

POLICY BRIEF

Initial findings and policy recommendations to sustain the live reef fish for food industry, Palawan Province, Philippines

Status of the Palawan live reef fish for food fishery

The live reef fish for food fishery of Palawan is being over exploited and depleted as early as 2003. Based on the current status of the reef areas within Palawan, the computed province-wide maximum sustainable yield for grouper (**MSYG**)¹ was computed at **186.09 t/yr** under the best of conditions (i.e., assuming no overfishing, yearlong use of cyanide and other destructive methods leading to degradation of reefs and to depletion of live fish stock) while maximum sustainable export for grouper (**MSEG**)² was computed at **139.56 t/yr**. In contrast, the volume of live groupers shipped out of Palawan was recorded at 309.19 tons in 2003 and has steadily increased to 669.08 tons in 2007. This shipment data can be taken as the minimum harvest considering the inherent mortality associated with the live reef fishery. Given the moderate to heavy fishing pressure that the groupers have been experiencing since 4 years ago, the groupers' rate of depletion has therefore been increasing and the current harvests are not sustainable anymore (**Figure 1**).

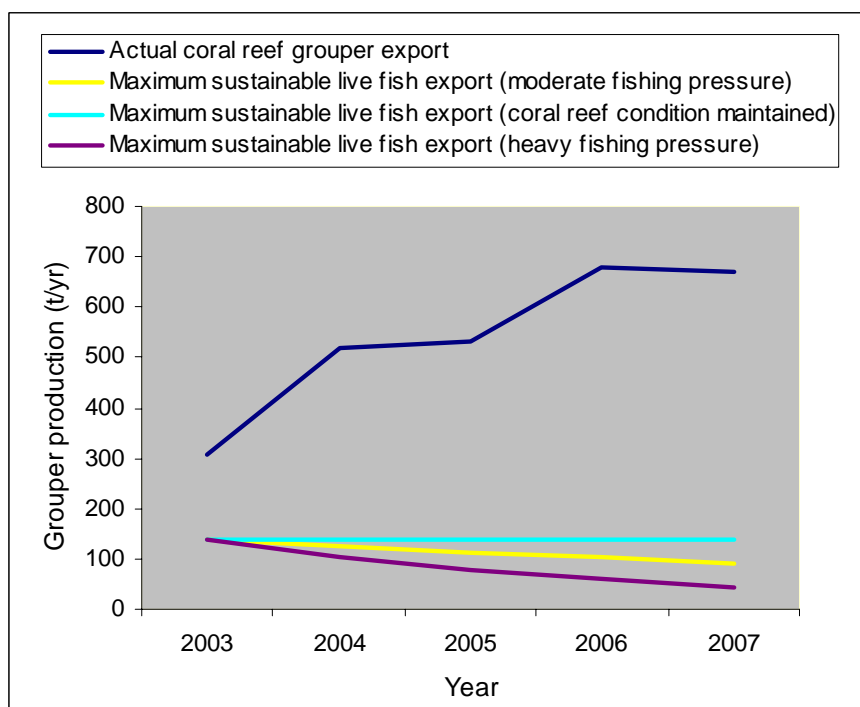


Figure 1. Actual live grouper export against varying levels of fishing pressure

The 2007 estimated **provincial level depletion** under varying levels of fishing pressure are **624.93 t** (heavy fishing pressure), **577.52 t** (moderate fishing pressure), and **529.52 t** (negligible fishing pressure). The same scenario of depletion is shown to occur on a per cluster basis. The 2007 estimated level of depletion versus the estimated MSEG for the whole province and by cluster is shown on **Table 1**.

¹ The maximum grouper productivity of a reef in an area in a year; measured in tons or kilograms of grouper fish per square kilometer or hectare of a reef per year

² The maximum volume of live grouper in a year that can be shipped out of Palawan; assumed to be 75% of the MSYG

Table 1. Estimated level of depletion of grouper (tons) for 2007, Palawan Province

Area	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
Province wide	669.08	44.16	624.93	91.57	577.52	139.56	529.52
Calamianes Grp.	233.71	6.80	226.90	14.10	219.60	21.50	212.21
Mainland and nearby Island municipalities	308.15	33.20	274.95	68.84	239.31	104.93	203.22
Cuyo Grp	127.23	4.16	123.07	8.62	118.61	13.14	114.09

Contributing to the depletion are the generally bad health condition of our coral reefs due to (1) illegal methods of fishing such as the use of cyanide and dynamite, (2) siltation from the terrestrial areas, (3) sea water temperature increase due to global warming, and (4) the continuous over-fishing over the years. The Palawan reefs only has **109.234 km² (13.37%)** in **excellent to good reef conditions** while the larger area of **707.513 km² (86.63%)** are classified as being in **fair to poor reef conditions**. This translates to poor reef productivity (**Figure 2**).

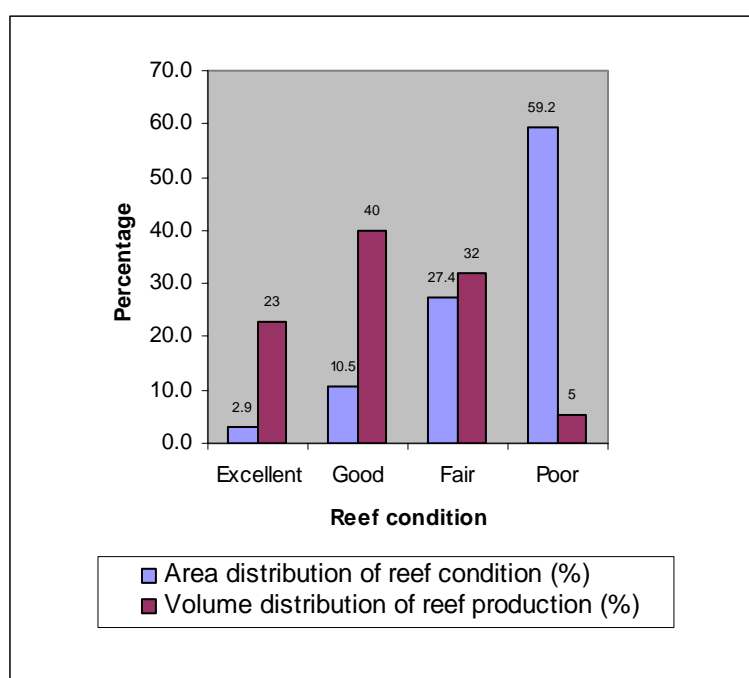


Figure 2. Percentage of coral reef live fish yield per condition, Palawan Province

Meanwhile, the increasing trend in the volume of live reef fish shipped out of the province is also a major contributing factor. Shipment out of the province more than doubled within the last five years (**Table 2**).

Table 2. Live reef fish for food exported out of Palawan, 2003-2007

Year	Actual Live fish Volume (t) shipped out of Palawan	Volume (t) shipped out of Palawan, accounting for 5% under-coverage
2003	305.19	321.25
2004	517.92	545.18
2005	531.81	559.80
2006	679.26	715.01
2007	669.08	704.30

Recommendations

Following the initial findings and analysis, the initial recommendations are as follows:

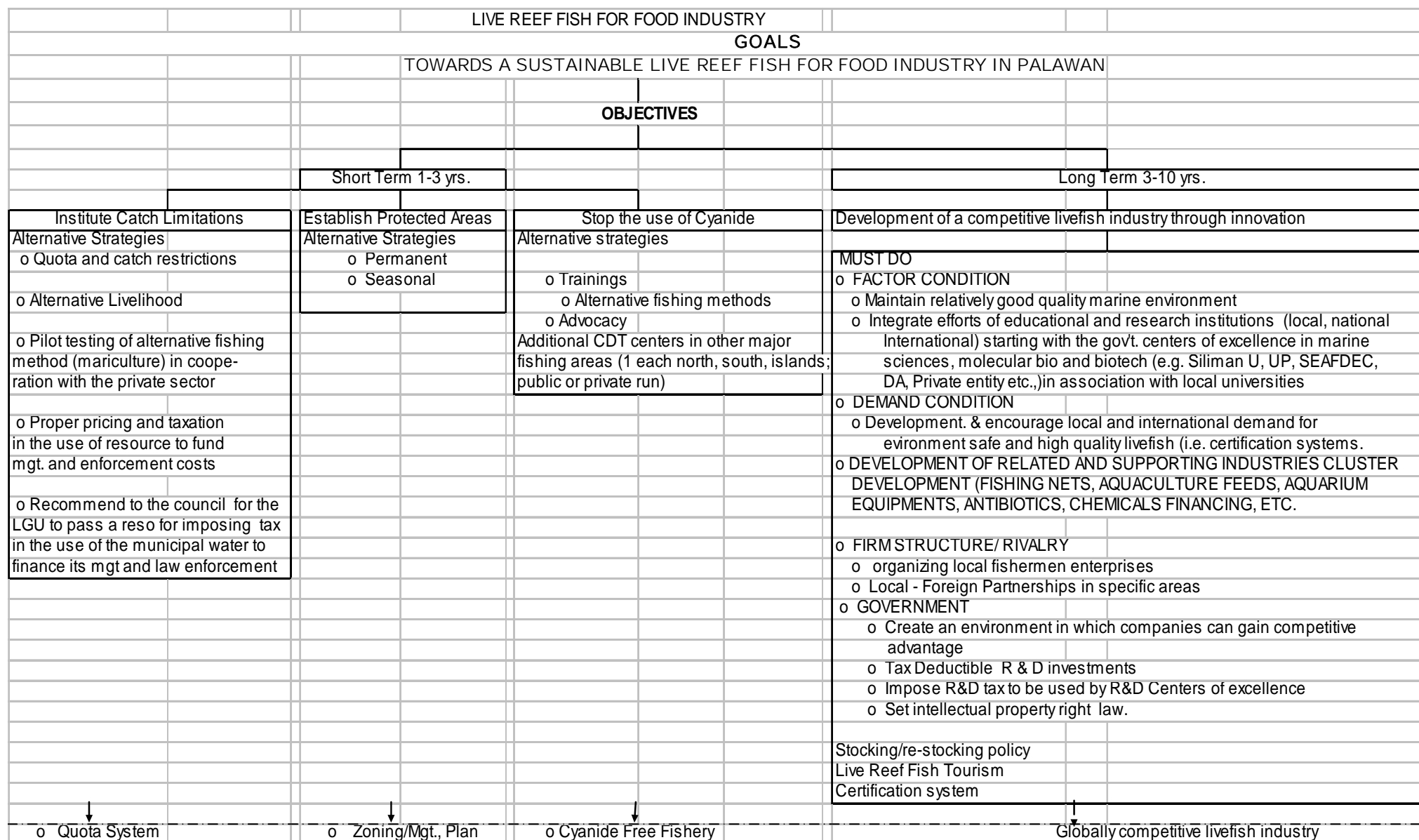
- Reduce the exploitation by the removal of depletion to the 2007 level. This will be done by setting the annual quota to be traded at the MSEG level either province wide or by cluster UNDER condition of negligible fishing pressure, distributed among the existing (100) accredited traders, AND to be implemented over a 3 year period. Under this condition, the quota in the export volume will amount to 493 t, 316 t, and 140 t, in year 1 (2008), year 2 (2009), and year 3 (2010), respectively. The third year will level off the depletion rate to the current MSEG. **Table 3** is the expected yield quota per trader in 2010 if the number of traders given new or renewed accreditation remains the same as today.

Table 3. Maximum sustainable live reef fish production and export, number of live reef fish trade accreditations, and live reef fish quota per trade accreditation after 3 years

Area / Region	MSYG (t/year)	MSEG (t/year)	Number of existing trading accreditations	Annual allowable live fish export (t/year) per trader
Entire Palawan Province	186.09	139.56	100	1.40
Calamianes Group of Islands	28.66	21.50	25	0.86
Cuyo Group of Islands	17.52	13.14	3	4.38
Palawan Mainland and neighboring island municipalities	139.90	104.93	72	1.46

- Development of a provincial innovation for the live reef fish for food industry towards sustainable global competitiveness employing a combination of clean environment, science and technology, the involvement of private sector, the academe, the government and the communities (**Figure 3**).

Figure 3. Policy framework for developing a sustainable live reef fish for food industry in Palawan



POLICY PAPER

Sustaining the Palawan Live Reef Fish for Food Industry

A Report to The Palawan Council for Sustainable Development

**Planning and Technical Services Department
Palawan Council for Sustainable Development Staff**

September 2007

DRAFT ONLY: NOT FOR QUOTATION OR REPRODUCTION

POLICY PAPER

Sustaining the Palawan Live Reef Fish for Food Industry

1.0 INTRODUCTION

1.1 The international context

The live reef food fish (LRFF) trade is an international trade. Though there are disagreements in literature on the status of the trade, a recent study by WWF showed that the trade is growing (WWF, June 2007, Live Reef Fish Trade in the Sulu-Sulawesi Marine Ecoregion - Trade Scoping Study Draft Report). The declared imports into Hong Kong increased 27.5% between 2002 and 2005, and major growth has been recorded in low- and medium-value species. The same study showed that the Philippines is the major exporter of the commodity to Hong Kong with record of 1,724.073 MT in 2005 compared to the other two major exporters, Indonesia and Malaysia. This accounts for 46% of the three country exports to Hong Kong.

Hong Kong is the major trading and market destination for much of the traded live product, accounting for around 65-80% of the trade. In turn, the bulk of its imports are sent to mainland China, which appears to be the largest market, followed by Hong Kong (Graham, 2001). Taiwan is the next largest market, but imports of market-size product are becoming less important as Taiwan increases local full-cycle and grow-out production (F. McGilvray, IMA Hong Kong, pers. comm., 2001). Other important markets for live reef food fish in the region include Singapore, Japan and countries scattered throughout the Pacific rim, including western USA, where temperate reef species are increasingly being marketed live (Sadovy and Vincent, in press).

1.2 The Palawan context

The live reef fish for food fishery is an important economic activity for the province of Palawan. The fishery is highly valued, with estimate of Php 1.22 Billion for a total volume export outside of the province of 769.26 tons in 2006 (**Table 1**).

Table 1. Palawan live reef fish for food export volume and value, 2003-2007

Year	Reported live Reef Fish Volume (t) Shipped Out of Palawan	Approximate Gross Value, Php (based on Php1,800 landed price in Manila)
2007	669.08	1.20 Billion ¹
2006	769.26	1.22 Billion
2005	531.81	957.26 Million
2004	517.92	932.26 Million
2003	305.19	549.34 Million

¹ Export volume for July-December 2007 projected based on the recorded export volume for the same periods for 2004-2006

For 2007 a total of 186 PCSD accreditations were issued, broken down as follows (**Table 2**): trading, 89; caging, 62; and transport, 35. The highest number of 21 trading accreditations was issued in Coron Municipality. Meanwhile, the number of caging accreditation is most numerous in Taytay Municipality. For live fish transport, Puerto Princesa City and Taytay Municipality registered 6 accreditations each. The fulltime fishermen engaged in the industry is estimated to be 3,000.

Table 2. Number of PCSD issued accreditation by municipality, 2007

Municipality	Trading	Caging	Carrier	Total
<i>Calamianes Group of Islands</i>				
Busuanga	1			1
Coron	21	10	4	35
Linapacan	2	1		3
<i>Cuyo Group of Islands</i>				
Cuyo	2			2
Magsaysay			2	
<i>Greater Palawan</i>				
Aborlan	7	6	3	16
Araceli	3	3		6
Balabac	2	2		4
Bataraza	4		1	5
Dumaran	2	2		4
Narra	2	1		3
Puerto Princesa City	1	2	6	9
Quezon	8	4	4	16
Rizal	4	3	4	11
Roxas	11	6	2	19
San Vicente	5	3	3	11
Taytay	14	19	6	39
TOTAL	89	62	35	186

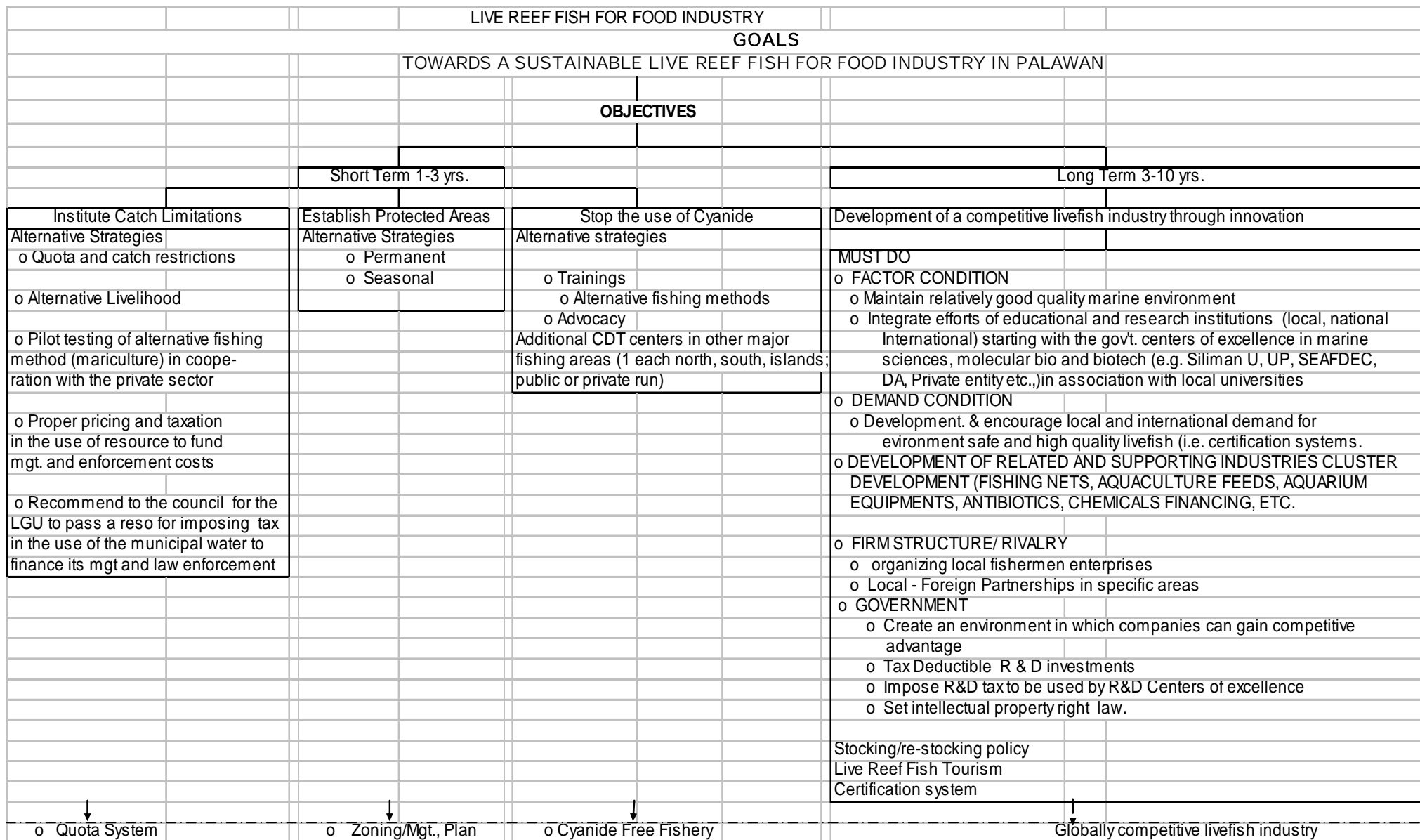
Currently, there are two main policies being implemented relating to the LRFF industry: Provincial Ordinance No. 941, as amended, and PCSDS Administrative Order No. 05, as amended. Both policies address the problem of sodium cyanide use in the LRFF trade. In addition, Provincial Ordinance No. 941, as amended, goes beyond the issue of illegal fishing in the industry. The ordinance also focuses on the issue of overfishing (with provisions for size limits and close and open season) and the protection of wild stocks through the identification and establishments of Spawning Aggregation Areas (SPAGS) as fish refuges, sanctuaries and Core Zones under the ECAN of the SEP.

There is still a need, however, to strengthen these policies towards developing a sustainable live reef fish for food industry for the province. Specifically, there is urgency to determine the following: (1) the setting of the annual quota to be harvested and traded, (2) the annual number of PCSD Accreditation to be issued, and (3) the annual allowable quota to be traded for each Accreditation. Furthermore, there is the need to (4) review and set size limits for each species captured and traded, (5) identify SPAGS areas, (6) declare these SPAGS areas as fish refuges, sanctuaries, and Core Zones under the ECAN, (7) set-up an effective trade monitoring system, and (8) review of the sodium cyanide test protocol.

2.0 THE PROPOSED PCSD POLICY ON THE LIVE REEF FISH FOR FOOD INDUSTRY

The summary of the proposed policies is contained in the policy framework, shown in **Figure 1**. The ultimate policy goal that was developed is for a sustainable LRFF industry in Palawan Province that ensures viable fish stocks, healthy reef ecosystems and suitable livelihood options for present and future generations. Any policy to address this goal must be simple, cost-effective and enforceable. Furthermore, before any consideration can be given to policy options for developing a sustainable LRFF industry in Palawan Province, five overriding issues will need to be addressed. First, there is a need for effective monitoring and enforcement mechanisms. Second, it requires active industry support. Third, viable alternative and supplemental livelihood opportunities will need to be created for the fishers. Fourth, a LRFF management plan must be developed. Fifth, political will must be present. No matter what policy option is considered and eventually agreed upon, without addressing these five issues, it will be ineffective.

Figure 1. Policy framework for developing a sustainable live reef fish for food industry in Palawan



2.1 Short term policy (1-3 Years)

2.2.1 Objective

The short-term (1-3 year) policy objective is the development of a sustainable LRFF in Palawan Province through the reduction of threats associated with destructive fishing methods and overfishing. This will be achieved through (1) a regulated LRFF industry trade with quota assignment in the accreditation of traders, (2) marine ecosystem conservation and rehabilitation, (3) the strengthening of existing enforcement and monitoring initiatives, and (4) provision of viable livelihoods and community and economic development for coastal communities.

2.2.2 Recommended specific activities

The LRFF trade shall be regulated province-wide based on the level of over-exploitation. A quota system per municipality shall be established in terms of (1) the volume of live-reef fish allowed to be caught and traded, (2) the number of PCSD Trading Accreditation to be issued, and (3) the volume of live reef-fish to be assigned for each PCSD Trading Accreditation. The initial recommended allocation of quota shows drastic reduction in export of the live reef fish for food (**Table 3**). The implementation of this quota system can either be province-wide or by cluster, AND can be imposed immediately (one time) or progressively (subsequent quota reduction).

Table 3. Maximum sustainable live reef fish production and export, number of live reef fish trade accreditations, and live reef fish quota per trade accreditation

Area / Region	MSYG (t/year)	MSEG (t/year)	Number of existing trading accreditations	Annual allowable live fish export (t/year) per trader
Entire Palawan Province	186.09	139.56	100	1.40
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Following this system shall be the following supporting actions:

(1) all compressed air gear for fishing would be banned;

(a) All compressors and associated equipment and SCUBA used for fishing will be banned from use in the waters of Palawan Province. Those current owners of compressors will be compensated by the government based upon an agreed standard value for the equipment.

(b) Fishers will be re-trained in the use of non-destructive fishing methods, such as hook-and-line, and in the proper handling of fish at capture and during post harvest to reduce incidence of live reef fish for food mortality. Outreach efforts will be undertaken to induce fishers to switch to non-destructive fishing methods.

(2) all non-resident fishers would be banned from municipal waters;

(c) Only licensed fishers who can show full time residency in a municipality of Palawan Province will be allowed to fish in the municipal waters (within 15 km from shore). Each vessel must display a license number on the boat and each fisher on the boat must have proper license identification.

(d) Each trader applicant shall be required to organize their own catchers which the trader applicant shall apply for PCSD Accreditation simultaneous with the trading application.

(3) spawning aggregations for target species of the trade would be closed;

(e) There will be an annual closure of a determined period on fish aggregations for selected target species of the trade during spawning. Marine protected areas (MPAs) will be established at these sites. MPAs can serve to protect and enhance fish stocks, improve ecosystem integrity and functions, and support ecosystem rehabilitation. In some cases, permanent closures of areas may be necessary to protect fish stocks from depletion. Fifth, enforcement will be improved and increased as recommended above.

(4) individual target fish in the trade with the following maturing and mature sizes (size range at sexual maturation or first reproduction) shall be banned from being caught and traded:

(f) Initially, the following size limits for each specific species shall be imposed:

Species Name	Common Name	Mature size (TL)
<i>Plectropomus leopardus</i>	“Sono”	28 cm to 33 cm
<i>Cephalopholis miniata</i>	Coral hind	16 cm to 19 cm
<i>Cromileptes altiveles</i>	Humphead grouper	30 cm to 40 cm
<i>Epinephelus ongus</i>	White-streaked grouper	18 cm to 21.4 cm

(5) the ban on the use of cyanide would be enforced through testing at a cyanide detection testing laboratory²;

² The efficacy of testing for cyanide will still largely depend on any instituted protocol pending a review of the testing process. The integrity of CDT has lately been questioned due to the generation of “false positive” and “false negative” results and the fact that results of the testing may not be admissible in courts (Sadovy, presentation to the PCSD Council Meeting, 28 September 2007).

(g) A cyanide detecting testing (CDT) laboratory will be established in Coron. All exporters from the area will be required to submit to random sampling and testing, inspection, and government licensing. All shipments will require a certificate showing the origin, volume, and species composition of the shipment, and certifying that the shipment has been subject to random CDT procedures and is cyanide free. A tax will be levied on each shipment to pay for testing and monitoring.

(6) a monitoring system, monitoring team and network would be established;

(h) All players in the LRFF industry – fishers, traders/middlemen, boat owners/operators, exporters - will be required to be accredited by the PCSD (as required under PCSD A.O. Order No. 00-05). All accredited entities will be required to submit monthly records of fish catch by species, volume and location, and fish mortality, to a monitoring team. Field monitoring shall be done by a monitoring team to be led by the Provincial KSK and to be composed of representatives from Bureau of Fisheries and Aquatic Resources – Department of Agriculture (BFAR-DA), Philippine National Police (PNP), Palawan Council for Sustainable Development Staff (PCSDS) and municipal government.

(i) The accredited players will be subject to random checks on catch and records by enforcement staff of the monitoring team.

(j) The export and transport of fish and fisheries products in the Philippines require permits from the BFAR. License conditions require that the exporters maintain and submit records on the number and species of fish exported.

(7) for every fish exported out of the municipality, a levy would be charged equivalent to 10% of the traded value of the live reef fish per kilogram.

(k) This amount would be used by the LGU to fund the management of the live reef fishery stocks, enforcement, monitoring and administrative costs associated with the industry.

(l) Furthermore, to ensure the implementation of a workable monitoring system, municipalities where the industry will be allowed shall submit to the PCSD the following requirements, specifically ensuring that cyanide will not be used in the industry:

1. Declaration from the municipal government of a policy to combat the use of cyanide in the LRFF industry either by resolutions or by local ordinances which include implementing guidelines addressing the problem of sodium cyanide use in the industry.
 2. The establishment of an operational regulation and monitoring system that addresses the use of sodium cyanide in the live fish industry.
 3. The allocation of resources, including manpower and budget, to the above-mentioned initiatives in the annual plan and budgetary appropriation of the municipality.
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4. The municipality shall endeavor the active involvement of the Barangay/Municipal Fishery and Aquatic Resources Management Council (B/MFARMC) or equivalent body, non-governmental organizations (NGOs) and people's organizations (POs) in the implementation of regulatory and monitoring system that addresses the problem of sodium cyanide use in the live fish industry.

2.2 Long term policy (3 to 10 years)

2.2.1 Objective

The long term policy for the industry is "to become a globally competitive industry through the development of sustainable capture fishing and mariculture."

2.2.2 Recommended specific activities

Specific activities to address the long-term objective include: (1) stimulation of sustainable live reef fish mariculture; 2) eco-labeling of live fish and certification of the LRFF trade; and (3) community and economic development, including alternative livelihood development for fishers and their families. To achieve the long-term (within the next three to ten years) objective, a partnership should be formed between government and key industry players to engage in the development of competitive aquaculture, particularly fish breeding, management and grow-out for live fish and bioengineering for ornamental fish. In order to keep up with the technology being developed by other countries involved in the trade, we need to put an end to our reliance to harvesting live fish from and depleting our wild stocks. We can innovate to make our live reef fish industry competitive in the global market.

2.2.3 Getting to global competitiveness.

Three conditions must be considered in order for the Palawan LRFF industry to be competitive: factor conditions, demand conditions, and support industries development. The prevailing positive **factor conditions** include the province's archipelagic nature with long coastline and rich and clean marine areas where aquaculture can be developed and maintained. There is a need to integrate efforts of educational and research institutions at the local, national, and international levels, starting with the government's centers of excellence in marine sciences and molecular biology and biotechnology, such as the University of the Philippines Marine Science Institute (locally, this can be done with the Palawan State University and the Western Philippines University), in collaboration with the Southeast Asian Fisheries Development Council. The focus needs to be on development and maturation of research and technology on bio-engineering and captive breeding of reef fish; innovation through establishment of marine reservations and concession areas as rearing/harvest zones for marginal fishermen. Taiwan has already shown that full-scale mariculture of live reef fish can be done and is economically viable.

Other countries have been engaging in grow-out of wild seed, with the Philippines as supplier of fingerlings. We need not export these wild fingerlings if we ourselves can grow them into full maturity under controlled conditions.

As to **demand condition**, local and international demands for environmentally safe and high quality live fish through certification and eco-labeling need to be promoted. The system protects the integrity of the environment and helps sustain the long term viability of the industry. Eco-labeling is premised on the fact that live reef fish which are caught using legal and sustainable fishing methods are of better quality and demand higher price in the market. Although the system is currently being adapted in the ornamental live fish industry, this has the potential to be adapted for the live reef-fish for food industry. At the local level, efforts towards this system can already be done through the development and implementation of a Code of Conduct for Responsible Live Reef Fish Operation. Each major player of the industry, especially the fishermen-catchers, middlemen and traders, exporters, and carriers, should institute a set of guidelines that will govern their operation. Such guidelines may include: non-use of chemicals, especially cyanide, non-destructive fishing practices in live reef fish fishing, establishment and management of no-take zones, non-patronage of known illegally caught live reef fish. Support mechanisms will need to be given to the stakeholders. These include trainings on proven technologies in catching live reef fish, resource management, information and education about the environment, and market information about the industry.

The **development of related and supporting industries** can take the form of developing clusters among supporting industries (i.e., fishing nets, aquaculture feeds, aquarium equipment, antibiotics, and chemicals) and undertaking related researches in ways of transporting live fish at reduced mortality. Firm structure and rivalry can be stimulated by organizing small local fishermen into groups and associations. This will give them stronger force in the market especially in determining better price for their catch, and will enable them to compete with existing industry players. Furthermore, foreign companies, in partnership with local companies, should be encouraged to enter in specific areas of the industry, within the limits of the Philippine Constitution. Potential areas of partnership are captive breeding, bioengineering, and research and trade in feeds and chemicals. These will spur competition and stimulate industry players to innovate. The government, on the other hand, needs to provide a favorable climate for innovation and growth in the industry. Given the government's tight financial situation, it may not be able to provide much funding to develop the industry. Thus, the industry players, those who stand to benefit the most, must not wait and instead take the lead. In support, government must encourage firms to fund individual R & D through tax deductions or by imposing industry specific tax that shall be used to fund R & D by the centers of excellence and by local educational institutions. Further, the government needs to set intellectual property rights laws to safeguard new developments and innovations to serve as incentives to researchers and firms.

References:

- Alvarez, Aquilino Jr. A.. *Dead corals in exchange for live fish export*. Marinelife (online)
- Baquero, Jaime. 21 February 1999. The Trade of Ornamental Fish from the Philippines. <http://www.reefs.org/>
- Bentley, N. 1999. "Fishing for Solutions: Can the Live Trade in Wild Groupers and Wrasses from Southeast Asia be Managed?" *SPC Live Reef Fish Information Bulletin*, 6:25-27
- Chan, P. 2000. "The Industry Perspective: Wholesale and Retail Marketing Aspects of the Hong Kong Live Reef Food Fish." *SPC Live Reef Fish Information Bulletin*, 7:3-7
- Cheng, Maria. 27 October 2000. *More than We Can Chew*. vol. 26, no. 42 www.AsiaWeek.com
- Correspondents. October 2000. www.Aquafeed.com
- Environment News Service. 1999. *Gourmets Gobbling up the Coral Reef Fish of SE Asia*
- Johannes, R.E. and M. Riepen. 1995. *Environmental, Economic, and Social Implications of the Live Reef Fish Trade in Asia and the Western Pacific*. The Nature Conservancy, Honolulu
- Lau, P. and R. Parry-Jones. 1999. *The Hong Kong Trade in Live Reef Fish for Food*. TRAFFIC East Asia and World Wide Fund for Nature Hong Kong, Hong Kong
- Graham, Thomas. 2001. *A Collaborative Strategy to Address the Live Reef Food Fish Trade*. Asia Pacific Coastal Marine Program, Report # 0101. The Nature Conservancy, Honolulu, HI, USA
- International Marinelife Alliance Website. www.imamarinelife.org
- Lau, P.P.F. and Parry-Jones, R. 1999. The Hong Kong Trade in Live Reef Fish for Food. TRAFFIC East Asia and World Wildlife Fund for Nature Hong Kong, Hong Kong
- Lem, Audun. 2000. Aquaculture and Trends. FAO at the Conference on Aquaculture, Economics and Marketing Debrecen, Hungary, 30 August - 1 September 1999
- Marine Aquarium Council. www.mac.com
- Padilla, J. et.al. 2002 (draft report). *Sustainability Assessment of the Live Reef-Fish for Food Industry in Palawan, Philippines*. World Wildlife Fund for Nature Philippines
- Pomeroy, R.S., et al. 2007. Evaluation of policy options for the live reef food fish trade in the province of Palawan, Western Philippines. Marine Policy, doi:10.1016/j.marpol.2007.04.006
- Reyes, Geronimo P. 2000. *Cyanide Fishing and the Marine Aquarium Trade in the Philippines*. Unos Newsletter. Vol. 3, no. 3, 4 July-December 2000
- Robertson, John. March 1998. Workshop on the impacts of destructive fishing practices on the marine environment. Reef Research, vol.8 no.1
- Sadovy, Yvonne. *Marketing and Monitoring Live Reef Fishes in Hong Kong, an update*. SPC Coastal Fisheries Programme
- Sadovy, Y. and A.C.J. Vincent. (In Press) "The Trades in Live Reef Fishes for Food and Aquaria: Issues and Impacts." In: *Coral Reef Fishes: New Insights into their Ecology* (P.F. Sale, ed.). Chapman and Hall
- Southeast Asian Fisheries Development Council. www.seafdec.org
- Traffic Asia and WWF for Nature Hong Kong. 1999. *Hong Kong Trade in Live Reef Fish for Food*

Tacon, A.G.J. 1997. Contribution to Food Fish Supplies. FAO Fisheries Department Review of the State of World Aquaculture Contribution of Aquaculture to Food Supplies.

TRAFFIC East Asia and WWF Hong Kong. *The Hong Kong Trade in Live Reef Fish for Food.* www.traffic.org

TRAFFIC Network. April 1998. *Southeast Asia a wildlife emporium.* Dispatches. www.traffic.org

TRAFFIC. 2 November 1999. Network. *Fishing for Solutions.* www.traffic.org

TRAFFIC East Asia and WWF Hong Kong. 17 June 1999. *Reef Fish Hang in the Balance.* www.traffic.org

University of the Philippines System. www.upd.edu.ph

World Wildlife Fund. June 2007. The Live Reef Fish Trade in the Sulu-Sulawesi Marine Ecoregion: Trade Scoping Study Report, Final Draft.

BACKGROUND DOCUMENT

Coral Reef Health and Extent as Estimators of Maximum Sustainable Yield for the Live Reef Fish Food Industry, Palawan Province, Philippines

A Report to The Palawan Council for Sustainable Development

**Planning and Technical Services Department
Palawan Council for Sustainable Development Staff**

September 2007

DRAFT ONLY: NOT FOR QUOTATION OR REPRODUCTION

Coral reef health and extent as estimators of maximum sustainable yield for the live reef fish food industry, Palawan Province, Philippines

FINDINGS OF THE STUDY

- In terms of ecologically acceptable levels of production and consumption from coral reefs, the Palawan live reef fish for food (LRFF) trade is currently unsustainable. The live fish caught in and exported from the province, as a whole, is way above the sustainable live fish yield and export even from the start of the fish volume data collection (2003). It is expected that at the end of the year, the actual exports will be 4.8 times the sustainable export level.
- The maximum sustainable yield and export for the entire province should be around 186 t/year and 139 t/year, respectively. Note that these conservative values are arrived at without accounting yet for the fishing pressure or intensity.
- If the current trend of positive depletion continues and no immediate strategies for regulation is enforced, the 'mining' of live fish stocks and the continually degrading coral reefs will lead to the collapse of the Palawan live fish industry.

RECOMMENDATIONS

- The LRFF trade must be regulated by municipality or by cluster of Palawan depending on the level of overexploitation. The amount of depletion in the live fish can be used as an indicator of overexploitation.
- Our computation shows that drastic cuts in the catch and export of live fish have to be made in order to quell the threats to coral reefs and to the target live reef fishes.
- A quota system have to be established in terms of
 - (1) the volume of live reef fish allowed to be caught, traded, and exported,
 - (2) the number of PCSD Trading Accreditation to be issued, and
 - (3) the volume of live reef fish to be assigned for each PCSD Trading Accreditation.
- The calculated maximum sustainable export volume for grouper (MSEG) should be the upper bound of live fish industry extraction in order for the LRFF trade to be biologically and ecologically sustainable. It should be considered the basis for the quota on live reef fish trade/export.
- If the computed maximum sustainable yield (MSYG) and maximum sustainable export for grouper (MSEG) will be equally distributed among the current live fish trading with valid accreditation to date (September 2006 to September 2007), the annual allowable export volume per accreditation in each area can be set (**Table 1**).

Table 1. Maximum sustainable live reef fish production and export, number of live reef fish trade accreditations, and live reef fish quota per trade accreditation

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Cuyo Group of Islands	17.52	13.14	3	4.38
Palawan Mainland and neighboring island municipalities	139.90	104.93	72	1.46

- Since the larger the number of traders means that the export volume limitation will be further decreased, the number of accreditations to be allowed in the trade will now depend on the cost-benefit analysis of business profitability in light of new trade limitations and the cost of putting up and maintaining a new trading business.
- The number of trade accreditations and the trade quota will also affect the income of the fishers. This, as well as the benefit of the industry to the general society, should be considered in the quota to be adopted.
- A more equitable access to the industry should be pursued. Small-scale traders should be prioritized in the accreditation so that more players will benefit while not exceeding the established quota.
- The annual quota can be broken down into monthly and weekly quotas. Since it may be impossible to strictly observe the catch limitation at a given time, disincentives such as the imposition of a larger tax (that is still within the bounds of law) on fish catch and fish trade exceeding “weekly or monthly quota” must be applied. The annual quota, however, must still remain.
- Traders whose live fish tested positive for cyanide should be penalized by suspension of accreditation and/or reduction of allotted quota.

Annex B-1 Methods of the study

BACKGROUND

- The concept of marine ecological footprint (MEF)¹ in Palawan Province is used for the live reef fish for food (LRFF) industry.
- Estimate of the maximum sustainable yield is derived from Palawan coral reef areas and corresponding live coral cover. The healthier the coral reef, the more productive is its fisheries. An indication of reef health is the total live coral cover.
- Estimate in depletion can be derived by comparing the maximum sustainable export of live fish and the annual volume of live fish exports from 2003 to 2007.

OBJECTIVES

- Give an estimate of the maximum sustainable yield (MSY) and sustainable export of live reef fish from Palawan coral reefs
- Calculate the depletion in the live fish industry
- Recommend how to integrate MSY value in the regulation of live reef fish-food industry through the introduction of quota on live fish volume for export and quota on the number of live fish accreditation

METHODS

- Palawan coral reefs are mapped using two methods: digitization of coral reefs from National Mapping and Resource Information Authority (NAMRIA) topographic maps and interpretation of coral reef areas from satellite images using remote sensing techniques.
- The health of coral reef ecosystem is based on several coastal resource surveys employing manta tow surveys and line intercept technique (LIT).
- The live fish export volume of Palawan is taken from the actual live fish shipment data that is recorded by Air Transportation Office (ATO) in Manila. It is gathered between year 2003 and the first seven months of 2007.

Maximum sustainable yield of grouper (MSYG)

The maximum sustainable yield (MSY, in t/year) is calculated using assumptions and benchmarks found in literature. Given reef area for each category of total live coral cover, the formula to compute for the maximum sustainable yield of grouper (MSYG) is given below.

¹ MEFs measure the area of marine ecosystem appropriated by human populations to supply seafood and other marine products and services. In the case of LRFF industry, the estimation of coral reef fishery production based on the MEF is calculated either as ratios (e.g. the number of times above or below sustainable levels) or as spatial areas (e.g. km² of appropriated coral reef) (Warren-Rhodes et al., 2004). This concept is illustrated in **Annex B-2**.

$$\text{MSYG} = \left[\sum_{c=1}^4 (A_c \cdot Y_c \cdot G_c) \right] \cdot F_f \cdot P_f \quad (1)$$

where:

- MSYG = maximum sustainable yield of grouper (in t/yr)
 c = the four reef health state (excellent, good, fair, and poor)
 A_c = reef area for each reef condition (in km^2)
 Y_c = reef fishery yield allocation for each reef condition (in $\text{t}/\text{km}^2\text{-yr}$). For the total reef fishery allocation, Y_c , we use productivity of 3, 8, 13, and 18 $\text{t}/\text{km}^2\text{-yr}$, respectively, for poor, fair, good, and excellent reefs (following Warren-Rhodes et al., 2004, citing McAllister, 1998). This range of values is an “optimistic scenario” since another study pegged sustainable yields from tropical reef fisheries at 1-10 $\text{t}/\text{km}^2\text{-yr}$ (Dalzell, 1996, used as “pessimistic scenario” in Warren-Rhodes et al., 2004).
 G_c = percentage of grouper yield for each reef condition. This is around 0 to 15% of the finfish yields (Russ, 1991, and Cesar, 1996, also in Warren Rhodes et al., 2004). The values assigned for this study are the following: excellent reefs – 15% of finfish yield; good reefs – 10%; fair reefs – 5%; and poor reefs – 1%.
 F_f = percentage of finfish in total reef fishery yield. In this study, this is a constant equal to $\frac{2}{3}$ (J. McManus, pers. comm., as cited in Cesar 1996, in Warren-Rhodes, et.al. 2004).
 P_f = fishing pressure. This variable is further discussed below.

Maximum sustainable export of live grouper (MSEG)

The maximum sustainable export for grouper (MSEG) is a fraction of MSYG. It is the volume of live fish in a year that is finally exported after the non-export grouper (i.e., fresh fish) is discounted. The formula for MSEG is:

$$\text{MSEG} = \text{MSYG} \cdot E_{\%} \quad (2)$$

where:

- $E_{\%}$ = percentage of live grouper exported out of the total live grouper caught. We assume that 75% of the live fish caught in Palawan are exported.

Fishing intensity

- The modeling effort has to incorporate fishing pressure in order to get a better picture of the MSYG and MSEG. Unabated fishing pressure due to the use of cyanide, overfishing, and other destructive methods of fishing leads to degradation of reefs and to depletion of live fish stock.

- The more intense the fishing pressure, the smaller the maximum sustainable fishery yield becomes.
- Heavy fishing pressure (by a progressive annual yield reduction of 25%) will further reduce sustainable grouper yield by as much as 68% in four years time. In the same span of time, moderate fishing pressure – an annual yield reduction of 10% – is expected to reduce grouper yield by up to 34%.

Depletion

Depletion is computed as the difference of actual live reef fish export in Palawan and the computed MSEG. A positive depletion implies fishing above the level of what is sustainable in a particular reef area.

$$\text{Depletion}_{\text{MSEG}} = \text{actual export} - \text{MSEG} \quad (3)$$

RESULTS AND DISCUSSION

Reef area and reef health

The Palawan reefs cover an estimated 816.75 km² (**Table 2**). The dense reef areas composed of excellent and good reef conditions (reefs with live coral cover > 50%) is calculated at only 109.23 km² (13.37%) while the larger remaining area of 707.51 km² (86.63%) is classified as sparse reef areas consisting of fair and poor reef conditions (live coral cover up to 50%).

Volume of live fish export

Live fish exports are found in **Table 3** and shown graphically in **Figure 1**. The volume data available is in terms of the number of boxes. It is converted to kilograms using the conversion factor 1 box = 7 kg. The total for the year 2007 is projected by linear regression using the August-December data of the previous years. The data showed an increasing trend in export volume out of the province from years 2003 to 2006, and a projected decrease in the current year presumably due to the implementation of a “closed season” this year.

Table 2. Estimate of coral reef extents (km²) by reef condition, Palawan Province

Municipality / City	Excellent	Good	Dense	Fair	Poor	Sparse	Total
Busuanga	0.752	1.357	2.109	4.330	36.157	40.487	42.596
Coron	0.083	0.248	0.331	2.315	80.048	82.364	82.695
Culion	1.670	8.360	10.030	20.059	28.909	48.968	58.998
Linapacan	0.000	0.993	0.993	15.887	19.896	35.784	36.776
Cuyo	3.197	1.106	4.302	10.760	3.774	14.534	18.836
Agutaya	0.612	1.986	2.598	6.659	47.798	54.457	57.055
Magsaysay	0.000	0.924	0.924	5.587	0.844	6.431	7.355
El Nido	0.000	2.531	2.531	2.290	29.448	31.739	34.270
Taytay	11.086	22.172	33.258	66.710	94.522	161.232	194.490
Dumaran	0.126	2.504	2.630	6.690	2.845	9.535	12.165
Araceli	0.000	13.289	13.289	13.515	2.233	15.749	29.037
San Vicente	0.010	0.020	0.030	0.064	4.151	4.214	4.244
Roxas	0.113	1.545	1.659	4.822	9.254	14.076	15.734
Puerto Princesa	0.184	0.584	0.769	1.845	28.135	29.980	30.749
Aborlan	0.000	0.204	0.204	2.440	0.000	2.440	2.644
Narra	0.000	1.735	1.735	3.933	0.000	3.933	5.668
Quezon	2.267	4.962	7.229	11.241	0.616	11.856	19.085
Española	0.026	0.759	0.785	1.001	0.000	1.001	1.786
Brooke's Point	0.000	0.498	0.498	5.568	0.000	5.568	6.065
Rizal	0.000	4.728	4.728	6.510	0.662	7.172	11.900
Bataraza	0.339	3.603	3.942	1.539	29.486	31.026	34.967
Balabac	3.173	11.489	14.662	30.041	64.927	94.968	109.630
TOTAL	23.637	85.597	109.234	223.808	483.705	707.513	816.747
Percentage	2.89	10.48	13.37	27.40	59.22	86.63	100.00

Note: Excellent = 76-100% coral cover; Good = 51-75%; Fair = 26-50%; Poor = 1-25%; Dense = Excellent + Good; Sparse = Fair + Poor.

Table 3. Live reef fish for food exported out of Palawan in 2003-2007

Year	Live fish volume (kg)			
	Calamianes	Cuyo	Greater Palawan	Palawan Province
2003	137,123	47,950	120,113	305,186
2004	260,652	100,989	156,282	517,923
2005	217,910	84,588	229,313	531,811
2006	250,985	116,795	311,479	679,259
2007	233,705.5*	127,228.5*	308,150.5*	669,084.5*

*projected for the entire year

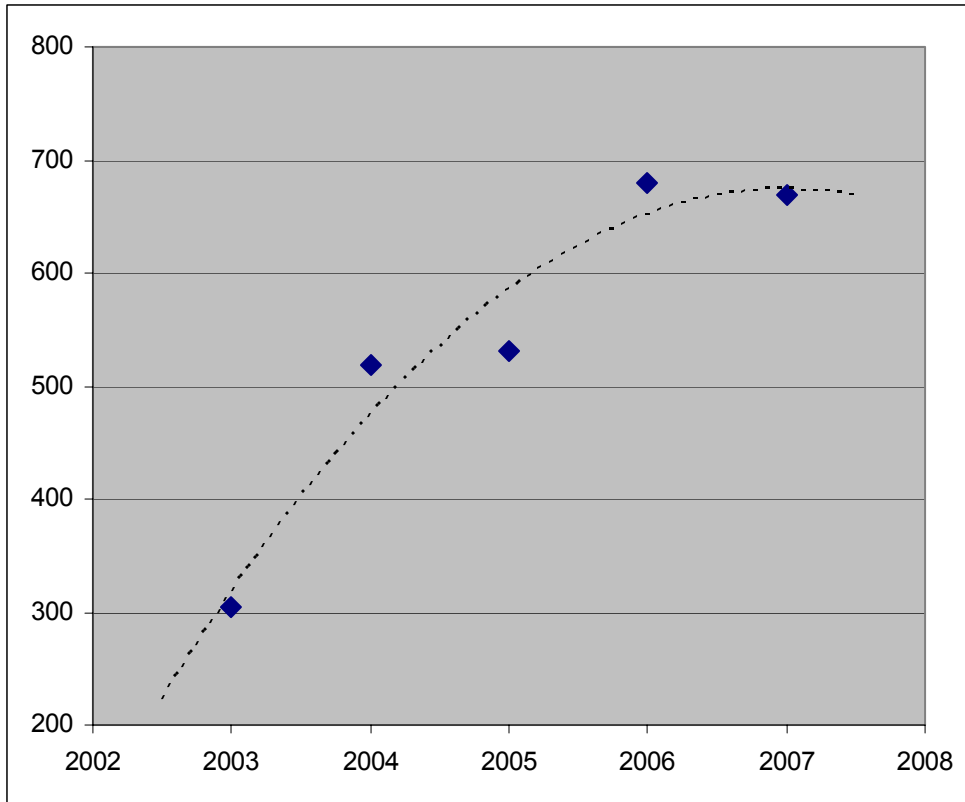


Figure 1. Total live reef fish export (t), Palawan Province, 2003-2007

Grouper yield per reef condition

The coral reef grouper fishery production (%) for each reef extent (%) and condition is shown in the following graph. It shows that good to excellent reefs produce 63% of the live reef fish yield while the poor to fair reefs produce only 37% of live fish yield. The assumptions used for these percentages are described below.

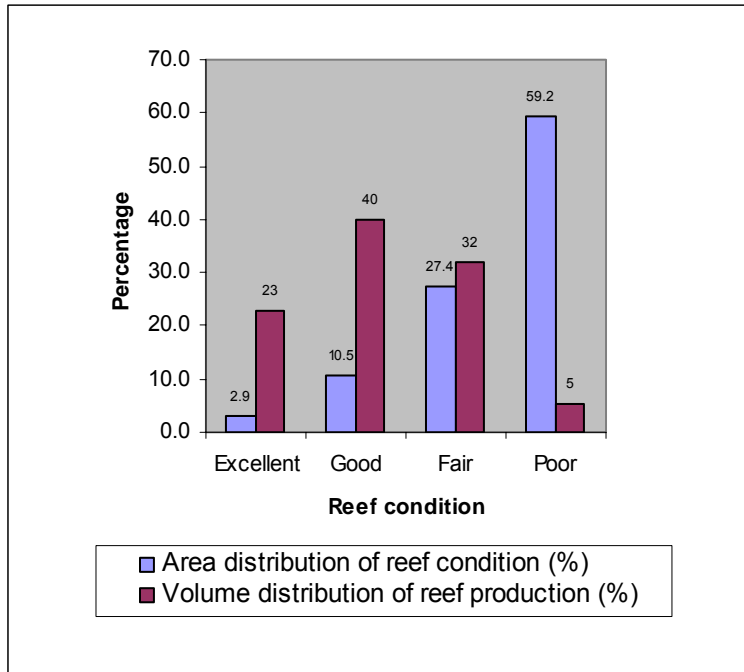


Figure 2. Percentage of coral reef live fish yield per condition, Palawan Province

Sustainable live reef fish production

- The coral reef productivity-based MSYG and MSEG will be used to ascertain depletion rates under varying fishing pressures. For the whole province, these values are **186.09 t/yr MSYG** and **139.56 t/yr MSEG** **when there is negligible fishing pressure between the years 2003 and 2007**. These values occur when the fishery yield is 3-18 t/km²-yr, finfish yield is 2/3 of total fishery, grouper yield is 1-15% of finfish yield, and 75% of the annual grouper yield in Palawan is set for export.
- Because the actual mortality rates of grouper species are expected to be high, the computed MSYG and MSEG values are conventional values. A study of the total mortality rates of coral trout *Plectropomus leopardus* in the Calamianes, for example, finds that the mortalities reach up to 93%, comprised of 20% natural mortality and 73% fishing mortality (Mamauag et al., 2003, preliminary results, adapted in Padilla et al., 2003).
- The actual grouper production of coral reefs (in t/yr) for the whole province of Palawan and for the three sub-regions (Calamianes, Cuyo, and the greater Palawan area) is reflected in the following table. This table shows that the Calamianes area has the smallest relative proportion of excellent and good reefs and therefore a smaller contribution of grouper yield, around 49% of the total yield.

Table 4. Estimated sustainable grouper yield for Palawan based on reef health and reef extent (without fishing pressure)

	Whole Province		Calamianes	
Reef health	Area (km ²)	Grouper yield (t)	Area (km ²)	Grouper yield (t)
Excellent	23.64	42.55	2.50	4.51
Good	85.60	74.18	10.96	9.50
Fair	223.81	59.68	42.59	11.36
Poor	483.71	9.67	165.01	3.30
Total	816.75	186.09	221.07	28.66
	Cuyo		Greater Palawan	
Reef health	Area (km ²)	Grouper yield (t)	Area (km ²)	Grouper yield (t)
Excellent	3.81	6.86	17.32	31.18
Good	4.02	3.48	70.62	61.21
Fair	23.01	6.14	158.21	42.19
Poor	52.42	1.05	266.28	5.33
Total	83.25	17.52	512.44	139.90

Depletion: Province wide

- We compute depletion for the years 2003-2007 using the computed MSEG of 139.56 t/yr for Palawan and the actual volume of live fish exports. We use three scenarios: (i) negligible pressure on reef health, i.e., non-changing reef health, (ii) heavy fishing pressure, and (iii) moderate fishing pressure. The province wide trend shows an increased depletion rate of the grouper stocks beginning from 2003 for all levels of fishing pressure, **Table 5** and **Figure 3**. The projected depletion for 2007 ranges from 530 to 625 t depending on the fishing pressure. An assumption of a possible 5% under-coverage or unreported live fish exports is also made. (The computations for this are presented in **Annex B-4**). Under-coverage will result to a further increase in the depletion levels. Another measure of fish exploitation, the MEF ratio, is presented in **Annex B-5**.

Table 5. Depletion of grouper (t), Palawan Province

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	305.19	139.56	165.62	139.56	165.62	139.56	165.62
2004	517.92	104.67	413.25	125.61	392.31	139.56	378.36
2005	531.81	78.51	453.31	113.05	418.76	139.56	392.25
2006	679.26	58.88	620.38	101.74	577.52	139.56	539.69
2007	669.08	44.16	624.93	91.57	577.52	139.56	529.52

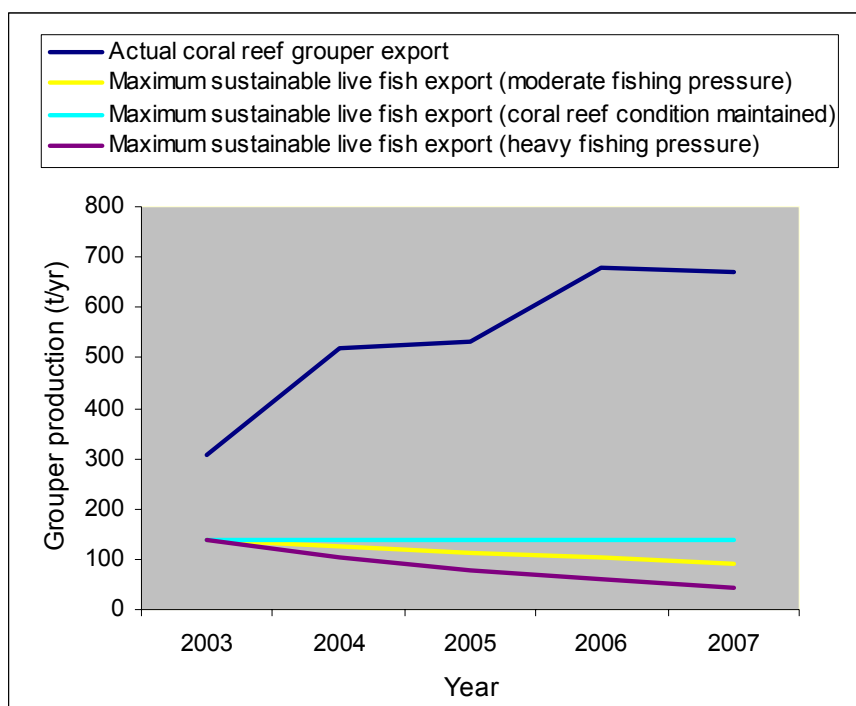


Figure 3. Actual live grouper export against computed maximum sustainable export of live grouper at varying levels of fishing pressure, Palawan Province, 2003-2007

Depletion: Calamianes

In the Calamianes Group of Islands (Busuanga, Coron, Culion, and Linapacan Areas), the depletion of stocks has been exhibited as early as 2003. At the end of the current year, the positive depletion amounts to around 212 to 227 t.

Table 6. Depletion of grouper (t), Calamianes Group of Islands

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	137.12	21.50	115.63	21.50	115.63	21.50	115.63
2004	260.65	16.12	244.53	19.35	241.30	21.50	239.16
2005	217.91	12.09	205.82	17.41	200.50	21.50	196.41
2006	250.99	9.07	241.92	15.67	235.31	21.50	229.49
2007	233.71	6.80	226.90	14.10	219.60	21.50	212.21

Depletion: Cuyo

The Cuyo Island Group (municipalities of Cuyo, Agutaya, and Magsaysay) has exhibited depletion of stocks as early as 2003. The trends for any level of fishing pressure are the same and reflect the trend in the volume of live fish export. Positive depletion increased from 2003 to 2004, slowed a year after, and again increased further (**Table 7**).

Table 7. Depletion of grouper (t), Cuyo Group of Islands (Cuyo, Agutaya, Magsaysay)

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	47.95	13.14	34.81	13.14	34.81	13.14	34.81
2004	100.99	9.85	91.13	11.83	89.16	13.14	87.85
2005	84.59	7.39	77.20	10.64	73.95	13.14	71.45
2006	116.80	5.54	111.25	9.58	107.22	13.14	103.66
2007	127.23	4.16	123.07	8.62	118.61	13.14	114.09

Depletion: Palawan Mainland and nearby island municipalities

- Like the provincial trend in depletion, the municipalities in the mainland of Palawan and the nearby island municipalities also have positive depletion in 2003. The depletion of stocks since then has been in the increase (**Table 8**).
- We note that several southern Palawan Mainland municipalities do not have records of live fish exports from 2003-2007. This may be due to the transshipment of live fish export from southern municipalities to air carriers in the north. Thus, subdivision of Palawan Mainland into North and South for analysis of each of the trend of MSYG, MSEG, and depletion, may not give conclusive results due to possible attribution of exports in the south to those of the north.

Table 8. Depletion of grouper (t), Palawan Mainland and nearby islands

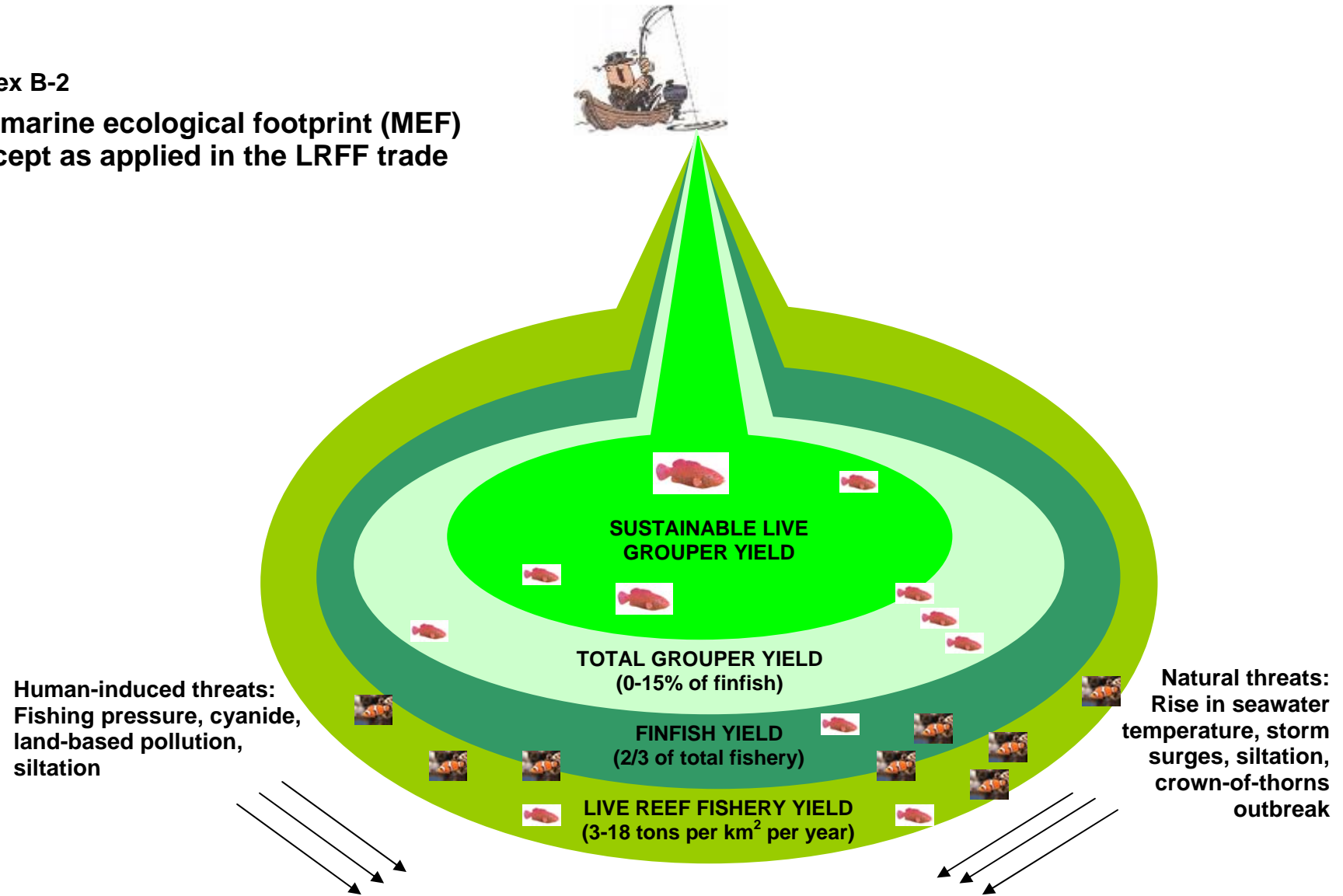
Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	120.11	104.93	15.18	104.93	15.18	104.93	15.18
2004	156.28	78.70	77.59	94.44	61.85	104.93	51.35
2005	229.31	59.02	170.29	84.99	144.32	104.93	124.38
2006	311.48	44.27	267.21	76.49	234.99	104.93	206.55
2007	308.15	33.20	274.95	68.84	239.31	104.93	203.22

REFERENCES

- Las Marias, N. (Undated). An analysis of the benefits and costs of live reef food fish trade in the Calamianes, Northern Palawan, Philippines. Final Report. Conservation International-Philippines.
- Padilla, J.E., et al. (2003). *Sustainability assessment of the live reef-fish for food industry in Palawan, Philippines*. Quezon City: World Wildlife Fund-Philippines.
- PCSDS, NSCB, and UNDP. (2002). *Palawan Asset Accounts: Fishery, Forest, Land/Soil, Mineral and Water Resources*.
- PCSDS. (2005). *The State of the Environment 2004, Province of Palawan, Philippines*. Puerto Princesa City: Palawan Council for Sustainable Development.
- Pomeroy, R.S., et al. (2007). Evaluation of policy options for the live reef food fish trade in the province of Palawan, Western Philippines. *Marine Policy*, doi:10.1016/j.marpol.2007.04.006
- Warren-Rhodes, K., et al. (2004). Marine ecological footprint of the live reef fish food trade. *SPC Live Reef Fish Information Bulletin #12*.

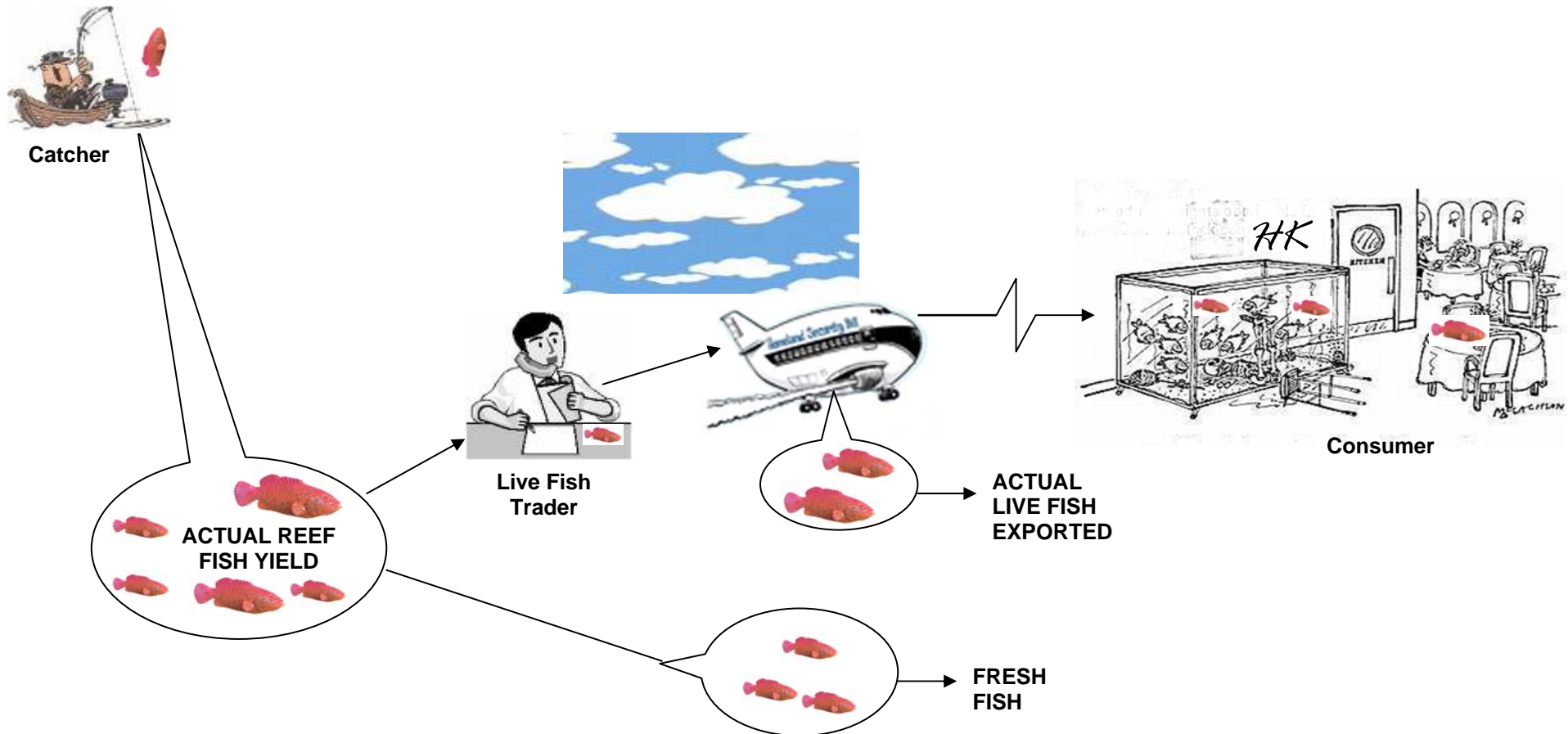
Annex B-2

The marine ecological footprint (MEF) concept as applied in the LRFF trade



CORAL REEF of various conditions {Poor, Fair, Good, Excellent}

Annex B-3
Live reef fish trade chain: Catcher to consumer



Annex B-4

Depletion in the live fish volume, accounting for under-coverage of 5%

Depletion of grouper (t), Palawan Province

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	321.25	139.56	181.68	139.56	181.68	139.56	181.68
2004	545.18	104.67	440.51	125.61	419.57	139.56	405.62
2005	559.80	78.51	481.30	113.05	446.75	139.56	420.24
2006	715.01	58.88	656.13	101.74	613.27	139.56	575.44
2007	704.30	44.16	660.14	91.57	612.73	139.56	564.73

Depletion of grouper (t), Calamianes Group of Islands

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	144.34	21.50	122.84	21.50	122.84	21.50	122.84
2004	274.37	16.12	258.25	19.35	255.02	21.50	252.87
2005	229.38	12.09	217.29	17.41	211.97	21.50	207.88
2006	264.19	9.07	255.13	15.67	248.52	21.50	242.70
2007	246.01	6.80	239.20	14.10	231.90	21.50	224.51

Depletion of grouper (t), Cuyo Group of Islands (Cuyo, Agutaya, Magsaysay)

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	50.47	13.14	37.33	13.14	37.33	13.14	37.33
2004	106.30	9.85	96.45	11.83	94.48	13.14	93.16
2005	89.04	7.39	81.65	10.64	78.40	13.14	75.90
2006	122.94	5.54	117.40	9.58	113.36	13.14	109.80
2007	133.92	4.16	129.77	8.62	125.30	13.14	120.79

Depletion of grouper (t), Palawan Mainland and nearby islands

Year	Live fish export (t)	MSEG (t) for Heavy fishing pressure	Depletion (t)	MSEG (t) for Moderate fishing pressure	Depletion (t)	MSEG (t) for Negligible fishing pressure	Depletion (t)
2003	126.12	104.93	21.19	104.93	21.19	104.93	21.19
2004	164.10	78.70	85.40	94.44	69.66	104.93	59.17
2005	240.78	59.02	181.76	84.99	155.79	104.93	135.85
2006	327.05	44.27	282.79	76.49	250.56	104.93	222.12
2007	323.56	33.20	290.36	68.84	254.71	104.93	218.63

Annex B-5
MEF ratio² of Palawan LRFF industry

Year	Palawan Province			Calamianes Group of Islands			Cuyo Group of Islands			Greater Palawan		
	Negligible fishing pressure	Moderate fishing pressure	Heavy fishing pressure	Negligible fishing pressure	Moderate fishing pressure	Heavy fishing pressure	Negligible fishing pressure	Moderate fishing pressure	Heavy fishing pressure	Negligible fishing pressure	Moderate fishing pressure	Heavy fishing pressure
2003	2.2	2.2	2.2	6.4	6.4	6.4	3.7	3.6	3.6	1.1	1.1	1.1
2004	3.7	4.1	4.9	12.1	13.5	16.2	7.7	8.5	10.2	1.5	1.7	2.0
2005	3.8	4.7	6.8	10.1	12.5	18.0	6.4	7.9	11.4	2.2	2.7	3.9
2006	4.9	6.7	11.5	11.7	16.0	27.7	8.9	12.2	21.1	3.0	4.1	7.0
2007	4.8	7.3	15.2	10.9	16.6	34.4	9.7	14.8	30.6	2.9	4.5	9.3

² MEF ratio is given by the following formula:

$$\text{MEF ratio} = \frac{\text{actual export}}{\text{MSEG}}$$

No under-coverage is assumed for the actual export. MEF ratio values less than 1 imply exportation of grouper below the sustainable level. Greater than 1 means unsustainable export of grouper. The higher the MEF ratio, the more exploited is its live reef fishery.