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New Threat to Coral Reefs: Trade in Coral Organisms

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Coral reef ecosystems are a valuable source of food and income to coastal communities around the world. Yet destructive human activities have now put nearly 60 percent of the world's coral reefs in jeopardy, according to a 1998 World Resources Institute study. Pollution and sediments from agriculture and industry and overexploitation of fishery resources are the biggest problems, but the fragility of reef ecosystems means that even less damaging threats can no longer be ignored. Prominent among these is the harvest of coral, fish, and other organisms for the aquarium, jewelry, and curio trades, as well as live fish for restaurants. Much of the demand comes from the United States, which has made protecting coral reefs a top priority.

International trade in marine fishes and some invertebrates has gone on for decades, but the growing popularity of reef aquaria has increased the types and the quantity of species in trade. More than 800

species of reef fish and hundreds of coral species and other invertebrates are now exported for aquarium markets. The vast majority of fish come from reefs in the Philippines and Indonesia—considered to be the world's most biologically diverse marine areas—and most stony coral comes from Indonesia. But the commercial harvest of ornamental reef fish and invertebrates (other than stony coral) occurs on reefs worldwide, including those under U.S. jurisdiction. In 1985,

the world export value of the marine aquarium trade was estimated at \$25 million to \$40 million per year. Since 1985, trade in marine ornamentals has been increasing at an average rate of 14 percent annually. In 1996, the world export value was about \$200 million. The annual export of marine aquarium fish from Southeast Asia alone is, according to 1997 data, between 10 million and 30 million fish with a retail value of up to \$750 million.

Although there are no firm estimates of the impact that trade is having on overall coral reef health, it is unlikely that it is minimal, as some believe. Indeed, although the diversity, standing stock, and yield of coral reef resources are extremely high, most coral

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reef fisheries have not been sustainable for long when commercially exploited. Indonesia, the world's largest exporter of coral reef organisms, is a case in point. Because of overfishing and destructive practices such as using cyanide to stun fish for capture, coral mining, and blast fishing, only 5 to 7 percent of Indonesia's reefs were estimated in 1996 to have excellent coral cover. Unfortunately, however, because of the growing international demand for aquarium organisms and live food fish, overharvesting in nearshore waters has simply pushed commercial ventures to expand their harvesting into more remote ocean locations.

As the world's largest importer of coral reef organisms for curios, jewelry, and aquariums, the United States has a major responsibility to address the damage to coral reef ecosystems that arises from commerce in coral reef species. The United States took a critical first step in 1999 by approving a plan to conserve coral reefs, which included strategies to promote the sustainable use of coral reefs worldwide. The plan identified unsustainable harvesting of reef organisms for U.S. markets as a major source of concern. Now we need to adopt some concrete steps to put that plan into action.

Increasing exploitation

The group of organisms commonly known as stony corals consists of animal polyps that secrete a calcareous skeleton. They are used locally for building materials, road construction, and the production of lime and are traded internationally for sale as souvenirs, jewelry, and aquarium organisms. Corals in trade may be live specimens, skeletons, or "live rock," which is coral skeletons and coralline algae with other coral reef organisms attached. Live rock, often broken out of the reef with crowbars, is reef structure; removing it harms or destroys habitat for other species. Extraction of stony corals and live rock is known to increase erosion, destroy habitat, and reduce biodiversity. It is likely that the destruction of coral reef ecosystems will continue unless conservation efforts are improved.

Statistics on the type and number of coral reef specimens in trade, the source, and the importer have been available since 1985, thanks to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All stony corals, including live rock, are listed in Appendix II of CITES. Com-

mercial trade in Appendix II species is permitted under CITES, provided that the exporting country finds that the take does not constitute a significant risk to the species in the wild or its role in the ecosystem.

The stony coral trade is dominated by exports from Southeast Asia and the South Pacific. The United States either prohibits or strictly limits the harvest of stony corals in most of its own waters because of the key role that corals play in the ecosystem and because of widespread concern that the organisms are vulnerable to overexploitation. But the lucrative U.S. market remains open to foreign coral, and thousands of shipments arrive yearly from Indonesia, Fiji, and other nations. Indonesia exports approximately 900,000 stony corals each year. Fiji is the primary supplier of live rock and the second largest exporter of stony coral, with a trade that has doubled or tripled in volume each year for the past five years. In 1997, more than 600 metric tons of live rock was harvested from Fijian reefs, 95 percent of it destined for the United States.

Until about a decade ago, more than 90 percent of the corals harvested for international markets were sold for decoration; these were harvested live, bleached and cleaned to remove tissue, and exported as skeletons. Although the trade in coral skeletons has remained fairly constant since 1993, the volume of live specimens for the aquarium trade has grown at a rate of 12 percent to 30 percent per year during the 1990s. In 1997, live coral constituted more than half of the global trade.

Aquarium specimens are typically fist-sized colonies that represent six months to ten years of growth, depending on the type of coral. Most often, these are slow-growing, massive species with large fleshy polyps, many of which are uncommon or are vulnerable to overexploitation because of their life history characteristics. The flowerpot coral (*Goniopora*) and the anchor (or hammer) coral (*Euphyllia spp.*) are the most abundant corals in trade, partly because they must be continually replaced. These species survive poorly in captivity. They are also easily damaged during collection, are susceptible to disease, and acclimate badly to artificial conditions.

The preferred corals for the curio market are "branching" species. These grow faster than most corals destined for the aquarium trade; however, they are traded at a significantly larger size. Colonies in

trade are often more than a meter in diameter, representing a decade or more of growth. In addition, these species are most susceptible to crown-of-thorns sea star predation, physical damage from storms, and bleaching. Bleaching is a response to stress, particularly elevated seawater temperature, in which corals expel energy-producing symbiotic algae. Coral can survive bleaching but usually do so in a weakened state. In 1998, coral reefs around the world experienced the most extensive bleaching in the modern record. In many locations, 70 to 90 percent of all corals bleached and subsequently died; branching corals sustained the highest mortality. Continued extraction of these species at current levels may reduce the ability of coral reefs to recover from disturbances such as bleaching.

The impact on fish

Destructive fishing practices and overexploitation of certain fish species are having significant effects on populations of coral reef fish and other organisms, as well as on reef ecosystems. Nearly 25,000 metric tons of reef fish are harvested alive each year for the fish food trade, with an annual retail value of about \$1 billion. Unfortunately, cyanide fishing is the preferred method for capturing these fish, and currently at least 10 key exporting countries use it. One of the most deadly poisons known, cyanide usually only stuns the fish, but it destroys coral reef habitat by poisoning and killing non-target animals, including corals. Other chemicals, including quinaldine and plant toxins, are also used to capture reef fish alive. Field data on these practices are hard to come by because they are illegal, and thus fishers are secretive about them.

Destructive fishing practices probably figure in the high mortality rate of organisms while they are in transit. A 1997 survey of U.S. retailers found that between one-third to more than half of the aquarium fish imported from Southeast Asia died shortly after arrival. No conclusive studies on the reasons have yet been published, but these deaths are believed to be due to the poisons used in capture or the stress of han-

The lucrative U.S. market for coral organisms may be the major force driving destructive fishing practices in the Indo-Pacific region.

dling and transport, or both. The need for replacements is one factor that keeps demand high and thus contributes to overexploitation.

Compounding the threats posed by cyanide fishing, overexploitation of ornamental fishes can lead to depletion of target species and may alter the ecology of the reef community. The marine aquarium trade possesses a major potential for overexploitation, because fish collectors capture large quantities of particular species. Herbivorous surgeonfish are one of the primary targets. These fish are a critical component of a healthy

coral reef ecosystem, because, along with parrotfish, they control the algae population; unchecked, algae can overgrow stony corals and inhibit settlement and growth of coral larvae. Fishers also tend to capture the smaller young fish before they can reproduce. In some cases, aquarium fish collectors are in direct competition with subsistence fishers, because several fish species captured as juveniles for the aquarium trade are also commercially important food fish. Studies have only recently begun to document the extent and potential impact of collection for the aquarium trade on reef fish populations. For instance, in Kona, Hawaii, five of the top aquarium fish species were 45 to 63 percent less abundant in areas where tropical reef fish collection is allowed.

Efforts to improve conservation

Several exporting countries have recognized the potential threats associated with the coral trade and have taken steps to address them. Mozambique, for example, banned the trading of coral skeletons and stony corals because of excess harvest rates and the high death rates that occurred during the 1998 bleaching. The Philippines implemented a total ban on coral trading after studies found that areas of intensive coral harvest exhibited a reduced abundance and altered size distribution of commercially collected coral species. From the combination of intensive coral collection, cyanide use, and blast fishing, several Philippine reefs became barren. To reverse this trend, the country has established a pilot program to conserve

coral reef resources while allowing nondestructive sustainable collection. The Philippine government and the International Marinelife Alliance have implemented an aggressive program to retrain fishers in alternatives to cyanide, such as using nets for aquarium fishes and hook and line for food fishes. Five cyanide-detection facilities have also been established. After five years of intensive efforts, live reef fish that test positive for cyanide have declined from 80 percent to less than 30 percent.

Instead of banning coral collection, Australia has developed an effective management strategy designed to ensure sustainability of the resource. Coral reef habitats have been zoned for different uses, including no-take areas. Collectors are licensed, and the collection of coral is permitted only in selected areas that amount to less than 1 per cent of the reefs in a region. Collectors have harvested 45 to 50 metric tons of coral per year for 20 years, with no noticeable impact on the resource.

Hawaii has established a regional fishery management area along the west coast of the Big Island. As of January 2000, a minimum of 30 percent of the nearshore waters were designated as fish replenishment areas where collection of aquarium fish is prohibited. The Marine Aquarium Council (MAC), on behalf of hobbyists, the industry, and some environmental groups, is developing a certification scheme that will track an animal from collector to hobbyist. The goals of MAC are to develop standards for quality products and sustainable practices and a system to certify compliance with these standards and to create consumer demand for certified products.

Recognizing the power of the United States to shape the reef trade, a presidential executive order established the U.S. Coral Reef Task Force in 1998. Its purpose is to lead U.S. efforts to protect and enhance coral reef ecosystems. The task force, composed of the leaders of 11 federal agencies and the governors of states, territories, and commonwealths with coral reefs, found that more than 80 percent of the stony coral and nearly 50 percent of marine aquarium fish in trade during the 1990s were destined for U.S. ports and that international trade is increasing by 10 to 20 percent each year.

The task force has identified several key actions to reduce impacts associated with the trade. These include training and education programs, guidelines for sustainable management and best handling prac-

tices, and improved data collection and monitoring to ensure that the growing harvest of ornamental coral reef organisms is sustainable.

International efforts

Internationally, CITES establishes a global regulatory framework for the prevention of trade in endangered species (those listed in Appendix I) and for the effective monitoring and regulation of trade in species that are not necessarily threatened with extinction but may become so unless trade is strictly controlled (species listed in Appendix II). Concern about the potentially damaging effects of coral harvest on the survival of reef ecosystems prompted member nations to list 17 genera of the most popular corals in trade in Appendix II of CITES in 1985 and the remaining stony coral species in 1989; currently all scleractinian coral, black coral, blue coral, fire coral, organ-pipe coral, giant clams, and queen conch are listed on the controlled list in Appendix II.

The CITES regulatory framework gives both producer and consumer countries responsibility for ensuring that the coral trade is sustainable. Using CITES data, it is possible to obtain an idea of current trends in the trade of a particular listed stony coral, as well as information about whether the trade has shifted to a different country or different taxa or to live versus dead coral. CITES provides a powerful incentive for improving management without discouraging sustainable and ecologically sound trade.

The CITES listing requires that shipments contain an export permit from the country of origin and gives CITES parties the authority to refuse the import of CITES-listed corals without valid permits. Permits are supposed to be issued only if the country's CITES Management Authority and Scientific Authority find that trade in that particular specimen is not detrimental to the species' survival in the wild. CITES specifies that the export of a species should be limited in order to maintain that species throughout its range at a level consistent with its role in the ecosystem and well above the level at which the species might become eligible for inclusion on the endangered list in Appendix I.

In principle, the CITES requirements are designed to ensure sustainable harvest. In practice, countries may be unable to make a science-based finding of no detriment because of limited resources and expertise. Therefore CITES regulations permit an importing

country to implement additional restrictions or require additional documentation to enhance conservation. In an attempt to follow international guidelines for CITES species, Indonesia recently developed a management plan for the commercial harvest of corals, including a species-by-species quota on live corals and a ban on the export of recently killed corals. Although this is a beneficial approach, the relatively high quotas established for certain uncommon species has raised concerns about sustainability. These concerns prompted the European Union to temporarily ban imports of six coral genera from Indonesia—an example of how CITES provides a powerful framework for monitoring and regulating international trade in stony corals.

The role of mariculture

One way to reduce the pressure on coral reef ecosystems is to improve the ability to farm desirable organisms for trade. It is possible to create a stunning reef aquarium using only captive-bred or cultured organisms, including live rock, stony and soft corals, giant clams, fishes, and algae. Mariculture can be an environmentally sound way to increase the supply of such organisms, and it has proven successful for many invertebrates and certain fish.

Most branching corals, for instance, can be propagated from small clippings taken from a parent colony and achieve a five- to tenfold increase in biomass in a year or less. More than 75 species of coral can be captive-bred, but only fast-growing corals appear to be economically profitable. Another example is cultured live rock from waters off Florida. Porous limestone collected from inland relict reef deposits and placed in marine waters away from existing reefs produces a product that is suitable for sale within six months to two years. Although mariculture of coral reef fishes has proven more complicated, a number of farmed fish species are available to the hobbyist.

But mariculture operations, including coral farms in the United States, make up only a tiny fraction of the total current market. Captive-bred fish currently account for less than 2 per cent of the market and include only two or three dozen of the 800 or so species

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in trade. Wild-harvested coral reef invertebrates and fishes are widely available, cheaper, and often larger than cultured organisms.

Expanded research, development, and marketing of captive-bred aquarium organisms—a crucial step in coral reef conservation—has been recognized and endorsed by the U.S. Coral Reef Task Force. However, these operations must be monitored to ensure best practice. Regulations and

containment technology are necessary to prevent introductions of exotic species and disease-causing organisms. In addition, reliable labeling and stronger enforcement are necessary to prevent an increase in wild harvest and trade of organisms that are improperly and illegally marketed as captive-bred.

The U.S. conservation plan

The impact of the marine ornamental trade must be reevaluated and additional strategies developed and implemented to better manage the detrimental impacts on harvested species and the ecosystem. Ensuring sustainability will require action, capacity-building, and education at each step of the trade, from harvest, through export and import, to the consumer market. The United States continues to work within existing international frameworks, including CITES, the Asia-Pacific Economic Cooperation forum, and the International Coral Reef Initiative (ICRI) to eliminate destructive fishing and reduce unsustainable harvest. In fall 1999, ICRI partners adopted a resolution recognizing that “international trade in corals and coral reef species is contributing to the stresses on these systems.” It has proposed strategies to reduce the adverse ecological and socioeconomic impacts of trade in these species.

In March 2000, the U.S. Coral Reef Task Force presented a strategic action plan that includes several potentially effective conservation objectives. Among them are continued consultations with coral-exporting countries and other stakeholders to assess problems associated with the trade in coral reef species and to discuss approaches to mitigating the negative impacts of the trade. Also included are expanded ways of helping source countries collect trade data, assess the status of reefs, evaluate the impact of extraction,

and develop and implement sustainable management. The plan also proposes coordinated efforts with stakeholders to eliminate destructive collection practices and reduce mortality during handling and transportation of coral reef species. It further provides for helping source countries develop certification schemes and institute environmentally sound collection practices and alternatives such as mariculture. The plan also calls for collaboration among stakeholders to develop public education aimed at reducing unsustainable harvest practices. Implementation of these strategies will require much more coordination and consultation among exporting and importing government agencies, environmental organizations, and the private sector.

A global approach

Ensuring a sustainable trade in coral reef organisms will require long-term international commitment to a policy that protects them from overexploitation and prohibits destructive harvest practices. A key first step is for exporting and importing countries to establish data-gathering and monitoring systems to obtain accurate species-specific information on the trade in ornamentals, including both numbers of organisms traded and the extent of their survival from harvest to consumer.

Countries should complement trade statistics with in situ monitoring. Information on the life history of the species of concern; its distribution, abundance, and role in the ecosystem; the life stage at which it is harvested; its longevity in captivity; and potential threats that affect the species and its habitat must be evaluated in order to determine sustainable harvest levels. It is unlikely that this will be practical for more than a handful of the most abundant coral reef species currently in trade. However, management plans that apply a precautionary approach and are linked with monitoring of collection sites can provide warnings about the more egregious signs of environmental deterioration or overharvesting. Man-

The U.S. Coral Reef Task Force has made some potentially effective recommendations for promoting a sustainable harvest of coral reef organisms.

agement plans must include the limitation of harvesting to a geographic subset of each potentially harvested habitat. Geographic areas designated for harvesting may be combined with temporary closures or rotation of areas, as long as a significant percentage of areas remain permanently closed to harvest. Without effective law enforcement, the management plans will be useless. Choosing appropriate collection areas, education, and partnerships with local communities can enhance the effectiveness of enforcement.

Ultimately, any decision on whether a country should allow commercial exports of coral reef

species—and if so, at what level—must take into account the economic and social importance of the industry, the capacity of the resource to sustain harvests, and the effects of harvesting on the activities of other reef users. It is critical that the total volume of organisms in trade does not exceed the natural rate of replacement, that the methods of collection be as benign as possible, and that significant areas of habitat be set aside for nonextractive uses. Mariculture alternatives must be critically examined to ensure that they do not contribute to additional coral reef losses through spreading disease or introducing non-native species that can outcompete native organisms. By improving collection, handling, and transport, mortality will decline throughout the chain of custody. Improved survival in captivity may translate to a manageable demand for wild specimens, thereby diminishing the negative effects of the trade on the threatened coral reef ecosystems of the world.

The development of management plans that result in sustainable harvests is essential to the marine ornamental industry. But even more important, such plans could also provide a crucial boost to local economies. Once it has become a sustainable industry, the trade in marine ornamentals could provide steady and permanent income for coastal communities in Southeast Asia, the south Pacific, and other tropical areas.