SUMMARY

Background

Live fish have long been traded around Southeast Asia as a luxury food item. Fish captured on coral reefs entered this trade only in recent years but, because of their superior taste or texture, have become the most valued fish in the trade. The majority of live reef food fish (LRFF) are imported into Hong Kong, China either for local consumption or for transshipment to mainland People's Republic of China (PRC).

The LRFF trade presently includes a wide variety of fish, but is dominated by several kinds of groupers. Retail prices for LRFF range from US$5 to $180 per kilogram (kg), depending on species, taste, texture, availability, and time of year—prices rise during festive periods. Preferred size of fish (family-size) for consumption is 600 grams–1 kg. The trade is not well monitored, but is likely to involve at present about 18,000 tonnes (t) of fish per year entering Hong Kong, China. The total regional trade may be around 30,000 t per year, with Hong Kong, China estimated to account for about 60% of the trade.

The trade is complex, with many links in the chain from fisher to retailer. Fish enter the trade either as wild-caught fish that are held briefly before export, about 50–70% of the total trade (15–21,000 t); undersize fish that are grown in cages or ponds until they reach market size, 15–40% of the trade (about 5,000–12,000 t); or reared from egg to market size in controlled conditions in full-cycle (i.e. hatchery-based) aquaculture, 10–15% (3,000–5,000 t). Transport of LRFF is by sea or air, depending mainly on the location of the fishery or holding facilities and available air links.

The fishing grounds shifted rapidly in response to increasing demand in the 1990s. Reefs near Hong Kong, China were quickly depleted and sources of capture now extend well into both the Pacific and Indian oceans, broadly the Indo-Pacific region. With few exceptions, the fishery for market-sized fish tends to remain in one area for a short period, often no more than a few years until the target fish become hard to find, then moves

on; thus, it is characterized, from the point of view of the countries concerned, as a sequence of "boom-and-bust" operations. The nomadic fishery may move on to different fishing grounds within a country, as in Southeast Asia, or to different countries, as in the western Pacific.

The major issues facing the trade are

- overfishing and consequent depletion of resources that are in many cases used in other subsistence or commercial fisheries;
- destruction of coral and mortality of nontarget fish when using cyanide solution in some places;
- fishing the spawning aggregations of some target fish, causing depletion of reproductive fish;
- the contribution of reef fish aquaculture, which is still largely dependent on grow-out of wild-caught fish, to depletion of the target fish stocks —and the extensive use of wild fish as fish feed;
- the wastage of nontarget fish—many are killed during fishing operations but not eaten, while many fish that could be used as food in local communities are caught to feed LRFF during grow-out—and because of deaths of target fish before reaching the market;
- social issues resulting mostly from conflicts and corruption regarding prices and access to fish, and from injuries and deaths from diving; and
- the inclusion of threathened species in the trade.

Economics and Trade

Actual quantities of fish in the trade are difficult to determine. For most source countries, LRFF exports are not disaggregated at a species level, and species are misreported and underreported. Even in the major trading center, Hong Kong, China, the full extent of the trade is unknown. Improvements to the harmonized code system there in 1997 and 1999 enabled identification of major imports of LRFF to species or species group level. However, imports by Hong Kong, China-licensed vessels do not have to declare their imported fish, although some such vessel

operators voluntarily supply import figures to the Government. Also, LRFF trade between Hong Kong, China and mainland PRC is not documented.

Government figures show an overall decline in the total volume of imports of LRFF into Hong Kong, China from about 22,000 t in 1998 to about 13,000 t in 2002. During this period, there were marked changes in the composition of imported LRFF, such as the rising numbers of Australian coralgroupers, declining proportions of some species from other countries, and a doubling of imports of brown marbled groupers.

Based on government data on imports and retail prices, the gross retail value of the trade in Hong Kong, China during 1999–2002 was around $350 million per year. Corrected for unreported fish, the total retail value in 2002 of the trade there was around $486 million and for the region as a whole, about $810 million.

The main exporting countries of LRFF are Indonesia, Philippines, Australia, PRC, Malaysia, Thailand, Viet Nam, and Taipei,China. Other countries involved are Fiji Islands, Maldives, Marshall Islands, Papua New Guinea (PNG), Seychelles, Singapore, and Solomon Islands. The higher-priced fish come mainly from Indonesia, Malaysia, Philippines, and Australia.

Beach prices, those paid to the fisher or fishing company that caught the LRFF, are generally in the range of 2–4 times the price paid for the same fish when dead.

There is a mark-up of 100–200% on wholesale prices in Hong Kong, China, because of the high rental costs, the restaurant's reputation and location, and the desirability of the LRFF purchased. Both wholesale and retail prices are on average higher in mainland PRC than in Hong Kong, China. There is a considerable difference between wholesale and retail prices for cultured and wild-caught individuals for some species, often attributed to consumer perception that cultured fish do not have the same taste and flesh qualities as a wild-caught fish of the same species.

Capital costs of the trade vary enormously across the exporting countries, from floating cages to vessels, to land-based holding facilities. Similarly, operating costs vary, primarily according to the mode of holding fish and their transport, mainly to Hong Kong, China. The increasing use of air transport, where available, has probably lowered investment risks, particularly to importers/major traders.

Macroeconomic issues affect the trade in both exporting and importing countries. For example, the decrease in the Hong Kong, China consumer price index from end-1997 to end-2002 was accompanied by falls in wholesale and retail prices of LRFF. Of growing concern is the LRFF market expansion associated with increasing incomes in mainland PRC, which is placing increasing pressure on supplies of wild-caught stocks. Source countries have experienced decreasing prices for LRFF in recent years but the impact of these price declines has been mitigated by favorable exchange rate fluctuations, as the US dollar strengthened against other currencies.

At present, value adding—the price increment paid for live fish above the price of similar dead fish—remains one of the key attractions of the LRFF trade in most source countries. While complex business relationships tend to obscure the real distribution of value among market participants, returns from LRFF fisheries evidently remain profitable for some in many countries.

Fish Resources

The most desired fish in the LRFF trade, the groupers, are relatively uncommon and long-lived, and mature late in life. Thus, reefs can be depleted quickly. Some of these groupers form spawning aggregations, which are sometimes fished heavily with consequent negative effect on the reproductive component of the population. At other times, the capture of a large proportion of juvenile fish or young adults—most groupers are females at this time, changing sex as they grow larger—also potentially reduces the reproductive population.

Total regional grouper production from all sources, live and dead, was estimated to be about 184,000 t in 2001, with the following components. Total LRFF wild-caught market-size grouper production from reefs in the Indo-Pacific region was about 21,000 t, while production from grow-out culture of wild-caught groupers was estimated at 32,000 t. Both figures include an average mortality estimate of 50% between capture (or farm) and market. The regional grouper fisheries catch (from FAO data), which is assumed to overlap little with that of the LRFF fisheries,

and therefore represents the dead fish component, was 131,000 t in 2001. Thus, live fish represent almost 30% of total grouper production in the region.

These data represent an average total, annual grouper yield of about 0.6 t per km^2 in 2001 across the total Indo-Pacific reef area of some 284,300 square kilometers (km^2). Assuming that about 80% are LRFF species, then regional yield of LRFF species was close to 0.5 t per km^2.

Past surveys and studies in various parts of the region indicate that total attainable fish yields from reefs in moderate condition may average some 5 t per km^2 per year, of which groupers make about 10%, or about 0.5 t per km^2, and LRFF species, thus, about 0.4 t per km^2. This value is close to the present yield.

The trend of the FAO production data suggests that the overall grouper fishery has not yet reached maximum catch level and that yield, therefore, can still rise. However, possibly much of the increased catch in recent years is from expansion of fishing areas rather than yield increases. Further, for live fish, at least, most yield comes from a relatively small portion of the region. There is every indication that wherever an LRFF fishery occurs it is usually associated with localized heavy depletions—and demand is expected to grow.

Ultimately, the impact of excessive extraction of live fish on local subsistence and commercial fisheries for the same target species could result in fishing down the food chain with unknown long-term ecosystem effects through changes in interactions between organisms. A new equilibrium could arise in the absence of some of the top predators (groupers), possibly precluding the reestablishment of groupers and other affected species, and threatening vulnerable species like humphead wrasse.

Social Issues

The nature of the LRFF trade in the region—often boom-and-bust within the countries concerned—has meant that most of the initial expectations of governments and fishing communities have gone unrealized. The trade has provided some communities with the opportunity to earn, temporarily at least, additional income from their fish resources in areas where very few

income-generating opportunities exist. Also, some communities have benefited by receiving funds for community needs. However, these benefits have often come at considerable cost, ecologically, economically, and socially. There has also been significant health impact from diving-related accidents, because of inadequate training of divers and poor equipment.

There are very few places where social disputes and disruption have not occurred as a result of the LRFF trade. Commonly, disputes erupt between the operators and fishing communities over issues to do with prices, destructive methods, and unfulfilled promises. Another social impact has been the development or exacerbation of disputes between fishers and even villages over ownership and use rights to areas and resources, and over distribution of benefits such as the payments of royalties. One of the most significant legacies of the LRFF trade has been corruption and coercion. There are also tensions within communities between fishers who use cyanide and those strongly opposed to it. The LRFF trade has been responsible for the introduction of sodium cyanide as a fishing "method" into areas previously naïve to this method.

Another legacy of the LRFF trade, once it moves on, is degraded habitat, reduced reef resources, and reduced reproductive potential from the use of fishing methods that destroy habitat, the reduction and possible elimination of reef fish spawning aggregations, and the removal of juveniles (and hence reproductive potential) for grow-out. Many of the target fish are important for both subsistence and local commercial fisheries, and the added pressure from the LRFF trade, which may result in extreme overfishing, can have a negative effect on the resources long after live fish businesses have moved on. In addition to the loss of these fish resources for local use, there is also a loss of potential alternative income-generating opportunities, such as scuba diving and other ecotourism-related activities, while species diversity is also threatened.

Fisheries Management and Trade Controls

In most countries, LRFF fisheries have arisen alongside existing subsistence fisheries and, thus, cannot be viewed in

isolation. Managing these fisheries requires monitoring the activities of all users of the resources including fishers, buyers, brokers, wholesalers, and retailers, as well as government agencies and trade associations.

Management of the LRFF trade can be done at different points along the market chain, for example by managing the size and scope of the fishery itself (controlling the fishers), placing controls on the activities of the buyers, brokers, and wholesalers, (controlling the traders), and by market-based approaches (influencing the consumers).

Management of the fisheries per se can be done by controlling the input, i.e., amount of fishing (such as number of fishers or boats, open/closed seasons and areas) and equipment used (such as handlines rather than cyanide and prohibiting compressors which are frequently associated with cyanide use). Management can also be applied to the output, such as through quotas, bans on certain species, export controls and size limits.

Some form of input control is in place in some LRFF producing countries, although the level of compliance is not known and enforcement, with few exceptions, is nonexistent. Of the output controls, quotas have even more institutional requirements than input controls and have rarely been adopted. Export bans may have slowed, but not stopped, the export of one vulnerable species, the humphead wrasse. Size limits are in place in many countries but often do not cover species taken for the LRFF trade, while bans on the export of live fish have rarely been applied.

National control over LRFF fisheries has so far proved ineffective in most countries because the locations of both LRFF and subsistence fisheries are usually remote in many ways from decision makers, making implementation of management measures at the national level difficult if not impossible. Also, the close business relationship between traders and local officials has been identified as a major impediment to compliance and convictions for illegal activities. There may be more hope in local management by customary reef owners.

Given the low yields of LRFF that can be taken on a sustainable basis, however, it is questionable whether a well-managed LRFF fishery can be profitable, particularly when considered in the long term, as evidenced by the industry's present pattern of short-term fisheries moving progressively

farther from the market. At the same time, the public cost of properly managing such fisheries by any of the means above would be prohibitive. Economic analyses are clearly needed.

Trade standards, particularly use of best practices that encompass reefs, fish populations, and fishing communities, are needed to improve the conduct of the industry and help it move toward sustainability. Consumer awareness programs have potential to influence the eating habits of many LRFF consumers. The protection of vulnerable species through international conventions is a potential tool for trade control, although the implementation of such conventions has only recently been applied to commercially exploited marine fish species.

Aquaculture

Aquaculture, defined broadly as any intervention in the life cycle of aquatic organisms to increase production, is responsible for up to half of the LRFF trade. The focus is on groupers, which are preferred by most farmers in view of their high value. The largest producer is mainland PRC, followed by Taipei,China, Indonesia, Viet Nam, and Thailand, with a 2001 annual total of around 25,000 t. The majority, more than 60%, of these fish come from grow-out operations, in which small wild-caught fish are grown in cages to market size. Most are fed wild fish.

Full-cycle aquaculture, the rearing of fish from egg to market size, takes place mainly in Taipei,China, although there is increasing production from hatcheries in Indonesia. Other major producing countries are developing a hatchery subsector, but only a few species can presently be raised using hatchery techniques.

Recently, emphasis has begun to focus on sustainable grouper culture because of the high value of groupers in the LRFF trade and concerns about overfishing wild populations. The past five years have seen significant improvements in two major factors in sustainable grouper aquaculture: hatchery production of fingerlings and the development of pellet diets.

Overall, the grouper aquaculture industry provides important socioeconomic benefits to coastal communities throughout the region. Aquaculture at both hatchery and grow-out stages appears to be highly profitable. Backyard grouper

hatcheries in Bali have internal rates of return of 12–356%. Grow-out of grouper in cages and ponds in the Philippines brings returns on investment of 59% and 82%, respectively—far more than possible farming the more "traditional" crop, milkfish.

The main constraints to further development of grouper culture are insufficient numbers of small fish (from the wild or hatchery-produced) for grow-out; only a few species are available from hatcheries; erratic and possibly unsustainable supply of other fish (often bycatch from other fisheries) used for feed, and localized water pollution resulting from their use; low farmer acceptance of compounded feeds, and the high cost of pellet feeds; spread of fish diseases; and impact of culture operations on the environment. Fisheries for juvenile fish for grow-out contribute to local population depletions and spread of fish diseases. Finally, the use of fish to feed LRFF in areas where the same species are or were used for human food, means additional fishing pressure on and possible depletion of such food resources for local communities.

Institutional Aspects

In the Pacific-island subregion, a Pacific Regional LRFT (live reef fish trade) Initiative, spearheaded by the Secretariat of the Pacific Community, with the involvement of several nongovernment organizations (NGOs), has helped some countries to assess their LRFF resources and develop management and monitoring plans.

Several international NGOs, the Asia-Pacific Economic Cooperation (APEC) and the intergovernmental Network of Aquaculture Centers in Asia-Pacific (NACA), have undertaken activities at various levels—research, surveys, awareness programs, etc.—related to the LRFF trade.

Missing is a coordinating body to distil the information, minimize duplication of effort, and act as both a promoter and watchdog on the trade. A broad regional "trade" organization that includes all LRFF-producing countries would provide a large pool of experience and expertise, and attract assistance to accelerate research on solutions to some of the countries' dilemmas concerning LRFF fisheries.

Conclusions

There is inadequate information to understand fully the trends in and the full extent of the LRFF trade. Neither is there sufficient biological knowledge of the main species in the trade, the groupers, on which to assess their population sizes. Nevertheless, enough is known to conclude that the yields being taken on an individual reef basis are likely to be unsustainable and that this could have flow-on effects that affect the health of the reef ecosystems themselves, with long-term implications for the livelihoods that depend on them.

Overall, as currently practiced, LRFF fisheries are undesirable, not only because they appear to damage the reef ecosystems and thus the potential yields of other fisheries for the same and other species, but also because the short-term economic benefits they typically provide to source country communities have generally come at a high social—and sometimes health—cost.

Although there are many available management tools for this kind of fishery, most would not be cost effective because attainable yields of a sustainable LRFF fishery, equivalent to a few fish per square kilometer per day, are insignificantly small and the costs of monitoring high.

Aquaculture of some LRFF species, primarily full-cycle aquaculture based on hatchery production of seed fish, holds more promise of sustainability, despite a variety of constraints at present. Existing aquaculture operations are quite profitable. Their expansion should be based on hatchery production and attend to incipient ecological problems, such as pollution from feed and the use of other reef fish to feed the LRFF.

There are roles for a regional trade organization and for international and nongovernment organizations to encourage some self-regulation, act as watchdogs, and assist the trade to move from destructive to sustainable practices.