports. In addition, Singapore (25% of exporters), Taiwan, Province of China (21% of exporters), China (13% of exporters), Japan (8% of exporters) and Thailand (4% of exporters) were also reported as destination markets. Of the 24, only about 8 exported significant quantities of HHW from Indonesia according to DKP-Budidaya records and an additional 4 did not appear on any government records. The trade survey interviewed 9 of the most actively exporting companies.

- This same data set from central DKP documents collection sites reported by exporters. Papua is the most reported source province in Indonesia of HHW catch (7 exporters), followed by South Sulawesi (6 exporters). Maluku, west Nusa Tenggara and North Sulawesi are of equal third importance (5 exporters each), followed by east Nusa Tenggara (4 exporters).

- Data from the Hong Kong SAR survey strongly suggests that much of the HHW imported into Hong Kong SAR is re-exported to mainland (mainly southern) China. The volumes involved could not be determined because there are no re-export data currently collected from Hong Kong SAR into China and no import data in Mainland China.

- Primary fishing grounds for HHW in Indonesia have gradually moved eastwards towards Papua, while the former source areas in the west, such as in Sumatra, have largely been exhausted. However, some traders still report sources for Humphead Wrasse in coastal areas of east Kalimantan, east Java, Bali-Kangean Islands, the Riau Archipelago in southern Sumatra, and Indonesia's remote Natuna Islands (South China Sea). This pattern was consistently reported in both the Hong Kong SAR and Indonesia trade surveys.

- Of the 10 traders/exporters interviewed in Indonesia, all reported exporting live HHW to Hong Kong SAR, with 50% of traders reporting direct exports to mainland China as well. The survey confirmed that fish are exported to these markets by both air and sea.

- Of the 10 traders/exporters interviewed in Indonesia, 80% of them exported live HHW to Hong Kong SAR by air either from Bali (Denpasar) or Java (Jakarta), while the remaining 20% export

the fish by sea. When the HHW is exported by sea, it is usually with other live reef fish. However, when it is exported by air, it is usually just for the species alone. It is more common to air ship small than large fish.

- Some dead HHW were reported to enter the export trade, but most interviewees reported that any dead specimens were sold immediately to domestic market consumers.

Monitoring and Law Enforcement

- Enforcement and monitoring methods are made extremely challenging by the vast geographic expanse of the Indonesian archipelago. The authorities that have a responsibility towards fishing or marine-related issues, such as DKP, Indonesian Navy and Maritime Police do not have the manpower or vessels necessary to carry out their functions. There is also a lack of clarity over which province has responsibility for enforcing maritime jurisdictions.

- While some regulations exist to manage the harvest of this species and collect data, the study revealed, and responsible departments have admitted, that implementation has been weak and data collection poor. Interviews with a variety of stakeholders indicate that *C. undulatus* (and in many cases, its habitat) continues to be threatened by unmanaged fisheries and destructive fishing practices, such as the use of cyanide.

- CITES permits have been required for international trade since *C. undulatus* was listed in Appendix II of the Convention, which came into force in January 2005. However, during the survey, Indonesian authorities were observed to be having difficulty in enforcing and monitoring the trade in this species, particularly with relation to jurisdiction between the Department of Fisheries and the CITES Management Authority of Indonesia.

- The surveys revealed some identification problems among fishermen and also among the government officials such as DKP and Quarantine, including mistaking HHW for grouper, parrotfish, or other wrasse species of the genus *Cheilinus*. It was found that few officials responsible for the monitoring of fisheries trade could effectively identify HHW in all its life stages. An identification chart was developed to assist with this problem.

- Although some provincial fisheries departments (e.g. North Sulawesi) have conducted training workshops on fisheries regulations and protected species identification, in general the status of the HHW as a CITES Appendix II species is still largely unknown in Indonesia. This lack of awareness was common among the fishermen and some Government officers responsible for marine, fisheries and CITES issues. Awareness of agency responsibilities was observed to be inconsistent.

- COREMAP (Coral Reef Rehabilitation and Management Program run by LIPI) is the only programme within Indonesia that appears to be addressing coral reef resources from an awareness-raising perspective. Better awareness would greatly assist monitoring initiatives. COREMAP, however, tends to focus on coral habitat rather than fishery resources. DKP does not appear to address monitoring issues related to reef-associated resources other than as general categories such as groupers and ‘reef fish’.

- Foreign vessels from Hong Kong SAR and Taiwan, Province of China were reported most often as collecting HHW directly from Indonesian suppliers. The activities of these vessels are largely illegal, unreported and unregulated. In addition, fishing vessels flagged as coming from Japan, Malaysia, the Philippines (and in one isolated report, Germany) were reported as visiting Indonesian waters to source HHW.

Harvest Methods, Catch Size and Rates

- Traditional fish traps or *bubu* were reported to be the most frequent method of HHW capture, followed by hook-and-line, and cyanide administered by divers using both SCUBA and hookah apparatus.

- Anecdotal evidence collected from various actors in the trade across the five administrative jurisdictions points to a general decline in fish body size, as well as catch rates over time, and that some formerly abundant fishing grounds had become exhausted. Interview responses suggest that the catch and trade has declined up to 50% in the past 5-10 years. The majority of traders and collectors also reported that increased regulation had made participation in the trade more difficult.

- There are many indications from trade interviews, inspections of holding pens and the typical plate-size of fish retailed in Hong Kong SAR that the main harvest size for HHW is often below 1 kg (minimum legal size) and that many of these fish are exported before attaining 1 kg, either directly after capture or following grow-out.

- The mortality variously associated with capture, transport within Indonesia and during grow-out was reported to be highly variable, from very low to substantial.

Mariculture and growout

- There are two established mariculture facilities in Indonesia that are working with HHW – one in Sumatra (Lampung) and one in Bali (Gondol); both were visited. Neither has been successful in culturing (breeding) and rearing HHW to adult size, despite about five years of effort. As it is unlikely that the species will be raised by hatchery at commercial levels in the near to mid term; capture and exports will continue to depend on fish sourced from the wild.

- The technical definition of mariculture (actual spawning/breeding from adult broodstock) has been broadened in Indonesia to include ‘grow-out’ farming operations. As the two actual mariculture facilities have not produced any real alternative supply, and the ‘grow-out’ facilities are simply holding pens for wild-caught individuals, the status of mariculture in Indonesia currently has no benefit to the survival of wild populations.

Underwater Visual Census – Field Surveys

- An underwater visual census (UVC) survey method was developed and tested that is appropriate for surveying a large and wide-ranging fish like the HHW. The method uses a Global Positioning System which allows surveys to be repeated in the same area, and is simple and effective to use for this species.

- A standardized protocol for HHW UVC was developed, which can just as easily be used for snorkel as for SCUBA surveys, with recommendations regarding species identification issues, equipment requirements and training for fish length estimation provided. Large distances must often be covered to provide a representative estimate of density of the HHW.

- Underwater visual census surveys were conducted in three areas of Indonesian waters, Bunaken as a lightly fished area (National Park), Raja Ampat as a medium fished area and Kangean Islands (north of Bali) as a heavily fished area. The mean density of fish in the three study areas was 0.4 fish per 10,000 m^2, ranging from a low of 0.4 to a high of 0.86. The total linear distance surveyed was 125 km. There were clear differences between lightly/unfished and medium to heavily fished areas in abundance and fish size; lowest abundance and sizes being in the heavily fished areas. Less clear was the distinction between Raja Ampat and Bunaken possibly because, despite the presence of a national park, poaching occurs in the surrounding area which also has a history of exploitation for HHW.

- Of the various areas surveyed, large fish (large adults) were only present in protected areas or those that are *de facto* protected (i.e. not readily accessible to fishing because of currents, for example).

- Given the huge extent of Indonesia's coral reefs, three more UVC surveys, in addition to the three already completed (Annex II) are planned to provide additional information for developing a stock assessment as a basis for NDF. LIPI has again been invited to join the remaining surveys and DKP has been invited.

- The HHW is charismatic and considered a valuable tourist attraction in areas where SCUBA diving is carried out as part of the tourist industry.

Non-Detriment Findings

- In collaboration with FAO, a preliminary yield-per-recruit (YPR) stock assessment analysis is being developed based on the information collected in the three completed surveys. This preliminary assessment will allow for the development of a more detailed assessment to be based on a set of (six) surveys to be completed by mid October, 2006, and which considers the data-poor situation for this species. The completed assessment will evaluate the optimal level of exploitation of humphead wrasse populations in Indonesia. In general, YPR analysis determines the optimal fish size of capture and appropriate level of fishing mortality to achieve maximum sustainable, or most appropriate, level of yield per recruit (i.e., potential catch per fish recruited into the stock), under equilibrium conditions, by considering interactions between growth, natural mortality, and fishing. The stock assessment is then combined with an estimate of abundance (as determined from field work an UVC), to determine a sustainable offtake on a yearly basis. This can then be used for NDF, alone or in combination with other measures.

- The basic life history and fishery parameters for the YPR analysis of HHW wrasse were obtained from published and in press literature and from Annexes I and II of this report. The additional UVC surveys will supply further field data. Specifically, the parameters being assessed are natural mortality rate, growth, reproduction, gear selectivity, abundance, fishing mortality, and allowable catch (= catch quota). Given that the species is a protogynous

hermaphrodite, the standard YPR approach is being adapted to take account of a species that changes sex.

- The development of a stock assessment for the HHW is not intended solely as a possible means of establishing a quota for NDF by Indonesia although it will be ready in time for consideration for 2007 quota setting. Stock assessments are important for moving towards sustainable resource use, in general, and have not previously been conducted in Indonesia for specific reef fishes. For effective sustainable use, adaptive management is necessary which involves a sustainable management plan based on a stock assessment, development of a monitoring protocol and, possibly, adjustments of the plan according to responses of the exploited species following implementation.

Recommendations

Improving policy, management and regulatory measures

1. Catch and export regulations must be made available to all government regulatory agencies, as well as all parties involved in the trade to allow for transparency and clear procedural understanding.

2. Improved inter-agency co-operation between the various divisions of Fisheries (Mariculture, Quarantine, Provincial and National), the CITES Management (PHKA, BKSDA) and CITES Scientific (LIPI) Authorities, Marine Police and Customs. The option to establish a CITES-competent department within Fisheries should be considered, in order to allow the department to monitor and issue export permits for HHW.

3. A central permitting authority should be established for the facilitation of permit application at national and provincial levels – to function like a one-stop centre for traders to apply for export permits. Such a system would make applications clear and eliminates the necessity of the varying authorities from being aware and keeping track of what permits have been, or have yet to be, issued to the trader, and would allow for procedural checks to be made to determine if catches have been acquired legally and according to quota allocation. Fisheries authorities, in co-operation with the CITES Management Authority of Indonesia, need to decide where this central 'clearing house' should be located to ensure all documents and permits are in compliance before export is approved.

4. Immediate steps have to be taken at the Indonesian policy level, as well as the policies of the demand countries or entities (Hong Kong SAR, China, Singapore, Taiwan, Province of China) to ensure the sustainability of HHW is managed and to improve communication. Collaboration between NGOs, IGOs, universities, fishing communities, and relevant departments in Indonesia, Hong Kong SAR and China is essential to provide a balanced and integrated approach for reducing the pressure of fishing activity on HHW populations. CITES Management Authorities in Province of China and Singapore, and relevant departments or authorities in Taiwanshould be approached regarding trade in HHW.

5. Encourage co-operation between government agencies in neighbouring provinces to facilitate better monitoring, law enforcement and seizures in the major HHW fishing areas.

6. Protection of juvenile HHW, in line with the recently released (2006) Regional Guidelines for Responsible Fisheries in Southeast Asia published by ASEAN (Association of Southeast Asian Nations) and SEAFDEC (Southeast Asian Fisheries Development Centre), would assist in preventing growth overfishing of HHW populations.

Capacity Building for improved Implementation

7. All relevant government agencies should clearly understand their responsibility and that of their counterparts in order for them to effectively monitor and enforce regulations. For example, Customs and Quarantine would have to be informed in exact detail of all the procedures required to obtain the necessary permits for the internal trade and export of a CITES-listed species. As Fisheries staff come into contact with exporters, collectors and their staff, officers should be able to accurately advise and educate exporters, collectors and their staff about the necessary procedures and permits required for export of HHW. Government departments involved in managing the trade of HHW require capacity building on the following key issues:

    a. Which permits are necessary for trade (both intra-Indonesian and international) in HHW;
    b. Existing regulations – including size limits for HHW and export quotas, and the purpose of such protective measures;
    c. Develop collaborations with major importing countries that could strengthen enforcement.
    d. Species identification - especially for the field staff in the Quarantine and Customs departments, posters and identification cards should be developed. [Note: a simple card is available that could be translated – see Appendix II of Annex I]..
    e. Programmes such as COREMAP could be used to build awareness about the HHW both within government and in the wider community.

Monitoring and Law Enforcement

8. Meaningful penalties should be set and enforced against illegal/unsustainable fishing methods (such as cyanide) to provide deterrents to further such activity. Collectors and exporters should be held accountable if fishermen contracted by them use illegal/unsustainable fishing methods and catch HHW outside the legal size. Suppliers of cyanide should also be held accountable.

9. Community-monitoring schemes in remote areas should be examined to better monitor unauthorised fishing and the presence of outsiders in traditional fishing areas. For example, North Maluku has a programme where fishing communities work closely with the DKP Monitoring and Conservation Department to apprehend individuals employing illegal fishing methods. A similar approach may be adopted, and where they exist, to improve upon existing community enforcement and monitoring efforts by conducting a review to make the system more effective in putting pressure on illegal fisheries.

10. The COREMAP programme could possibly assist in education and raising awareness about the Humphead wrasse, in respect of its vulnerability as an exploited species within the reef fish fishery.

11. Additional resources, both human and technical, as well as the necessary equipment, should be allocated to the management of Marine Protected Areas to better safeguard against illegal

fishing practices that lead to continuing deterioration of reef habitats, including incursions by illegal vessels. Marine Police and the Navy should be encouraged to work more closely with Fisheries and vice versa. Collaborative approaches need to be developed to address the challenges of policing illegal sea vessels entering Indonesian national waters.

12. Inspection should be carried out on all live, frozen and fresh fish exports, and HHW specifically identified rather than being lumped with 'groupers' as in Manado. Inspections could be carried out on exports of fish in transit through Jakarta international airport because fish arriving from destinations within Indonesia must exit the airport to be repacked prior to export. Inspections should be carried out to determine sizes of fish being exported. Information on practices used within the trade, such as storing HHW in cages hidden below non-CITES species such as groupers, should be disseminated.

13. Consideration should be given to the banning of all sea exports to control the quota, size limit and other regulatory measures through efficient export monitoring at designated points of export by air, such as Bali, Jakarta, Makassar and Manado. This would greatly assist implementation on the import side in Hong Kong SAR, the major importer, because of the current difficulty of monitoring sea imports in Hong Kong SAR. This measure could be considered until better controls of shipments at sea are in place, on both the exporting and importing sides.

14. The authority of the Marine Police regarding inspection of holding pools of collectors and issuing fines for the possession of fish should be clarified with reference to their responsibilities in monitoring and enforcement of maritime laws.

15. Complementary investigations should be carried out in the primary end-market destination in Hong Kong SAR, and mainland China on geographic sources of fish, methods of transportation, methods of re-export, importers and re-exporters, restaurants, and mortalities in trade. The trade into and through Singapore should also be investigated, particularly given that although the Singapore CITES Management Authority has not issued any CITES trade permits for Humphead Wrasse, Hong Kong CSD import data shows 12.45t of HHW arriving from Singapore in 2005.

16. Regular, standardised monitoring of registered traders and industry participants should be carried out by the Department of Fisheries, the CITES Authorities of Indonesia, and relevant experts. This information should be utilized in determining harvest and export quotas, and monitoring numbers of registered industry participants. Several exporters identified, but not appearing in any government records of official traders, should be approached.

17. There is a need to develop a protocol for confiscated fish, both those confiscated within Indonesia as well as those that might be returned to Indonesia from importing countries.

Information Management

18. All offices/departments, responsible for the monitoring and enforcement of trade in a CITES-listed species need to standardize methods of documenting and archiving data at Fisheries and Quarantine offices, and links established with BKSDA and through these offices to central

databases at central DKP and PHKA. PHKA's own database for CITES trade could possibly be a starting point for adaptation to the needs of DKP in helping monitor trade in HHW.

19. In most provinces visited, even hard copy 'book-keeping' was not readily accessible, or was reported to be lost. A standard procedure for recording HHW trade at both provincial and central levels should be developed in Indonesia. Data concerning HHW capture and trade gathered quarterly from the provinces should be collated annually in a centralised database linked to both Fisheries records and CITES. Information concerning the size of the fish should be recorded on the permits.

20. Computer software and literacy, as well as hardware, must be made available to all provinces. Prior to the implementation of a standard method of data entry and management, staff of the relevant authorities need to be trained in using new computer technology. The local constraints of record-keeping (e.g. unreliable electricity supplies) should also be factored in to a practical system to record data.

21. As a back-up, hard copy 'duplicates' of the computer-entered data should be filled in by hand, recording species, weight, size, source, and destination of fish traded domestically or internationally should be recorded.

Quota Setting

22. Regular evaluations of the trade, relative to the status of HHW populations and ecology in the wild, should be carried out by LIPI (ID CITES SA), in conjunction with the Department of Fisheries and relevant scientific experts. This information should be utilized (in tandem with the methodology being developed by IUCN, in collaboration with FAO, for conducting a stock assessment for this species) for determining science-based quotas for harvest and export,.

23. Mortality levels from capture, transport and during grow-out need to be estimated to factor them into stock assessments/quota setting since mortality represents removal of wild Humphead wrasse that is not reflected in export figures but nonetheless represents a quantifiable, possibly substantial, level of removal.

24. HHW stock assessments should be carried out in selected provinces currently targeted by fishing effort to determine if stocks are as rich as they are perceived to be, and also if they are capable of supporting the currently high levels of fishing pressure. Regular surveys of fishers and fish numbers (using underwater visual census) are needed to determine whether current quotas are appropriate. Collaborations with experts and local Universities could be developed to participate in this work.

25. Annual quotas for HHW harvest and export should be reviewed regularly in an 'adaptive management' system as new information comes to hand on the status of wild populations and trade. The quota system should be explained to all stakeholders in the trade, particularly the exporters, in order to educate them on the scientific basis behind conservation and management decisions. Quotas may have to be combined with other measures for effectiveness.

26. In addition to an annual national quota, provincial components of this quota should be set and applied according to the potential for harvest and export of HHW in relation to wild population status and management capability. Intra-Indonesian trade relative to these provincial quotas

will necessarily need to be monitored, and any new regulations should pay close attention to monitoring all key points in the chain of custody.

27. Guidelines for methods to reduce mortalities of Humphead wrasse after capture and in transit should be developed and adopted. Estimates of mortality in shipments within Indonesia, during export and grow-out should be made by observers and included into estimates of overall catch since export figures do not reflect such mortality. Mortality estimates need to be factored into the overall recommended export quota for this species.

28. All 'grow-out' facilities and their fish holdings should be considered within annual quota management and mortality in holding monitored.

29. Measures such as minimum/maxiumum size controls could be considered in addition to quota-setting to protect juvenile fish and large spawners (high egg production/males).

Mariculture and Growout

30. Further research and development is needed to achieve regular hatchery production of Humphead wrasse. Additional funding will be required and a research effort focused on this wrasse (labrid), rather than one adapted from serranid (grouper) culture. In the short to mid-term it is clear that hatchery production will not be a significant source of HHW in trade.

31. There is no evidence that grow-out of wild caught fish in captivity takes pressure off wild stocks because (a) there is mortality during grow-out, and (b) most fish taken for grow-out are of a size or age whereby they are likely to be well beyond the early stage of high mortality that would justify the use of grow-out a means of enhancing natural survivorship.

32. Consideration should be given to ensuring a reliable supply of healthy broodstock from the field, by sufficient protection of spawning stock. This could best be addressed by ensuring sufficient protected areas to maintain breeding populations or sub-populations.

33. Any initiatives that aim to ranch Humphead wrasse (i.e., allow adults to release eggs while in cages placed in the sea) need to provide scientific evidence of the advantage to natural populations of placing wild fish in captivity and allowing them to release eggs if ranching is to be used as a conservation measure. The same proviso applies to restocking initiatives should these be attempted.

Underwater visual census – field surveys

34. UVC surveys should be repeated on a periodic basis to assess HHW populations for any changes in fish body sizes and abundance, at key areas in Indonesia to be determined.

35. Marine protected areas should be considered as one way to preserve a full size range of this species and, thus, a healthy reproductive population.

36. Additional surveys need to be conducted. A fourth survey has just been completed in Nusa Tenggara (Sape Strait) as a heavily fished area, Derawan Islands (medium fishing pressure) and Banda Is. (light fishing pressure) will be surveyed in September/October 2006.

37. Personnel from LIPI and DKP should be involved in remaining UVC surveys to further understand the methodology for UVC that has been developed. Training in UVC monitoring has already been provided in the field for one staff member of LIPI.

Non-Detriment Findings

38. Complete a preliminary YPR analysis prior to the international meeting in June, 2006, for discussion by major exporting countries. Once additional survey data have been collected to bring the total number of UVC survey areas to six (by end October, 2006), the stock assessment can be completed. Recommendations will be available for use in quota-setting in 2007. In developing the stock assessment, IUCN and FAO should work closely with DKP and LIPI.

39. It is important to emphasize that a quota for sustainable offtake must include catches and mortalities that occur for a range of reasons that are note associated with the export trade. This means that only a proportion of the sustainable offtake can be allocated for export. For example, fish can be directly removed from the wild (offtake) for export of food fish, for local consumption, for the export of aquarium fish. Indirect removals must also be accounted for since they will affect wild populations: examples include mortality due to capture method (often occurs with cyanide-caught fish); mortality in transport within Indonesia to export of grow-out facilities; mortality during grow-out. Such indirect mortality is often not considered when allocating export or catch quotas but is, nonetheless, important since all HHW are currently sourced from wild populations.

40. Effective NDF will require the use of periodic follow-up surveys to determine the effects of management on depleted stocks, and must involve a regular monitoring system in areas where export of HHW is permitted. This monitoring system needs to be developed soon. If HHW populations continue to decline, or enforcement is a problem, the NDF will have to be modified accordingly to ensure that exports are sustainable.

41. Other approaches to NDF for the HHW could include minimum/maximum size limits and controls of mode of transport for exports. Air transport only controls would aid in implementation of the listing at both export and import sides and is reasonable for this species from the trade perspective.

International collaboration on HHW

42. The preliminary NDF model should be discussed at the international meeting on Humphead wrasse to be held in Hong Kong SAR in June, 2006, with a view to its possible adoption in the region.

43. Other issues related to the control of trade, monitoring and implemention of the Appendix II listing for the Humphead wrasse should be discussed.

44. Collaborations should be developed between exporting and importing countries to assist in enforcement and implementation of the CITES Appendix II listing for the Humphead wrasse.

ANNEX I

Survey of Trade Dynamics in Indonesia, June-August 2005

Synthesis Report by TRAFFIC-Southeast Asia and IUCN Groupers & Wrasses Specialist Group

TRAFFIC
SOUTHEAST ASIA

IUCN
The World Conservation Union
Groupers & Wrasses Specialist Group

Table of Contents **Page No.**

Abbreviations and acronyms used in the report

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COREMAP	Indonesia's *Coral Reef Rehabilitation and Management Progam* (managed by LIPI)
GWSG	Groupers and Wrasses Specialist Group (IUCN Species Survival Commission)
HHW	Humphead wrasse, Napoleon Wrasse, Ikan Napoleon, *Cheilinus undulatus*
BKSDA	*Balai Konservasi Sumber Daya Alam* (Regional Office for the Conservation of Natural Resources, under the jurisdiction of PHKA, Ministry of Forestry)
DEPHUT	*Departemen Kehutanan* (Indonesian Ministry of Forestry, the parent agency of the CITES Management Authority of Indonesia)
DKP	*Departemen Kelautan dan Perikanan* (Ministry of Marine Affairs and Fisheries)
DKP Budidaya	*Departemen Kelautan dan Perikanan Budidaya* (Ministry of Marine Affairs and Fisheries – Mariculture division)
FAO	Food and Agriculture Organization (of the United Nations)
Fishmonger	Fishmarket seller/vendor
IGO	Intergovernmental Organization (e.g. FAO and IUCN)
IUCN	The World Conservation Union
IUU	Illegal, Unreported and Unregulated (in reference to fishing activity)
KDPK	*Kepala Dinas Perikanan dan Kelautan* (Provincial Department of Fisheries and Marine Affairs)
LIPI	Indonesian Institute of Sciences (the CITES Scientific Authority of Indonesia)
LRFF	Live Reef Food Fish
PHKA	*Perlindungan Hutan dan Konservasi Alam* (the Directorate General of Forest Protection and Nature Conservation, under the Ministry of Forestry), the CITES Management Authority of Indonesia
PPI	Port Fisheries Authority
TRAFFIC	The wildlife trade monitoring network, a joint programme of IUCN and WWF
WWF	the conservation organization, also known as World Wide Fund for Nature: and World Wildlife Fund in the US and Canada

1) Introduction and Project Background

The Humphead Wrasse *Cheilinus undulatus* was listed in CITES Appendix II in October 2004 because of current and projected declining populations due to unsustainable harvest, in particular for the live reef food-fish export trade. It is a high-profile reef fish species and an important example of a valuable commercially important reef fish. Indonesia is the major exporter of this species and is also at the centre of its geographic range. Hence the status of the Humphead Wrasse in Indonesia is important for its global status. As it is unlikely that the species can be raised by hatchery at commercial levels in the near to mid term; capture and exports will continue to depend on fish sourced from the wild.

Harvest characteristics of the Humphead Wrasse, according to the IUCN 'Guidance for CITES Scientific Authorities' fall under category 1.5 – 'Live capture' involving the removal of live specimens from the wild. Since available trade information suggests that the majority of fish in international trade are *captured* as small to large sub-adults (i.e. do not come from eggs or early post-settlement fish), all fish removed from the wild are considered 'Live capture' and not derived from 'Ranching' (IUCN harvest type 1.3). Current knowledge of natural mortality rates of reef fishes is that major declines in natural mortality are within the first few weeks to months after settlement, such that older (hence larger) fish are unlikely to have survival significantly enhanced by captive grow-out.

This research paper is a component of the project "Development of fisheries management tools for trade in Humphead Wrasse *Cheilinus undulatus*, in compliance with Article IV of CITES", led by the IUCN Grouper and Wrasse Specialist Group under contract to the CITES Secretariat. The compilation of trade data contained in this report will contribute to the design of methodologies to conduct "non-detriment findings" (in compliance with Article IV of CITES) to allow for export of sustainably managed *C. undulatus* and assist recovery and long-term persistence of wild populations. This analysis of trade dynamics of Humphead Wrasse in Indonesia, with additional pertinent data collected in Hong Kong SAR, the major importer of this species, is designed to complement an Underwater Visual Census (UVC) and assessment of what is currently known of its wild population status and biological characteristics conducted by IUCN.

In this report, Humphead Wrasse *C. undulatus*, also known as Napoleon or Maori Wrasse, is largely referred to by the acronym HHW. HHW are found on reefs across the Indian and Pacific Oceans, and have the potential to reach a length of up to 2.3m and a weight of up to 180kg, making the HHW one of the largest of the so-called reef fishes. The HHW is considered a naturally uncommon species, with adult densities rarely exceeding a maximum of only 20 fish/10,000m^2 (Sadovy *et al*., 2003). The species is thought to reach sexual maturation at about 35-50 cm in total length and under five years of age. The species can live to 32 years. Most small adults are female while males can exceed 1m. The species is also known to be hermaphroditic, exhibiting female to male sex change in some fish (Sadovy *et al*., 2003).

The body shape and colour of HHW change as it matures. All phases have a pair of distinctive darker-coloured lines running through the eyes, with the lines being more distinct behind the eyes of juveniles. This line marking is not found in any other wrasse. Juveniles range from a light to pale green colour, while adults are more olive to green. Adult males at the maximum size have a pronounced forehead and are more blue-green to blue in colour.

HHW is of considerable traditional customary significance in many Pacific islands and is much appreciated by divers, spear-fishers and seafood gourmets alike (Sadovy *et al*., 2003). However, it

gains its highest value in the live reef food fish export trade, where it is commonly taken in its juvenile size range, either for direct sale, or increasingly, to be grown-out to market size.

The primary threat to this species is the lucrative demand for live reef fish in up-market Asian, predominantly ethnic Chinese, restaurants. It has been reported that importers and traders of HHW finance illegal operations to harvest the fish with cyanide in Indonesia, the Philippines and much of the Indo-Pacific region. Besides threats from illegal or unsustainable fishing, this reef-dependent fish is threatened by habitat destruction (Johannes and Riepen, 1995; Sadovy and Vincent, 2002).

In 1996, HHW was listed as vulnerable on the IUCN Red List of Threatened Species, the first Red List assessment to focus specifically on the status of marine fishes, and in 2004, the listing was updated to endangered. This species was listed because of many concerns over rapidly declining numbers in many areas, particularly within the last decade, as well as protected future demand in the growing live reef food fish trade (LRFFT).

At the 13th Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in October 2004, *C. undulatus* was listed in Appendix II of the Convention, thus regulating international trade of this species under a permit system which requires exporting and re-exporting countries to authorise trade. In the case of Indonesia, permits should only be granted if the Indonesian CITES Authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild and that specimens were acquired legally.

The monitoring and control of trade of HHW in Indonesia has been managed by the Head Office of Mariculture (*DKP Budidaya*) within the Ministry of Marine Affairs and Fisheries (DKP). Since January 2005, when the CITES listing came into force, international trade in *C. undulatus* has come under the purview of the CITES Management Authority (the Directorate General of Forest Protection and Nature Conservation (PHKA), under the Ministry of Forestry (*Departmen Kehutanen*).

The most pressing challenges in Indonesia are to institute an agreed set of responsibilities between the jurisdictions of fisheries management and CITES, and to establish a Non-Detriment Finding (NDF) protocol to ensure that Humphead Wrasse harvest and trade is managed for the long term – and thereby ensure that the species does not further decline at local and national wild population levels. Initiatives need to be developed to enable implementation and enforcement of any quota or regulations introduced to ensure the sustainable exploitation of the HHW.

Five provinces were surveyed for this study, namely Bali, South Sulawesi, North Sulawesi, Jakarta, and North Maluku, with additional records collected in Hong Kong SAR on imports recorded from Indonesia.

In Indonesia, local names of HHW include *ikan napoleon, su mei*, *ikan maming*, *ikan angke*, *lemas*, *singha, and haka.*

Values listed in this report are based on the values of exchange as listed on xe.com Universal Currency Converter® on July 26, 2005, where USD1 = IDR9806.63, and USD1 = HKD7.77730.

2) Geographic Locations surveyed

The Indonesian provinces surveyed for this report were selected by IUCN Grouper and Wrasse Specialist Group and TRAFFIC Southeast Asia, in consultation with representatives from the Indonesian Ministry of Marine Affairs and Fisheries (DKP), the Indonesian Institute of Sciences (LIPI, the CITES Scientific Authority of Indonesia) and Directorate General of Forest Protection and Nature Conservation (PHKA, the CITES Management Authority of Indonesia). Locations for trade surveys were discussed and selected during two workshops, conducted by IUCN GWSG in Jakarta, on February 17th and March 22nd, 2005. See Fig. 1 for a map of Indonesia showing the administrative divisions. Comments from traders also helped to determine those locations variously sourced for this species.

Bali, the island immediately to the east of Java, has a population of 3 million people, of which 90% are Hindus, and a Muslim minority of which many are coastal fishermen. The island is surrounded by coral reefs and experiences a dry season between April to September.

South Sulawesi province is located on the south-western peninsula of the island of Sulawesi. Its provincial capital and largest city is Makassar (also known as Ujung Pandang). The city is southern Sulawesi's primary port, with a long tradition – cultural and economic – of involvement in the inter-island trade of marine products and other commodities within the Indo-Malay archipelago, as well as international trade links with foreign markets.

North Sulawesi province is at the tip of the island's northern peninsula, and borders only Gorontalo province. The region is predominantly Christian with a Muslim minority, which is an exception in this largely Muslim country. North Sulawesi has a population of about 1.97 million and its provincial capital and largest city is Manado. As the largest city in the region, Manado is a key tourist transit point for visitors (and is one of Indonesia's international gateways for tourism). Ecotourism is the biggest attraction in Manado. Scuba diving and snorkelling on the nearby island of Bunaken are popular attractions. Bunaken is an island covering 8.08 square kilometres in the Bay of Manado. It is part of the Manado Tua Marine National Park, which has some of the highest levels of marine biodiversity in the world

Jakarta is the capital and the largest city of Indonesia. Unlike other cities in Indonesia, Jakarta has a special administrative status. It is under the regency (*kabupaten*) of Kepulauan Seribu, the only regency in Jakarta province, which means it is governed by neither provincial nor federal legislation. As such, the city is headed by a governor instead of a mayor. Jakarta is divided into five districts called *kota*: Central Jakarta, East Jakarta, North Jakarta, South Jakarta, and West Jakarta. Each is headed by a mayor.

Between 1950 and 1999, all the Maluku Islands formed a single regency (province) of Indonesia, from the Halmahera Islands to the Aru Islands. In 1999 the regency was split into the provinces of **North Maluku** (Halmahera Islands, which includes Ternate, Bacan, Obi, Gebe and Morotai) and Maluku (Seram, Tanimbar and Aru Islands).

In 1999 and 2000, a series of ethnic, political and religious riots in the new Indonesian province of North Maluku led to the death of around 3000 people, the displacement of 250,000 refugees and the destruction of approximately 20,000 houses. The violence began as a territorial dispute between the Kao and Makian ethnic groups but quickly developed into a wider inter-religious conflict largely through the efforts of

Makian elites. At the same time, competition between bureaucratic and political elites for the political and economic spoils of the new province of North Maluku (created in late 1999) became intertwined with these ethnic and religious tensions, exacerbating the conflict. Throughout much of 2000, conflict continued on the island of Halmahera between Muslim and Christian militias. According to officials, this history has rendered all data of HHW trade non-existent during that period, and all data prior to the civil unrest inaccessible because North Maluku had yet to become a province. However, much HHW was sold directly to exporters at sea (offshore) making production extremely difficult to monitor (Suharsono, pers. comm.).

The population of North Maluku is 724,897 (Indonesian National census, 2000), making it the least populous province in Indonesia.

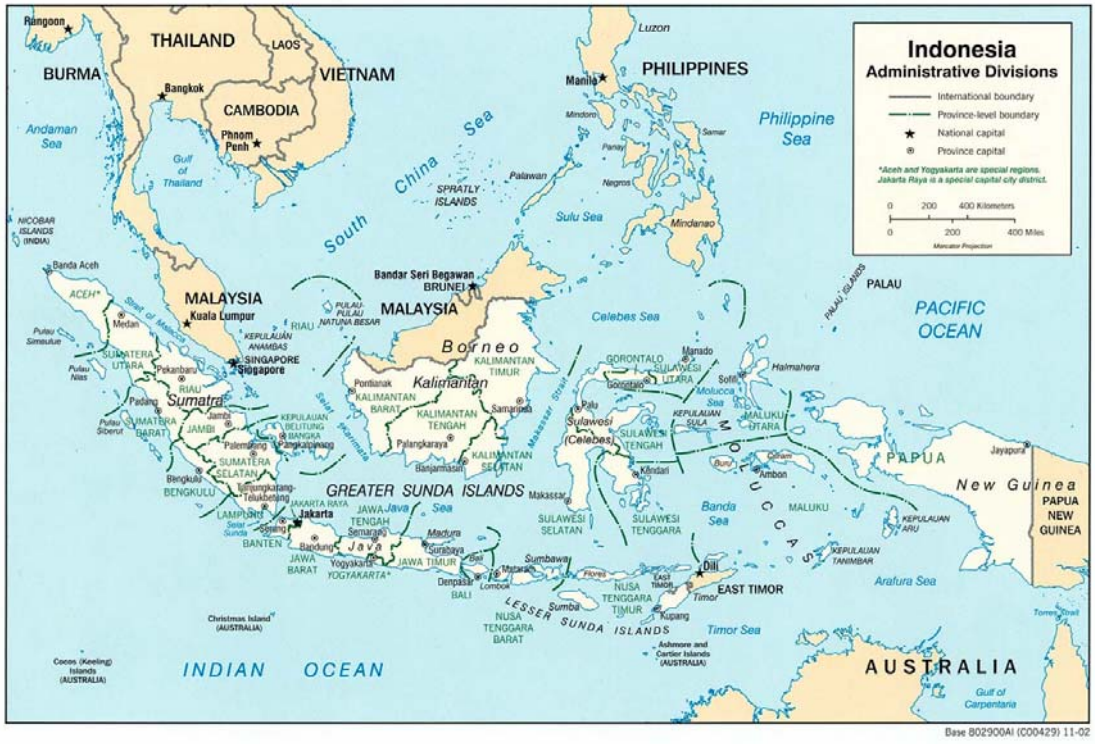

Figure 1: Map showing Indonesian provincial jurisdictions

3) Methods

Data were gathered in Bali, South Sulawesi, North Sulawesi, Jakarta and North Maluku through interviews with officials from *Kepala Dinas Perikanan dan Kelautan* (KDPK, or Provincial Department of Fisheries), including officials from the departments of Fisheries Quarantine, Fisheries Laboratory and Port Fisheries (PPI). Officials from BKSDA were also contacted and interviewed in North Maluku. All available trade documents, including permits and import/export data, concerning HHW, were copied from the various government departments. International export data were obtained from both the DKP Budidaya (for years 2001 to 2005) and PHKA, the CITES Management Authority of Indonesia (for 2005 only)

Interviews and site visits to the facilities of the primary traders in each province, as identified and facilitated by KDPK, were also conducted. Subsequent informal interviews were conducted with local

fishermen at fish markets and fish ports to more accurately understand and quantify the availability and trade dynamics of HHW.

All interviews followed a standard questionnaire (see Appendix 1) as drafted by IUCN and TRAFFIC, following consultations with Indonesian counterparts from DKP, LIPI and PHKA. The scope of the questionnaire was designed to collect objective information to assist in developing and improving the management of HHW for international trade. Information was compiled on harvest seasons, collection techniques, geographical restrictions, monitoring schemes, enforcement measures, management plans, quotas, conservation status of species, stocks and abundance, socio-economic factors, and stakeholder needs for capacity-building programmes.

Training and orientation in marine fish surveys in general, and regarding HHW in particular, was provided by the IUCN-GWSG on the first trade survey to Bali. An identification sheet was designed to assist in species identification since the HHW goes through several distinct colour phases during its lifetime (Appendix 2)

Local Indonesian counterparts were consulted and assisted in identifying traders, making introductions and, when necessary translating for the primary researcher in each province of the survey. Interviews were conducted in the appropriate languages, which included Bahasa Indonesia and other Indonesian local languages and dialects, Mandarin, Hokkien and English.

In addition, a workshop on the wild population status and trade dynamics of *C. undulatus* in Indonesia was organized on 14-15 February, 2006 in Jakarta to provide an opportunity for Indonesian government authorities to share further information from national and provincial jurisdictions on Humphead Wrasse (HHW) population status, harvest methods and trade dynamics of the species.

3.1 Number of people interviewed

During this survey, a total of 94 individuals were formally and informally interviewed between June and August 2005 (Table 1).

Going by the estimated number of exporters described by other industry participants, both in Hong Kong SAR (Liu Min and Yvonne Sadovy, pers. comm.) and in Indonesia, it is fair to assume that most major exporters of HHW were interviewed. In DKP export records 24 companies are listed but few of those exported significant amounts of HHW between 2001 and 2005. Of the list of 24, about 8 companies export significant quantities of HHW and all eight appear on another official government list of 15 companies permitted to export HHW (Section 4.2). During interviews in both Hong Kong SAR and Indonesia four additional companies were identified which are involved in significant export of HHW from Indonesia. Therefore, in all, there are about 12 significant exporters of HHW, of which 9 were interviewed during the current trade survey.

Table 1 presents the occupations and backgrounds of the interviewees. The category labelled "DKP" represents officials from all departments within the Department of Marine Affairs and Fisheries, which are DKP, DKPB, PPI (Port Fisheries Authority), Quarantine, and Laboratory.

	Bali	South Sulawesi	North Sulawesi	Jakarta	North Maluku	Total
Dive Masters	2		2			4
Fishermen	7	6	6			19
Fish Mongers	4	2	4	7	3	20
Traders/ Exporters	3	3	2	1	1	10*
Collectors	1	1	1	2		5
DKP	6	6	4	3	8	27
Aquarists	1					1
Restaurants	1			2		3
BKSDA					1	1
Random locals	2		2			4
Total	**27**	**18**	**21**	**15**	**13**	**94**

Table 1: Occupations / categories of interviewees during this survey
* Includes both branches of one company with branches in both Bali and Jakarta in this total

3.2 Supplementary data on HHW imports from Indonesia to Hong Kong SAR

Hong Kong SAR is overwhelmingly the major importer of HHW from Indonesia. During 2005 and early 2006, therefore, data were compiled in Hong Kong SAR on imports of HHW (by both sea and air), on sizes of fish in trade (to establish the preferred or actual sizes of retailed fish), and interviews were conducted with several major traders of HHW who have experience of importing the species from Indonesia (IUCN/GWSG, 2006). Opinions were gathered from traders during a workshop conducted in Hong Kong SAR on the HHW in January 13th, 2006; the workshop was jointly organized by IUCN GWSG and the government fisheries department, and discussed implementation on the CITES listing in Hong Kong SAR (IUCN/GWSG, 2006).

4) RESULTS

4.1 Policy framework for monitoring of harvest and trade

There is no single, comprehensive document that describes all the permits necessary for the capture and export of HHW. The responses of various interviewees to questions regarding regulations governing Humphead Wrasse trade indicated general confusion and a lack of clarity pertaining to agency responsibility and co-ordination. This confusion was common to fishermen, collectors, exporters and even sub-sections within the Ministry of Marine Affairs and Fisheries (DKP), and its provincial arm, the KDPK.

Since the listing of HHW in CITES Appendix II came into force in January 2005, the implementation and enforcement of Fisheries regulations for export of the species should have been conducted in collaboration with the CITES Management Authority of Indonesia. During the survey, it was particularly significant that offices of KDPK and the provincial offices of the CITES Management Authority of Indonesia, the BKSDA, did not seem to be in contact at all. Many of them also cited a lack of formulation and dissemination of new regulations since international trade in HHW came under the purview of CITES. HHW is regulated under Decree of Ministry of Agriculture No: 375/Kpts/IK.250/5/95 and Decree of Ministry of Trade No: 94/Kp/V/95.

Article 1 of the *Declaration of the Directorate General of Fisheries Regarding the Size, Location, and Catching-Methods of Napoleon Wrasse* [No. HK.330/S3.6631/96 (4 July, 1996), the Amendment of the *Decree of Director General of Fisheries*
No. HK.330/DJ.8259/95 (6 Sept 1995)] (see Appendix 3), lists the permits required HHW harvest and trade by the DKP, states:

1. Local collecting company are fisheries companies or cooperatives that have a Trade Permit for Local Collector (*Ijin usaha pengumpul lokal*), with the activity specified to collect Napoleon Wrasse that are caught by traditional fishermen according to partnership system and those able to cultivate the fish and to sell the yield for domestic consumption;
2. Export collecting company are fisheries company or cooperation that have Trade Permit for Export Collector (*Ijin usaha pengumpul ekspor*), with the activity specified to collect Napoleon Wrasse from local collecting companies and/or traditional fishermen and those able to cultivate the fish and to export the yield;
3. Explanation letter for catching and cultivating (SKPP) and the letters issued by the head of fisheries department of the regency/city or the authorized officer, as listed in Appendix 3 of this decision, with verification that the trade of Napoleon Wrasse is from traditional fisherman or from mariculture.

Article 4 of the same Fisheries Declaration describes the permits necessary by the parties in permitted to harvest and trade HHW:

1. Researcher must have research permit, and traditional fisherman must have catching permit and carried out by partnership system.
2. Catching permit for researcher is given by Director General of Fisheries
3. Catching permit for traditional fisherman is given by Head of Department of Fisheries or authorised officer

It is also mentioned in Article 4 that along with the catching permit, the fishing grounds of HHW must be regulated with attention to the carrying capacity of fish resources and the environment.

Articles 10 and 12 of the same Fisheries Declaration continue to list the permits necessary for harvest and trade, and the departments from which they should be acquired. Articles 13 and 14 describe the monitoring efforts and obligations of DKP regarding the harvest and trade of HHW.

Other permits that were reported by interviewees to be required are:

1. Customs permit from Customs and Trade Department
2. Distributor Letter, Capture Letter and SATS LN Permit (for trade in CITES species) from BKSDA

The Fisheries Declaration states: "The harvest of Napoleon Wrasse and permit to be traded whether domestic or export out of Republic of Indonesia territory, must involve fishes sized from 1 to 3 kilograms."

Regarding implementation of the Appendix II listing in Hong Kong SAR, the major export destination for HHW from Indonesia (according to export data provided by DKP Budidaya), the Agriculture, Fisheries and Conservation Department on the Hong Kong SAR government (AFCD – the CITES Management Authority of Hong Kong) advised that the listing has not yet been implemented as of April, (June) 2006. Hong Kong SAR is currently undergoing legislative amendment on the relevant local legislation that gives effect to CITES in Hong Kong SAR. The aim of the legislative amendment is to align Hong Kong SAR's control regime on endangered species with CITES and to streamline the licensing requirements. Such legislative amendment takes longer than the standard updating procedure usually required to reflect the changes in the Appendices after each CoP. The Appendix II listing for the HHW, *Cheilinus undulatus*, will be implemented in Hong Kong SAR when the New Ordinance is in operation.

The New Ordinance was passed by the Hong Kong SAR government Legislative Council on 1 March, 2006, and the Administration is now preparing the exemption orders which will provide exemptions in line with CITES (e.g. co-operative conservation programme, personal or household effects, etc). Under the New Ordinance, possession of HHW will require a possession licence (a stricter domestic control in addition to import, export and re-export licensing controls). This amendment will strengthen Hong Kong SAR's ability to control the import and movements of HHW. The new ordinance is anticipated to come into operation within 2006. Hong Kong SAR will also have to address challenges in monitoring imports of fish coming in by sea because this is not controlled at present and with re-exports to mainland China: a significant number of fish imported into Hong Kong SAR are rapidly re-exported to China by land and sea and currently there are no data available such trade.

AFCD, in collaboration with the IUCN GWSG held a one-day workshop on January 13th, 2006, to advise traders of the pending legislation, seek opinions and provide a forum for information exchange. A second workshop will be held in June 2006 for further and regional information exchange and to discuss NDF options.

4.2 Available Trade Data

Data collated by DKP Budidaya at central level revealed that during the period 2001-2005, recorded exports of HHW from Indonesia by 24 exporters totalled 108,241kg. Considering the legal export limits for *C. undulatus* in Indonesia is restricted between 1-3kg, this equates to a range of 36,080 to 108,241 specimens exported over five years. However, this recorded export volume was only 36% of the total allocated quota for that 5-year period (298,250kg). Of the 24 companies listed in the export records, only one third (i.e. 8 companies) exported more than 5 tonnes (total per company) over the 5-year period. Ten of the known exporters from Indonesia accounted for 95% of all recorded HHW exports during the period 2001-2005. Interviews were conducted with nine of these 10 companies during the course of the 2005 trade survey under this project (Table 2; Figure 2).

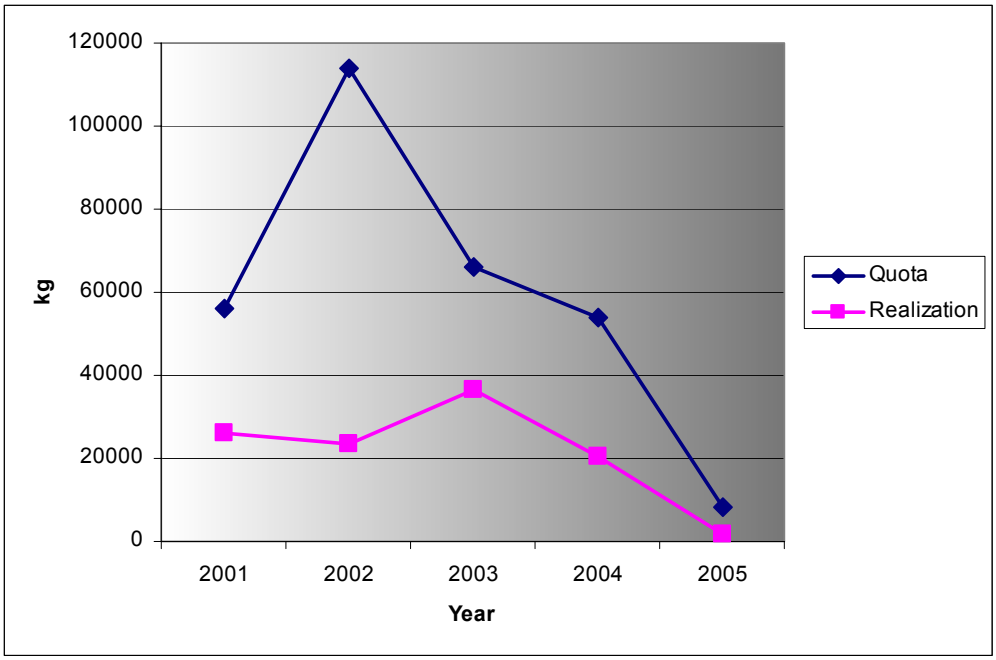

Figure 2: Actual exports (Realization) compared to national quota, 2001-2005

			Quota (fish)		*Export (fish)*	
Year	**Quota (kg)**	**Actual Export (kg)**	**# Fish (1kg)**	**# Fish (3kg)**	**# Fish (1kg)**	**# Fish (3kg)**
2001	56000	26304	56000	18667	26304	8768
2002	114000	23542	114000	38000	23542	7847
2003	66000	36411	66000	22000	36411	12137
2004	54000	20384	54000	18000	20384	6795
2005	8250	1600	8250	2750	1600	533
Totals	***298,250***	***108,241***	***298,250***	***99,417***	***108,241***	***36,080***

Table 2: Comparing HHW quotas and exports in kilogrammes, extrapolated to show approximate numbers of HHW fish specimens ranging between export limit of 1-3kg

In 2005, following the listing of *C. undulatus* in CITES Appendix II, international export from Indonesia came under the purview of the CITES Management Authority of Indonesia. Each international export consignment should now be accompanied by a CITES export permit, as well as the requisite permits from DKP and BKSDA for intra-Indonesian transport prior to export. Since Hong Kong SAR has not yet implemented this listing, however, it is not possible to cross-check permits issued with imports into Hong Kong SAR.

After some discussion over the export quota volumes, an interim limit of 8,000 specimens was put in place for the calendar year 2005 (Table 3). According to permit records, 5320 specimens of that quota were realised as actual exports by December 31, 2005.

Napoleon Wrasse CITES Exports, 2005					
No.	**Species Name**	**Quota***	**Actual Exports**	**Quota Balance**	**Details**
1	*Cheilinus undulatus*	8,000	5,320	2,680	Catching Areas: Papua (Irian Jaya) Bali, west Nusa Tenggara Barat, Sulawesi
* Quota based on recommendations from LIPI, the ID CITES SA					

Source: CITES Management Authority of Indonesia, February 2006

Table 3: CITES export permits issued in Indonesia, for calendar year 2005

However, indications from field interviews suggested that the new quota 'system' was only implemented from June 2005 onwards, which may suggest that this total represents only 6 months of exports. How indicative this number of fish specimens is of overall real export levels is uncertain, but DKP export records for calendar 2005 indicate 1,600kg of live *C. undulatus* exports. Under the Indonesian size limit of 1-3kg for exports, this gross weight would equate to 533-1600 specimens (although given the apparent predominance of undersize fish (i.e. < 1 kg) in trade (see Section 4.7) the number of individuals is likely to be substantially greater than 1,600. The CITES export quota for *C. undulatus* has again been set at a limit of 8,000 fish for the calendar year 2006 (CITES Management Authority of Indonesia, *in litt.* to TRAFFIC Southeast Asia, February 2006), with allocations assigned to just five 5 areas (Papua I, II and Maluku each 2,000 fish; east and west Nusa Tenggara, each 1,000 fish) (Samedi, PHKA).

Hong Kong SAR import data - Inspection of import figures in Hong Kong SAR for 2005, a major destination for Indonesian HHW, strongly suggests that international trade in the HHW from Indonesia remains high and very probably well exceeds the interim quota imposed by Indonesia for 2005. Census and Statistics Department (CSD) data of the HK government show 4,619 kg imported, predominantly by air, plus a significant amount was almost certainly imported by sea (50% of recorded sea imports is considered a conservative estimate for imports from Indonesia and represents about 7,000 kg by AFCD; see Table 4 for further details), for a possible total export of > 11,000 kg.

Comparing exports and imports of HHW from Indonesia into Hong Kong SAR, indications are that far more exports were made than are indicated. Exports of 1,600 kg compare with imports of 4,619 kg by air and substantially more by sea. Notably, a large volume of HHW was recorded to enter HK from Singapore, the first time this country has appeared in CSD records as an exporter of the species. Since Singapore does not have significant stocks of this species it is likely that some of these imports are sourced from Indonesia and/or Malaysia and re-exported through Singapore. Singapore CITES Management Authority records show that there has been no permits issued by Singapore for import, export nor re-export of Humphead Wrasse since its listing in CITES App II came into force in January 2005 (Lye Fong Keng, SG CITES MA, *in litt.* to TRAFFIC Southeast Asia, June 2006).

Table 4: Import data for HHW in Hong Kong SAR for 2000 to 2005 inclusive. Data sources are Census and Statistics Department (CSD) of the Hong Kong SAR government collected from all air imports and from non-Hong Kong SAR licensed vessels (Commodity code: 0301 9931), and data voluntarily supplied to the Agriculture, Fisheries and Conservation Department of the Hong Kong SAR Special Administrative Region (AFCD data) from Hong Kong SAR registered vessels. Note that AFCD considers the voluntary data submitted to represent about half of all the imports by HK-licensed vessels and that a significant proportion of these shipments come from Indonesia, according to volunteered information from traders. [For more details see IUCN/GWSG, 2006).]

CSD import volumes of HHW **(kg)***	2000	2001	2002	2003	2004	2005
Australia	0	2,651	49	0	0	0
Cambodia	1,479	0	0	0	0	0
Indonesia	875	499	5,344	2,526	544	4,619
Malaysia	4,503	3,438	2,497	2,541	2,730	0
Philippines	5,055	5,343	20,752	11,191	5,889	212***
Thailand	30,483	0	0	0	0	0
Vietnam	4	360	0	16	89	0
Papua New Guinea	0	0	0	0	0	4,516
Singapore	0	0	0	0	0	12,450
Sub-total **(kg)**	42,399	12,291	28,642	15,434	9,174	21,797
AFCD import volumes of HHW **(kg)****	38,673	24,660	20,031	30,127	24,219	14,059
Total import HHW (CSD + AFCD) **(kg)**	81,072	36,951	48,673	45,561	33,393	35,856
% HHW import by HK-licensed vessels	47.7	66.7	41.2	66.1	72.5	39.2

*CSD (Census and Statistics Dept. of the HK government) record imports from all countries by air and by non-HK-licensed vessels but does not record imports by HK-licensed vessels. For this reason, AFCD collects additional data which records imports on HK-licensed vessels. The AFCD and CSD data combined provide the best available estimate of minimum import volumes of HHW into Hong Kong. (there are reportedly few non HK-licensed vessels so most of the CSD data represent air shipments).

Imports by sea mainly from **Indonesia according to Agriculture, Fisheries and Conservation Department of the Hong Kong SAR Special Administrative Region (AFCD data); WH Law, AFCD Fish Marketing Section (April 2006; pers. comm.).

*** Note that officially the Philippines does not export CITES Appendix II listed species.

4.3 Range of prices along the trade chain and value of the trade

The highest price for live HHW in the export trade chain from Indonesia is obtained by either exporters or collectors (Table 5; Table 6). However, even though local consumption is likely far less significant than the export trade in terms of volume and frequency, the consumer pays the highest price for a serving of HHW in the restaurants (Fig. 3). At the lower end of the scale, fishmongers obtain the lowest price – most likely because all HHW sold by them are fresh (dead) to local consumers within their province or city.

	Bali	South Sulawesi	North Sulawesi	Jakarta	North Maluku*	Average
Exporter (Parties that conduct and directly profit from exports)	35	34	30	61	4.5	32.9
Collector (Parties primarily involved in the collection of commodities amongst fishermen, and works with an exporter or consumer e.g. restaurant)			70	80		75
Fishermen	6	30	12.5		10	14.63
Fishmonger (dead specimens)		1.5	4		3	2.83
Restaurant	76			125		100.5

Table 5: Maximum or fixed price for HHW sold by the various actors involved in the trade (all prices in USD/kg), according to interviews.

* the prices quoted by exporters interviewed in North Maluku were inconsistent with all other provinces surveyed – which may indicate that the traders/exporters did not reveal the real price. This anomaly is so inconsistent it may be best to leave it out of any further data analysis.

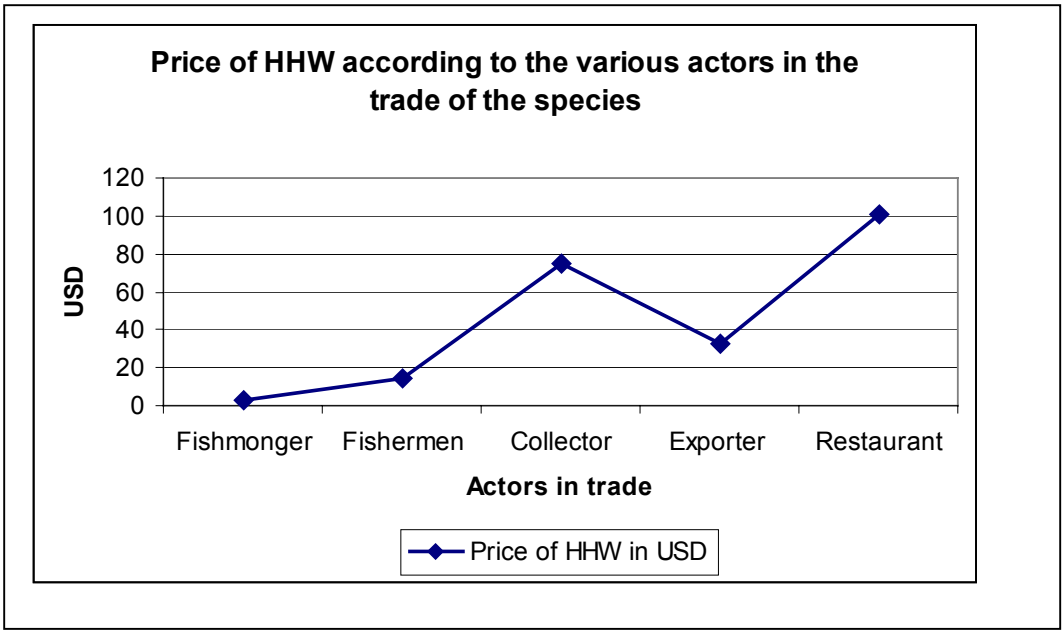

Figure 3: Average prices of HHW (per kg) according to stakeholders interviewed

Several interviewees stated that the reason why stakeholders participate in Humphead Wrasse harvest and trade is because the species commands higher prices than other fish, particularly when it is captured and sold live. Information collected during the survey regarding prices for other reef food fish when sold fresh (dead) revealed average prices that suggested that even when not entering the live trade, HHW was worth more in local markets than other reef food fish.

Type of reef fish	Price per kg (USD)
Mouse Grouper *C. altivelis*	2.00
Snapper *Lutjanus* spp.	2.50
Parrotfish *Scarus* spp.	1.20
Tuna *Scombridae*	1.20
Coral trout *Plectropumus* spp.	1.7
HHW (fresh dead) *C. undulatus*	2.00 – 5.00
HHW (live) *C. undulatus*	12.50 – 35.00

Table 6: Comparative retail prices of HHW against other reef fish (price of fish sourced from markets and applies to fresh (dead) specimens). The consumer pays the above-mentioned prices. All fish listed above are fresh (dead) unless stated.

Data collected by DKP Budidaya regarding exports in the period 2001-2005 show the 108,241kg recorded exports had an export value of USD1,391,441, which equates to an average of USD12.86 per kg (Table 7). Over the five year period, average prices per kg ranged between USD10.96 per kg (2002) up to USD36 per kg (2005).

Year	Actual export (kg)	USD	Average USD/kg
2001	26,304	36,2587	13.78448
2002	23,542	25,7947	10.95689
2003	36,411	45,7090	12.55362
2004	20,384	25,6217	12.56952
2005	1600	57,600	36
Totals	***108241***	***USD 1,391,441***	***USD 12.86***

Table 7: DKP Budidaya data showing actual exports (kg) and USD value (total) and average per kg on an annual basis

The data indicates that the reported HHW export trade has been worth USD278,288 per year to Indonesia over the period 2001-2005.

4.4 Sources and Market Destinations

Central DKP data for 2001-2005 documents collection sites reported by 24 traders. Papua is the most reported source of HHW catch (7 traders), followed by South Sulawesi (6 traders). Maluku, west Nusa Tenggara and North Sulawesi are of equal third importance (5 traders each), followed by east Nusa Tenggara (4 traders). Only about 8 of these companies trade HHW in significant quantities i.e. over 5 tonnes in 5 years each. A further four exporters of HHW from Indonesia do not appear to be included in any government list of exporting companies.

Interview results suggest that primary fishing grounds for HHW have gradually moved eastwards towards Papua, while the former source areas in the west such as in Sumatra have largely been exhausted. However, some traders still report sources for Humphead Wrasse in coastal areas of east Kalimantan, east Java, Bali, the Riau Archipelago in southern Sumatra, and Indonesia's remote Natuna Islands (South China Sea).

Appendix 5 shows five maps (A-E) that indicate the complexity of the trade routing within Indonesia and the distances of many source areas from points of export. Collection occurs in much of eastern Indonesia and, according the interviews conducted, leaves through airports in Halmahera, Bali, Jakarta,

Manado and Makassar. These maps clearly show that companies are sourcing from a wide and diverse set of areas within Indonesia. There were reports of suspected undocumented exports by boats used to transport fish to Hong Kong SAR, reports corroborated by interviews conducted on the Hong Kong SAR side (Liu Min, personal communication) and variously reported in the literature (e.g. Johannes and Reipen, 1995; Bentley 1999). If there is significant IUU this could account for the large discrepancy between official exports from Indonesia and the (higher) estimated imports in Hong Kong SAR for 2005.

Of the 10 traders/exporters interviewed, all reported exporting live HHW to Hong Kong SAR, with 50% of traders reporting exports to mainland China as well (Table 8).

	HK	**CN**
Number of Traders/Exporters	10	5

	Re-exported	**Retained for domestic market**
Number of Collectors	3	2

Table 8: a) Destination of live HHW exports from Indonesia; b) Domestic *vs.* International supply of HHW by collectors within Indonesia

Of the five collectors interviewed, all trade live HHW within Indonesia, while 3/5 collectors mentioned that their fish were re-exported by traders/exporters to Hong Kong SAR or mainland Chinese markets. The remaining 2/5 collectors claimed their fish were sold within Indonesia's domestic market.

Of the 18 fishmongers interviewed, 15% were observed selling fresh (dead) HHW in the domestic market, 55% of them claimed not to sell HHW at all, and the remaining 10% said they had sold or sell HHW on occasion. All fish sold at local wet markets in South Sulawesi, North Sulawesi, and North Maluku was reported to be consumed domestically.

Of the 19 fishermen interviewed, 5% claimed they collaborated with Taiwanese middlemen, who exported HHW to Taiwan, Province of China.

Export figures compiled by central DKP show 24 exporters currently active in Indonesia, 100% of which report Hong Kong SAR as a destination for their exports. In addition, Singapore (20% of exporters), Taiwan, Province of China (21% of exporters), China (13% of exporters), Japan (8% of exporters) and Thailand (4% of exporters) were also reported as destination markets. In Jimberan, Bali, it was also reported that frozen fish are shipped to Taiwan, Province of China; this was the only records of export trade in chilled HHW.

Hong Kong SAR is a major destination of HHW from Indonesia. An ex-trader in Hong Kong SAR identified his understanding of the history of exploitation in Indonesia which was consistent with interview outcomes in the current trade survey. Eastern Indonesia is now the major source of HHW with businesses moving progressively east to supplement supplies (Fig. 4). It is possible that some traders in Hong Kong SAR are unaware of declines in HHW supply in Indonesia; at the workshop in Hong Kong SAR in January 2006 several traders indicated that they have many sources of fish and keep shifting the areas from which they source fish, so they do not notice overall declines in their trade.

Figure 4: Map of eastern Indonesia (western Indonesia inset – red ellipses supplies considered low; some fish still sourced from green ellipses), where most HHW are now sourced showing changes in source areas over time. Information provided by prominent Hong Kong SAR trader in 2005. Red ellipses (mainly those around Sulawesi and western Sumatra: Operations commenced in 1988 with Ujung Pandang (Makassar) as the base. Only one ship was involved and thee HK divers were employed. The main operational areas were SE of Sulawesi and Selayar. Green (mainly around Halmahera and western Kalimantan) & blue ellipses (mainly Moluccas and eastern Nusa Tenggara): 2nd stage of operation. An Indonesian Company with military background set up a base at Kendari and invited about 40 HK fish vessels to catch fish in Indonesian waters. The operation covers all Green and Blue markings. Brown ellipses (mainly west and north Papua): Since fish have been getting less the operations, more recently, moved further to the east, including to Irian Jaya.

In Jimberan, Bali, it was reported that frozen fish were shipped to Taiwan, Province of China.

4.5 Modes of transport and trade routes

Of the 10 traders/exporters interviewed in Indonesia, 80% of them exported live HHW to Hong Kong SAR by air either from Bali (Denpasar) or Java (Jakarta), while the remaining 20% export the fish by sea. North Sulawesi (Manado) was also stated to be an important export point for HHW by air, as well as Makassar in South Sulawesi.

Bali and Jakarta act as the two major HHW collecting points, from where live fish are exported to Hong Kong SAR and China from Nguruh Rai (Denpasar) and Soekarno-Hatta (Jakarta) international airports. No records of export were available from Soekarno-Hatta because it was claimed that fish do not stop and are, therefore, not inspected. However, this airport is a major exit point from Indonesia and all traders claimed that fish transiting Jakarta for export leave the airport to be repacked. This provides an opportunity for monitoring exports from Jakarta.

Reported source areas were concentrated around the provinces of eastern Indonesia (Papua, Nusa Tenggara, Maluku / North Maluku) as well as the coastal areas and outlying islands of Sulawesi, Bali,

Kalimantan, southern Sumatra and Java. Most intra-Indonesian transport was reported to be conducted by sea, but traders/exporters received fish from collectors by both air and by sea depending on the distance involved, and the availability and cost of flights.

Practicality of transport was also a factor; for example, if a large shipment of HHW was being transported, it was likely more cost effective and reliable to transport the fish by sea.

Fish can also be transported by land from collection points such as Gorontalo and Lampung (Sumatra), to their point of collection/export in Jakarta and Manado respectively.

4.6 Harvest/Capture methods

Article 1 of the *Declaration of Director General of Fisheries regarding the Size, Location and Catching Methods of Napoleon Wrasse* states that only traditional fishermen are allowed to harvest HHW, specifying that "traditional fisherman are fisherman that are catching the Napoleon Wrasse fish using a non-motorised boat, or attached motor, or with completely motorised vessel less than 5 (five) gross ton, and/or with machine less than 15 horse power (hp), and using fishing gear and/or using the material that can not cause damage of fish resources and the environment."

Article 8 of the Declaration also states that "traditional fisherman can only catch the Napoleon Wrasse by using hook and line, *bubu* and gill net."

Table 9 collates the various methods of fishing employed to capture HHW in Indonesia. Some of the capture methods are more specifically targeted at HHW than others. The findings were primarily acquired though interviews as official documents give little if any data of the capture methods for HHW or fisheries in general.

The numbers reflect the frequency of positive answers given by the interviewees regarding fishing methods, and may not necessarily tally with the number of interviewees as some abstained from answering, did not know, or described more than one method that is employed in the respective area.

	Bali	South Sulawesi	North Sulawesi	Jakarta	North Maluku	Total
*Bubu**	3	2	1		2	8
Hook-and-line	1	6	3	3	3	16
Cyanide/SCUBA		2		2		4
Cyanide/*Hookah*			2		3	5
Trawling	1					1
Longline	1					1
Spear	1		1			2
Purse seine	1					1
Bombing					2	2
Gillnets			3			3
Free diving/nets				1		1

* *Bubu* is a cage trap made of woven steel, nylon, or rattan

Table 9: HHW capture methods according to interviewees, grouped by provinces

***Bubu*:** A cage trap made of woven steel, nylon, or rattan. Can be placed anywhere on a reef or on the seabed, and left for a "soak time" varying between one day and 1-2 weeks. The trap is often baited

with dead fish, and weighed down with rocks, except steel *bubu* that can sink if heavy enough. It is an un-targeted method of fishing, although the size of the fish caught can vary with the size of the trap-door. Fish caught using this method will be retrieved alive although sometimes injured by ramming against the cage in an attempt to escape.

Hook-and-line: A simple apparatus of nylon line and steel hook. Used without a rod these lines are often short, no more than 5 m, held up by the hand and suspended from boats over a reef or when standing on a reef flat or beach. Often used by children to pass time, and can be commissioned by collectors for their catches, as is largely the case in North and South Sulawesi provinces. Hook and line is apparently the most effective and deployed method for catching HHW. Fish caught using this method will be retrieved alive and usually in good condition.

Cyanide/SCUBA: Cyanide (Potassium cyanide) is released into the water around reef habitat to stun fish and enable easy collection. This method allows for species-targeted fishing, as divers rigged with SCUBA units get within close range of the fish and squirt cyanide into reef crevices. When fitted with SCUBA units, divers can stay down for as long as their air or cyanide last. Being expensive, cyanide is allegedly supplied to subsistence fishermen by wealthier collectors and exporters because the fishermen are unable to afford it. Fish caught using this method are retrieved and sold live. Mortality rates of HHW caught with this method are almost negligible as the fish can be easily revived when being immersed in fresh and clean water. The cost of cyanide has had little if any influences on the comparative cost or returns, as the profit margins from the sale of the fish at the exporter/collector end remain high.

Cyanide/*hookah*: Basically the same as the SCUBA section above, however the divers this time are breathing air through a line attached to a surface compressor. This method of diving is extremely dangerous with high risk of decompression sickness or related illness. Fishermen using this method often go deep by using extremely long hoses, sometimes between depths of 30 and 60 metres. Using *hookahs*, divers stay down for as long as they can physically tolerate. Fish caught using this method will be retrieved alive.

Trawling: This involves actively pulling a fishing net through the water behind one or more boats. Nets of varying sizes can be trawled in surface waters, deep water and over the bottom. This method is known for its non-selective catch. Reef fish caught using this method are often damaged or killed and are usually sold dead.

Longline: A technique adopted by subsistence fishermen from commercial fishing vessels, longline fishing involves hundred of baited hooks hanging from a single line. In Indonesia longlines are often made of nylon but also of steel, though the former is preferred for its lower cost. It is also non-selective, but catches mainly grouper and snapper, although HHW are also sometimes caught. Fish caught with this method are usually sold dead.

Spear: Spear-fishing involves free-diving or SCUBA diving, armed with a pneumatic powered spear-gun to strike the hunted fish. While spear-fishing with SCUBA unit is illegal in some countries, it remains legal in Indonesia. Most fishermen are unable to afford SCUBA units and continue to free-dive. Fishes caught with this method are always sold dead.

Traditional purse seine: Different from commercial purse seine, traditional purse seine fishing is carried out over a reef flat. It often involves two boats and people walking on the reef flat to frighten fishes into the net as it is narrowed and closed by pulling a drawstring along the bottom of the net. This

method of catching reef fish is significantly destructive, often getting tangled with coral on the reef and hauling up undifferentiated fish and marine organisms. Fishes caught with this method are usually sold dead.

Bomb: Home-made explosives detonated on a reef that cause severe damage to an area of coral and associated species. An indiscriminate method of fishing that can also kill fish and other marine organisms by sonic boom. Bomb fishing was outlawed in Indonesia in 1995. All fish caught with this method are sold dead.

Gillnets: The gillnet is designed so that the fish get their head into the gap between the strands, but not their body. When the fish enters and then tries to get out, the net snags the gill covers or operculum and traps the fish. Normally, the mesh size of the net allows smaller fish to pass through unharmed. However, as more fish are caught by the net, smaller fish may be caught as well, unable to pass through the tangled netting caused by the initial layers of larger fish. These nets may also trap marine mammals and other non-target species.

Free-diving: Also known as breath-hold diving, this method is also used for the application of cyanide on reefs and spear fishing. Divers equipped with small, hand-held nets choose and harvest fish from the reef. Fish caught with this method can be sold live.

4.7 Sizes of fish and trends over time

Anecdotal evidence collected from various actors in the trade across the five administrative jurisdictions points to a general decline in size over time. However, as very few fish were actually seen during the survey, this is indicative only.

The typical size of fish in trade, as determined by interviews, visual inspections of cages and packing facilities (e.g. Fig. 5, Fig. 6) and as judged by retail sizes in HK are very small, often below legal size i.e., below 1 kg.

Bali – The HHW size trend could not be accurately verified in Bali. However, three exporting operators gave the sizes of the HHW that were purchased from fishermen around Bali's waters (Table 10).

Operator	Size of fish purchased in 2005
Operator A	1-2 kg
Operator B	0.1–10 kg (The small HHW are grown out to the preferred market size before being exported)
Operator C	150-200 g (The small HHW are grown out to the preferred size before being exported)

Table 10: Reported fish sizes in Bali, 2005

A visit to one holding facility allowed inspection of several floating cages full of small (approximately 15-25 cm) HHW being grown-out. At a packing facility, fish of 15 cm (i.e. below 1 kg) were being held (Fig. 5).

Figure 5: Bali – holding pen in coastal waters (left); fish in packing plant in Denpasar (right); the ruler is 30 cm

South Sulawesi – In South Sulawesi, the exporting operators were able to give a range of HHW sizes that were bought from fishermen in previous years and also the HHW size that are caught now. Table 11 gives a range of sizes of HHW that were caught (by fishermen) and bought (by collectors/exporters) in South Sulawesi.

Operator	Previously	Present (2005)
Operator 1	(2000) 10-15kg	>1kg
Barangcadid (market)	"bigger"	0.3 – 20kg
Operator 2	(1998) 1-3kg	< 1kg
Operator 3	> 10kg	0.3-3kg
Paotere (market)	(2000) 40kg	5kg
Batu Batu (market)	(1998) > 10kg, (2001) "all sizes"	1-50kg

Table 11: Reported fish sizes in South Sulawesi, 2005

Generally, the size of HHW caught has decreased, although there are still big HHW being caught infrequently. According to interviewees, HHW that are too small are sold to operators with grow-out facilities. One operator stated there were no more big HHW left to catch while another operator, Another said big HHW specimens (>10kg) are not bought because of potential trouble with the law.

Figure 6: Makassar – fish being held for packing (left) and packed for transport (right); note the yellowish liquid due to the chemical that fish are often transported in. These fish are probably about 20-25 cm in total length and well below 1kg each in weight.

North Sulawesi – Generally, HHW caught in 2005 ranged from below 1kg to above 9kg, although little information was obtained regarding historical catch sizes of HHW over time. Table 12 indicates the HHW sizes caught in North Sulawesi.

Interviewee	Previous size	Present size
Fishermen: Tumbak	-	0.5-9 kg
Fishmonger: Bersehati	"Mostly small" (<400g)	2->10 kg, generally mixed sizes
Collector	-	0.6->10 kg

Table 12: Reported fish sizes in North Sulawesi, 2005

Jakarta – According to one commercial operator who has links to Jakarta trade, the size of fish served in the Jakarta restaurants has decreased from 3-4kg to 0.6-2kg. Similarly, another operator also said that the size of HHW served in the Jakarta restaurants now ranges from 0.3-1kg only. No information was obtained directly from restaurants in Jakarta.

North Maluku – For North Maluku, the DKP officer there stated that from 1994-1996, the HHW caught were in phases (b) and (d) of the identification chart (Appendix 2). Estimates of present sizes ranged from 0.5-40 kg, with large HHW now rarely caught.

Sizes in trade in Hong Kong SAR. Major consumers of HHW are from Mainland China (Guangdong, Beijing and Shanghai) and much of the fish entering Hong Kong SAR is re-exported to mainland China to meet demand. Preferred fish size is 'plate-size' (600-800 g/fish, with some demand for large HHW (2-5 kg/fish, and sometimes larger than 5 kg/fish) (Liu Min, pers. comm).

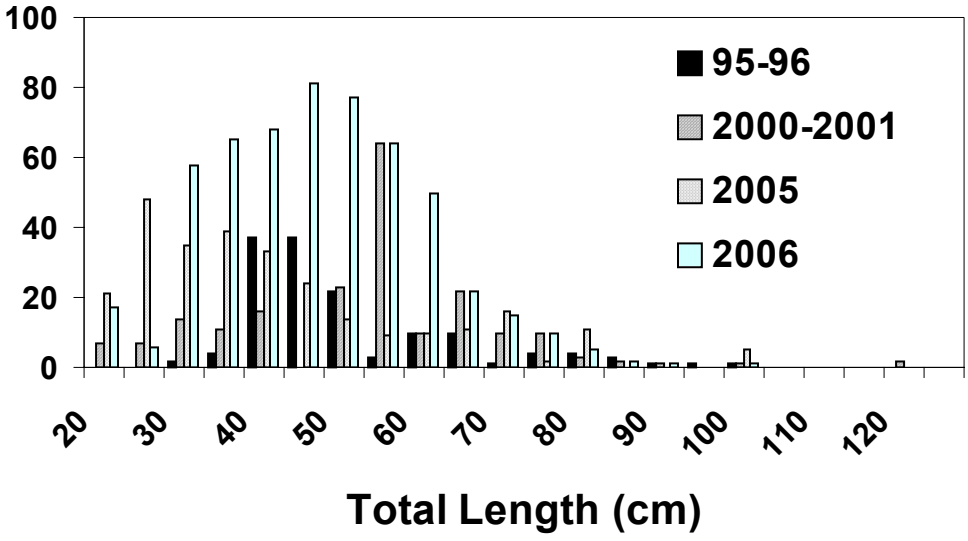

Figure 7: Size-frequency distributions of HHW in the HK retail sector during four different survey periods, 1995-1996, 2000-2001, 2005 and 2006. Fish measurements (total length) are taken using a ruler held against live fish in glass tanks. A significant number of the fish retailed in Hong Kong SAR come from Indonesia so the overall size range should typify the sized of fish exported from Indonesia.

Size data collected from fishes in tanks outside restaurants and ready for retail and wholesale sale in Hong Kong SAR are shown in Figure 7 for several time periods over the last decade. The most recent data (2005/6) show that most fish are retailed below 50 cm in total length (TL) and many are at or below the approximate size of sexual maturation (35-50 cm TL) (Liu Min and Yvonne Sadovy pers. obs.). Since a 1 kg fish is about 40 cm long, and 2 kg is about a 50 cm TL fish, many of the fish in trade are below 1 kg.

4.8 Identification problems

The surveys revealed general identification problems among fishermen and also among the government officials such as DKP and Quarantine. To untrained personnel, the HHW can be mistaken for a grouper or parrotfish, and several wrasses of the genus *Cheilinus*. However few of the alternative species of *Cheilinus* are sold live and exporters readily distinguish HHW from all other species.

In Bali, fishermen interviewed were often confused between the HHW and the Bumphead Parrotfish *Bolbometopon muricatum*, which looks similar to *C. undulatus* when it is in its adult phase. This confusion persisted despite presentation of colour images and explanation of the HHW going through different appearances as it progresses through different life-phases.

In North Sulawesi, Fisheries Quarantine officers had problems identifying HHW in its different life stages (as presented in the survey identification key), particularly (a) & (b). However, they found it easier to identify the HHW when the fish is in stages (c) and (d) (Appendix 2).

4.9 Mariculture and growout

Mariculture is defined as the spawning/breeding of adults (known as broodstock), the production of eggs and their successful care until the fish reach market size. If managed carefully, mariculture can help species to recover if maricultured fish replace some or all "wild-caught" fish in trade.

However, in Indonesia, a major problem of definition occurs between mariculture and what are essentially the 'grow-out' facilities of wild harvested stock. Fish that are caught in the wild and put into temporary holding areas for feeding, with no scientific evidence of survival benefit, are considered "farmed", and are included in what is commonly perceived as "mariculture".
There are two mariculture centres in Indonesia that are currently attempting to breed HHW. One is in Gondol (Bali) and another is in Lampung (Sumatra). Situbondo (East Java) also has an interest in culturing HHW. The mariculture and research centre in Gondol has conducted spawning and nursery research of HHW since 1998. Researchers in Gondol have been attempting to culture HHW for six years, and all such attempts to raise HHW have so far failed. However, the centre has successfully managed to spawn the mature wrasses in an artificial environment several times and managed to raise the larvae to fingerlings. The appropriate food for the HHW larvae to feed on has not yet been identified and resulted at one time in the death of the entire brood. The facility has thus been unsuccessful in rearing captive-bred HHW beyond the larval stage. Researchers in Gondol have admitted that culturing HHW is not easy and that the species is not a good species for commercial mariculture as the growth rate is very slow, requires substantial operational capital and the larvae are hard to feed. A visit to the Lampung mariculture centre in February 2006 revealed a very similar situation with successful production of eggs but little success in raising the larvae. In both facilities, workers indicated that significant more funding would probably be necessary to make further progress.

Mariculture is not having any conservation benefit to the wild populations of, and hence the sustainability of the trade in, Humphead Wrasse from Indonesia. Loss of large HHW from fishing grounds in Indonesia will back it even harder to obtain broodstock for mariculture research than it is at present.

At the workshop in February, 2006, in Jakarta, there was brief discussion of possible ranching of HHW by allowing fish to release eggs released while adults were held in cages. No evidence was presented, however, to demonstrate that such activity would enhance natural populations.

4.10 Status of HHW populations and catch rates according to interviews

Interviewees reported general concurrence that HHW catch rates have declined over the past 5-10 years. Reasons given included habitat damage, overfishing, increased competition from fishermen (including outsiders), and new laws making it harder to trade HHW.

Bali - Fishermen in Bali attributed reduced numbers of HHW in Bali's coastal waters to the reefs being damaged by destructive fishing methods, and to a fish population that has been over-fished. One fisherman's example compared the period 1982-1990 with 2005, stating that the monthly HHW catch during the season January-April had declined by 600kg to 400kg (33% decline), and the contemporary catch was mostly juveniles in the (b) and (c) phase of the identification chart.

South Sulawesi – Increased competition among fishermen, destruction of HHW coral reef habitat, and new laws controlling the catch of HHW were attributed to declines of 10-50% over the past 5-10 years as stated by fisherman, collectors and traders. In 1999, 4-5 foreign vessels arrived every month, however, presently only one vessel arrives each month, which is assumed to be due to declining fish stocks and depletion of good fishing grounds.

North Sulawesi – Fishermen and collectors stated that the supply of HHW has declined compared to the past years but not due to a decline in wild stocks, rather a reduced number of fishermen catching the fish due to new regulatory restrictions.

Jakarta – One of the three major traders in Jakarta reported that over 12 years of business, the number of wild fish in general had gone down by about 30%. This applied to source areas in Belitung (Sumatra), Natuna (offshore from Riau, in the South China Sea), the east coast of Selayar, Kendari, Togian, Sangir and Talaud (Sulawesi), and Derawan (east Kalimantan).

North Maluku – DKP officials reported a 5-10% population decline year-on-year since 2000, and that the total harvest of HHW and grouper between 1994 and 1996 amounted to 12 tonnes, but it is only 2 tonnes today. HHW stocks were said to have depreciated because of increased fishing activity by outsiders, as well as habitat destruction (bomb and cyanide fishing practices), which were killing a lot of juvenile fish. HHW catches were said to have been reduced by some 60% over the past five years. One exporter stated that since 2000, the trade had decreased by about 50%, from an annual volume of 1800kg of HHW traded in 2000 to only 800kg over the most recent 12-month period.

4.11 Post-capture mortality

Mortality rates of fish post-capture, either until time of, and during, export, or during the grow-out phase and transfers within Indonesia, are highly variable. Cumulatively, they can be substantial. Much seems to depend on the size/age of the fish, the experience of the fisher/trader/exporter, the capture

method and the overall condition of the fish when it is being transferred or exported. Mortality information was obtained from nine different exporting businesses.

For trade between Indonesia and Hong Kong SAR, typical mortalities varied from <1% to 30%, possibly due to stresses associated with changes in water temperature (water is continuously changed in transport), and also from injuries and the manner in which the animals are transported (i.e. container type). One exporting company stated that it does not receive any payment for fish that arrive dead in Hong Kong SAR; hence payment to Indonesian suppliers is made only after the commodities arrive at Hong Kong SAR, reflecting the risks involved; occasionally, whole shipments are lost due to accidents or poor management.

It is widely known that the use of cyanide to capture fishes often results in mortality within days, weeks or months following capture. Since many HHW are believed to be caught with cyanide, this might represent a significant factor in mortality.

Mortality is also associated with the grow-out phase. It was generally agreed that young fish (those that are placed in cages for grow-out) are more susceptible than older fish to dying in captivity, during domestic transport, in holding facilities, and during export. High mortality can occur in fish below 100g, with fish above that weight suffering an average mortality of less than 50% during grow-out, according to interviews.

Cumulatively, therefore, there can be substantial mortality rates between capture and export of HHW. While attempts are being made by some companies to reduce mortality rates in transit, it is clear that mortality factors must be included in estimates of sustainable yield, to account for lost fish. Moreover, initiatives to reduce capture rates should be strongly encouraged.

4.12 Monitoring and law enforcement

The presence of illegal fishing vessels in Indonesia, and the likelihood of HHW leaving Indonesia without the correct paperwork or permits, would imply that a large amount of HHW trade is not recorded. Traders also indicated that vessels often transport live HHW in hidden compartments. Differing responses from interviewees across the different provinces suggested a distinct lack of inter-agency law enforcement collaboration which could be largely attributed to a lack of specificity, and knowledge, about individual agency responsibility (Fig. 8). If illegal vessels are caught in Indonesian waters, they would be apprehended by the Navy, Provincial Fisheries or Marine Police.

Illegal vessels fishing without permits include those flagged as from Hong Kong SAR, Japan, Korea, Malaysia, Philippines, Taiwan, Province of China and Thailand mostly fishing for tuna. An isolated report also suggested that German-flagged vessels had also been sighted. Taiwanese fishing operations are reportedly based in Bali, Ujung Pandang, and Sumbawa, and Chinese vessels pick up live fish in small quantities from Flores.

Seizures of HHW were made in 2004 and 2005 (see Table 13) in South Sulawesi. In 2005, more then 165 HHW were seized by the BKSDA, due to harvesting in a Protected Area, having the wrong documents and harvesting without a permit. A news release from WWF in January, 2006, reported that North Sulawesi Water Police confiscated 207 HHW of 5-30 cm long from a floating net cage which was being kept beneath another net full of live grouper, presumably to hide the HHW because the cage was located in Bunaken National Park.

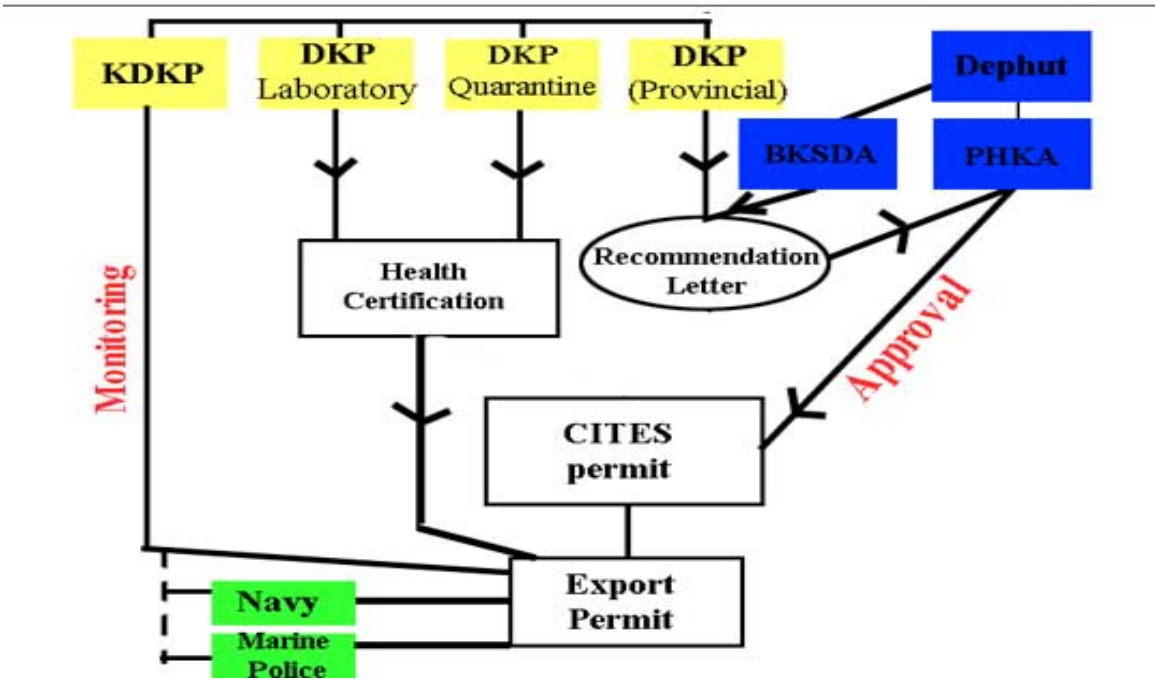

Figure 8: Recommended inter-agency collaboration necessary to monitor HHW trade

Year	Case	Location	Explanation
2004	Seized 46 HHW	TN Takabonerate, Selayar	Harvesting in a Protected Area
2005	Seized 146 HHW	TN Takabonerate, Selayar	Harvesting in a Protected Area
2005	Seized twice (18 HHW)	Makassar, at the Quarantine HQ of Hasanuddin	Wrong documents
2005	1 incident	Makassar	Harvesting without permit

Table 13: Seizures of HHW in South Sulawesi
Source: Trade of HHW in South Sulawesi. Presentation by Ir. Darsono. South Sulawesi I BKSDA

In North Maluku, a programme to mobilize villagers to be active in apprehending illegal fishermen or fishermen using illegal fishing methods was recently instituted to protect the exclusive economic zone.

5) Conclusions

Indonesia is a major source of HHW for East Asian markets in Hong Kong SAR, Taiwan, Province of China, and increasingly, mainland China. HHW have been sourced from nearly all provinces of the Indonesian archipelago, but it is apparent that fishing grounds are gradually moving eastwards towards Papua, and former fishing grounds in the west, such as in Sumatra, have been abandoned. Even operations in the provinces of Maluku are expanding their fishing grounds to include Papua. Not only are businesses expanding, but subsistence fishermen who work with collectors or exporters are also travelling increasingly further to capture HHW. Although chilled fish may also be exported, the major exports are live fish.

While a majority of fishermen claimed that sustainable hook-and-line methods were being employed to catch HHW, there continue to be reports of unsustainable and illegal fishing methods such as cyanide to capture HHW and illegal exports of fish by sea out of Indonesian waters; illegal both in the sense of lack of documentation and permits and involving undersize (i.e. < 1 kg) fish. Also, while mortality is variable and often low, sometimes it can be high between capture and export, or during grow-out. This suggests that the number of animals removed from the wild is likely to be substantially higher than appears in any export/import trade records.

Despite the challenges, the trade in live HHW remains attractive to all parties along the supply chain due to the high price the species commands in the market. Harvest activities continue to pressure the species throughout its range, and consumer demand remains persistent from Hong Kong SAR and mainland China. It is clear that there were substantially higher imports of HHW into HK from Indonesia than is indicated by available exports figures for this species in Indonesia, for 2005. Although, Hong Kong SAR has not yet implemented the CITES Appendix II listing for HHW, additional legislation will assist it in implementation by also requiring a possession licence.

There is an intricately structured network of trade routes, both within and involving export from Indonesia, that accompanies the export of HHW. While the quantity of HHW being exported is comparatively less than other LRFF, the frequency is more or less consistent, except for a few reports in 2005 from traders confused by the new procedures for permits claiming to have halted exports until a clearer understanding is reached. Observations at holding facilities also suggest that HHW is collected at every opportunity and that the numbers do add up to significant quantities of hundreds of fish per shipment.

Interviewees stated HHW are not normally traded in species-specific cargoes because their quantities are often too low to justify the cost of shipping, and were instead shipped along with other live reef fish species (albeit in separate containers). However there was little observational evidence to suggest that that claim was true, at least for air cargo shipments, and HHW was observed as a sole cargo being received from a domestic exporter, and being domestically exported as single species consignments on two occasions during this survey period.

DKP and Quarantine records also reflected that occasionally HHW, even in small quantities, exit Indonesia into the Hong Kong SAR market as single species. This was mainly by air, while export by sea often required that exporters fill the vessels up with as many fish as they can to offset the cost of chartering the vessel.

Research into mariculture (in the sense of hatchery production) of HHW has so far been unsuccessful in large-scale commercial hatchery production and in all provinces surveyed in June-August 2005, 100% of HHW in trade were sourced from the wild. Wild capture therefore supplies all fish for both export, and grow-out of sub market-sized fish. More research and development is needed to commercially produce HHW by hatchery.

Fishermen and traders interviewed stated that HHW has never been a primary source of income; they cite their reason being its availability is rare and inconsistent and can never be caught in large numbers.

Theoretically the increased number of permits now required for trade in HHW should mean better control of the trade. However, without incentive for compliance or enforcement, or without strong enforcement capacity, the CITES listing will not succeed in promoting sustainable fisheries management and trade. Additionally, it is not clear what disincentive exists for evading any or all of

the permitting procedures because of existing complications in inter-agency co-operation between individual departments of the DKP and the BKSDA/PHKA CITES offices, and whether additional permit requirements will promote additional illegal export routes.

Enforcement and monitoring are made extremely challenging by the vast geographic expanse of the Indonesian archipelago. Efforts are further challenged by a lack of competency and organisation in basic record keeping. In most offices visited data were only available from the last few months, or year, and in Manado HHW are included in the category 'groupers' in Manado with no record of HHW export or internal movements being available. The international airport in Jakarta did not have available records of HHW exports. Lack of computer hardware and software, and the requisite training, is also compromised by the infrequent and often intermittent supply of electricity on remote islands of eastern Indonesia. Overall, there appears to be very little information on, or awareness of, inshore reef fish fisheries, including for HHW.

The authorities with responsibility towards fishing or marine-related issues, such as DKP, Indonesian Navy and Maritime Police do not have the manpower/vessels necessary for their extremely demanding tasks. The jurisdiction and role of Marine Police in enforcing the CITES listing for HHW is not clear.

There is also a lack of a comprehensive and structured protocol describing the methods by which enforcement authorities are to monitor, enforce, and issue permits with regards to HHW trade. While existing DKP regulations list a logical plan and procedure for the management of HHW trade, evidence from surveying five provinces showed that few of the recommendations in the regulation were implemented or enforced, nor were data documented in an accessible format. There is lack of co-operation between PHKA, BKSDA, and DKP with the relevant enforcement and monitoring departments i.e. DKP Quarantine, and Customs.

Immediate steps should be taken at the Indonesian policy level, as well as the policies of the demand countries to ensure the sustainability of HHW is managed. Collaboration between NGOs, IGOs, universities, fishing communities, and within and between relevant departments in Indonesia, Hong Kong SAR and China is essential to provide an integrated approach towards reducing the fishing pressure on the HHW. The role of Singapore as a re-exporter and end-consumer market should also be clarified further. Guidelines for the management of fisheries in Southeast Asia, as outlined in the recently released (2006) Regional Guidelines for Responsible Fisheries in Southeast Asia published by ASEAN (Association of Southeast Asian Nations) and SEAFDEC (Southeast Asian Fisheries Development Centre), that include protection of juveniles and of spawning areas (under 'refugia' in the report) would assist in preventing growth and recruitment overfishing of HHW populations.

Capacity- building and general awareness in respect of coral reef-associated fisheries is needed both within government and the wider community. COREMAP may be well-placed to address this issue.[1]

Acknowledgements

We are most grateful to the many people who have helped us to complete this report, from the traders and fishers who kindly accepted to be interviewed, to the many government staff who facilitated and assisted in the collection of information and the design of the trade survey.

[1] COREMAP was designed as a 15-year programme to develop decentralized community-based resource management systems with support from the national and regional governments, enforcement authorities, the private sector, and NGOs. COREMAP is implemented by the Indonesian Institute of Sciences (LIPI). DKP is involved in Phase II.

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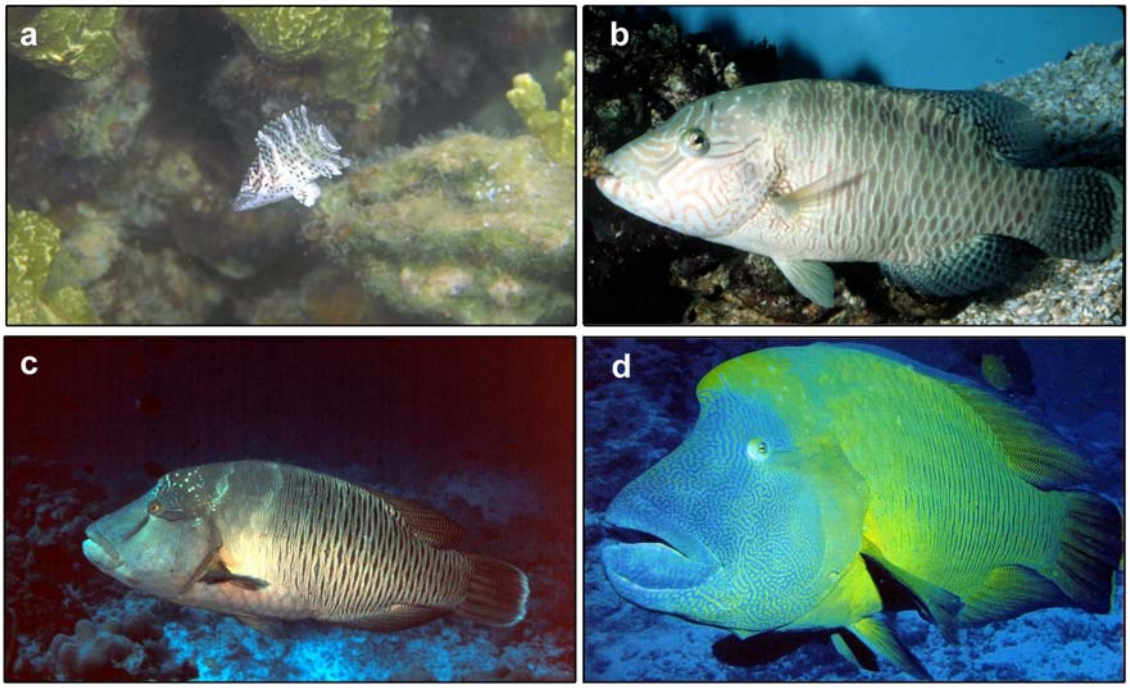
Appendix 1

QUESTIONNAIRE FOR TRADE SURVEY

Objective: *To provide information to assist in developing and improving the management of* Cheilinus undulatus *for international trade. Specifically, to compile information on harvest seasons, collection techniques, geographical restrictions, monitoring schemes, enforcement measures, management plans, quotas, etc, conservation status of species, stocks and abundance, socio-economic factors, stakeholder needs for capacity-building programmes. Questionnaire would be given in appropriate language.*

- **Date**
- **Name of surveyor and code for interviewee**
- **Address/location**
- **Buyer/Middleman/? role**
- **How long have you been in the business**
- **Business trends (in last year; in last 5 years) regarding Humphead Wrasse?**
- **What capture gear is used to catch Napoleon fish? Is this the same gear as used 5 years ago? If not, please explain**
- **What are the price trends in the last year; in last 5 years (price per kg for fish of given size –** ***note that price per kg varies with total fish size*****)**
- **What is the typical size of fish you catch/buy in the last year/last 5 years?**
- **Turnover – how long does it take to sell the fish you catch/buy?**
- **Who do you sell to? Is this the same/are these the same people as before? Is it on an order basis or can you sell all you can catch?**
- **Do you need a license or permit to catch this species?**
- **Where are the fish caught? Last year/last 5 years? Has the source/location changed? If so, why do you think that is?**
- **How many fish do you catch/buy a week in the last year/last 5 years?**
- **How many fish does a single fisherman catch per fishing trip? Now and 5 years ago?**
- **How many fishermen do you purchase this species from?**
- **How many other people (middlemen) are there working in this area? Is this more/less/the same as five years ago?**
- **Is there any IUU?**
- **What is the mortality between capture and export? What is the main source of mortality? If there is mortality, can it be reduced? How?**
- **How much fish is exported and how much used within Indonesia of this species**
- **Is there any special harvest season? If so, is that because of fish availability or because of demand from buyers?**
- **What percentage of your annual income is provided by the Napoleon fish?**
- **Does the fishery division monitor the catches/sales of Napoleon fish?**
- **What proportion (or how many) of the fish you buy/catch comes from/goes into grow-out facility, rather than directly for export?**
- **Who do you sell to? Indonesian buyers or foreign buyers? Has this changed over the past five years?**
- **How are your fish exported? – air or sea?**
- **How many of these fish are sold live? Do you sell any dead or frozen?**
- **Are you aware of quotas?**
- **Is there any legislation? If so, is there any enforcement?**

Appendix 2



NAPOLEON FISH (HUMPHEAD WRASSE) *Cheilinus undulatus*

Map shows global distribution of the humphead wrasse (Napoleon fish) – the species occurs in the areas shown by the thick lines. Body shape and colour change markedly with growth. All phases have a pair of distinctive lines running through the eye (see arrow and note that the lines are more distinct behind the eye and in juveniles; these marks are not found in any similar wrasses)
Photos on reverse side: (a) small juveniles are light with dark bands; (b) larger juveniles are pale green; (c) adults are olive to green; (d) the largest fish have pronounced forehead and are blue-green. Most fish (except (a)) have bright yellow dorsal margin to caudal fin.
Note: there are two related species that can be distinguished as follows. (1) do not have the strong eye stripes or a distinct bright yellow dorsal edge to the caudal fin (2) do have rows of white spots (C. chlorourus) (3) do have pink dots and rows (C. trilobatus)
(Photographs by kind courtesy of J.E. Randall [a,b,c] and R. F. Myers [d].).

Courtesy: Groupers and Wrasses Specialist Group, IUCN (www.humpheadwrasse.info)

Appendix 3

DEPARTMENT OF AGRICULTURE
DIRECTORATE GENERAL OF FISHERIES

DECLARATION OF DIRECTOR GENERAL OF FISHERIES
No. HK.330/S3.6631/96.

REGARDING

The change of Decision of Directorate General of Fisheries
No. HK.330/Dj.8259/95 regarding
The size, location and the catching methods of
Napoleon Wrasse (*Cheilinus undulatus* Ruppell).

Director General of Fisheries,

To consider:
a. With the decision of director general of fisheries No. HK.330/Dj.8259/95 has been establishing the size, location and the catching methods of Napoleon Wrasse as implementation guideline for the decision of minister of agriculture No. 375/Kpts/IK.250/5/95.
b. To adjust with the condition, is needed for the old implementation guideline to make an alteration.

To considering:
1. Decision from the President of Republic of Indonesia – Number 44 Year 1974;
2. Decision from the President of Republic of Indonesia – Number 15 Year 1984 and Number 83 Year 1993;
3. Decision from the President of Republic of Indonesia – Number 298/M Year 1995;
4. Decision from the Minister of Agriculture Number 96/Kpts/OT.210/2/1994;
5. Decision from the Minister of Agriculture Number 375/Kpts/IK.250/5/95;
6. Decision from the Minister of Agriculture Number 509/Kpts/IK.120/7/95;

TO DECIDE:

To Establish:
For the size, location and catching methods of Napoleon Wrasse (*Cheilinus undulatus* Ruppell).

Article 1

In this decision, what is meant by that term is:
a. Traditional fisherman are fisherman that catching the Napoleon Wrasse fish using non machine boat, or attach machine, or with completely build up machine less than 5 (five) gross ton, and/or with machine less than 15 (fifteen) horse power (hp), and using fishing gear and/or using the material that can not cause damage of fish resources and the environment;
b. Napoleon wrasse is the fish with the scientific name *Cheilinus undulatus* Ruppell as showing in the picture on appendix 1 of this decision;
c. Local collecting company are fisheries company or cooperation that have Trade Permit for Local Collector (Ijin usaha pengumpul lokal), with the activity to collecting Napoleon Wrasse that catch

by traditional fisherman according to partnership system and able to cultivate the fish and to sale the yield for domestic;

d. Export collecting company are fisheries company or cooperation that have Trade Permit for Export Collector (Ijin usaha pengumpul ekspor), with the activity to collecting the Napoleon Wrasse from local collecting company and/or traditional fisherman and able to cultivate the fish and to export the yield;
e. The cultivating on napoleon wrasse are activity to maintain, to enlarge and/or to breeding in the container or any breeding facility in certain period with special treatment to achieve the consumption size and harvest the yield;
f. Explanation letter for catching and cultivating (SKPP) are the letter that issued by the head of fisheries department of the regency/city or the authorize officer, as inform on this appendix 2 of this decision, with explanation that the trade of napoleon wrasse are from traditional fisherman or from cultivating;

Article 2

The catchments of napoleon wrasse only by:

a. Researcher, for research and development purpose and for science and the development of cultivating; and
b. Traditional fisherman.

Article 3

(1) The collection of napoleon wrasse only by collecting company
(2) Collecting company as explain in article (1) are:
    a. Local collecting company; and
    b. Export collecting company.

Article 4

(1) For to catch the napoleon wrasse as mentioned in Article 2:
    a. Researcher must have research permit;
    b. Traditional fisherman must have catching permit and carried out by partnership system.
(2) Catching permit for researcher as mentioned in Article 2a, is given by Director General of Fisheries;
(3) Catching permit for traditional fisherman as mentioned in Article 2b, is given by Head of Department of fisheries or authorizes officer.
(4) With in the catching permit as mentioned in point (3), has regulate the fishing ground with attention to the carrying capacity of fish resources and the environment.

Article 5

The caught of napoleon wrasse and allow to be trade whether domestic or out of Republic of Indonesia territory, must have size 1 (one) to 3 (three) kilograms.

Article 6

If the caught of napoleon wrasse size more than 3 (three) kilograms or less than 1 (one) kilogram, the fish must be cultivate in domestic and/or release back to nature.

Article 7

(1) To sale the napoleon wrasse from catching or cultivating system in domestic must be completed with SKPP.
(2) The export of napoleon wrasse from the territory of Republic of Indonesia must have export recommendation issuing by director general of fisheries as explain in appendix 3 of this declaration.
(3) Export recommendation as mention in point (2), has given after the applicant attached the export recommendation from local provincial, the export recommendation issued by the head of department of fisheries.

Article 8

Traditional fisherman can only catch the napoleon wrasse by using hook and line, bubu and gill net.

Article 9

In case of traditional fisherman doing partnership trade, the traditional fisherman must sale the napoleon wrasse to Collecting Company as partnership.

Article 10

(1) Local collecting company as mentioned in article 3 point (2) a, ought to have a permit of local collecting trade that issue by Head of Provincial Department of Fisheries or authorized officer.
(2) Export collecting company as mentioned in article 3 point (2) b, ought to have a permit of export collecting trade that issue by director general of fisheries, after have the recommendation of collecting and cultivating from the Head of Provincial Department of Fisheries as attach in appendix 5 of this declaration.
(3) Recommendation for collecting and cultivating as mentioned in point (2) including the location with the concerning on environmental and controlling aspect and after the recommendation from interrelated institutions.

Article 11

(1) Export collecting company is obligated to carry out the cultivation of napoleon wrasse in collecting location that establish and facilitate with means of cultivation and experience person with fish cultivation.
(2) Local collecting company can carry out cultivation the cultivation of napoleon wrasse in collecting location that establish and facilitate with means of cultivation and experience person with fish cultivation.

Article 12

(1) To carry out the cultivation as mentioned in article 11, the local collecting company is obligated to have a permit cultivation trade (IUP) that issue by the provincial head department of fisheries, after have the recommendation from regency/city head department of fisheries.
(2) To carry out the cultivation as mentioned in article 11, the export collecting company is obligated to have a permit cultivation trade (IUP) that issue by the provincial head department of fisheries, after have the recommendation from regency/city head department of fisheries.

Article 13

Controlling and monitoring for the implementation of this declaration has done according the steps as follows:

a. For regency/city level, by officers from Regency/City Department of Fisheries that authorized by the head of regency/city department of fisheries.
b. For provincial level, by officers from Provincial Department of Fisheries that authorized by the head provincial department of fisheries.
c. For central level by officers from Directorate General of Fisheries that authorized by the director general of fisheries.

With cooperation system between interrelated institution.

Article 14

Head of provincial fisheries department is obligated to report every 3 (three) months to the Director General of Fisheries about:

a. Amount of catching permit that issue and the location of catchments.
b. Amount of permit for local collecting trade and permit for cultivating trade and location of trade.
c. Amount of SKPP that issue by Head of Fisheries Department of Regency/City in their work area.
d. Amount of production (catching and cultivating).
e. Port of export.

According to report form as added to the appendix 6 of this declaration.

Article 15

With the effective of this declaration, the declaration of director general of fisheries No.Hk.330/Dj.8259/95 is not valid anymore.

Article 16

This declaration is valid from the date of establishment.

Establish in Jakarta,
Dated, July 4th – 1996.

DIRECTOR GENERAL OF FISHERIES

Signed.

FX. MURDJIJO.

Forwarding to:
1. Minister of Agriculture (as a report).
2. Minister of Internal Affairs.
3. Minister of Trade and Industry.
4. State Minister for National Planning and Development/Head of BAPPENAS.
5. State Minister for Environmental.
6. Navy Chief of Staff.
7. Provincial Governor for entire Indonesia.
8. Director General for International Trade.
9. Leaders of First Echelon for Department of Agriculture.
10. Head of Provincial Department of Agriculture for entire Indonesia.
11. Head of Provincial Department of Fisheries for entire Indonesia.

List of Appendix

Declaration of Director General of Fisheries

No: HK.330/S3.6631/96
Dated: July 4th, 1996.

Director General of Fisheries.

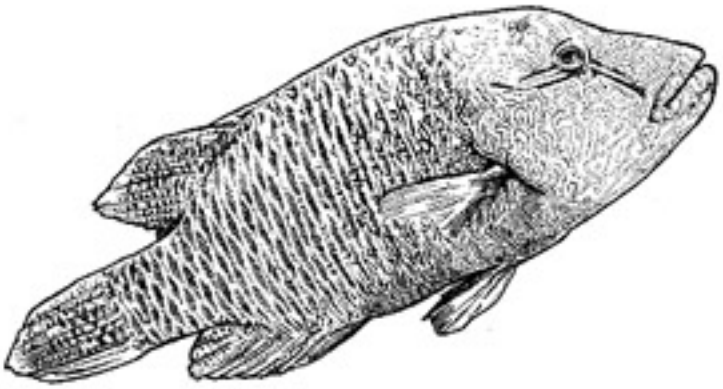
Signed.

FX. Murdjijo.

Appendix 1

Declaration of Director General of Fisheries
No: HK.330/S3.6631/96.
Dated: July 4th, 1996.

The Picture of Napoleon Wrasse



Notice:

Phylum	: Chordata.
Class	: Pisces.
Order	: Percemorphi.
Family	: Labridae.
Genus	: Cheillinus
Species	: *Cheillinus undulatus* Ruppell

Appendix 2.

Declaration of Director General of Fisheries
No: ……
Dated: ……...

Department of Fisheries of Regency/City…….
Address: …….

Notification Letter for Catching and Cultivating (SKPP)
of Napoleon Wrasse

No: ……
Dated: ……

After the examine carefully of requesting letter from company/personal no……, dated, ……., and according to the field checking result from checking officer on date ……., herewith the head of department of fisheries of ……..…….. province/city explained that:

1. The napoleon wrasse that mentioned above are from :
   (a). Catching of traditional fishermen :
      1). Name : ……..
      2). Address : ……..
      3). Catching permit : No. ……, Dated: …...……...
      4). Fishing gear that apply : bubu/hook and line/gill net*)

   (b). Cultivating :
      1). Name of company/personal : ……..
      2). Address : ……..
      3). Permit for fisheries trade : No. ……, Dated: …...……...
      4). Name of guarantor : ……..

2. The napoleon wrasse that for trade; ……. Fish or ……. Kg, with detail as follows:

Size per fish	Amount (fish)	Total weight (kg)	Notice
1,00 – 1,50 kg	……	…….	
1.60 - 2.00 kg	……	…….	
2.01 – 2.50 kg	……	…….	
2.51 – 3.00 kg	……	…….	
Total	……	…….	

Thus this notification letter for catching or cultivating has delivered for the useful needed.

Head of Fisheries Department
Of Regency/city …….

……

Forwarding to:

1. Director general of fisheries.
2. Governor of …… province.
3. Regent of …… regency.
4. Head of …… province department of fisheries.

Appendix 3.

Declaration of Director General of Fisheries
No: ……
Dated: ……...

EXPORT RECOMMENDATION OF NAPOLEON WRASSE FROM THE TERITORY OF REPUBLIC OF INDONESIA

After examine carefully the requesting letter from Company/personal ……, No. ……., dated. ……, and the export recommendation of Napoleon Wrasse from the department of fisheries of ……. Province, herewith the Director General of Fisheries agreed for export the Napoleon Wrasse (*Cheillinus undulatus*) from the territory of Republic of Indonesia to:

Company/personal : ……..... ;
Address : ……..... ;
Guarantor : …… ;
I U P : No. ……. ;

With conditions :

1. Amount of quota : ……. fish for 6 (six) month period;
2. Size : 1 to 3 kg per fish;
3. Catching area : ……... ;
4. Area of Collecting/ Cultivating : ……... ;
5. Port of Export : ……... ;
6. Destination country : ……... ;
7. To obey the export rules and regulations that be in effect.
8. Report the export realization every month (whether or no realization) to director general of fisheries or director of developmental farming trade and harvest management and forwarding to the head of provincial department of fisheries;
9. Is prohibited to use this recommendation by any other company;
10. This recommendation is valid from the issuing date to the date of ……..;

This recommendation is given as a condition/covenant for export napoleon wrasse from the territory of republic of Indonesia.

Director General of Fisheries,
……...,

Forwarding to:

1. Head of Center of Agriculture Quarantine.
2. Head of Provincial department of fisheries.
3. Head of Airport Quarantine Station.

4. Head of Airport Customs.
5. Head of Seaport.

Appendix 4.

Declaration of Director General of Fisheries
No: ……
Dated: ……...

EXPORT RECOMMENDATION OF NAPOLEON WRASSE FROM THE PROVINE OF ……
No, ……., dated, ……..

After examine carefully the requesting letter from Company/personal ……, No. ……., dated. ……, herewith the head of the fisheries department of ……. Province, give the export recommendation of napoleon wrasse (*Cheillinus undulatus*) from the province of …….. :

Company/personal : ……..... ;
Address : ……..... ;
Guarantor : …… ;
I U P : No. ……. ;

With conditions :

1. Amount of quota : ……. fish for 6 (six) month period;
2. Size : 1 to 3 kg per fish;
3. Catching area : ……... ;
4. Area of Collecting/ Cultivating : ……... ;
5. Port of Export : ……... ;
6. Destination country : ……... ;
7. For sale/trade the yield of catching or cultivating of napoleon wrasse must be completed with:
    a. Notification Letter of Catching and Cultivating (SKPP) that issue by provincial department of fisheries;
    b. Certificate of Export Quality from the department of fisheries of ……. Province;
8. To obey the export rules and regulations that be in effect.
9. Report the export realization every month (whether or no realization) to the head of provincial department of fisheries;
10. This recommendation is valid from the issuing date to the date of ……..;

Appendix 5.

Declaration of Director General of Fisheries
No: ……
Dated: ……...

RECOMMENDATION OF COLLECTING AND CULTIVATING OF NAPOLEON WRASSE
No. ……..
Dated. …….

After examine carefully the requesting letter from company/personal; ……, no. ……., dated. ……., and with the attention to aspect of environment and aspect of controlling:

- free of pollution,
- no disturbing to the shipping line,
- according to the purpose,
- carrying capacity of resources,
- easy to reach,

Herewith the head of fisheries department of …… province,

1. Give recommendation for collecting and cultivating of napoleon wrasse (*Cheillinus undulatus* Ruppell) to:
   - Name of company/personal :
   - Address :
   - Guarantor :
   - IUP : No.

2. Establish the location of collecting or cultivating of napoleon wrasse (*Cheillinus undulatus* Ruppell) as follows:
   - Coordinate :
   - Village :
   - Subdistrict (Kecamatan) :
   - Regency/City :

This recommendation is use as a condition/covenant for obtaining the trade-collecting permit of napoleon wrasse from the director general of fisheries.

Head of Fisheries Department
……, Province

Appendix 4 maps

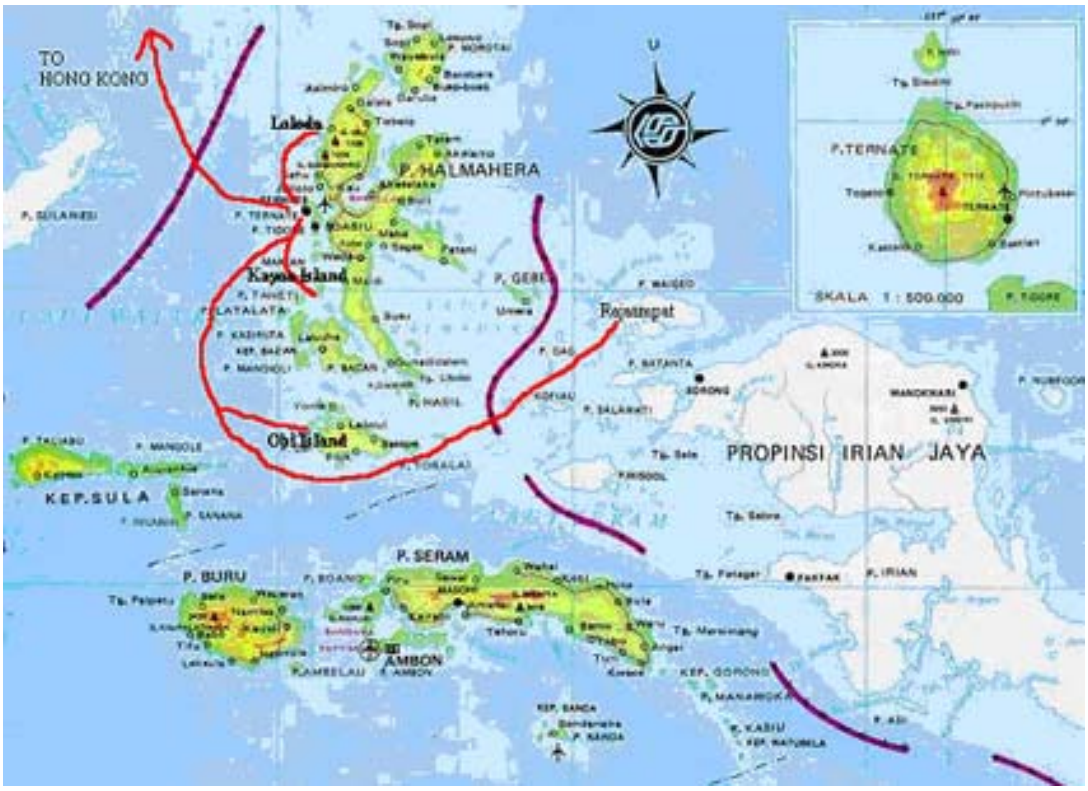


Figure A: Collection areas for north Maluku, into Ternate for export to Hong Kong SAR. Thicker lines are province boundaries

Figure B: Sources and destinations of HHW in the Bali market. Sea routes are red (pale in black and white)

Figure C: Sources of HHW in the Jakarta market (red=boat; blue=air; green=road; mid grey, dark grey and light grey, respectively)

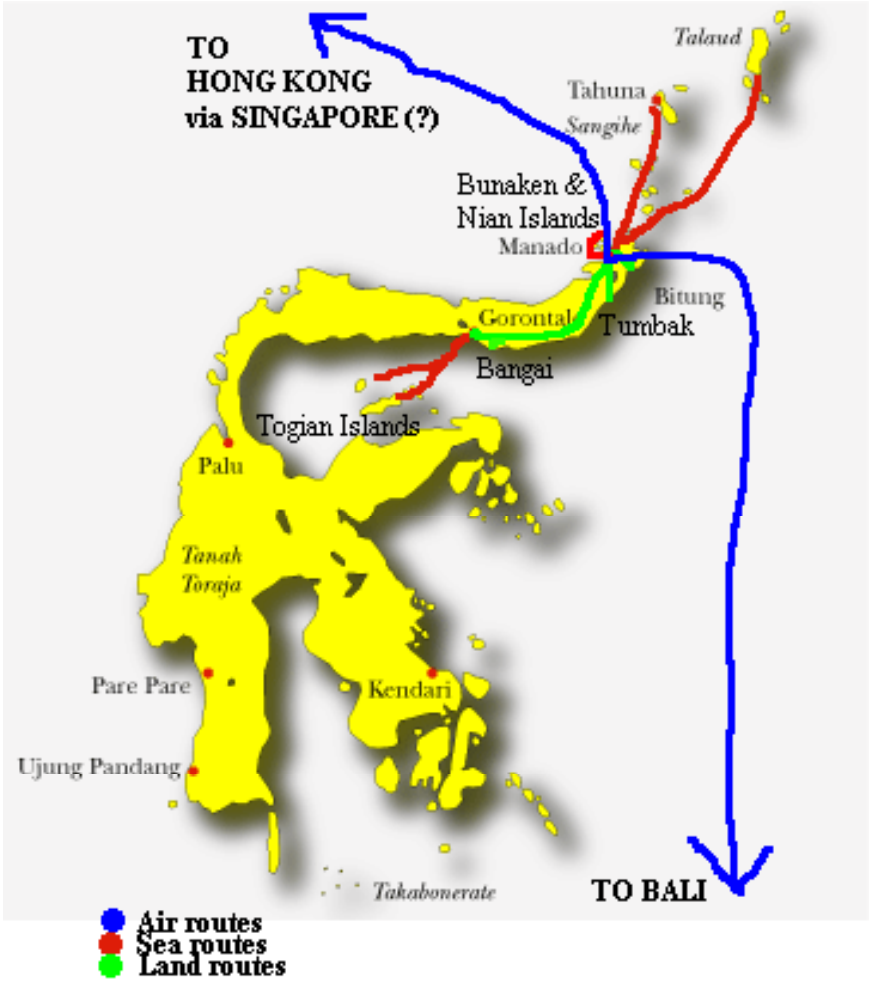


Figure D: Sources and destinations of HHW in North Sulawesi

Figure E: Sources and destinations of HHW in South Sulawesi

ANNEX II

Underwater Visual Census of *Cheilinus undulatus* (humphead wrasse, Napoleon fish) in three areas of Indonesian waters, 2005

Patrick L. Colin
Director, Coral Reef Research Foundation,
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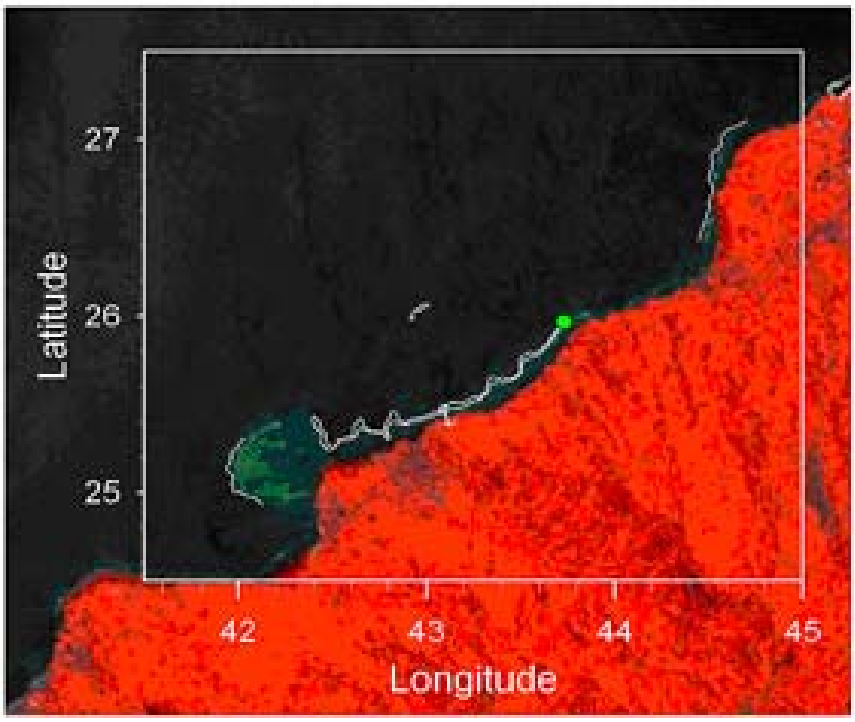
crrf@palaunet.com



Groupers & Wrasses Specialist Group

TABLE OF CONTENTS

Page Number

I. Introduction

Three trips were made to Indonesian waters to investigate the abundance of juvenile and adult humphead wrasse, *Cheilinus undulatus*, on reefs and other shallow water habitats. This species is also commonly known in English as Napoleon fish and Maori wrasse (Sadovy *et al*. 2003). Abundances of this fish were estimated through Underwater Visual Surveys (UVC) using techniques designed to quantify density levels of these relatively uncommon and wide ranging fish. Emphasis was placed on using techniques that are practical and allow repeatable and comparable surveys, so these areas can be resurveyed at some future date to assess changes in population size over time. In this report, *C. undulatus* will subsequently be at times referred to as "HHW" (for HumpHead Wrasse). This acronym refers to both the juvenile and adult forms of the fish.

The three areas surveyed (Fig. 1) were 1) eastern Bali-Kangean Islands (21-28 June 2005), 2) north Sulawesi in the vicinity of Manado (13-27 July 2005), and 3) the Raja Ampat area of Papua Province (16-20 November 2005). The areas were selected by recommendations from two

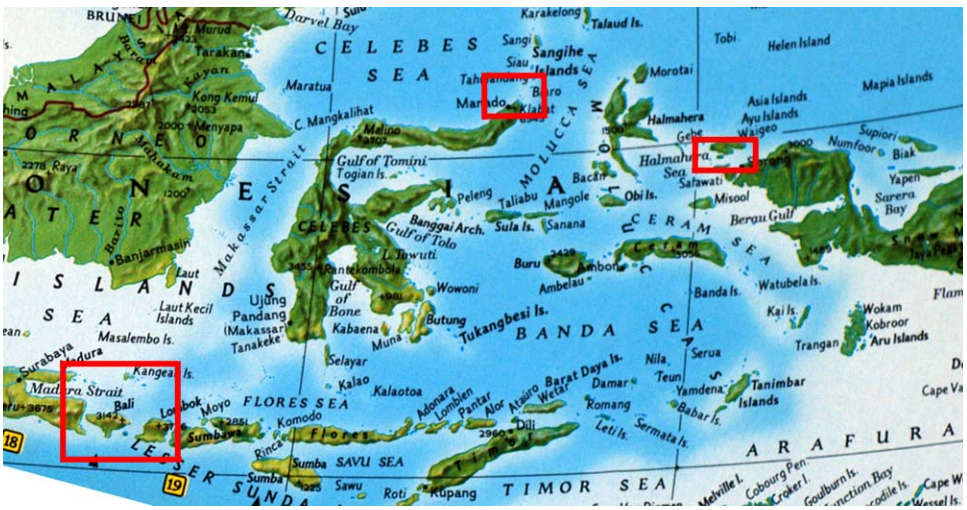


Figure 1. Map of eastern Indonesian region with the three general locations of *Cheilinus undulatus* surveys shown as red boxes. The boxes are referred to subsequent figures based upon Landsat satellite images.

meetings held in Jakarta (February 17th and March 22nd, 2005) in relation to the Napoleon fish CITES/IUCN project, and from the outcomes of information provided by traders during trade surveys. Each area has characteristics that were considered important in some aspect of assessing the sustainability of *C. undulatus* populations. The first area (eastern Bali-Kangean Islands) has intensive exploitation of *C. undulatus* plus areas where tourist dive considerations are important. The second (north Sulawesi) is near a large urban area with intensively fished narrow island shelves, but with a major marine protected area (Bunaken Marine Park). The third (Raja Ampat) is in a remote area with a small human population and minimal development, but where the live reef fish trade (LRFT), although less developed than in many other areas of Indonesia, is, nonetheless, an important source of local cash income.

The report is structured with a description of the methods used to visually survey large areas of reef. The results of the visual surveys for the three areas are presented on the basis of density of fish (and area per fish) for each individual survey, followed by summaries of each area and the surveys as a whole. The size frequencies of fish observed are detailed for the areas where sufficient fish were observed to allow some indication of population structure. Appendices at the end of the report include further details on survey methodology and a suggested list of equipment needed for future surveys.

II. Methods Used.

The "GPS (Global Positioning System) Density Survey" method was used for the Underwater Visual Censuses (UVC) during this project (Colin et al. 2005), as it is particularly suited to assessing abundance of uncommon and wide-ranging species, such as *C. undulatus*. Even in relatively undisturbed regions, HHW are among the less common of reef fishes. Conventional underwater visual survey (UVC) techniques (typically 50 or 150 m long transects) are not really feasible to document the abundance of these reef fish, because of the large distances that sometimes need to be covered. To be able to survey the amount of area needed to gain a somewhat definitive idea of the occurrence and abundance of HHW, distance and areas one order of magnitude or more must be surveyed compared to conventional techniques.

The GPS density survey method uses a "position logging" GPS receiver in a water proof floating housing which is towed on the surface by the observer. It can be used snorkeling (towed behind the swimmer) or SCUBA diving (GPS float deployed from diver reel). The GPS is set to log its position every 15 seconds, allowing an accurate record of the track surveyed after downloading. The observer carries a waterproof watch synchronized to the second with the time displayed by the GPS receiver. Fish within a predetermined distance either side of the swim track (up to 10 m in clear water) are surveyed by swimming along a reef feature or in a relatively straight line at a steady pace or drifting with currents. The time any target fish is observed is recorded on an underwater slate, as well as the estimated standard length. The standard length is estimated visually from experience with reference to a length scale in centimeters on the side of the recording slate. Total length would be somewhat greater than standard length reported here and is easily determined from standard length using the relationship of these two values. It is estimated such length estimates are accurate to within about 10-15% for an experienced observer (McCormick and Choat 1987). Fish of 5-20 cm standard length were assigned to 2.5 cm size classes (5, 7.5, 10, 12.5, 15, 17.5, 20 cm). Those from 20-50 cm were assigned in 5 cm increments, and from 50-100 cm in 10 cm increments. Fish more than 100 cm in standard length were lumped in a single class, as it is difficult to estimate length in such large fish with precision.

When the logged data from the GPS are downloaded using Garmin Map Source World Map software (or other similar for other brands of GPS receivers), this provides a continuous track of the survey swim and, within the accuracy limits of the GPS, a permanent record of the area surveyed, allowing for replication in the future. Using the concurrent time log and the time of fish observations, the position on the track where any fish was observed can be closely (within a few m) determined from the time and position data. The distance (and thereby the area depending on swath width) covered during a given survey is documented and the number of fish observed provides a density (fish per unit area) value. The survey track and positions of individual fish along that track can be plotted on habitat maps, satellite images or other backgrounds to provide a visual display of fish numbers and dispersal against a habitat image providing insights into the relationship between the fish and the environment.

In essence, the GPS Density Survey is a (theoretically) quantitative method for measuring distribution and density of uncommon, wide-ranging reef fishes. Usually, the surveys were conducted along a given reef feature, such as the edge of the reef slope or a given depth contour along a sloping outer reef face. At other times, the surveys, particularly on shallow reef flats, ranged across open bottom without any particular feature or habitat being followed. Since the tracks are latitude-longitude referenced, these surveys can be repeated at a future date by any qualified observer. In most cases fish were surveyed 10 m either side of the swim track for a total survey swath of 20 m with each meter of track swim, resulting in the survey of 20 square meters of bottom area. While it is not possible to measure the swath width being surveyed exactly, an approximation of the width is achieved by noting

the angle of view from the horizontal compared to the water depth. For example, if the water is 10 m deep, then the 10 m side swath width would represent at 45 degree angle from the observer. Shallower water depths would have a higher angle of view to the point where the water might become too shallow to be able to clearly see 10 m to the side of the observer. In the present case, because HHW were so uncommon, any fish that were seen were within 10 m of the survey track and were therefore counted. Only in the situation where fish are common does the accurate determination of swath width become a critical issue, since whatever error in swath width occurs, also reflects in the abundance of fish. The width of the survey track can be decreased if the water is shallow or not clear, with consequent reduction in the area surveyed per meter of survey track.

The precision and accuracy of the method is determined largely by factors that influence the ability of the observer to see and record the fish of interest, and by environmental factors that may change fish distribution over short periods of time. Hence, if substantial numbers of fish hide on the approach of the observer (which is generally an unknown), an underestimate of abundance and density of fish will result. Other factors, such as temporary influence of tides, currents or wave action on fish distribution will affect observations. In most cases, these factors will result in an underestimation of fish numbers and density. The only conditions that might result in overestimations would be if fish are counted twice or more, or if species are misidentified (see below). Since the influence of most of these factors are not known, no attempt was made to compensate for their possible effects, rather information on conditions (tides, currents, waves, weather) during the surveys were recorded for future reference. Ideally, repeat surveys would be made during similar seasons, lunar phases, times and weather to reduce differences from changes in fish abundance due to these factors.

The GPS Density Survey method is most useful for fishes which are easily visible against the reef surface (not camouflaged), relatively large, and are not disturbed by human swimmers. Experience with the behavior of the fishes of interest will usually provide some insight as to whether data obtained from this method are reliable. If fishes bolt the instant they first see a human, then it is likely many others will do so before ever observed, resulting in low counts. Likewise, if they are superbly camouflaged, a high percentage will generally not be observed.

HHW are generally suitable for these surveys, however, great care must be taken in making observations. When first seen juvenile and young adult HHW tend to freeze wherever they are for several seconds, then, once they have assessed the human presence, to gradually swim away from the observer. Those first few seconds are critical for making a good estimate of fish length and assessing that this is the proper species and what sex it might be (for larger fish). When surveying along reef edges, HHW tend (once they have seen the observer) to swim along the reef edge ahead of the observer. Often this is done near the limit of underwater visibility, with fish continuing to swim in and out of visual range ahead along the track the observer is swimming. This can easily result in double counting HHW swimming ahead of the observer. Once a fish has been noticed, it is important to keep track, as well as possible, where it is at any given time. Usually at some point, fish swimming ahead of the observer will stop staying ahead and gradually the observer will overtake and pass the fish, often the fish going deeper or shallower than the observer. Once the observer has passed a fish, and it swims in the opposite direction, it can be ignored; since it is very unlikely it would subsequently pass the observer again and be counted twice. Until the fish is behind the observer, it is essential to try and keep track of its position to avoid being counted again. Given that the HHW is not common, this is not considered to be a problem.

Abundance data were also taken incidentally for some additional species of fishes, since HHW were relatively uncommon and there was adequate time to deal with these extra species. These included close relatives of *C. undulatus* (some of which as juveniles resemble humphead wrasse) and

other large species (groupers, large parrotfishes, sharks, rays, other fishes, turtles) which are targeted for human consumption or are considered "charismatic megafauna".

Snorkel versus SCUBA surveys

GPS density surveys can be done either snorkeling or SCUBA diving. Both techniques were used during the present studies and each has its benefits and drawbacks. During the first survey trip, careful records were kept about distance covered with no current, and it was found that snorkel surveys covered an average of about 27 m/min while SCUBA surveys were less, at 20 m/min. A typical SCUBA dive at the depths where SCUBA is useful would last about 45-50 minutes and cover approximately 1 km. A snorkeling survey would cover about 1.3 km or more in the same time. Different individuals may have slightly different survey swim speeds, but since the GPS is logging positions over time, such differences do not affect density data.

Snorkeling surveys allow the observer to cover a greater area per unit time through a faster survey swim speed, produce less disturbance to the fishes (no bubbles or noise) and are not limited in survey time by the amount of air contained within the diving tank. Many snorkel surveys during the present work were 2-3 hours in duration. They were continued as long as the currents were favorable (or not opposing) to the swimmer and the observer was comfortable in the water. The need to interrupt surveys after 45-50 minutes to change tanks or move locations greatly reduces the time actually spent surveying fish. Juvenile *C. undulatus* tend to occur in shallow water, within the visual depth range of snorkelers, and sometimes in very shallow water (too shallow for SCUBA divers). Also, if any spawning aggregations of *C. undulatus* occur in an area, they are more easily detected while snorkeling, since the fish aggregate and spawn near the surface and are quite sensitive to disturbance by divers at that time. The infrastructure necessary to support SCUBA diving may not be available in many areas, but such problems do not exist for snorkel surveys. Moreover, many more people are able to conduct snorkel than SCUBA surveys.

Disadvantages to snorkel surveys include the inability to survey much below 12-15 m depth, the surface may have reduced visibility compared to deeper water, and it is often harder to distinguish some species when viewed from above (the normal situation when snorkeling) rather than from the side (when SCUBA diving). In a few cases stinging plankton (siphonophores) near the water surface inhibited surveys, but thin wet suits and a "stinger hood" easily solved this problem. However, where the species is common and the population healthy, individuals should be clearly visible in all depth ranges. Only where the population has been fished out in shallow water, might a remnant population remain at deeper depths, without an equivalent population in shallow water.

The main benefit of SCUBA diving surveys over snorkeling is that the observers can range deeper. *C. undulatus* occur to at least 60 m depth so some individuals can occur at depths below which they would not be seen by snorkelers on the surface. However, HHW are often shy, easily disturbed fish and tend to maintain their distance or actively swim away from SCUBA divers. The disturbance factor of the noise and bubbles of SCUBA divers is an important consideration in any survey and ideally observers should be familiar with techniques to minimize disturbance while diving. Diving rebreathers might be considered for use on surveys in some areas and situations, but the technical difficulties using this type of advanced equipment may out weigh the limited benefits. Additionally SCUBA diving generally uses a buddy system, with two individuals in the water within a reasonable distance of each other, and this amplifies the disturbance problem greatly. While it may not be consistent with safety considerations, solo SCUBA diving for doing surveys is preferable to reduce the disturbance which compromises the data obtained on any visual survey.

Nearly all areas of Indonesia where the present surveys were carried out have a very sharp edge to the insular shelf, usually at depths of 3-6 m. At the shelf edge, the reef slopes away quickly to great depth. Snorkeling along the edge of the shelf break allowed the observer to see both down the slope into depth generally of 15-20 m while also being able to see onto the shallow insular shelf reefs. For such a geomorphology, snorkel surveys are optimal for assessing a wide area. If the shelf break and insular shelf are deeper (12-15 m or more), SCUBA surveys might be more appropriate, however such geomorphology is uncommon along most Indonesian reef edges.

Currents affect the distance surveyed during any period of time. If there was no current, the observer swims along the reef edge at a steady, but measured, pace (again around 25-30 m per minute). If slight currents existed along a reef edge, the observer could maintain the same survey pace by simply drifting, and not actively swimming. This was the ideal situation, since the observer was not moving or splashing and very quiet, so there was minimal disturbance of fish. Stronger currents can cause the observer to be swept along at a faster pace, but it is still easy to take data in current speeds up to about 2 knots.

It seems optimal to combine extensive snorkeling surveys with a more limited number of SCUBA surveys in any attempt to document *C. undulatus* abundance in an area, as was done during the present work. Snorkeling is low tech, inexpensive, does not require extensive training, and is inherently safer than SCUBA diving. Some fish would be missed in a "snorkel-only" survey, but the basic questions of abundance of juveniles and adults, occurrence of spawning aggregations and fish distribution with habitat can generally be answered more thoroughly by snorkel surveys. This should be the main method for any future surveys on *C. undulatus*. SCUBA-only surveys should definitely be avoided, as such would give very biased results.

In the field it is difficult to identify between juvenile and small female fish. Nominally, the change between juvenile and female is believed to occur at about 50 cm standard length, but there are no external morphological or coloration differences between them. Spawning studies in the field in Palau (pers. obs.) indicate numerous fish smaller than 50 cm SL are already spawning as females, so it is uncertain whether fish in the 25-50 cm SL size range are juveniles or females. On the other hand, histological study has shown that reproductively active females (mainly collected from Papua New Guinea) are rare below about 50 cm (Sadovy *et al*. 2003; unpublished data from Pohnpei). Unfortunately the sizes of fish observed spawning in Palau can only be estimated, since they were not collected after spawning, hence some of the doubt regarding the size of change between juvenile and female. In this report, fish larger than 50 cm SL are considered females, but in reality some proportion of smaller individuals may also be mature females.

Distinguishing between large females and small males is also difficult in the field. While large males are easily identified by their bulbous foreheads, distinctive coloration and behavior, at transitional sizes, about 70-80 cm SL, there are no easy distinctions. Spawning studies indicated fish spawning as males can have coloration identical to large females. The only feature that distinguishes them is a very slight development of the forehead bump, compared to similar sized females. It is necessary to get a close look at the forehead profile of a fish to see whether or not it has developed any trace of a bump, and often in the field, the fish do not cooperate, remaining far away or not turning laterally to the observer. Since large females and small males can not be easily distinguished in the field, in this report if a fish is over 75 cm SL it is considered to be a male, under that size (but above 50 cm SL), it is considered female. An ageing study indicates that females can live as long as males but that females do not grow as large as males (Choat *et al*., in press).

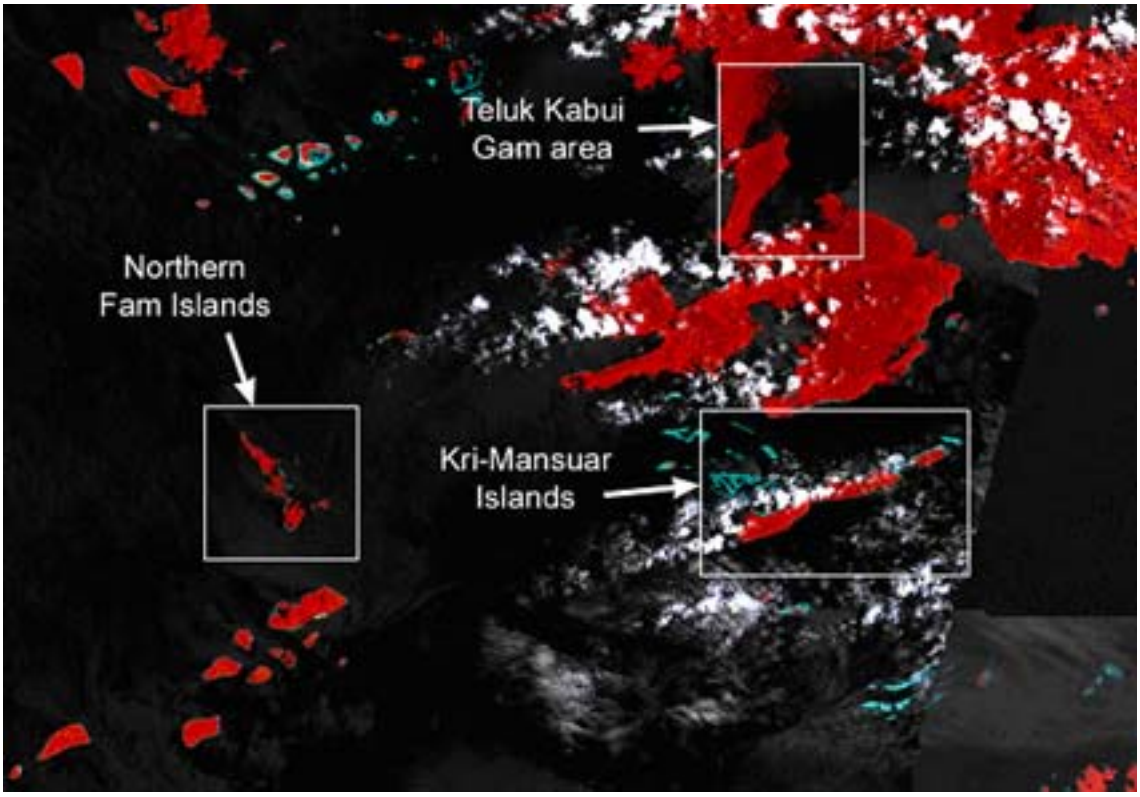


Figure 2. Landsat satellite image of the Raja Ampat area, Papua Province, Indonesia. The areas visited during the surveys (16-27 November 2005) are indicated by the white boxes.

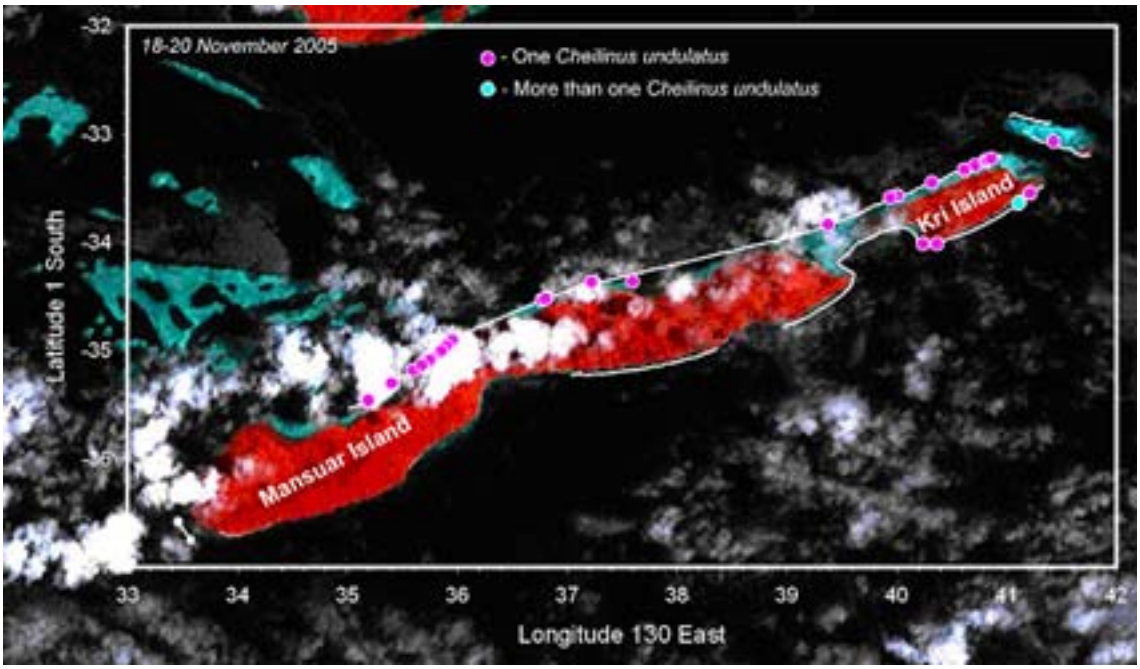


Figure 3. Landsat satellite image of the Kri Mansuar Island area in the Raja Ampat group. The white lines along the island shore are the swim survey tracks. The occurrence of single *C. undulatus* are noted by the pink (black in black/white version) circles, the light grey circles indicate the occurrence of more than one individual *C. undulatus.*

Choat of James Cook University, Australia, found that females were not found beyond 1 m in total length, only males grew larger, unpublished data). This is not a perfect situation, but at present is the best that can be done during field surveys of this species.

III. Results

Field Surveys

Area and density data from the surveys are shown in Tables 1-3. The location of surveys and the occurrence of fish are shown in Figures 2-15. Short snorkel surveys (any distance value less than about 500 m) were generally the result of currents opposing the desired direction of survey.

Very few or no fish were found in areas without any significant protection. The only populations of any size were found near to Bunaken Island, within the marine park. The closer to the ranger station on Bunaken Island, the more fish there were. In the Raja Ampat region, moderate numbers of juvenile HHW were found, but no adult males were encountered. Comparison of densities in these areas with a relatively unexploited area like Palau indicate numbers of HHW are much lower in all the survey areas, with the possible exception of Bunaken Island.

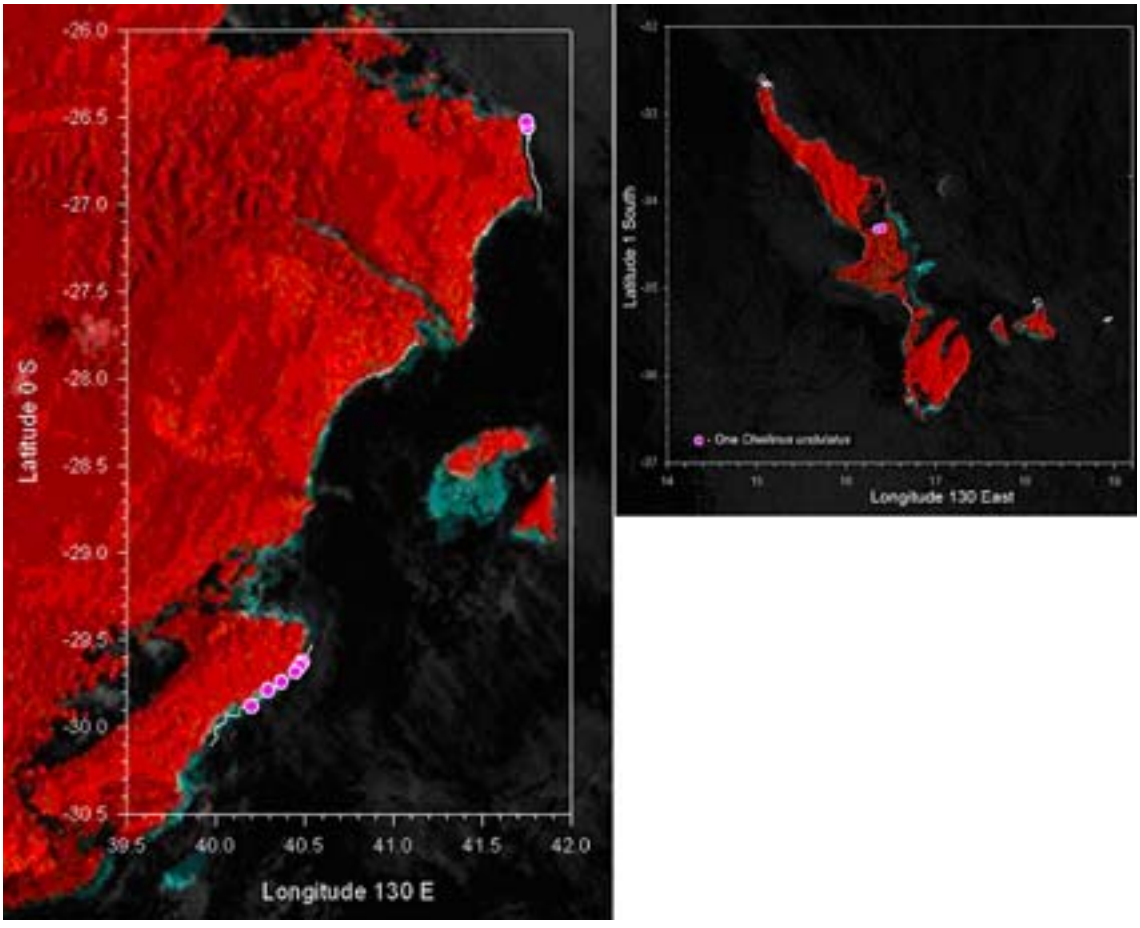


Figure 4. Left - Landsat satellite image of the Gam Island area of the Raja Ampat Islands. The surveys areas are indicated by white line for the swim surveys and the occurrence of *C. undulatus* are indicated by the pink (light grey in black and white version) circles. Right - Landsat satellite image of Penemu Island (Fam Islands area) in the Raja Ampat group. Location of survey dives are shown by white lines, while occurrence on *C. undulatus* on snorkel surveys are shown by grey circles. Only two juvenile (less than 50 cm SL) *C. undulatus* were seen at this site.

Table 1. Summary of *Cheilinus undulatus* density surveys around Raja Ampat area

Date-Location	Distance Meters	Area meters^2	Number *C. undulatus* J	F	M	Area (m^2) per fish	Fish per 10,000 m^2
18 November 2005 -Kri Island (Figure 3)							
Reef edge	574	11,480	4	0	0	2,870	3.48
Reef flat	430	4,300	0	0	0	0	0
19 November 2005 - Kri/Mansuar Islands (Figure 3)							
Reef edge	3,125	62,500	4	1	0	12,500	0.80
Reef edge	687	13,740	0	0	0	0	0
Reef edge	134	2,680	1	0	0	2,680	3.73
Reef edge	1,324	26,480	1	0	0	26,480	0.38
Reef edge	194	3,880	3	0	0	1,293	7.73
Reef edge	72	1,440	1	0	0	1,440	6.94
Reef edge	2,270	45,400	10	0	0	4,540	2.20
20 November 2005 - Kri/Mansuar Island (Figure 3)							
Reef edge	6,055	121,100	7	2	0	13,456	0.74
Reef edge	2,688	53,760	1	0	0	53,760	0.19
Reef edge	1,095	21,900	1	0	0	21,900	0.46
Reef edge	871	17,420	0	0	0	0	0
21 November 2005 - Gam Island (Figure 4)							
Reef edge	1,783	35,660	6	1	0	5,094	1.96
22 November 2005 - Waigeo Island (Figure 4)							
Tidal channel edge	300	6,000	0	0	0	0	0
Lagoon edge	400	8,000	0	0	0	0	0
23 November 2005 - Gam Island (Figure 4)							
Lagoon edge	1,249	24,980	0	0	0	0	0
Reef edge	262	5,240	0	0	0	0	0
23 November 2005 - Mansuar Island (Figure 3)							
Reef edge	400	8,000	0	0	0	0	0
24 November 2005 - Waigeo Island (Figure 4)							
Lagoon edge	300 (est)*	6,000	0	0	0	0	0
Reef edge	1,265	25,300	3	0	0	8,433	1.19
Reef edge	1,725	34,500	6	0	0	5,750	1.74
25 November 2005 - Fam Islands (Figure 4)							
Reef edge	500 (est)*	10,000	0	0	0	0	0
Mangrove/reef shore	364	7,280	0	0	0	0	0
Reef edge	600 (est)*	12,000	0	0	0	0	0
Reef edge	872	17,440	0	0	0	0	0
Reed edge	800 (est)*	16,000	0	0	0	0	0
Totals	**30.3 km**	**602,480 m^2**	**48**	**4**	**0**	**11,582**	**0.86**

* - For some areas the GPS float was not towed during SCUBA diving due to strong currents. The approximate distances surveyed were determined later from maps, satellite photographs and start/end positions determined by GPS receiver on the dive boat.

Table 2. Summary of *Cheilinus undulatus* density surveys around north Sulawesi

Date-Location	Distance Meters	Area meters^2	Number *C. undulatus* J	F	M	Area (m^2) per fish	Fish per 10,000 m^2
15 July 2005 - Sulawesi coast south of Manado (Figure 7)							
Reef slope	2,096	41,920	0	1	0	41,920	0.23
Reef flat	1,725	34,500	0	0	0	0	0
Reef slope	2,428	48,560	0	0	0	0	0
Reef flat	2,233	44,660	0	0	0	0	0
16 July 2005 - Southern coastal portion of Bunaken Park (Figure 6)**							
Reef edge**	2,146	42,920	2	1	0	14,307	0.69
Reef edge**	1,938	38,760	0	0	0	0	0
Reef edge**	667	13,340	0	0	0	0	0
Reef edge**	1,420	28,400	0	0	0	0	0
Reef edge**	1,139	22,780	0	0	0	0	0
17 July 2005 - Sulawesi coast south of Manado (Figure 7)							
Reef edge	1,568	31,360	0	0	0	0	0
Reef edge	1,560	31,200	0	0	0	0	0
Reef bank	510	10,200	0	0	0	0	0
Reef edge	1,294	25,880	0	0	0	0	0
19 July 2005 - Gangaa Island area (Figure 8)							
Reef edge	1,937	38,740	0	0	0	0	0
Lehaga Is. Reef	1,904	38,080	0	0	0	0	0
Reef edge Gangaa	1,489	29,780	0	0	0	0	0
Reef edge Gangaa	1,025	20,500	0	0	0	0	0
20 July 2005 - Bangka Island (Figure 8)							
Reef edge	2,327	46,540	0	0	0	0	0
Reef edge	686	13,720	0	0	0	0	0
21 July 2005 - Bangka and Talisei Islands (Figure 8)							
Reef edge, Bangka	1,566	31,320	0	0	0	0	0
Reef edge, Bangka	1,616	32,320	0	0	0	0	0
Reef edge, Talisei	1,581	31,620	0	0	0	0	0
Reef edge, Talisei	1,749	34,980	0	0	0	0	0
Reef edge, Talisei	1,765	35,300	0	0	0	0	0
23 July 2005 - Bunaken Island (Figure 9)**							
Reef edge, e side**	4,799	95,980	2	7	5	6,856	1.46
Reef edge, sw side**	1,279	25,580	1	3	4	3,198	3.13
Reef edge, w side**	2,248	44,960	0	4	2	7,493	1.33
24 July 2005 - Mantenhage (Figure 9)**							
Reef edge**	1,628	32,560	0	0	0	0	0
Reef edge**	328	6,560	0	0	0	0	0
Reef edge**	1,079	21,580	0	0	0	0	0
24 July 2005 - Siladeng (Figure 9)**							
Reef edge**	1,759	35,18	0	1	0	35,180	0.28

Reef edge**	612	12,240	0 0 0	0	0
24 July 2005 - Bunaken Island (Figure 9)**					
Reef edge-SCUBA**	549	10,980	0 1 2	3,660	2.73
Reef edge**	2,555	51,100	2 2 4	6,388	1.57
25 July 2005 - Manado Tua (Figure 9)**					
Reef edge**	1,110	22,200	0 0 0	0	0
Reef edge**	1,568	31,360	0 1 0	31,360	0.31
Reef edge**	1,308	26,160	0 0 0	0	0
25 July 2005 - Bunaken Island (Figure 9)**					
Reef edge**	322	6,440	0 0 0	0	0
Totals	**59.5 km**	**1,190,260 m^2**	**7 21 17**	**26,450**	**0.38**

** - Indicates protected area part of Bunaken Marine Park.

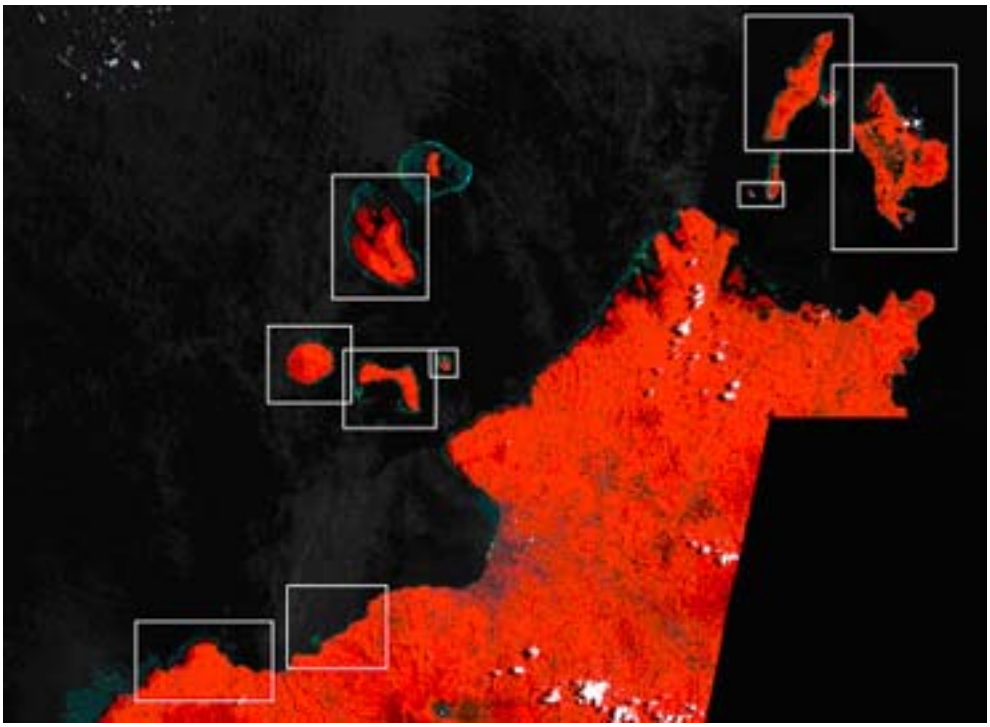


Figure 5. Landsat satellite image of the north Sulawesi area of Indonesia. The areas where surveys of *C. undulatus* occurrence were carried out are indicated by the white boxes.

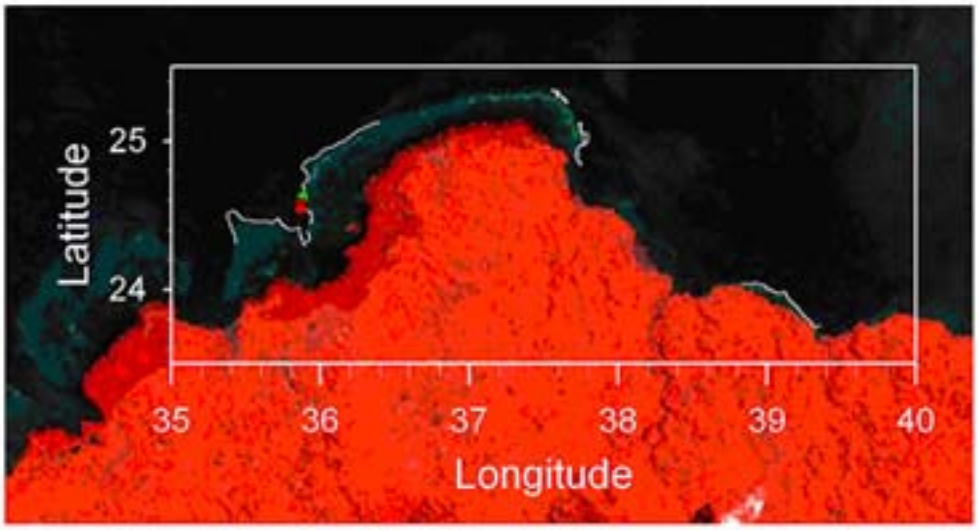


Figure 6. GPS swim survey tracks along the coastal section of northern Sulawesi. Shown is a portion of the coast in the coastal section of Bunaken marine park. Adult *C. undulatus* are indicated by red (white in black and white) circles, while juveniles are red (light grey in black and white) circles.

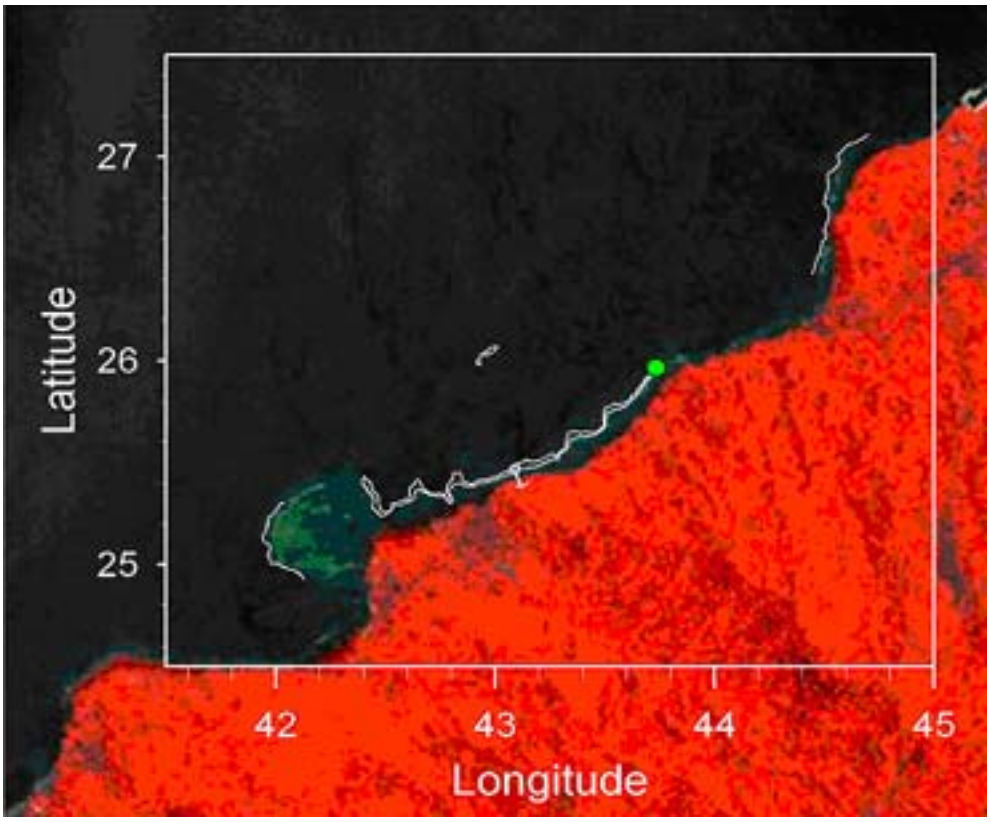


Figure 7. GPS swim survey tracks along the coastal section of northern Sulawesi. Shown is the area near Lumba Lumba diving.

Table 3. Summary of *Cheilinus undulatus* density surveys around east Bali-Kangean Islands

Date-Location	Distance Meters	Area meters^2	Number *C. undulatus* J…F…M	Area (m^2) per fish	Fish per 10,000 m^2
22 June 2005 - Sepanjang Island, south coast (Figure 11)					
Outer slope	1,855	37,100	0 0 0	0	0
Seagrass	334	6,680	0 0 0	0	0
Back reef	622	12,400	0 0 0	0	0
22 June 2005 - Sepanjang Island, Tembing Pt. (Figure 11)					
Outer slope	846	16,920	0 0 0	0	0
Shallow reef top	30	600	0 0 0	0	0
Seagrass	485	9,700	0 0 0	0	0
22 June 2005 - Sepanjang Island, western reef (Figure 11)					
Outer slope	539	10,780	0 0 0	0	0
Shallow reef	711	14,220	0 0 0	0	0
23 June 2005 - Kangean Island, western end (Figure 12)					
Reef slope-SCUBA	1,041	20,820	0 0 0	0	0
Reef edge	774	15,480	0 0 0	0	0
Rocky shore	356	7,120	0 0 0	0	0
23 June 2005 - Manburit Island (Figure 12)					
Reef slope	710	14,200	0 0 0	0	0
23 June 2005 - Kangean Island, north coast (Figure 12)					
Reef slope-SCUBA	1,172	23,440	0 0 0	0	0
Reef slope-SCUBA	881	17,620	0 0 0	0	0
24 June 2005 - Miongan Island (Figure 13)					
Reef slope-SCUBA	200 (est)***	4,000	0 0 0	0	0
Reef edge	1,225 (est)***	24,500	0 0 0	0	0
Reef edge	775 (est)***	15,500	0 0 0	0	0
Reef edge	1,350 (est)***	27,000	0 0 0	0	0
24 June 2005 - Igangan Island (Figure 13)					
Reef slope-SCUBA					
Reef edge	714	14,280	0 0 0	0	0
Reef edge	497	9,940	0 0 0	0	0
Shallow reef flat	410	8,200	0 0 0	0	0
25 June 2005 - Pulau Setabo (Figure 13)					
Reef slope-SCUBA	200	4,000	0 0 0	0	0
Reef edge	553	11,060	0 0 0	0	0
25 June 2005 - Pulau Seredang Besar (Figure 13)					
Reef edge	150	3,000	0 0 0	0	0
26 June 2005 - Bali, Tulamben (Figure 14)					
Reef slope-SCUBA	1,255	25,100	0 0 0	0	0
Reef edge	878	17,560	0 1 0	17560	0.57
Reef slope-SCUBA	150 (est)*	3,000	0 0 0	0	0

26 June 2005 - Gili Biaha (no Figure)							
Reef slope	100 (est)*	2,000	0	0	0	0	0
27 June 2005 - Bali, Amuk Bay (Figure 15)							
Reef slope-SCUBA	1,307	26,140	0	0	0	0	0
Reef edge	2,741	54,820	0	1	0	54,820	0.18
Reef slope-SCUBA	100 (est)*	2,000	0	0	1	2,000	5.0
Reef edge	614	12,280	0	0	0	0	0
Inner bay mixed	1,636	32,720	0	0	0	0	0
Reef edge-SCUBA	150 (est)*	3,000	0	0	0	0	0
28 June 2005 - Nusa Penida (Figure 15)							
Reef slope-SCUBA	3,116	62,320	0	0	0	0	0
Reef edge	6,018	120,360	0	0	0	0	0
Totals	**35.1 km**	**703,900 m^2**	**0**	**2**	**1**	**234,633**	**0.04**

* - For some areas the GPS float was not towed during SCUBA diving due to strong currents. The approximate distances surveyed were determined later from maps, satellite photographs and start/end positions determined by GPS receiver on the dive boat.
*** - At Miogan Island the batteries of the GPS failed at the start of the survey and no GPS position data were obtained. The tracks and distances were later determined from maps and satellite photos with reasonably good accuracy.

When the three surveys are combined (Table 4), the area per HHW comes out to approximately 1 per 25,000 square meters with a density of 0.40 HHW per 10,000 square meters. This includes all fish, which are mostly juvenile and is highly influenced by the relatively high density (but much less than other areas outside of Indonesia) found in the Raja Ampat region.

Table 4. Summary of *Cheilinus undulatus* density surveys around all areas.

Location-Date	Distance Meters	Area meters^2	Number *C. undulatus*	Area (m^2) per fish	Fish per 10,000 m^2
Raja Ampat Nov 05'	**30.3 km**	**602,480 m^2**	**52**	**11,586**	**0.86**
N. Sulawesi, Jul 05'	**59.5 km**	**1,190,260**	**45**	**26,450**	**0.38**
Bali-Kangean, Jun 05'	**35.1 km**	**703,900**	**3**	**234,633**	**0.04**
Totals all surveys	**125 km**	**2,494 km^2**	**100**	**24,940**	**0.40**

Figures 5-18 show the areas where surveys were conducted with GPS swim survey tracks shown. The location of each individual fish is also shown on these figures as a green circle.

Habitat Types and Depths of Surveys

It is difficult to characterize the distribution of HHW by specific habitat type except for broad categories. Most of our information on distribution comes from other areas, such as Palau and Papua New Guinea, where juveniles and adults are more common. If a simple breakdown of (moving inshore) reef slope, reef break (where the slope meets the flat), reef flat, mixed coral seagrass, seagrass, sand, and mangroves, it is clear that medium to larger sized HHW occur along the reef slope and near the reef break. Medium to small individuals occur on the reef flat and among coral sea grass habitat.

They do not occur in stands of pure seagrass, over open sandy bottoms or among mangroves. Small individuals can occur in coral areas bordering mangrove stands.

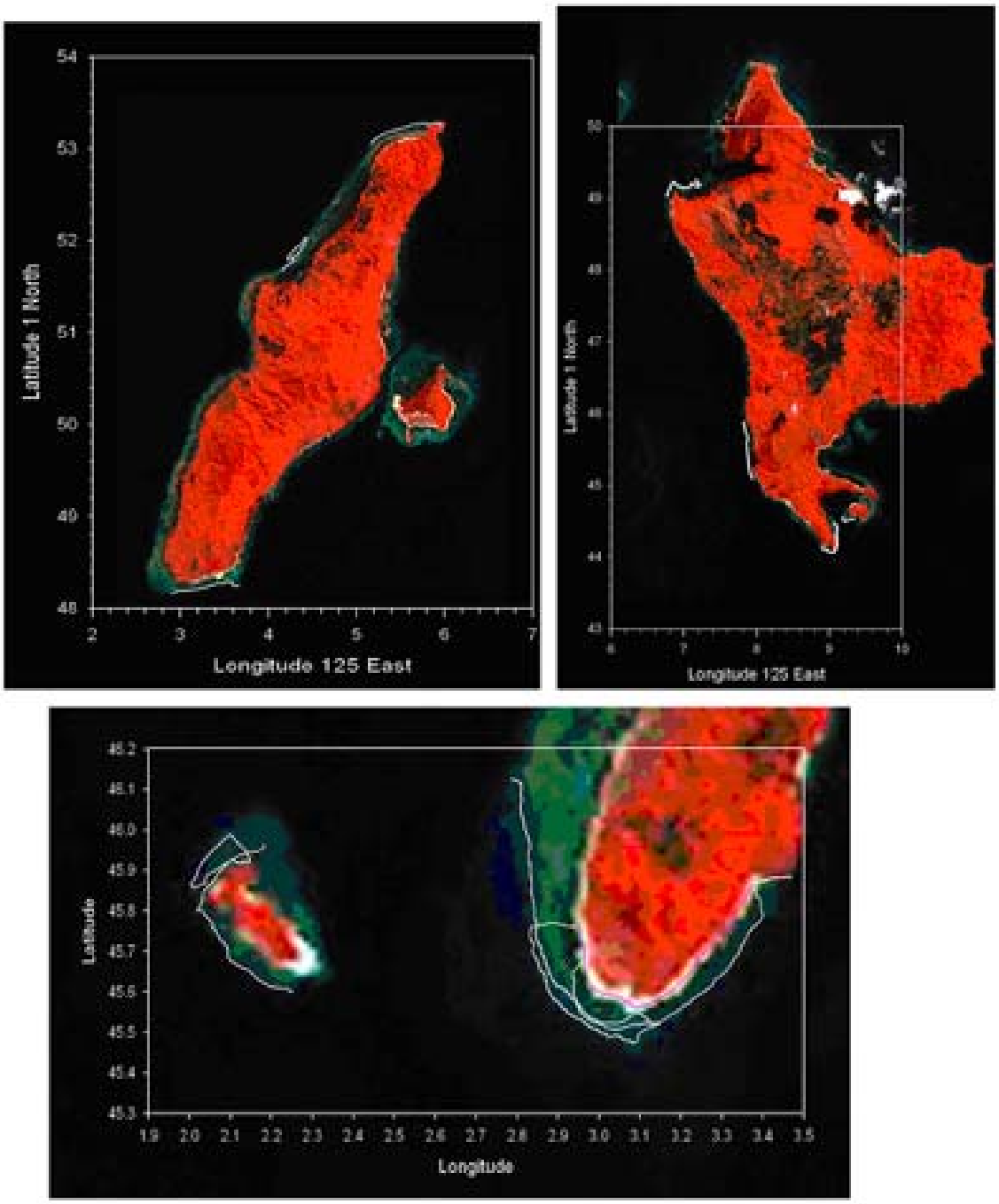


Figure 8. Landsat satellite images of the islands north of the northern end of Sulawesi Island with swim survey tracks shown as white lines. Upper left - Talisei Island with three GPS swim tracks indicated. Upper right - Bangka Island with three swim tracks indicated. Lower - Gangaa Island (right) and Lehaga Island (left) with GPS swim tracks indicated. No *C. undulatus* were seen on any of these tracks.

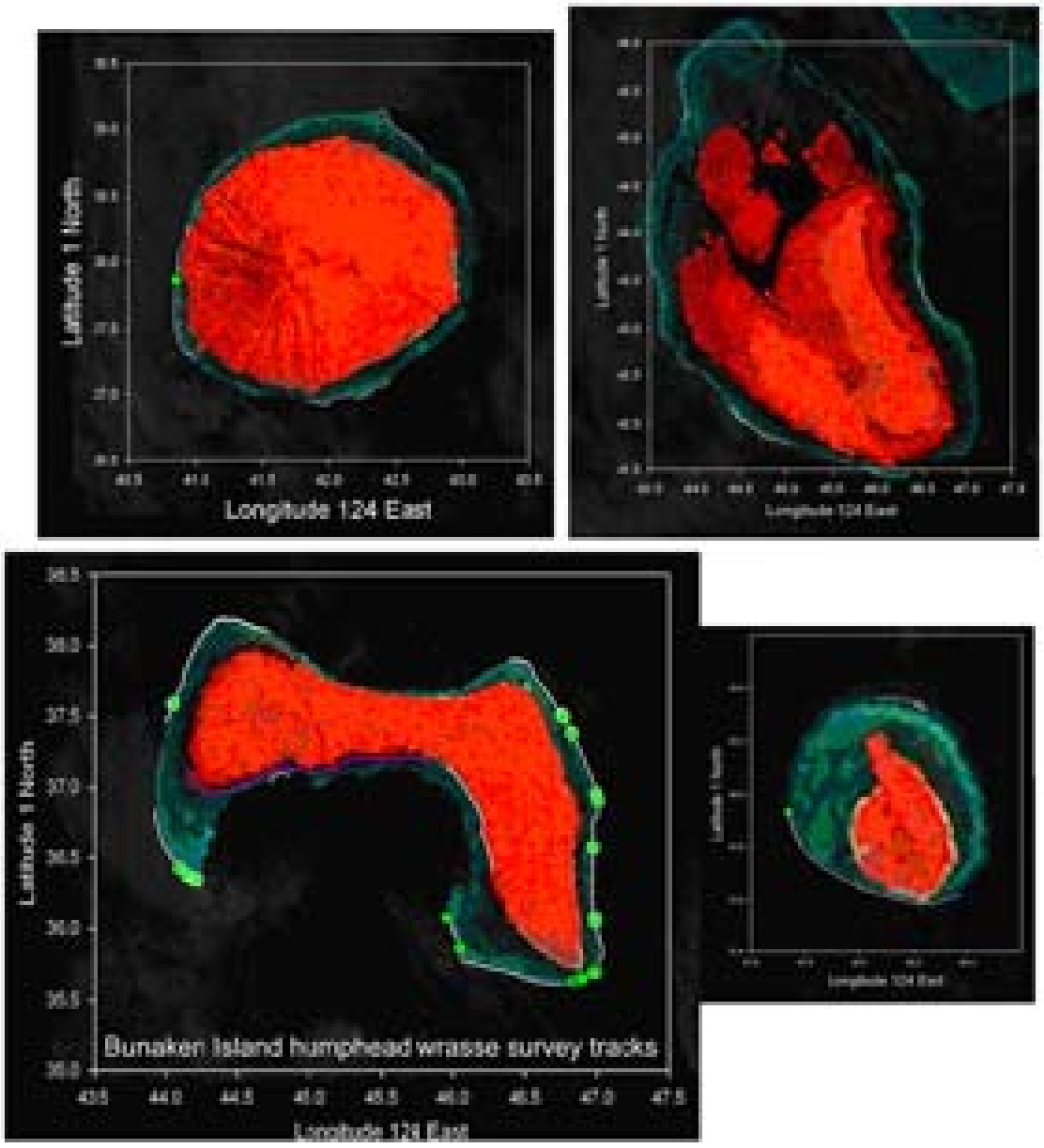


Figure 9. Landsat satellite images of the islands of Bunaken Marine Park with swim survey tracks shown as white lines. Upper left - Manado Tua with GPS swim track and 1 *C. undulatus* (circle) indicated. Upper right - Mantehange Island with tracks indicated, no *C. undulatus* seen here. Lower left - Bunaken Island with survey tracks and locations of numerous *C. undulatus* (white circles). Lower right - Silangen Island with two swim tracks and the location of 1 *C. undulatus*.

In Tables 1-3, snorkel surveys were limited to the upper 12-15 m. The reef break generally occurred at 3-6 m depth and fish could be seen both down the slope and near the edge of the break in water only 1-2 m deep. SCUBA surveys were generally done in the 12-25 m depth range, as this allowed adequate bottom time, yet was below the depths easily surveyed while snorkeling. I feel that the survey depths chosen provide the best all around range to assess the abundance of *C. undulatus*. It is well known that large fish can occur in both shallow (to the upper few m) and deeper (to 60 m or more) depths, but younger fish tend to occur in the upper 10 m of water. Since nearly all the fish in the live trade for HHW, or collected for growout for the trade, are now juveniles and smaller females, surveys in the shallower depths are most suitable for quantifying the occurrence of these fish. Also significantly, if any spawning aggregation of *C. undulatus* occur in an area, they will be present in the upper 10 m and easily seen while snorkeling, but likely to be missed by SCUBA.

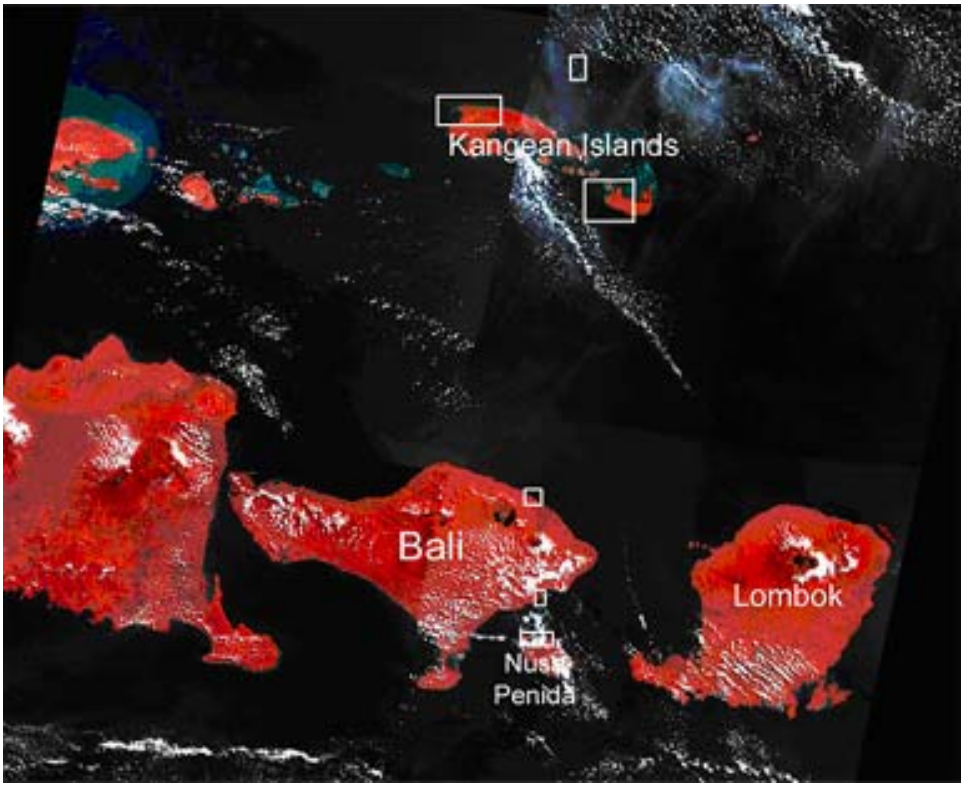


Figure 10. Landsat satellite image of the Bali-Kangean Island area with general locations sampled during Bali-Kangean survey trip indicated by white boxes.

It is not possible to include all information on habitat "quality" and other occurrence data gathered during the surveys. The nature of the reef along the reef slope and reef break could constantly change over short distances, so it was not possible to simply say an area had "healthy" or "poor" coral reef condition, as over 20-30 m the condition could completely change. Therefore it was not possible to characterize HHW occurrence with the specific "health" of the reef. In general, the amount of coral cover did not seem to be a significant factor in determining HHW occurrence, except that areas reduced to rubble, from what had obviously been previously healthy reefs, had few fishes, including *C. undulatus*. Other than that, no generalities can be drawn from the surveys.

Many areas of "bombed" reefs were seen in some locations, and numerous blasts were heard underwater while doing surveys, particularly in the Kangean Islands area. Despite these localized areas of destruction, it was somewhat surprising to see that many areas had extremely luxuriant coral growth. Data of areas were recorded where coral growth was particularly nice for future reference. The occurrence of crown-of-thorns starfish (*Acanthaster planci*) or evidence of their feeding was recorded. Fortunately, these coral-feeding echinoderms were uncommon, and in no areas did they appear to represent a major threat to the health of the reef.

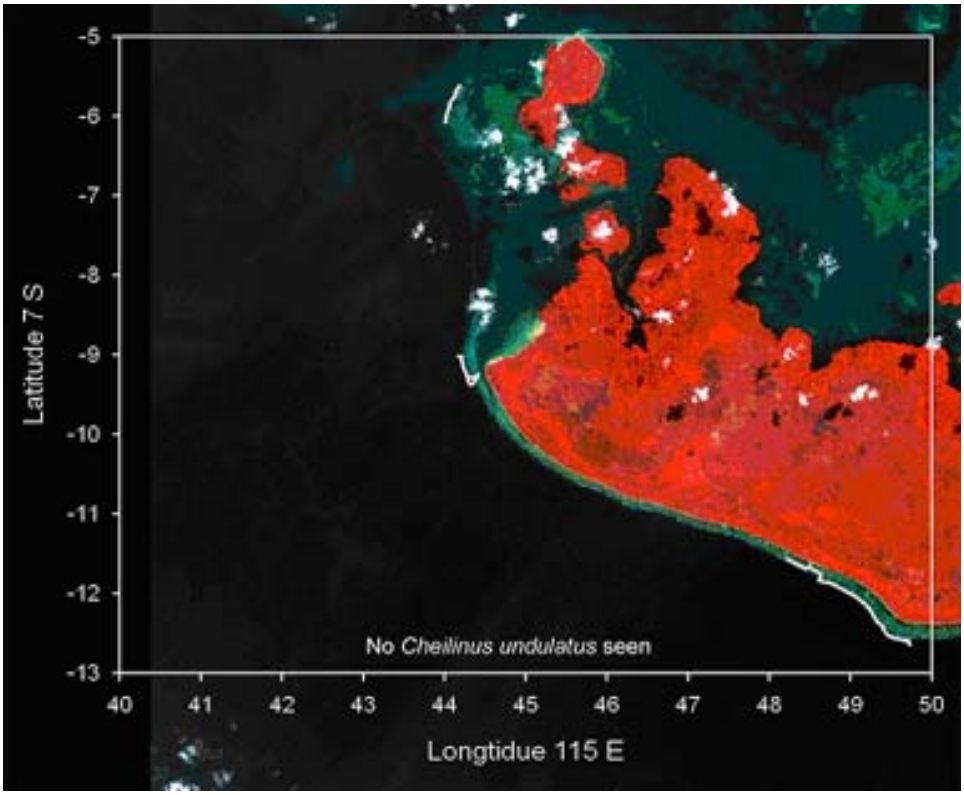


Figure 11. Landsat satellite image showing swim survey tracks as white lines along the southern shore of Sepanjang Island, Kangean Group. No *C. undulatus* were seen during these surveys.

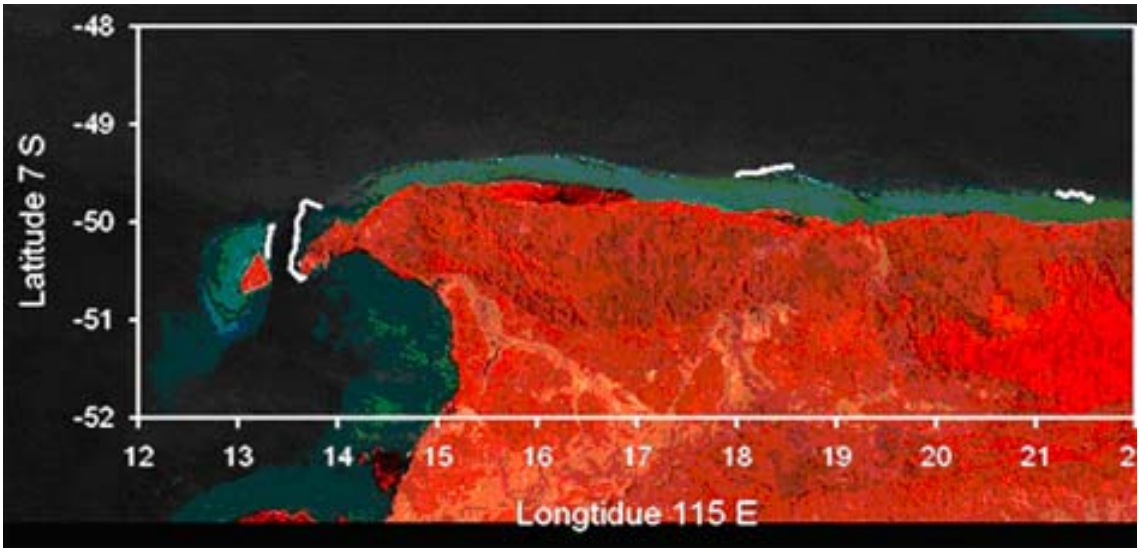


Figure 12. Landsat satellite image showing survey tracks along Kangean Island. No *C. undulatus* were seen during these surveys.

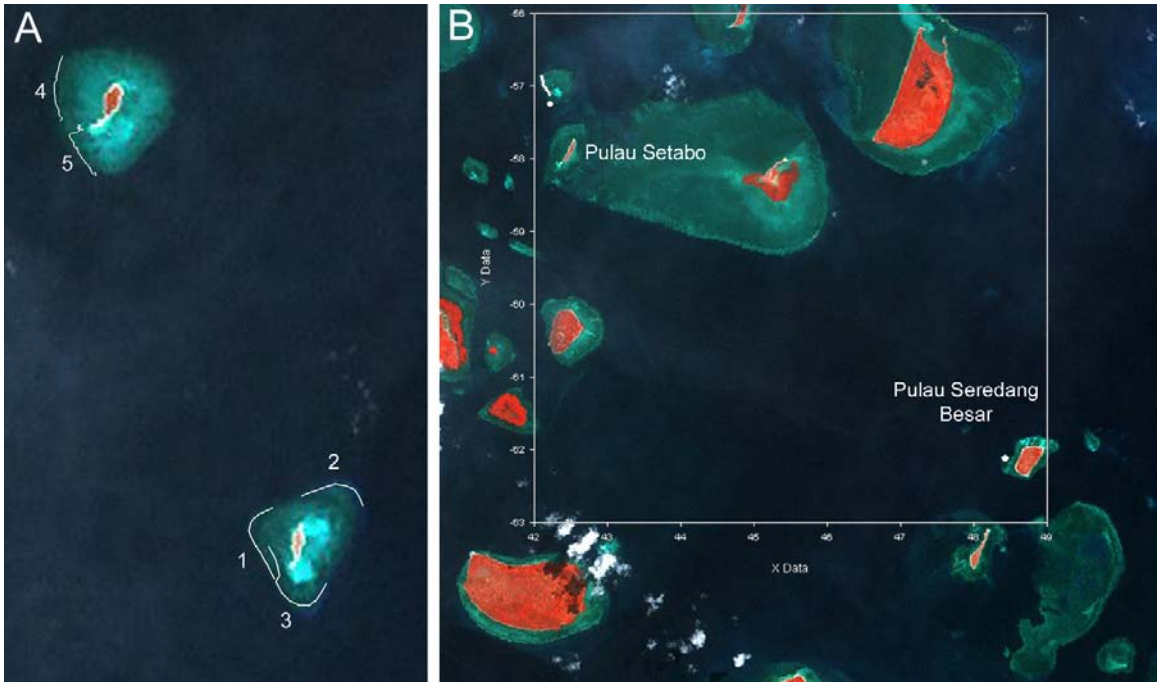


Figure 13. Landsat satellite image of reefs and islands north of Kangean Island with survey swim tracks shown as white lines. A. Miogan-Igangan Islands area. B. Central Kangean Islands area. No *C. undulatus* were seen during these surveys.

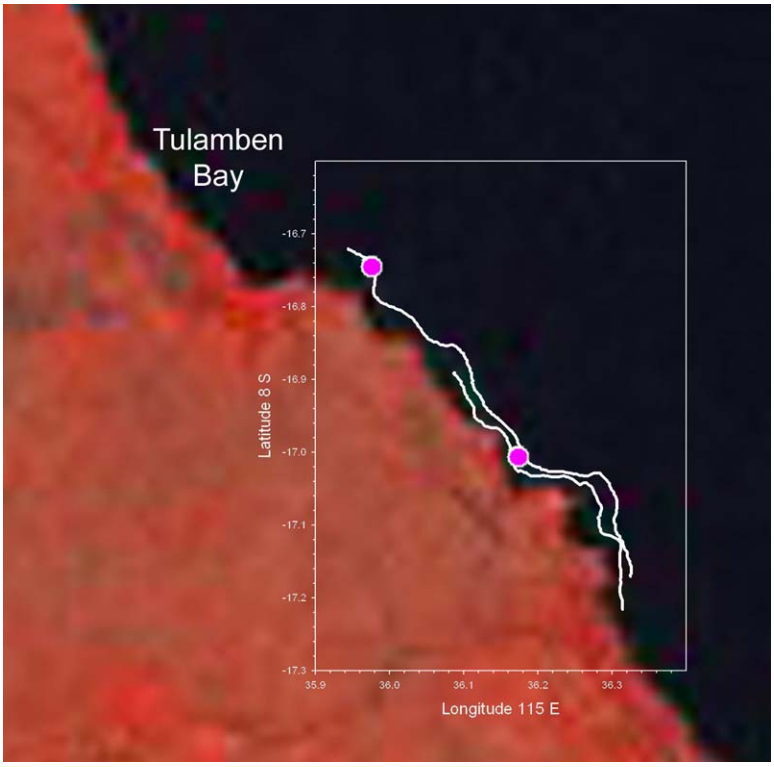


Figure 14. Landsat satellite image of swim survey area at Tulamben, northeast Bali. Adult *C. undulatus* observations indicated by circles. No juveniles were seen in this area.

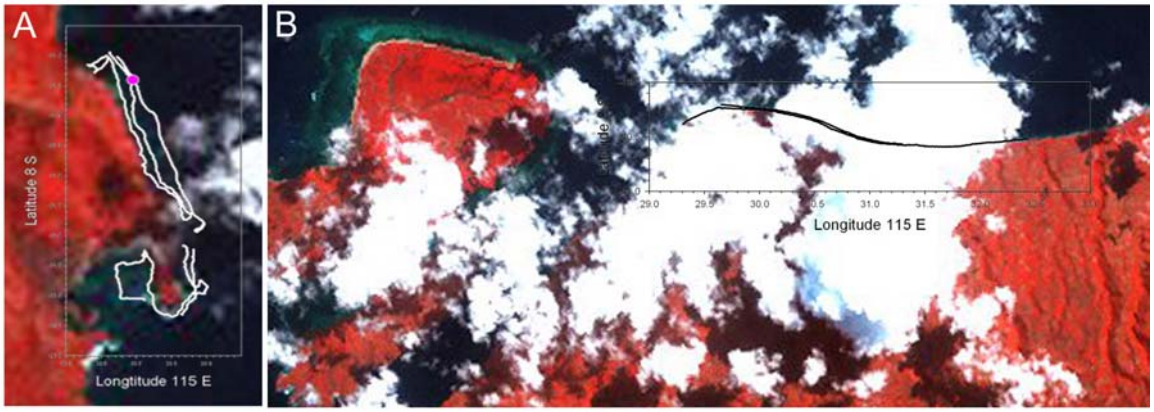


Figure 15. Landsat satellite image of swim survey tracks in the vicinity of Padang Bay, Bali (white lines) and the northern coast of Nusa Penida (black lines due to cloud cover over site). No *C. undulatus* were seen on the Nusa Penida surveys.

Sizes and Size Frequencies of Fish

Due to the low numbers of fish present in most areas, it is not possible to present useful size-frequency graphs for many areas. Only two areas had sufficient numbers of fish present to do meaningful size-frequency graphs. Bunaken Island (not the Bunaken Marine Park as a whole) had moderate numbers of fish and a graph of the frequency of estimated size is shown as Figure 16. The Raja Ampat area also had some fish and a second estimated size frequency distribution is shown as Figure 17. The standard lengths indicated are estimates, with accuracy probably on the range of 10-15%, and the standard length (from tip of snout to end of vertebral column) is less than total length.

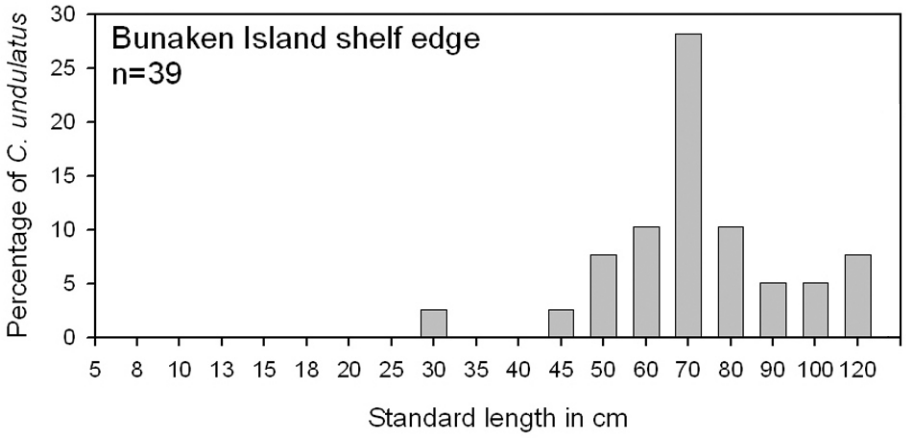


Figure 16. Frequency of estimated standard length for *Cheilinus undulatus* observed at Bunakan Island within the Bunaken Marine Park. This graph does not include the limited number of fish seen at other islands within the Bunaken Marine Park.

Sampling Strategy and Transect Numbers and Length

The strategy for doing transect sampling is straightforward for common reef fishes. Normally transects of 25 or 50 m with a width of 5 m total (2.5 m each side of transect) are surveyed by placing a measured tape along the bottom at either random or selected locations. For fishes, such as *C. undulatus*, that are easily disturbed, surveyors count fish along a known transect line or measure the distance later, as laying the transect tape invariably causes the fish to flee. In some cases where fish are

uncommon, transects of 150 m length are used. For the present study, it was deemed unfeasible and unproductive to try and use even 150 m transects, as the areas had not been surveyed before and there was no access to trained boat and dive assistants, necessary for typical transect tape surveys. More importantly, *C. undulatus* were so uncommon, that a large number of transects would be needed to establish density values, and this was not feasible. It takes approximately one hour to survey an area using a 150 m transect, when the distance must be measured by traditional means, the fish surveyed and the transect line recovered. The observer must swim the transect distance at least four times for each survey and unless the fish count is made on the first pass down the survey transect, the fish data are going to be compromised and nearly useless.

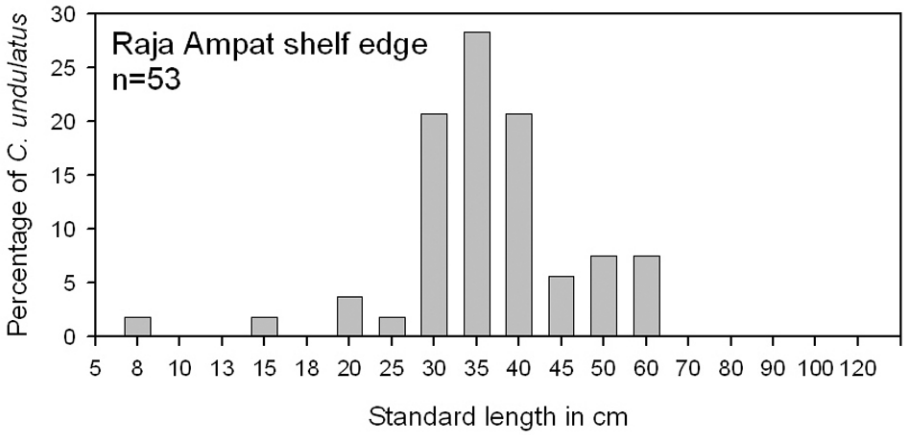


Figure 17. Frequency of estimated standard length for *Cheilinus undulatus* observed in the Raja Ampat region.

For these (and other) reasons, it was decided to use a continuous transect approach (GPS density surveys), with the distance surveyed being determined by logging GPS receiver, rather than laying out a transect tape. This is somewhat similar to the "timed swim" approach to surveying reef fishes, but that technique is not quantitative in the sense the observer does not know what distance was surveyed. Only when a survey is run between points with a known distances in between them can a timed swim be considered quantitative.

Based on previous work in Palau and Papua New Guinea, it was known that most *C. undulatus* occur on reef habitat. If there is a narrow insular shelf and sharp reef outer edge to the reef, the fish generally occur close to that reef edge. Therefore, it was decided to focus many of the surveys along this habitat. Surveys were also run in other habitats (reef flats, sea grass beds, sand bottoms) to establish if there were any sizeable populations there, but overall nearly all *C. undulatus* seen occurred along the shelf edge. The use of the reef edge as a survey habitat also has the advantage that in future surveys, observers will be able to follow the exact track swum by previous surveyors, rather than ranging across reef without features indicating where previous tracks might have been run. This will greatly strengthen the "repeatability" of future surveys.

To assess the ability of the continuous transect method (GPS density survey) to replicate the results of shorter 50 and 150 m transects, a comparison was run for data from Bunaken Island using both methods (Fig. 18). The Bunaken surveys were chosen for this comparison since they were in the only area with significant numbers of large *C. undulatus* seen on surveys. The start positions of transects along the survey line were established by random numbers and then transects run for the next 50-150 along the swim track. Multiples of 2, 5, 10 and 20 transects were run for 50 m distance, while 150 transects were limited to 2, 5, and 10 transects. Any fish observed in that distance were counted as occurring in the transect. Fig. 18. shows the relationship between transect length, number and density of fish. The density values of twenty 50 m transect and ten 150 m transects approaches the "actual"

density, as determined from the entire swim survey (4.7 km), and these should be considered minimal transects needed for an adequate survey in an area with a significant number of fish. This

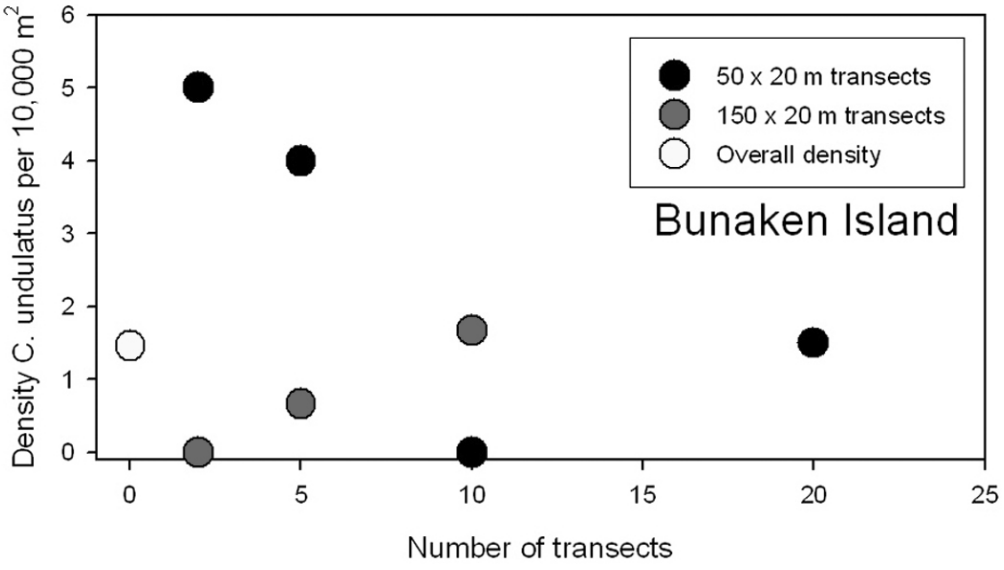


Figure 18. Comparison of transect length (50 and 150 m) and transect numbers (2, 5, 10 and 20) with calculated density of *C. undulatus*. The overall density from 4.7 km of continuous transect is shown (white circle) for comparison.

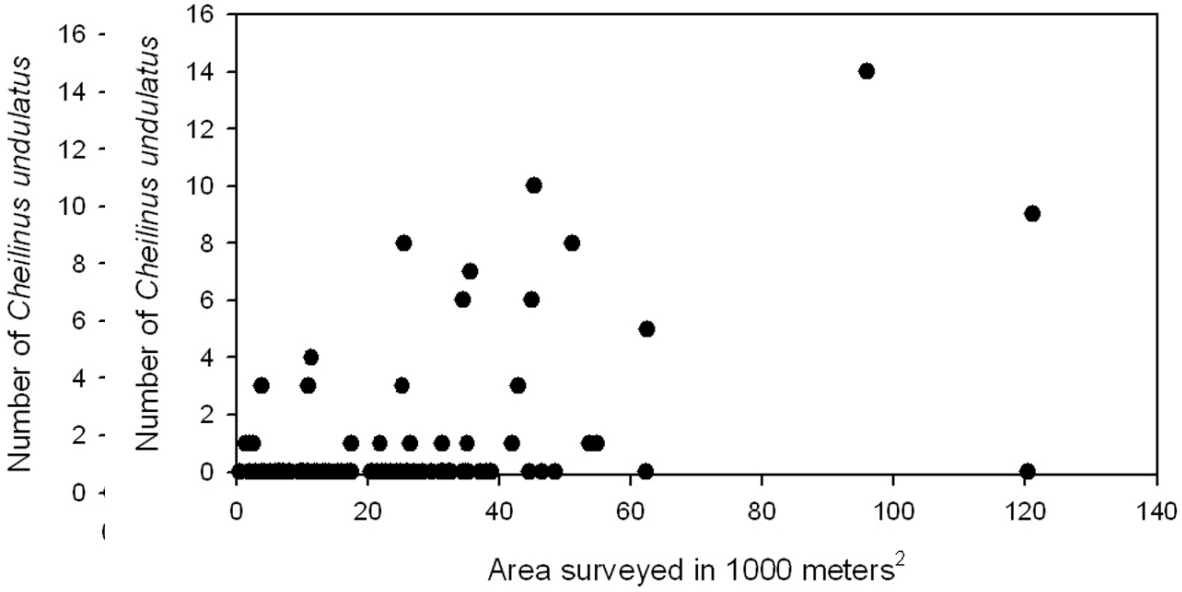


Figure 19. Comparison of the numbers of *C. undulatus* seen with the amount of area surveyed.

swim survey took approximately 3 hours to do, whereas, if 50 or 150 m transects had been used, only 10-20% as much area could have been surveyed. Clearly for areas even with a significant number of fish, the advantages of the technique used are apparent. For areas with fewer or no fish, the differences become more extreme. Attempting these comparisons using data from other areas with very few to no *C. undulatus* was a futile exercise, since there needs to be some number of fish present to made any type of comparison. The comparison for the Bunaken data can be extrapolated to any lesser number of

fish, and it quickly becomes apparent that an extremely large number of transects would have to be run in areas where there are virtually no fish left.

For areas with lesser numbers of fish, the amount of area surveyed before one or more fish is encountered can be quite large. Fig. 19 shows the relationship for all surveys during this work between numbers of fish seen versus area surveyed. There are many zero values, even for areas of 2,000-12,000 square meters. These areas represent the maximum amounts that could be surveyed during one survey swim of 1-3 hours and not a single fish was encountered during that time. The areas with the highest probable exploitation generally rest along the zero line in Fig. 19.

In an area with a significant number of fish (using Bunaken Park as a base line), how long a continuous swim transect is needed to obtain a reasonable idea of fish density? Figure 20 shows the relationship between the calculated density of *C. undulatus* and increasing length of the survey. When a single fish is encountered early in the survey, the density goes quickly upward, then gradually drops as more area is covered without additional fish being seen. This happens each time a new fish is observed, and results in the saw tooth pattern seen in Fig. 20. Eventually, the density data line becomes more horizontal, indicating that the distance surveyed is resulting in a stable and precise value for density. For the Bunaken survey, it appears from Fig. 20 that once a distance of 3-6 km has been surveyed, density values become relatively stable at 1-2 fish per 10,000 square meters. It is believed this is realistic value for this area. For areas with more or fewer fish, the distance required to

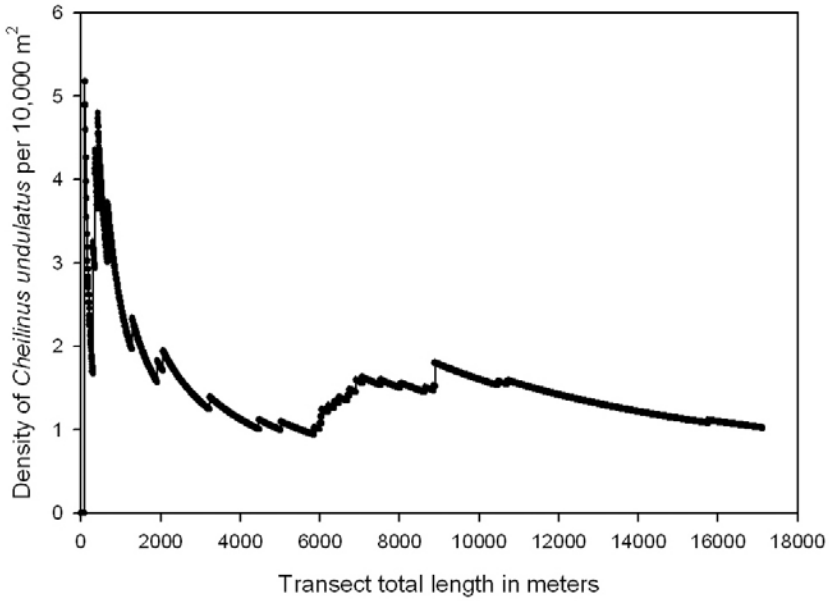


Figure 20. Comparison of the density value of *C. undulatus* with the distance along a continuous transect at Bunaken Island. Initial density values are high due to the presence of a few individuals early along the total transect, however, the value eventually reaches a relatively stable value after about 3-6 km of transect distance.

reach a stable density value would be different. Given that the Bunaken numbers represent a real-world value, it seems reasonable to suggest that a minimum survey distance of 2-4 km is required to establish the general level of a population of *C. undulatus*. If the population is much lower than that at Bunaken Island, then this would be evident from such a survey, but the actual density value would not be known, just that it is somewhat lower than this example; in such cases, longer surveys would probably be needed [Note: an additional survey in Nusa Tenggara area, which has been heavily fished and where HHW are at very low densities required at least 20 km of survey distance before density values stabilized; IUCN/GWSG, 2006]. Higher densities will quickly become evident and, if useful,

during a survey, the survey could be terminated sooner if a large number of fish have been observed; however, data should be plotted to determine when sufficient samples have been collected.

IV. Discussion

Humphead wrasse abundance, densities and sizes

Great differences were found in the abundance and density of *C. undulatus* in the different areas of Indonesia surveyed. Areas with large human populations and apparent high fishing pressure (based on numbers of boats seen fishing) had lower numbers of *C. undulatus*, often to the point that no fish were encountered during extensive in-water surveys. Despite the apparent lack of fish on visual surveys, commercial fishers for the live reef fish trade (LRFT) are evidently able to continue to find a low number of these highly prized fish. Given the apparent number of fishers involved in searching for them (based on hookah boats seen), over time they would be extremely effective at discovering most individuals in an area and capturing them. Such efficiency of capture is evident since large and middle sized fish are virtually gone in most areas and only the smaller juvenile and very small adult female fish are left. The capture of these small individuals by the LRFT does not bode well for the future populations of *C. undulatus*, since reproduction is unlikely or at most limited to a vestige of its former level due to a lack of adult brood stock on the reef.

The only population of *C. undulatus* surveyed which even began to approach that of an unfished population (such as occurs in Palau) was around Bunaken Island, in the Bunaken National Park, where reef fishes reportedly receive a relatively high level of protection. The areas of the Bunaken Park more distant from Bunaken Island, which has the park headquarters (and ranger station), had lower numbers of *C. undulatus*, and individuals there reported that there were moderate levels of poaching in the more outlying areas of the park which would affect HHW populations away from the park center. It is likely that small spawning aggregations of *C. undulatus* occur at Bunaken Island, with one knowledgeable dive guide indicating reliably he had actually seen spawning occurring on one reef point of that island. While this is one bright spot, *C. undulatus* larvae spend at least three weeks living in open water and the young produced by such spawning aggregations may recruit far distant from Bunaken (where the juveniles could be subject to intense fishing pressure). It is unlikely (although possible) that any locally spawned fish will recruit to the Bunaken Park area. Very few small *C. undulatus* were seen around Bunaken (the exact opposite to what was seen in Raja Ampat and areas outside of Indonesia), and it appears that there is little recruitment coming in to eventually replace the adult fish presently found there. While this may not have a large effect in the medium term (5-10 years), it is likely that once the present adult spawning population(s) dies out (HHW may live more than 30 years), there will be no population to replace these adults. The situation is worse in other areas surveyed, since fish are either very rare (if they occur at all) or, at best, occur in low density. Even if some survive the fishing pressure to reach adulthood, the small populations of juvenile fish implies that replenishment potential for *C. undulatus* within many areas of Indonesia is going to be limited for many years to come.

These fish are charismatic and the species is of prime interest for tourist divers. Every diver knows this fish, whether they have actually seen it or not, and the value of one large male to diving tourism is very high. Among more experienced divers, the presence (or absence) of this fish is one way that they assess the "quality" of a dive area. The ability of diver operators to be able to have guests see these fish is very important, and protected areas (either formal, or protected by common consensus) are an important way to preserve this experience and the tourist funds it generates. Moreover, maintaining areas where adults can reproduce ensures that some broodstock will be generated for mariculture development. The numbers of large adults around Bunaken Island, similar to an area such as Palau

which is not heavily fished, are confirmation that protection can work and will have a beneficial effect on diving tourism. It is also possible that such areas are helping to maintain distant populations.

Raja Ampat Area

Thirty kilometers of surveys were done in the Raja Ampat region, covering an area of over 600,000 m^2 with 52 fish seen, all juveniles or very small females. Raja Ampat provides an interesting situation since there is a relatively low human population with large areas of suitable reef habitat for *C. undulatus*. While it might seem that *C. undulatus* would be abundant in this area, the populations were found to be surprisingly low, particularly for large adult females and males. It is likely fishing pressure from the LRFT has removed most of the larger individuals and is steadily "fishing down" the size and numbers of the remaining population, as well as focusing on the smaller “plate-sized” individuals which get the highest market prices. Fishing pressure is probably heavy on those fish that are in the 5-8 years age bracket and represent the brood stock for future populations. It is possible the numbers of larger individuals are naturally low, but if so, this would be the first area I have seen where a moderate population of juvenile fish was not accompanied by at least a limited number of large adults.

Most villages in the Raja Ampat area are limited in the extent to which they can range away from their villages to harvest LRFT fishes. This may have a somewhat limiting effect on population decrease. However, as the value of individual fish increases as the stock declines (according to market forces of demand and supply), this could bring incentives and financial resources to search a wider area using better boats and for longer periods of time at sea. Raja Ampat may have some areas that are so remote that they will continue to have low fishing pressure for some time in the future, but such were not sampled during this work.

North Sulawesi Area

Nearly 60 km of surveys were done in the north Sulawesi area, covering almost 1.2 million m^2, with only some areas of Bunaken Marine Park having any significant populations of *C. undulatus*. The generally low densities of *C. undulatus* around the north Sulawesi area is not surprising given the human population density and apparent level of fishing activity. The relatively robust populations found around Bunaken Island are an encouraging sign that protection is helping maintain a spawning population that area. There was a reported spawning aggregation site for *C. undulatus* at the southwestern tip of the Bunaken reef. This site was visited with a dive guide (Robert from Froggies Divers) who had seen the fish spawning there, and although it was not the right time to observe spawning, there were a number of adult fish there. It is very likely that the guide has actually observed spawning, since he clearly knew what he was talking about, had received training from WWF on reef fish spawning aggregations and after watching a powerpoint presentation on the spawning of HHW agreed that it was what he had seen.

East Bali-Kangean Island Area

Thirty five kilometers of surveys were conducted in eastern Bali-Kangean Island area, covering an area of over 700,000 m^2 with very low numbers of *C. undulatus* seen. The sparse populations of *C. undulatus* in the Kangean Islands were quite surprising at first, since the expectation was that this area, remote from high population islands, would have moderate numbers of fish; the area is also an important supplier to traders operating out of Bali (Y. Sadovy, pers. comm. from traders). However, the level of fishing pressure (as indicated by numbers of fishing boats), including explosive fishing and evidence of LRFT, is consistent with the lack of individuals of *C. undulatus*. In eastern Bali, areas with

extensive diving tourism seemed to be the only areas where large individuals of *C. undulatus* could be found.

Much more disturbing is the fact that in the east Bali-Kangean area not a single juvenile individual was seen in anywhere. Experience with spotting juvenile HHW from work in Palau and Papua New Guinea was excellent preparation for these surveys but none were to be seen throughout the trip. As indicated below in the "notes of methods" the search technique employed carefully scans all fishes visible, with an already strong search image present in this observer, and similar fishes were regularly seen (small wrasses and other fishes similar in shape or appearance).

Trade Information Gathered - Live Reef Fish Trade Issues

Most areas visited during this work had activities associated with trade in live *C. undulatus*. Most common were collection and sale of live humphead wrasse for the "Live Reef Fish Trade' (LRFT). An effort was made to visit collection stations at villages in all areas and to make inquires about the nature and extent of trade. Collection stations are usually floating net holding pens where local villages keep captured *C. undulatus* and other fishes prior to sale to trading boats calling at intervals of a few weeks to pick up fishes for shipment onward. Only juvenile and (potentially) small female HHW (i.e. fish less than 50 cm standard length and below 2 kg in weight) were seen in holding pens. This correlates well with the types and sizes of individuals seen during UVC. Views of some typical holding pens are shown as Figure 21.

Figure 21. View of typical live reef fish trade holding pens, Gam Island, Raja Ampat, Papua Province.

The rarity of HHW in Indonesia and nearby areas has been noted in various rapid ecological assessments. Allen (2005) summarized data collected from six different areas, and found the three areas of Indonesia surveyed to have very low numbers. During a three week survey in the Raja Ampat islands in 2001, he encountered only 7 HHW individuals, "most under 30 cm in length". In the Togian/Banggai Islands survey only 8 juveniles were seen. At only 15% and 12% of stations on these two surveys were any HHW seen and then usually a single individual. A survey in the Weh Islands, Sumatra, had no HHW observed during the entire survey. In Indonesia in general, anecdotal accounts from biologists and experienced divers have reported severely reduced numbers of this species in many areas and following many hours underwater (e.g. Mark Erdmann, J. E. Randall). Surveys in other areas, particularly Papua New Guinea, had numbers observed about 10 times greater than the Indonesia surveys (Allen, 2005). In Palau, where considerable work on HHW has been conducted, fishing pressure is light and the abundance, body sizes and density of HHW are many times higher than those seen during these surveys in Indonesia.

Allen (2005) reports *C. undulatus* "is a 'conspicuous indicator' of fishing pressure and that it is indeed heavily exploited, a typical situation in Indonesia". Amarumollo and Farid (2002) reported that in the Raja Ampat area LRF holding pens were found in the villages of Fam, Miosmauggara Mutus, Yembekwan, Arefi and Arborek. Reports indicated that fish ere usually loaded and shipped from villages of Mutus and Mioomanggara, where there are loading ports. They report in 2001 that serranids sell for 80,000 R (=Rupiah) and HHW for 130,000 R per kg to dealers, while fishermen receive about 3,000 R per kg. These authors did not report additional holding facilities, since the villages mentioned were the only ones visited. Many other villages in the region have holding facilities, and it is perhaps telling that the numbers of villages without holding facilities are very small. It is apparent that the entire village base of most areas is equipped and capable of catching live fish for the trade, when the opportunity arises, as this is a major source of cash income for them. [For recent trade and price data in Indonesia see accompanying report on trade surveys, and IUCN/GWSG, 2006].

Fish are reportedly (according to local informants) captured by divers probably using chemicals (sodium cyanide is typical), most often using hookah dive rigs, at various depths. Chemical use was not confirmed during the survey period but no other fishing method was evidently in use that would selectively harvest HHW and groupers for the LRFT.

Most of the villages in the Raja Ampat areas visited had live reef fish holding pens floating either offshore of the villages or located on nearby reefs. This is one is one of the few ways that villagers can earn cash money. The only holding station that had HHW during the visit (the fish are relatively uncommon compared to groupers) had 18 juvenile-small females individuals, of about 18-40 cm TL in a single holding net with about 50 juvenile *Plectropomus* and *Cromileptes* groupers. The HHW fetch R 250,000 per kg when sold to the trading boats, with groupers commanding a lower price. In the Kangean Islands, similar small HHW (15-35 TL) were worth R 350,000 per kg to the trading vessels, while groupers sold for only R 10,000 per kg.

No extensive LRFT holding facilities were encountered during the north Sulawesi trip; however, some villages had small floating cages (as opposed to the larger net pens) where some fishes were being held. Inquiries indicated, at most, a very low level of collection activity around Manado; however if a suitable fish were encountered, it would be captured and sold for LRFT. Although some restaurants in Manado reportedly do occasionally have *C. undulatus* on display for sale and consumption, the LRFT around Manado is evidently largely limited to local consumption, rather than for export. There were no reports of high levels of activity for the LRFT according to local informants and there were few major holding facilities present in the numerous villages visited.

Evidently the north Sulawesi area was extremely active in the LRFT in the early 1990's and potentially before, but it appears, based on limited information, that the reefs have become sufficiently fished out, or, perhaps, there is otherwise antagonism to the trade such that there is no longer any large to medium scale LRFT collection activity in the area. During 1993 on a diving trip to Manado, the author visited a LRFT holding facility on Bangka Island, just north of Sulawesi proper, and, although unfamiliar at the time with the LRFT, had been advised by Dr. Hanny Batuna of Murex Diving to go see the holding facility at Bangka Island for a sobering lesson in the extent of this trade. As he had indicated, the Bangka holding facility, located in a small bay at the southeastern corner of the island, had a floating pen with small house. There were many large adult *C. undulatus* in net pens, plus a wide variety of other large reef fishes, such as groupers, and other staples of the LRFT. The same bay was visited during the present work, but the station was not longer in place: reportedly it has been gone for some time as there were not enough fish left to support its existence. This small personal experience can perhaps give some indication how the LRFT can clean out areas and then move on to more productive harvesting grounds.

The Kangean Island area had a number of villages with LRFT holding pens, but large HHW are certainly rare in the area. Attention now appears to focus on juvenile individuals, plus groupers (generally also small) and *Cromileptes altivelis*. During four days surveying reefs of the Kangean area, covering about 25 km of reef edge and other habitats, not a single HHW was seen. However, despite the apparent rarity of HHW in the area (at least by visual surveys), one LRFT holding facility at Pulau Seredang Besar had over 20 HHW juveniles and about 100 grouper of several species. These small HHW in the Kangean Island area were reported to occur only in water 25-30 m deep (potentially fished out in shallow water) where they were captured by hookah divers using chemicals. The people running the hold facility indicated this fish is very uncommon and commands a very high price (R 350,000 per kg), probably higher than for any other fish. Other fishes, such as small *Plectropomus* and *Epinephelus*, fetch only R 100,000 per kg.

The presence of only juvenile and small female HHW in the LRFT trade, where there were previously much larger fishes (at least from the observations made during the earlier 1993 visit by the author), is very worrying. It appears that large individuals are now very rare in the areas visited and the live reef fish trade is now limited to the smaller fish, typically small females and juveniles. These may be preferred sizes for the live reef fish trade (or has the trade adjusted to the lack of large individuals?), and may be all that is available. Certainly even if the reportedly preferred sizes of *C. undulatus* (in the 500-1000 gm range) are available, all sizes of fish, including those under this desired size, are still being caught and held for sale. There still appear to be some large individuals left where diving operations provide incentive for their protection or other types of protection (such as marine parks) are in place. However, the status of HHW populations is quite worrying in the areas visited since the fisheries now appear to be taking smaller fishes, depleting the replacement fish at the juvenile stage. How spawning stocks can be maintained in the face of such pressure is problematic and includes the potential for a near total collapse of HHW fisheries in these areas of Indonesia.

Protection of fish at tourist diving spots and within marine parks can be important, if only to maintain a very small population capable of reproduction that might help to supply larvae to more distant, unprotected, regions. Populations of adults may also exist in areas that are difficult for fishermen to access for collecting using hookah diving and chemicals. The northern end of Talisei Island, according to the dive operator at Gangga Island, has several adult HHW and may well be a site for reproduction.

V. Recommendations for additional and repeat surveys

Additional notes on survey methodology have been developed (Appendix One), and a check-list of equipment needed for future trips prepared (Appendix Two). It is important to note that sometimes snorkel surveys must be done in areas where there is a high concentration of stinging plankton at the surface, hence in addition to a wet suit, it is advisable to use a "stinger hood" and gloves to cover the maximum of skin while swimming on the surface. Otherwise surveys might not be feasible (or at best uncomfortable) in some areas. Moreover, spending many hours on the surface can lead to sunburn on the head, which should be protected by a hood.

The importance of observers being able to properly identify juvenile HHW is critical to the validity of future surveys. On the present surveys, it was noted that several species of small wrasses could potentially be confused by inexperienced observers were also relatively common. In areas where juvenile HHW are not present (or at most very uncommon) there is no opportunity to have the visual image of the species reinforced for the observer, and unless observers are careful and already have a strong search image for HHW juveniles,

they are likely to mistake other species (which are generally more common in any area) for HHW, resulting in inaccurate and inflated surveys. This problem is discussed further below.

Training for estimation of fish length usually involves experience estimating the size of "model" fish (typically wooden forms of known length in the shape of fish of interest), first on land and then underwater. Because of the refractive index of water, objects underwater appear closer and larger than on land, resulting often in overestimates of length. It is also useful to have something with the person doing a survey to indicate lengths. Generally an underwater slate with its edge marked off in 5 cm increments (to provide a scale for comparison with fish length) is used and can be held out at a distance and the relative size of a fish compared with the length value on the scale. At best, the data obtained are estimates only, and trained observers can expect to be accurate to within only 10-15% of the actual length.

Additional general observations from survey trips.

Blasts from explosive fishing were regularly heard in the Kangean Island area. Generally 1-3 explosive blasts were heard per hour of survey time. Often times evidence of explosive fishing could be seen in reef areas, where hollowed out depressions occurred in coral areas that had been flattened by explosions.

The majority of areas visited had moderately to extremely healthy and lush coral. Often the general appearance of reef health could change quickly over short distances, from barren rubble to lush coral, and it is risky to make an assessment of reef condition based on just a small area viewed. Because of the rapid changes in reef condition, it is dubious to tie the presence of HHW to any particular condition of the reef, as long as the reef is fairly health and lush. Truly barren areas of coral rubble had no HHW at any time.

There was only one area where a significant indication of crown-of-thorns starfish (*Acanthaster planci*) damage was occurring. This was on the western side of Igangan Island where a small portion of a large area of lush coral, among the best seen during the trip, was being preyed upon by *A. planci*. Over time these *A. planci* may have an overall deleterious effect on this trip, but for the moment, although intense in a small area, they are not having a general effect on the reef.

VI. Problems with identification of juvenile HHW

Large male and female HHW are, of course, distinctive and unlikely to be confused with any other species. The only potential confusion might arise from confusing the name “humphead” and “bumphead”, in which case is more a matter of semantics, rather than biology, as the bumphead parrotfish, *Bolbometopon muricatum*, is not easily confused with HHW, except with regard to their common names.

A much more difficult problem is the identification of juvenile HHW, particularly underwater in the field. The juveniles in the LRFT appear to be of a size of about 25-35 cm total length, based on the ones seen at Pulau Seredang Besar and Raja Ampat. At this size there are a number of other reef fishes, particularly related labrids, which can be confused with *C. undulatus* on underwater visual surveys.

This is an extremely important factor that MUST be considered in any future efforts to monitor populations. Two wrasses for which their large juveniles and adults resemble juvenile HHW are *Cheilinus trilobatus* and *C. chlorurus* (Fig. 22). They are similar in shape, have some resemblance in coloration, swim in the same manner as juvenile HHW and can occur in the same habitat (indeed, their presence is a useful indicator that suitable habitat for the HHW is being surveyed). These similarities are a recipe for confusion and misidentification, and can easily result in fallacious population estimates for HHW. Since these more common wrasses can be confused with juvenile HHW, then the presence of juvenile HHW may easily be overestimated based on this misidentification, perhaps leading authorities to conclude the juvenile population is fine, when it is in fact not. There is also one parrotfish, *Scarus* sp. (species undetermined at present), for which the females have an overall gray color and from above have a general resemblence to *C. undulatus*. Under less than ideal conditions, this parrotfish can be mistaken for a juvenile HHW.

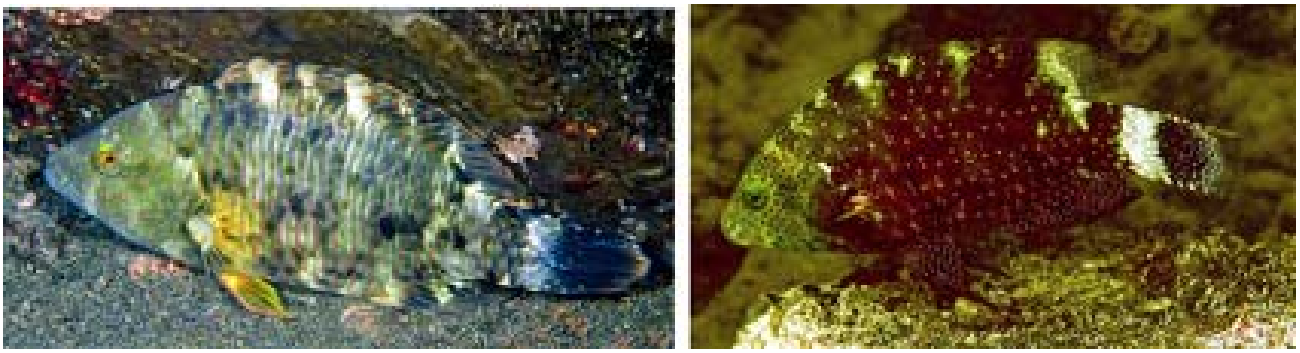


Figure 22. *Cheilinus trilobatus* (left) and *Cheilinus chlorourus* (right): under certain light conditions these species can closely resemble the HHW although the behavior of *C. chlorourus* is much more secretive and a little practice will make the species distinctions clear. With kind permission of Rudie H. Kuiter

One experience on the east Bali-Kangean Island trip was a good example of how this confusion might occur. Prior to visiting the fish holding facility on Palau Seeding Bear, the local dive guide on the Ambasi did not appear to have any clear concept of what a juvenile HHW looks like. He certainly had not mentioned seeing any on any of our previous dives. However, we saw numerous juveniles close up at a LRFT holding pen and on the next dive on the reefs off Tulamben, after the dive he mentioned that "there were a lot of young Napoleans" on the reef. In fact there had been was a lot of young *C. trilobatus* and *C. chlorurus*, not *C. undulatus*. On the dive in question there were many many smaller *C. trilobatus*, and the total lack of *C. undulatus*, so this comments was extremely revealing of the level of distinction by someone who, although a professional dive guide, has only a basic knowledge of reef fish species. On a later dive, the guide thought that a nearby *C. trilobatus* juvenile indicated was a juvenile HHW. If someone with broad experience working on the reef can make this understandable mistake, then this implies that great caution must be used to have any persons doing future surveys thoroughly understand the differences and be able to make the identifications of these similar species of *Cheilinus*. One could easily see a situation where a survey just completed, with no HHW juveniles being spotted, is repeated in a few years by an individual who confuses HHW with *C. trilobatus*. The observer reports that there are now quite a number of juveniles HHW present, therefore the species is recovering nicely, when this might not the case at all.

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APPENDICES

Appendix One - Additional notes on survey methodology

This field work used to the "GPS density survey method" to assessing the abundance of a relatively uncommon reef fish species. Overall a very large number (probably many millions) of reef fish were examined in assessing the presence of *C. undulatus*. The observer would swim along the desired track, or more conveniently be assisted by or totally propelled by currents, scanning all fishes moving over the bottom from a vantage point several meters above the reef. Those fishes visible are individually identified as to what they are and whether or not they are the target species. In this sense, each and every fish sighted is considered as to whether or not it is the target species. All those NOT the target species are required to be identified to some known taxonomic level before they are passed over. For example, it is not necessary to identify all surgeonfish to what species they are, but just to confirm that they are surgeonfish, not *C. undulatus*, before they can be ignored. Often, when a fish is not totally visible or at an angle at which the defining characteristics of *C. undulatus* can not be seen, it is necessary to focus closely on an individual until the species identification is confirmed.

An important need in this survey work is for the observer to have a firm "search image" for the fish(es) concerned. The observer needs to have experience in identifying reef fishes, and more importantly to have numerous occasions to see the focus species, such as *C. undulatus*, in the field and to be familiar with both juvenile and adult color, pattern and behavior. It is not advisable to have inexperienced persons do GPS survey swims, or indeed, transect, without considerable experience in the techniques and identification of reef fishes. While the techniques used are relatively simple, they can be easily compromised by mistakes of inexperienced observers to the point they are useless. This is the situation for *C. undulatus* where untrained observers can easily confuse juveniles and adults of several species of fishes for juvenile *C. undulatus*. In some cases, observing *C. undulatus* in fish tanks would be a useful exercise to obtain the proper search image, however, similar exposure to "look-alike" species is needed to make the critical discrimination between species. Errors in identifying *C. undulatus* will lead to overestimates of population numbers, if other species are confused for it.

When making observations of fish occurrence on GPS survey swims, a scanning technique is used to search for target species on the swim track. The observer should focus his vision in a direction, holding that direction for a few seconds (rather than constantly scanning without stopping) to detect fishes that are either stationary or moving in the area under consideration. The focus is constantly shifted, to cover a broad area ahead as well as to the left, right and directly down from of the survey track to make sure no fish escapes attention. It is also important to scan directly beneath the track (either side) to catch individuals which do not move until the closest approach of the observer. All efforts should be focused on getting accurate counts and greatly reduce the number of "missed" individuals. So it is a combination of scanning ahead and below, both left and right, while having a strong search image for the species of interest that allow observations cto be assessed instantly as positive or negative. This system works well for any species which either is visible against the reef or moves as an observer approaches. Missed observations would lead to underestimations of fish numbers of future surveys.

Those bottom-dwelling fishes which blend with the reef background and do not move are more difficult to accurately survey. Visual surveys are obviously going to miss a large number of them and such species would not the best candidates for GPS density surveys. As indicated above, for species of interest, such as *C. undulatus*, having prior knowledge of the appearance of the species of interest against the reef is very important, and allows the determination of whether or not a particular species is suitable for this type of survey. Having the proper "search image" is important for doing accurate surveys, and obtaining that "search image" is most easily acquired by experience. Therefore it would be important for future observers to have experience in looking for and locating the species of interest before GPS surveys are attempted. Where a species is uncommon, such as some areas included in these surveys, acquiring a search image for the target fish will be difficult, since there are few individuals to observe in the field. In such a case, underwater photographs, video footage, or visits to aquaria where the fish is on display may help to provide a search image for the observer in advance of field work.

The pace of swimming during the survey swim should be relatively slow and methodical, rather than trying to swim along at a fast pace to cover the most ground. The intention is to cover the most area while maintaining a swim speed well within that for which the observer is capable of detecting every individual of the target species. If enough time is not available to adequately scan the fishes seen, then the observer is moving too fast. The swimming speed can be slowed

down. There may be situations where currents are moving the observer faster than close observation can be made, but since it would be difficult to slow down by swimming against the current, there is little can be done in this situation except to try to deal quickly with the fishes observed as you pass by them.

Species and Habitats Surveyed – While the intentions of the surveys were to quantify abundance of *C. undulatus*, since these were relatively uncommon, it was decided to count the presence of selected other species of larger reef fishes of interest, to gather additional useful data for important species more abundant than humphead wrasse. At the start of the work, it was uncertain exactly what would be the species of interest that would be present in sufficient numbers to gather some interesting abundance data, however several fishes were quickly chosen within the first few survey swims. In general all large species of snappers (Lutjanidae) were counted when seen. These included *Lutjanus bohar*, *L. rivulatus, Symphorichthys* and some others. Scarids were quite common in reef areas, and only the presence of *Bolbometopon muricatum* was noted, although the presence of some larger scarids (*Cetoscarus bicolor* and other uncertain species) was occasionally noted. Other larger fishes noted included *Platax* sp. (round large one) and any sharks or large rays seen. Finally all turtles seen were recorded.

An interesting group of fishes for which data were NOT taken until late in the surveys were the larger angelfishes, such as *Pomacanthus imperator* and *Holacanthus semicirculatus*. These were often seen, but not in huge numbers so their presence should be noted in future surveys. In the second and third survey areas, some new species, uncommon in earlier areas, were seen and data taken on their occurrence.

Other labrids noted included the “look alike” species of *Cheilinus trilobatus* and *C. chlorurus*, plus occasionally *C. fasciatus*. These were noted to document the common occurrence of species which can be mistaken by the "uninformed" for juvenile *C. undulatus*, and just to document the presence of similar wrasses (congeners) to make it evident that the areas surveyed were being carefully searched for the presence of juvenile *C. undulatus*.

Notes were taken of habitats present, the condition of corals and coral reefs, presence of crown-of-thorns starfish (*Acanthaster planci*), coral disease, occurrence of large numbers of normally uncommon species, and the occurrence of underwater blasts from explosive fishing. All this information is noted by time, so position of any item of interest can be determined from the GPS track data.

Notes on Survey Maps.

It was found that the latitude/longitude scales of charts and maps of the areas surveyed often differed from the features presented by the GPS survey tracks. Because of the inaccurate locations of features on charts, GPS survey tracks would often plot out the land of islands, and not match the profile of islands with errors of around 400-800 m being common. Whenever possible, a known reference point was included in the survey track to allow accurate placement of the survey tracks, in the absence of an geographically correct map, relative to features found on charts and maps. Such georeference points included swimming along island shores with an identifiable profile, locating an object, such as a light marker, on the GPS swim. With a bit of imagination usually something can be found to more accurately position the survey on maps or other images for future reference. The ability of any competent investigator to properly located and repeat the present surveys in the future has been a constant consideration.

For satellite images, used in many of the figures in this report, the tracks have been fitted to reef profiles, island shores, and other features, as mentioned above, with the latitude/longitude scale included in the figures referenced to the GPS tracks. There may be slight errors in the positioning of the satellite image relative to the lat/long scales, however, these errors are relatively minor and do not compromise the accuracy and precision of the GPS survey tracks.

Errors found in survey tracks.

The survey tracks rely on relatively inexpensive hand-held GPS units. Garmin Etrex "Venture" units were used as they are about the most inexpensive (about US$150) which have the logging capability and are small in size. Most handheld GPS receivers are relatively good at giving accurate positions and in most cases the positions indicated have an accuracy of 6-9 m. Since the units only measure to 0.001 minute of latitude or longitude, they can only resolve a distance change of about 1.8 m (equivalent to 0.001 minute of latitude or longitude near the equator). Higher accuracy would only slightly increase their ability to accurately locate a position.

The strength of the method for assessing abundance comes more from the ability of the units to record changes in distance over the logging intervals, which is relatively robust as long as the observer is moving a few meters during the logging interval. At an easily maintained survey swimming speed of about 1 km per hour (30 m per minute), the logging

interval of 15 sec produces a horizontal position change of about 5-10 m. Since the minimum unit that can be detected by a 0.001 minute change in position is about 1.8 m, each 15 sec intervals should see a change in latitude/longitude of 0.003-0.006 minutes, an easily detected difference for the GPS receiver. Minor perturbations in the track from this resolution limitation are quickly reduced to insignificance over the course of 15-30 minutes of survey time. The errors are also increased slightly when using the GPS receiver while SCUBA diving since the float is deployed with using a reel and the receiver is often not directly above the swimmer. The use of minimum amounts of scope in the reel line helps, but has to be balanced against the need for the float to remain on the surface. If pulled under the surface by currents or insufficient scope on the towing line, the GPS unit will not receive its position data. It is necessary for the diver to be aware of what the surface float is doing and if pulled under, this is usually evident by increased tension on the towing line. Additional line is let out until the float returns to the surface. The GPS unit will quickly acquire the signal and continue logging. Interruptions in the logging are evident when downloading the track positions afterwards. The amount of scope of the towing line is a source of minor error (since the float may not be directly over the diver) and should be considered in any assessment of final accuracy of the survey. Overall the method is intended for surveying large areas, not conducting detailed surveys of areas of 50-100 m or less in extent. For this other methods should be used.

Accurate recording of time at which things are observed is very important, if accuracy of location is critical. If positions are being recorded every 15 sec an error in timing of a few sec is not important, but errors more than 5-10 sec from correct time (as determined by the time displayed on the GPS once it has acquired a position are being turned on) are to be avoided. If a shorter logging time interval is used, accurate times for observations are even more important. If the time error is more than half the logging interval, this probably represents an unacceptable degree of error in time versus position data.

Appendix Two - HHW Survey Trip Check List

Dive Equipment

Regulator with hoses and gauges
Dive Computer
Extra dive computer batteries
Wet Suit
Mask, fins, booties, snorkels
Snorkel holder
Extra masks and snorkels
Weight belt with clips
Extra weight belt for snorkeling with clip
Extra brass clips
Flasher light
Safety Sausage
U/W flashlight
Stinger hood for shallow work (also from the sun)
Gloves

GPS Survey Equipment

GPS floats (3)
Reels (2)
Extra screws for housings.
GPS units (4)
AA batteries, enough for one set (2) each day per GPS
Download cable (2)
Computer and charger
Plug adapters for Indonesia
Garmin world map software
Extra copies Garmin software (2)
UW slates and UW paper, pencils, string, tape
Rubber bands
Flash memory for back up
Short nylon line tether for snorkeling (to attach GPS float to)

UW Photography

Camera and Strobe housing
Extra port
Extra o-rings
Housing spare parts
Silicone grease
Extra camera battery
AA batteries
Download cable for card reader
Card reader
Extra flash card

General Supplies

Tools
Electric tester meter
Extension cords
Maps and other charts
Knife
Swiss Army Knife
Scissors
Tie wraps
Filament tape
Electrical tape
Package tape
Whirl Paks
Marine adhesives
Label paper
Pens, etc.
Notepads
Sandpaper for slates
Cleanser for slates
Language books
Towels
Calculator
Dessicant
Cheater plus
Envelopes/Stationary
1 liter plastic bottles``

Personal Items

As needed

Additions through 11 July 2005