SPECIAL MANGROVE EDITION

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Supporting Appropriate Mangrove Management

By Marta Vannucci

All cultures which border the sea in the tropical belt of the world have connections with mangroves in one way or another. These range from using mangrove wood for fuel or for making simple rafts (as the aborigines of the Timor Sea in northern Australia do), to the planting of seeds, propagules and saplings for coastal protection. In New Zealand, for example, there are remains of rows of mangrove bushes planted to stabilize the coast by early generations of Maori people. In other areas, such as Malaysia, *Rhizophora* was specifically planted because of its resistance to rot and boring animals, which makes it good for building houses and jetties. Nypa palms were encouraged to grow for their fronds and sap, and later this species was grown in plantations, for example in Indonesia. The productive waters surrounding mangroves have provided a range of fishery products, such as crustaceans and mollusks, which are harvested in a variety of ways. The waters are used for farming fish and crabs, and even algae, for food or chemicals. Taking one example, when the Portuguese first arrived in India, they learned from the indigenous people how to use the mangroves to create rice-fish-mangrove farms. Much of this traditional knowledge was described in the letters of the Viceroys to the King of Portugal, and was later taken by Jesuit and Franciscan fathers to Angola and Mozambique where the local people were trained in the techniques. In other parts of the world, mangroves were considered to be sacred forests, to be used only for the disposal of the dead, as in the Solomon Islands, or for special rites. Elsewhere mangroves have been valued for the beauty of their flowers or used to build impenetrable fences. The uses of this ecosystem would fill an encyclopedia.

Scientists were fascinated by the anatomy, histology, physiology and chemicals of the plants and animals adapted to such a demanding environment, and the noted Swedish botanist Linnaeus clearly appreciated the value of mangroves, naming *Avicennia officinalis* after a famous Arab doctor and the Latin word for medicinal: *officinalis*. However, most of the Europeans who swarmed across the world following the Age of Discoveries failed to recognize the benefits of this ecosystem, other than for capture fisheries

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Mangrove Management As Stewardship

By Stephen B. Olsen, Editor

The collection of reports and essays in this issue of *Intercoast Network* demonstrate that there is increasing convergence among the diversity of approaches as to how mangrove wetlands should be managed. The many voices and perspectives in this special issue reinforce that progress is indeed being made towards a stewardship ethic for these important and threatened features of tropical coastlines.

The term stewardship presents great difficulties for translators to many of the languages spoken where mangroves predominate. It is therefore often useful to

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SPECIAL MANGROVE EDITION

Why a Special Issue on Mangroves?

Intercoast Network tries in each issue to give a broad a range of viewpoints, ideas and information on coastal management issues as possible. So one might ask, "Why do a special edition that focuses only on mangroves?"

By doing a special edition, *Intercoast* is able to go into depth on a critical issue that cannot be explored as widely or as deeply in a regular issue. Mangroves are an essential component of estuarine systems, filtering inland water as it flows to the sea, and serving as a nursery and primary habitat for abundant and diverse species. The principal funders of this issue, the United States Agency for International Development (USAID) also took into account how a special issue on mangroves could make the bridge to other key areas in their diverse portfolio of projects.

"Mangrove forests form a vital link between terrestrial ecosystems and coral reefs," said Michael Benge, head of the USAID Center for the Environment's Forestry/Global Climate team. "Mangroves are being destroyed very rapidly, mainly due to cutting for charcoal and building ponds for shrimp mariculture–which has proven to be a very unsustainable use. This shortsighted exploitation of mangroves endangers not only the mangrove forests, but also the interacting environmental resources and local societies which rely upon their existence."

By more closely examining this resource within the entire coastal ecosystem, we hope to be able to offer valuable and usable information for those addressing complex mangrove management problems in the field.

Intercoast also works to create links to other coastal and non-coastal issues that affect coastal ecosystems. By expanding our scope and looking outside our traditional readership to a wider range of experts, we hope to find creative tools and techniques, and begin to forge the all-encompassing, "big picture" linkages that are so vital to effective integrated coastal management.

"USAID's global environmental program well understands the issue of coastal management, and also appreciates the value of mangroves both environmentally and economically. It is essential to increase public awareness of their value and vulnerability," concludes Benge, "so a balance among the uses of mangroves can be achieved and the benefits they provide both environmentally and economically for future generations can be sustained."

Mangrove Edition a Team Effort

This expanded special edition of *Intercoast Network* is the result of a unique team effort among authors from all parts of the globe, editors on two different continents and financial support from the United States Agency for Internation-al Development Forestry/ Global Climate Change Initiative in its Bureau for Global Programs, Field Support, and Research's Center for Environment.

This increased financial support allowed us to expand the length of this edition to more comprehensively cover the topic of mangroves and to secure a technical editor–Susan Wells–who could help draw together leading practitioners with expertise involving mangrove eco-systems, and to share their experiences and viewpoints in these pages. Wells, a coastal management professional, worked with *Intercoast* staff at the Coastal Resources Center (CRC) at the University of Rhode Island as a guest editor. A native of England, Wells is currently marine programme coordinator at World Wildlife Fund International's (WWF-International) office in Gland, Switzerland. She is active in a breadth of integrated coastal management initiatives, though more often with a focus on coral reefs than mangroves.

Wells arrived at CRC in the summer of 1996 to take on the challenge of putting out the biggest-ever issue of *Intercoast*, with its focus solely on one topic–mangroves. She remained at CRC for three months, working closely with editor Stephen Olsen and CRC staff to identify key managers and experts in the field of mangrove management, and get them on board as contributing writers. In November, she left the U.S. to take on her position with WWF-International. Despite starting a new job, through the modern miracles of E-mail and FAX machines, Sue managed to stay in constant touch with *Intercoast* staff and the authors of articles, and helped guide the issue through to final publication. Her expertise, extended network and hard work help make this edition one which we believe will improve integrated coastal management work with mangrove systems all over the world. We thank all of those who contributed to this inspiring effort.

– Chip Young, *Managing Editor*

Mangrove Management

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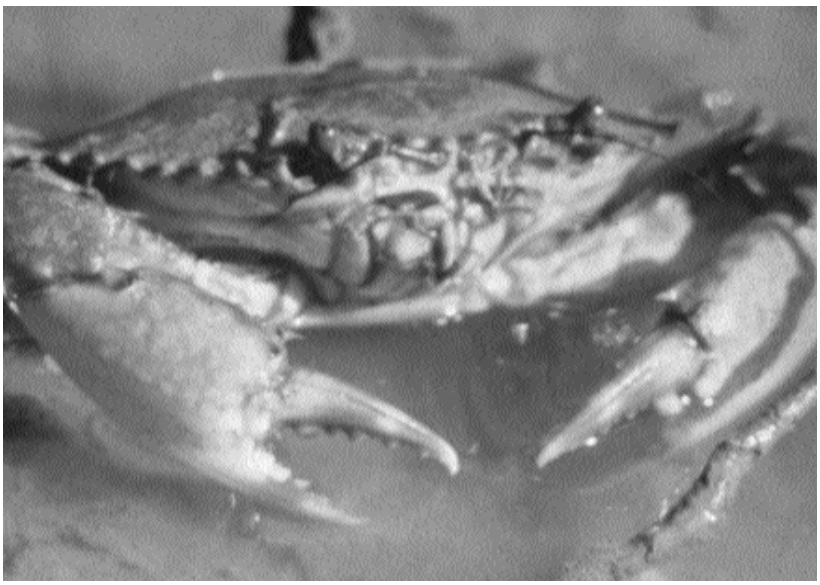
and fuel wood. Mangroves were usually considered to be wastelands, unhealthy for navigation and humans alike. Since the very early 16th century, they were marked on Portuguese charts, often using special symbols to indicate danger for any craft larger than dugout canoes, rafts and catamarans.

Apart from the management practices used in India, the traditional tambak-sari system of Java, Indonesia and other scattered examples, large scale intentional management of extensive mangrove areas started, as far as we know, only in the 19th century. The aims and goals varied with the needs and greed of the power game.

In the second half of the 19th century, the British applied practical knowledge accrued over centuries to the management of the Sundarbans, the "beautiful forests" of the Ganges-Brahmaputra delta, for timber. Watson, also from Britain, developed another forestry management system for the mangroves of the west coast of peninsular Malaysia. These two different systems have by and large stood the test of time and illustrate that there is no simple model for mangrove management. The term "mangrove" covers a range of habitat types that have little in common other than the fact that they are inundated by the sea at regular intervals. Mangroves include a vast range of combinations of tidal regimes, climatic variations, species composition, and physical, chemical and microbiological composition of soils and water, resulting in widely varying growth, reproduction and productivity. They must therefore be used and managed according to these constraints, bearing in mind the socio-economic needs of local people.

Well into the 20th century, scientific research focused mainly on taxonomy and description, while the "dreaded swamps" were treated with indifference or downright condemnation by developers, engineers, politicians and the military. Local people largely continued their simple, ecologically safe practices. But, as an old saying goes, "There is no evil that lasts forever nor good that will not come to an end," and there were major changes during and after World War II. New technologies and methodologies were introduced to achieve greater financial returns from mangrove areas, providing quick gains at the cost of permanent wealth.



Mud crab in a mangrove ecosystem.

In many places mangroves have been overexploited for fuelwood, for example in Africa and the small islands of the Caribbean and Central and South America, and for wood chips for the rayon industry. Developers, guided by foreign investors, often totally disregard legal obligations to replant or conserve buffer zones. The greatest numbers of offenders now are those who clear cut the mangroves to establish intensive shrimp farming. Intensive and semi-intensive methods have been used indiscriminately with total disregard for their suitability, resulting in major changes to the ecology of the area. This, combined with the intensive inputs of feed and fertilizer, and aeration, and the spread of epidemic diseases, has meant that after a few years the area is so badly degraded that shrimp production has to be abandoned. New areas are then clear cut. The tropical belt of the globe now looks like a pock-marked face, with much of the land eroded away by the encroaching sea. The long term survival and needs of local populations are largely ignored.

There are some encouraging signs, however. Tanzania, Pakistan, Bangladesh, India, Thailand, Venezuela and many island nations are among the numerous countries actively engaged in long term programs for sustainable management and use of mangroves. Activities range from the creation of protected areas and scientific studies of flora and fauna of the forests, waters and soil to reforestation and afforestation of the intertidal belt. Two countries–Bangladesh and Pakistan–are mentioned here because they tackle apparently impossible tasks:

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Save The Mangroves?

"Oh these mangroves. I never saw one that looked as if it possessed a decent conscience. Growing always in shallow stagnant water, filthy black mud, or rank grass, gnarled, twisted, stunted and half bare of foliage, they seem like crowds of withered, trodden-down old criminals, condemned to the punishment of everlasting life. I can't help it if this seems fanciful. Anyone who has seen a mangrove swamp will know what I mean".

–An early New Zealand novelist

Mangrove Resource Decline in the Philippines: Government and Community Look for New Solutions

By Roy Olsen D. De Leon and Alan T. White

Mangrove forest cover in the Philippines has declined substantially during this century, from about 450,000 hectares (ha) in 1920 to less than 150,000 ha in the late 1980s, of which only 46 percent (68,000 ha) is located outside the islands of Palawan and Mindanao. The most rapid decrease occurred in the 1960s and 1970s when government policies encouraged the expansion of aquaculture during a period when real prices for fish and shrimp were steadily rising. Although national laws prohibit the cutting of any mangroves, and the most important mangrove forests are protected in forest reserves, this ecosystem type has continued to decline.

Development of fish ponds has displaced much mangrove forest in recent years.

Despite a 1980 government ban on further conversion of mangroves to fish ponds, the reduction of mangrove area since that year through 1991 continued at a rate of about 3,700 ha/year, in parallel with an increase of fish pond area of approximately 4,100 ha/year over the same period. Today, fish ponds cover about 289,000 ha, with 80-90 percent in areas once covered with mangroves. Cutting of mangroves for charcoal-making, fuel wood and construction is probably the second most pervasive intrusion on the resource and conversion of mangrove areas to fish ponds has sometimes been just the final step in a process of destruction that began with over-harvesting of mangroves for fuel wood, frequently by persons other than those who ultimately built the fish ponds. Degraded areas are more easily reclassified as disposable lands, which makes conversion more likely. The current situation has therefore prompted the government to develop new policies for reforestation of mangroves and the recovery of abandoned fish pond areas.

Fish Pond Licensing

The Bureau of Fisheries and Aquatic Resources (BFAR) is responsible for licensing the development of fish ponds on government land. About 95,000 ha has been allocated for this purpose of which some 63,000 ha are under 25-year fisheries lease agreements (FLA). Under the Fishery Sector Program (FSP), initiated in 1991, an economic analysis was carried out which revealed that the fish pond lease fee of US$2 per year per ha was far too low to either encourage efficiency in the use of land for fish ponds or discourage conversion to aquaculture uses. The opportunity cost for the replacement of mangrove systems was determined to be quite high and was consistent with studies in other countries. An 1989 study gave estimates of US$500-1,550 a year for the opportunity cost of one ha of complete mangrove ecosystem. The FSP study found that various researchers had determined a minimum economic rent of at least US$550 a year for one hectare of inter-tidal land in the Philippines (Table 1).

The study recommended that FLA lease fees be raised to between $360 and $800 ha/year. It also recognized that the values attributed to marine fishery products dependent on mangrove system health were uncertain because of lack of information and so suggested that the basic wood value of mangrove stands be used as the initial economic rent level. This is about $156/ha/year, and a schedule was therefore recommended to implement an increase of lease fees over several years to this figure. Resistance from leaseholders, as well as political intervention, has meant that this has not yet been implemented but it is thought that it will eventually happen. Indeed, the renting of privately-owned fish and shrimp ponds is a flourishing market, deriving annual incomes of about US$120-600 per ha.

Mangrove Reforestation

The Department of Environment and Natural Resources (DENR) is responsible for mangrove management. Experiments in reforestation using contracts with local communities, giving stewardship agreements and encouraging communities to protect and manage the resource in their own way have been successfully carried out on Bohol and Panay. As early as 1964, small mangrove rehabilitation projects began on Bohol Island, Visayas, where harvesting for firewood and poles has long been a practice and where it is understood that if mangroves are thinned, they will grow more efficiently. A community in Jetafe reforested 100 ha, and students and school officials in Calape planted a 20-m wide band along 4.8 km of coast in 1968 for protection against wind and storm waves.

In 1984, an innovative program, the Central Regional Project, using experience from earlier community projects, began to experiment by providing secure tenure over a mangrove area to an individual or family in return for maintaining it as healthy forest. This arrangement was called a Stewardship Agreement and was initially used to promote reforestation in open areas, as national policy at that time did not allow community management of existing mangroves. Mangrove planting progressed rapidly but long-term success rates were less than 50 percent because information on methods and sites was lacking. Planting outside natural mangrove habitat predisposed efforts to failure and lack of land use planning meant that ownership and tenure were unclear. Furthermore, lack of suitable planting material led to single species dominance in newly planted areas.

These initial experiments resulted in 1990 in the first national policy on mangrove management that encouraged community involvement by providing long-term security of tenure through the issuance of Mangrove Stewardship Agreements. This was followed, however by a policy of contracting individuals or groups to plant mangroves. When communities were directly responsible with stewardship agreements, the cost/ha was about US$80. The contracting of individuals without any community organization or volunteer labor, increased the cost to more than US$400/ha. Success was still less than 50 percent and the communities generally participated in the contracting exercise to make some additional money without much concern for enhancement of the environment.

In 1991, management of an existing but degraded mangrove forest at Cogtong Bay, Bohol Island was started using a Mangrove Stewardship Agreement. Designated seed trees were allowed to grow while others were harvested for fuel wood and poles. Forest quality and the abundance of naturally occurring seedlings increased, and the need to stop fish pond development was highlighted through community opinion and resistance in the area. This success encouraged the DENR to increase its focus on the rehabilitation and management of existing forest in its programs through community involvement. The Buswang Mangrove Reforestation Project, started in 1990 in Kalibo, Panay Island, has been particularly successful. Here, the government contracted Kalibo Save the Mangrove Association, an organization with 26 family beneficiaries, to replant 50 ha. After four years, the organization was able to harvest and earn from the Nypa leaves on five ha of the area. DENR awarded the organization with a 25-year Forest Land Management Agreement in 1995.

In 1993, the DENR therefore stopped its straight contract reforestation efforts and in 1994 endorsed the NGO-assisted Community-Based Mangrove Forest Management approach. Between 1991 and 1994, the FSP also assisted the DENR in the reforestation of about 6,900 ha of mangrove. As with DENR, initially local communities were contracted to plant seedlings and young trees but this caused many problems, and was replaced by a more community-based management system with NGO assistance. Although the target of 30,000 ha was not achieved, the FSP has recognized that involving the community directly is a more sustainable approach to reforestation and maintenance of existing resources. Unfortunately, there is now a conflict between the existing legislation that bans mangrove cutting and the new policies allowing limited use by community stewards. This discrepancy in national law and preferred policy will need to be resolved.

Table 1: Estimated net annual economic value ($US) of Philippine mangrove areas for different levels of management

Level of management	Wood Products (value/ha)	Fish Products (value/ha)	Total (value/ha)
Mangrove plantation	$156	$538	$694
Managed naturally regenerated	$90	$538	$628
Unmanaged under-stocked stands	$42	$538	$580

Note: Wood harvest value based on average price of about $12/cu. m. of wood; fish products based on average annual weight of fish and shrimp/ha associated with mangrove areas and an average price of $.80/kg; values based on Philippine peso amounts in 1991 and converted at 25 pesos/1$US. Source: Schatz 1991

New Policies to Support Sustainable Use and Management

The official government-approved conversion of mangrove habitat to fish pond use has virtually stopped, an

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The Coastal Area Monitoring Project at Pearl Lagoon, Nicaragua

By Roberto Rigby and Patrick Christie

Natural resources are the economic base of 10 coastal communities living around Pearl Lagoon, the largest coastal lagoon on the Nicaraguan Caribbean coast. The communities are small, most with less than 500 inhabitants. The cultural diversity of the area is considerable with distinct Miskitu, Garifuna and Creole groups, each of which exploits coastal resources in a different way. The most common occupations are fishing and farming, depending on the season.

The lagoon is surrounded by extensive mangrove forests, pine savannas (*Pinus caribaea*), and lowland rain forest. While the lagoon ecosystem is still in relatively good condition compared to other systems in the region, a number of environmental stresses are of concern to local people. Of greatest importance are the potentially negative effects of large scale sedimentation of the lagoon as the watersheds of its tributaries are deforested by agriculturalists and logging interests. Overfishing is now possible with the introduction of modern fishing gears and processing plants for export of fish and shrimp to the United States. To date, 62 fish species have been identified in the lagoon. Crocodiles and caymans, once common in lagoon tributaries, have been heavily hunted. The harvesting of mangroves for fuel or tannins is limited but there has been recent discussion of the introduction of large scale shrimp culturing into the area.

Since 1993, the Coastal Area Monitoring Project (CAMP) has employed participatory environmental monitoring to document water quality, forest condition, and fish yield that will provide a foundation for the management plan which will be developed by local people. CAMP proposes to involve neighboring Pearl Lagoon communities and extend research efforts to include other terrestrial and aquatic environments. The development of local human resources is fundamental to this process. Communal resource management groups will be established and the training of CAMP staff and participants in environmental monitoring and management are important activities.

Pearl Lagoon's communities.

The project is based on a number of important principles. First, CAMP embraces the local perspective since it relies on local knowledge and participation which are critical for the success of such plans. Second, the management plan considers the social, political, cultural context. Third, data are collected on both terrestrial and aquatic ecosystems, a necessity if the plan is to ensure sustainable resource use. Finally, the concept of resource management as a potential economic and social benefit, rather than a threat, is being promoted through local participation, and this in turn is helping to develop local capacity for resource management. Already, local people are experiencing increasing control over the process and are making a number of decisions and taking actions on their own. For example, meetings have been held with local political leaders to discuss natural resource management issues and these leaders have responded with moral and material support.

CAMP is also conducting research that is resulting in valuable information about the participatory management process itself. Through the use of qualitative research methods, such as interviews and participant observation, CAMP staff are assessing the strengths and limitations of the project. This information is fed back to project participants for discussion and project reorientation. During interviews, the majority of people say that they prefer the participatory approach to the more centralized approaches to research and development that they have experienced. They feel empowered through the process and have noticed that CAMP is raising the consciousness of local people about the value of their natural resources. While participatory resource management is increasingly common, a thorough longitudinal study of this process is still relatively unique. The documentation of this case study of participatory natural resource monitoring and management could be useful for other projects in Latin America.

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Collaborative Management at Rekawa Lagoon, Sri Lanka

By Piyasena Ganewatte

Sri Lanka's Coast Conservation Department (CCD) estimates that there are about 12,000 ha of mangroves forming a narrow intertidal belt usually around the perimeter of coastal lagoons, with 14 species of true mangroves and 12 species of mangrove associates. Mangrove research is coordinated by the National Mangrove Committee within the Natural Resources, Energy and Science Authority (NARESA). Members include the National Aquatic Resources Agency (NARA), the Forest Department (responsible for the management and conservation of the mangroves), CCD, other government agencies and several universities.

Rekawa Lagoon, lying on the southeast coast about 200 km from Colombo, has been the site of an intensive participatory planning and management effort since 1993, focused on the natural shrimp fishery, mangroves, agricultural land use and beach habitat for sea turtles. The Rekawa mangroves contribute substantially to the health of the lagoon and its associated fisheries and traditional uses, and support a number of resident and migratory birds. The mangroves form a narrow fringe along the shoreline of both the channel and the main basin of the 200 ha lagoon, often interspersed with plants such as *Soneratia acidia* (Kirala) which is used to make cork. Traditional uses for mangrove products are varied in Sri Lanka and typical of other developing countries. There are also a few uses particular to the Rekawa area: the wood is used as fuel for lime kilns, as rafters and poles in house construction and as sticks to support vegetable plants. The plaited fronds of the Nypa palm (*Nypa fruticans*), are used as thatch in house construction.

A Special Area Management Plan has recently been approved by the local community and the concerned government and research organizations. It focuses on the development and implementation of sustainable use strategies for the mangrove resources through the collaboration of government, NGOs and community groups. The major partners are the Forest Department, NARA, CCD, Rekawa Special Area Management Coordinating Committee (RSAMCC), Hambantota Integrated Rural Development Project, Rekawa Lagoon Fishery Cooperative Society, the newly established Rekawa Development Association and the proposed Coastal and Lagoon Environment Education and Research (CLEER) Center.

The major objectives of the Special Area Management Plan in relation to mangrove management are to:

- Establish a Mangrove Forestry Unit in the CLEER Center, supported by the Presidential Task Force of the Southern Development Authority.
- Develop expertise in mangrove ecology, mangrove ecosystems and sustainable use of mangroves at the CLEER Center.
- Implement a comprehensive survey of the mangroves of Rekawa and the Southern Province of Sri Lanka and develop a national plan for their sustainable use.

There is also the need to develop and implement a zoning scheme and sustainable use plan for mangrove resources through the RSAMCC. The major activities involved in this are:

- Map locations of prime mangrove stands designated for strict protection.
- Designate areas of mixed mangrove vegetation where limited use will be permitted.
- Form an agreement between the Forest Department and community groups on joint management of the mangrove resources that stipulates

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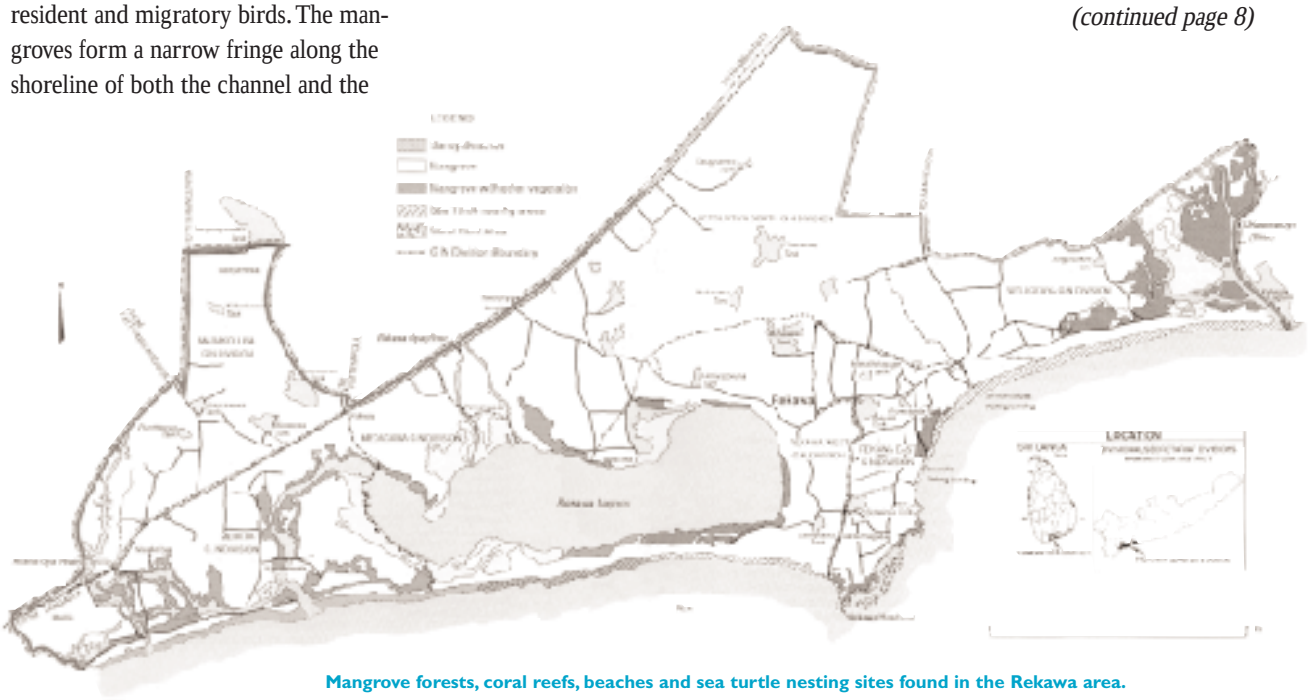

Mangrove forests, coral reefs, beaches and sea turtle nesting sites found in the Rekawa area.

User Groups Play Key Role in St. Lucia

By Mathias Burt and Brett Hudson

Since 1981, the Caribbean Natural Resources Institute (CANARI), the government of St. Lucia, and local resource users have been involved in a project aimed at the conservation of a 60 hectare (ha) mangrove forest on the southeast coast of this small island in the Lesser Antilles. The principal use of the forest is for the production of charcoal, which is a locally important fuel source. Already it was clear that the prevailing harvest level was depleting the resource base.

The mangrove was declared a marine reserve in 1984, making it illegal to harvest trees there. However, CANARI facilitated the establishment of a resource user's group which was granted tacit permission by the government to continue to produce charcoal in the reserve, at the same time collaborating with CANARI to monitor levels of production and trends in biomass. The formation of the user group and the development of other economic activities in the region reduced the number of people working in the mangrove. Improved cutting techniques were adopted which allow for better regeneration of harvested areas, and clear cutting has been abandoned. As a result, the mangrove has begun to recover. Surveys conducted in 1992 demonstrated that stem densities have increased over previous years, while the volume of charcoal being produced also increased.

Despite these improvements, problems remain. One of these is that the legal status and resource management responsibilities of the user group remain uncertain. This ambiguity and the physical characteristics of the resource mean that the user group is not always able to prevent others from cutting illegally. The result is an insecurity of tenure which is a disincentive to conserve. Trees continue to be cut well before they reach the age of maximum productivity for fear that others will cut them down if they are left to mature. A second problem is that partly because of the insecurity of tenure, the group has not developed sufficient organizational capacity to assume management responsibility for the mangrove as originally planned, and they continue to rely heavily on CANARI and the government to perform those functions.

To address both these concerns, the Department of Fisheries now plans to establish a local management authority for the mangrove, which would involve the user group in a co-management agreement with government agencies, CANARI, and other interested parties. Hopefully, this will consolidate the charcoal producer's legal rights to harvest, and provide the management expertise required to enhance the conservation of this important local resource.

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Rekawa

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core areas of strict protection, areas of limited and sustainable use, permitted uses, means of monitoring uses, and designated responsible persons or community groups.

- Formalize an agreement declaring the area a sanctuary or forest reserve with limited use permits.
- Develop a mangrove park of about 50 ha for research and nature tourism, and commence new livelihood projects such as sale of allowable mangrove products.
- Protect an area for migratory birds that is close to the area of the proposed CLEER Center.
- Conduct research in collaboration with the universities of Colombo, Peradeniya, Moratuwa, Ruhuna and NARA.
- Implement a community awareness, education and training program on the sustainable use of the mangroves.

The chief implementing agency for the Rekawa Mangrove Management Plan will be the Forest Department assisted by the CCD, NARA and several universities as needed. The RSAMCC, consisting of divisional heads and field officers of all development departments and representatives of the NGO sector, and chaired by the Tangalla Divisional Secretary, will serve as the Coordinating Committee. Collaborative management by the Forest Department and other government agencies, NGOs and community groups is a unique feature of the plan. An expected outcome is the generation of income and employment through sustainable use of mangrove products. Rekawa is in a good position as the community is already well organized, a community awareness program has been in operation for more than two years, and community organizations are taking action to minimize mangrove degradation.

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Rehabitating the Mangrove Forests of the Mekong Delta

By Wandert Benthem , Dr. Nguyen Duy Chuyen, L.B. van Lavieren and Wim J.M. Verheught

The rich natural resources of the Mekong Delta are of vital importance to Viet Nam. Covering an area of 3,900,000 hectares (ha), the delta supports major agriculture and aquaculture industries, with the mangrove forests providing a myriad of ecological functions and multiple uses, such as substantial small-scale fisheries, forest and non-timber forest products and a buffer against frequent storm surges. Excessive lumbering for timber and aerial spraying of defoliants during the Viet Nam War devastated large stretches of mangrove forest and caused a serious decline in biodiversity. More recently there has been widespread conversion into low-production aquaculture farms. Important fauna populations in the remnant mangrove forests are under great pressure due to habitat destruction and poaching. Loss of mangroves has also led to changes in coastal morphology, as the remnant forests no longer provide adequate protection. In the western part of the Delta there is accelerated accretion, whereas coastal abrasion is serious in the south-east, with up to 70 meters of land being lost per year, and frequent flooding and salt water intrusion ensues.

In March 1996, the government established the Rehabilitation of Mangrove Forests (RMF) Project for the Mekong Delta as a follow-up to the 1990-1994 UNDP/World Bank-funded Mekong Delta Master Plan (MDMP) and the 1995-96 World Bank-funded Coastal Wetlands Protection and Development Project. The RMF project aims to rehabilitate degraded mangrove forests along the south-eastern coast of the Mekong Delta in the provinces of Minh Hai and Soc Trang.

Some 145,000 people in this region are assumed to be directly or indirectly dependent on mangroves, and are mainly engaged in shrimp farming, crash crop production, salt mining, fuel wood collection and fishing. Before 1960, Minh Hai was covered with some 200,000 ha of mangrove, mainly in the peninsular of Ca Mau, but during the war more than half of this was destroyed. At present less than 60,000 ha is left and 340 kilometers (km) of coastline requires urgent protection against abrasive wave action. In the province of Soc Trang 60 km of the 72 km of shoreline are subject to serious coastal erosion.

From the outset, it was clear that in order to acquire legitimacy for the local stakeholders, the project would have to establish benefits for them and seek their active involvement. The project is therefore combining mangrove protection with aquaculture development, the feasibility of this approach having been assessed during the MDMP. After rehabilitation, the mangrove forest will be managed through community participation, according to a model established by the Forestry Department which is based on a combination of mangrove reforestation and shrimp farming with a clearly outlined responsibility for joint management. It involves providing 5-10 ha blocks of degraded mangrove area to individual farmers/fishermen. Under a lease arrangement, governed by a contract, 20-30 percent of this area may be used for aquaculture development, while the remainder must be reforested.

Phase I of RMF comprises detailed biophysical and socio-economic surveys to map current land use and sites in need of mangrove rehabilitation and reforestation. Workshops are being held to help communities understand the need for management of their sources of livelihood. Conservation education programs will focus on the importance of mangroves. Appropriate reforestation techniques will be tested including optional nursery management, site preparation and management, species selection and tending and management of seedlings.

During Phase II, 6,600 ha will be replanted. Four management strategies will be considered:

- Reforestation of seriously degraded or cleared coastal areas.
- Rehabilitation or additional planting in partly degraded mangrove forests.
- Natural regeneration in partly degraded areas where abundant natural seedlings are available.
- Active management and protection in areas with vigorous mangrove growth.

The project comes under the Ministry of Agriculture and Rural Development and is implemented by the provincial forestry departments. Technical assistance is provided by the Forest Inventory and Planning Institute, the Research Institute for Aquaculture and the Netherlands consultancy firms Euroconsult and Haskoning. While technical knowledge is available within the former Forestry Department, staff lack hands-on experience in mangrove forestry extension and working with local communities. The RMF project is seeking to strengthen the managerial and institutional capacity of the relevant agencies. It is focusing on pilot implementation for a number of selected sites and it is hoped it will have a positive effect on the income levels of families directly involved. A major component will be on-the-job training in silviculture techniques, people's participation and empowerment and conservation education techniques.

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Research and Rehabilitation in Australia

By Bill Streever

In Australia, rehabilitation of both inland and coastal wetlands has become increasingly common since 1990, and new government policies offer additional impetus for such activities. The Kooragang Wetland Rehabilitation Project (KWRP), which oversees rehabilitation at three Hunter River estuary sites, provides an example of effective interaction between researchers from the Univer-sity of Newcastle and a community-driven wetland rehabilitation project. Scientists often lose sight of ecosystem managers' needs, while managers may not understand scientists' methods and rationale. A research plan was therefore drawn up that formalized the relationship between rehabilitation management and research and recognized two distinct roles for research. Proactive research provides managers with information before a management decision is taken, while reactive research assesses the impact of management decisions by monitoring ecosystem change. This model–relating management, reactive research and proactive research–is being tested through a simple study and will help to clarify the role of scientific investigation in rehabilitation.

Wetlands within the three rehabilitation sites typically consist of salt marsh and mangrove forests. Over the past 200 years, the region's estuarine wetlands have suffered from drainage for agriculture, industrial development and waste disposal, cutting of mangrove, and dredge and fill operations. The study site described here is denuded shoreline along Kooragang Island's southwestern shore and is bordered on both sides by dense stands of gray mangrove. Although the initial impact that eliminated mangrove from the site is unknown, re-establishment of mangrove appears to have been hindered by cattle, which trample and eat mangrove propagules (already-germinated seeds).

New experiments were designed to 1) compare survival and growth of mangroves transplanted from other areas on Kooragang Island to survival and growth of mangroves grown in a shadehouse for three months prior to transplanting, and 2) assess the effect of fertilizer on growth. Results strongly suggest that shadehouse-grown plants have a better chance of survival and that highest mean growth rates can be achieved through the use of fertilized shadehouse-grown transplants. Research was used to assess the impact of the decision by KWRP in December 1995, to erect a fence to exclude cattle from the area. Although the study suffers from an absence of true replication, monitoring showed that over the first six months, the total number of mangrove plants had increased within an adjacent unfenced area by a factor of about 2.5, while the total number of mangrove plants in the adjacent unfenced area remained stable. This suggests that survival of mangrove propagules following fencing was about 2.5 times higher than survival in the unfenced area.

Conclusions from both studies are presented to KWRP management staff, who then use the information in management decisions. Ongoing research examines the change in assemblages of fish, plants, water birds and benthic invertebrates following removal of restrictions to tidal flushing. Ongoing new research is measuring plant productivity under different conditions, assessing methods of salt marsh creation, investigating patterns of plant community structure, and correlating environmental variables to an abundance of various species.

Three aspects of this research program may be relevant to other rehabilitation projects. First, the application of the scientific method may provide a more effective pathway to successful rehabilitation than the trial-and-error methods often adopted. Second, joint efforts by universities and community-driven projects such as KWRP can be mutually beneficial, providing funding, public exposure, and research opportunities for university staff and students while giving rehabilitation projects valuable insight at a reasonable cost. Third, an improved understanding of the role of research in management improves cooperation between managers and researchers, ultimately increasing the efficiency and reliability of rehabilitation efforts.

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The Restoration of Mangrove Ecosystems

By Colin Field

In recent years, there have been detailed studies of the fauna, flora, ecology, hydrology, physiology and productivity of many different mangrove ecosystems but the discrete nature of these data makes the principal factors controlling overall productivity very difficult to identify. This situation is, perhaps, not surprising given the heterogeneity of mangrove ecosystems and the lack of a single model that describes the way that they function. Mangrove ecosystems are places where tides and coastal currents bring constant variation and where plants and animals have to adapt to changing chemical, physical and biological characteristics. Even simple analysis is difficult because of the lack of comparable measuring techniques and a readily accessible data bank.

The question then arises as to the meaning of "restoration." Several terms are used to describe efforts to rebuild disturbed ecosystems, including reclamation, rehabilitation, eco-development and restoration, and these are often used interchangeably.

"Restoration" is used here as the act of bringing an ecosystem back, as close as possible, to its original condition, or renewing or bringing it back into use. In practice, restoration rarely means returning an ecosystem to its original condition.

Reasons for Restoration

Restoring a mangrove ecosystem implies that it has been altered or degraded in a way that conflicts with management or conservation objectives, leading to competition for land use. At times, though, it can arise from climatic impacts that have destroyed the natural vegetation. It is essential to define restoration goals as a first step, in order to identify the elements of the mangrove ecosystem which must be included and to provide a clear framework for operation and implementation (Table 1). There are two main reasons for restoring mangrove ecosystems, although the boundaries between these are frequently unclear–conservation for ecosystem preservation and restoration for sustainable utilization and protection of coastal areas.

I. Ecosystem Preservation

If the aim is to conserve an example of natural ecosystem, restoration will involve maintaining most ecological processes and preserving as much genetic diversity as possible. The best approach is probably to seek an undisturbed area and to restrict utilization and interference from external factors. If the area is truly pristine then it is likely that very little management will be required. If a mangrove forest is disturbed by logging, it is unlikely that it will regenerate to anything like its original state, as the mix of species, soil type, density of trees and numbers of animals will almost certainly change.

Table 1. Site characteristics to be considered when restoring a mangrove ecosystem

Stability of site	Insulation
Rate of siltation	Exposure to wind
Nature of soil	Height of the water table
Exposure to waves and tidal currents	Presence of pests (Acrostichum, barnacles, crabs)
Salinity of the soil water	Availability of propagules
Depth of tidal inundation	Signs of natural regeneration
Gradient of site	Absence of debris
Availability of fresh water (rain or run-off)	Cooperation from local communities

II. Sustainable Use and Coastal Protection

In this case, the priority will be to maximize sustainable productivity. Less attention can be paid to restoring as much of the ecosystem as possible and more given to the cost benefit of the product. A critical question is how much of the original mangrove ecosystem has to be restored to ensure sustained production. This demands further research on pristine and disturbed mangrove ecosystems. It has certainly not been established that maximizing biodiversity in restored mangrove ecosystems leads to maximum, or even optimal, sustainable yields. Furthermore, the concept of "purpose-built" ecosystems may take on real value and there may be a goal of enhancing productivity without regard to how the restored system compares with the original one.

Restoration Approaches

A common approach to restoration is essentially that of classical land management, with forestry or animal husbandry of a specialized kind. Successful restoration requires knowledge of the processes essential to developing and supporting the productivity of the system as a whole, rather than its parts. This is generally lacking for mangroves. If there is to be intensive and selective use of mangrove forests, then specialized knowledge needs to be acquired for plants and animals in areas such as genetics, nutrition, stocking procedures, disease control and harvesting. In turn, this knowledge needs to be supported by appropriate technology and suitable legislation.

Lugo (1988) describes four restoration activities, where the goal is sustainable use:

- Reduction of environmental stress (fire, cutting, over-grazing).
- Adding materials (plants, animals, water, fertilizer, soil).
- Accelerating or decelerating ecosystem processes (encouraging natural regeneration).

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Mangrove Replantation Project in Pakistan

By Najam Khurshid and Fayyaz Rasool

Sonmiani Bay on the Makran coast of Pakistan is surrounded by three villages: Sonmiani, Damb and Bhira. The mangroves around the Bay have been severely degraded by cutting and overgrazing. WWF-Pakistan is supporting a replanting project at Sonmiani where gaining the support and participation of the local people is a high priority.

Sonmiani itself does not have true mangrove forest, but there is suitable habitat. It was believed that if a mangrove plantation could be developed there, the villagers could visibly benefit from it, and word of the mangrove management there would quickly spread to the other coastal communities. An informal education and awareness program for local school children and villagers has been started, apprising villagers of the many benefits of mangroves and getting them involved in the project. An on-site project officer was appointed who interacts directly with the community and constantly promotes the value of mangroves. Rapport with the local community has been established, and acceptance has been gained for the project.

In May 1995, in collaboration with the Baluchistan Forest and Wildlife Department, two nurseries were established, as experimental work had shown that of the three species found in the area, only Avicennia marina grows successfully if sown directly into the wild.

Beds were prepared and pits dug, and seeds were held for germination. Ripe seeds which fall off the parent tree were collected and sown individually in each bag in the nursery by the villagers, with women and children actively participating.

Seedlings have to be cared for and protected for 8-12 months until they are sufficiently mature to be planted out and subjected to tides and strong winds. Transplanting of the seedlings was completed and new seeds have been sown for transplantation next year.

If the pilot work goes well, a full afforestation program will be developed for Sonmiani, and as local communities increasingly recognize the benefits of such efforts, mangrove restoration programs will be started elsewhere. With the development of this sense of "stewardship" for natural resources, WWF-Pakistan will then be able to expand the program to cover sustainable management of other marine and coastal resources.

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Restoration

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■ Changing site conditions (drainage, shading).

Finally, restoration can be extremely expensive, not only because of the technical aspects, but also because land purchase and litigation may be involved.

Measuring Restoration Success

Measuring the success of the restoration process is a challenge that is rarely recognized. If restored mangrove ecosystems are to be compared with naturally occurring ones, then comparative measurement of productivity, movement of organic matter and organization of the food chain will have to be carried out. Additional problems are:

■ An inability to define long-term or genetic changes in populations that may preclude restoration to a known original condition.

■ A lack of understanding of the natural variability of an ecosystem and its recovery process.

■ The often high cost of restoring an ecosystem to something like its original state as opposed to the creation of an alternative at substantially less cost.

Cairns and Buikema (1984) argue that an ecosystem's response to a disturbance depends on three characteristics–its ability to resist change, to recover and its resilience to repeated disturbances. In the case of mangroves, there is only patchy information on these characteristics.

Conclusion

Sustainable development implies that an ecosystem can be manipulated, exploited or disturbed without loss of integrity but there is often a reluctance among ecologists and conservationists to approve of such manipulation even though it may lead to enhanced productivity. Consequently, mangrove restoration has tended to concentrate on preservation of animal and plant species threatened with habitat loss. Mangrove restoration projects themselves could help to supply some of the scientific knowledge that is currently lacking, if they are carried out with clear objectives under carefully controlled conditions and incorporate long-term monitoring. A high priority is to document the many restoration projects underway around the world and to make such information freely available.

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Abandoned Shrimp Ponds: Options for Mangrove Rehabilitation

By N. J. Stevenson and P. R. Burbridge

Disused shrimp pond in Kumta, Karnataka, India. ***(Photo courtesy of Jesmond Sammut, University of New South Wales, Sydney)***

The extent of mangrove deforestation for shrimp farming is unknown, but is thought to be substantial on a global scale. For example, in the Philippines, an estimated 50 percent (approximately 141,000 hectares {ha}) of mangrove loss can be traced to brackish water pond development and in Viet Nam over 102,000 ha of shrimp ponds were constructed in mangroves between 1983 and 1987. Much of the mangrove conversion has been rapid, unplanned and unmanaged, and many farms have proven to be unsustainable. Consequently many ponds have been left idle or abandoned, and farmers have developed new sites in an effort to maintain production. This presents a major challenge for both coastal resource managers and pond owners who have to address the question of what to do with unproductive ponds.

An indication of the frequency of abandonment can be gained from information for Thailand. By 1989, about 22 percent of the farms in Samut Sakorn province had been abandoned, and a 1994 study noted that some 4,000-4,500 ha of ponds south of Bangkok have ceased production due to disease and are now largely derelict. An estimated 70-80 percent of ponds have been abandoned in Prachuap Khiri Khan, with similar figures for the provinces of Songkhla and Si Thammarat. The Bangkok Post of February 20, 1995 reported that overall about 24 percent of shrimp farms in Thailand are being abandoned, and that each 1,000 ha of abandoned ponds equates to an economic loss of 80 thousand pounds sterling each year. Similarly, it has been recently estimated that in some areas only 20 percent of farms are currently operational, and in other small producing areas, 100 percent of ponds may be inoperational.

Causes and Consequences of Abandonment

Ponds are left idle for a variety of reasons. For instance, declining environmental quality may cause an increased incidence of disease and has been widely cited as commonly causing production failure. A variety of diseases have spread from one location to another. In Thailand these included Monodon baculovirus in 1988, the Yellow Head baculovirus in 1992 and, more recently, White Spot disease which is estimated to have been responsible for losses of 50-80 percent production during 1996. Other countries where disease has led to pond failure include India, the Philippines, Taiwan and Indonesia.

Potential acid sulfate soils (P.A.S.S.) exist in many mangrove soils and, as a result of the excavation and construction of shrimp ponds, become oxidized and form actual acid sulfate soils (A.A.S.S.) which release large quantities of acid and toxic levels of iron and aluminum upon wetting. Research in Southeast Asia has revealed that acid, iron and aluminum are directly responsible for fish and prawn losses and general low productivity. Although it is possible to culture shrimps in ponds in acid sulfate soils by adding lime and increasing water exchange, the technology is not always available, and in Viet Nam the development of A.A.S.S. has led to pond abandonment. Other causes of pond failure or abandonment include improper site selection, poor construction methods, poor water quality and circulation, poor farming practices, a lack of post-larvae and/or broodstock, market constraints, and government policy or intervention.

The environmental conditions left after abandonment may be more significant in impeding rehabilitation of a pond than the original cause of failure. For instance, in Karnataka, India, hundreds of ponds are said to be abandoned as a result of White Spot disease but the major obstacle to their redevelopment is the prevalence of A.A.S.S. which, if untreated, may persist for many years. The acidic water resulting from these soils can destroy food resources, displace biota, release toxic levels of aluminum, precipitate iron which smothers vegetation and micro-

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Table 1. Use of abandoned shrimp ponds in Samut Sakorn, Thailand

	ha	*perent*
Converted to traditional system shrimp culture	1,173	33
Converted to salt farming	711	20
Converted to coconut plantations	248	7
Top soil sold for construction purposes	248	7
Left idle	213	6
Unidentified	962	27
Total	3,555 ha	100

(Source: NACA 1994 translated from Thai by B. Srethasirote 1996 pers.comm)

Abandoned Shrimp Ponds

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habitat, and alter the physical and chemical properties of the water (Sammut et al. in press). Consequently, acid-tolerant species may dominate and further impede restoration attempts.

Mangrove clearance, shrimp cultivation and the abandonment of ponds may also alter soils in other ways including accelerating soil erosion by increasing surface run-off and interflow; decreasing soil water storage capacity; reducing biodiversity of soil fauna; altering the transport of sediments, dissolved inorganic and organic constituents and principal nutrients; increasing levels of toxic chemicals; and depleting organic matter through leaching and mineralization.

Options for Rehabilitation and Restoration

There are three basic options for dealing with abandoned ponds:

1. Rehabilitation for shrimp production;
2. Rehabilitation for other sustainable uses such as salt production or integrated aquaculture;
3. Restoration of the environmental conditions within the ponds and surrounding area to a productive mangrove ecosystem.

Table 2: Intentions of farmers who have abandoned their land

	No. of farms	*percent*
Return to shrimp culture	38	73.08
Culture fish (Seabass)	1	1.92
Make salt farm	4	7.69
Sell land	3	5.77
Leave the land	2	3.85
Other (Agriculture land, housing and land for rent)	4	7.69
Total	52	100.00

(Source: NACA 1994 translated from Thai by Buntoon Srethasirote 1996 pers.comm.)

The suitability of these options depends on the causes of failure of the pond operations and the conditions which remain in the pond after abandonment. There are several successful examples of the second option–conversion to other uses. In Thailand, large tracts of abandoned shrimp ponds in Samut Sakhorn have been converted to housing estates and industrial development (although such activities may not constitute "best use" options and may have their own specific ecological impacts). Some abandoned shrimp farms have been converted to salt farms or fish culture operations for sea bass and tilapia, and shrimp farms located near main roads have sold top soil for construction projects (Table 1). The Department of Fisheries in Thailand has promoted cage culture of fish (including mullet and sea bass), blood cockles and mussels in abandoned shrimp farms. However there have been some major problems, including lack of seed for blood cockles, lack of suitable fish species for cage culture in idle ponds, lack of investment credit and the need for technology transfer related to aquaculture and mariculture.

Excavation of shrimp pond in Potential Acid Sulphate Soils (PASS) in Kumta, Karnatake, India ***(Photo courtesy of Jesmond Sammut, University of New South Wales, Sydney)***

There has been some success with using abandoned shrimp ponds for grouper culture in the Philippines and crab culture in Thailand, and it has been suggested that the abandoned ponds could be used for polychaete culture, integrated salt-artemia production or shrimp-salt production. Integrated shrimp culture may be the most attractive option to farmers who have ceased shrimp production but still own or have the lease rights to the ponds. Aqua-silviculture could be used to facilitate the restoration of abandoned, unproductive or denuded open areas to a productive condition, and might reduce mangrove replanting costs by providing a local supply of propagules and minimizing transport costs.

Constraints to Restoration and Sustainable Use

The remediation of acid sulfate soils presents many problems, not least of which are the time required and the costs involved. One treatment involves the deliberate oxidation of the acid-producing material (pyrite) and flushing out with brackish or fresh water. This reduces soil acidity but does not take into account the ecological impact of the acid leachate. In addition, successful replanting of abandoned shrimp ponds may be severely constrained by increased erosion, the activation of acid sulfate soils, and the presence of shrimp culture related chemicals. Variable success rates have been achieved with different mangrove species in small scale experiments.

Additional constraints include the lack of technical expertise in general habitat restoration and an even greater lack of experience in restoration of unproductive shrimp ponds. Market forces and the preferences of the pond operators must also be considered when identifying potential alternative uses, and their economic feasibility. For example, a survey in Thailand showed that the primary aim of farmers with unproductive ponds is to start shrimp culture again (Table 2). Options which meet both the management objectives of coastal resource managers and those of the pond owners should be pursued.

Finally, there is the question of who bears the costs of redevelopment. Restoration of unproductive shrimp ponds to a productive mangrove ecosystem is very expensive, particularly if propagules are in short supply and if it is necessary to create a

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Aquaculture in Madagascar's Mahajamba Bay

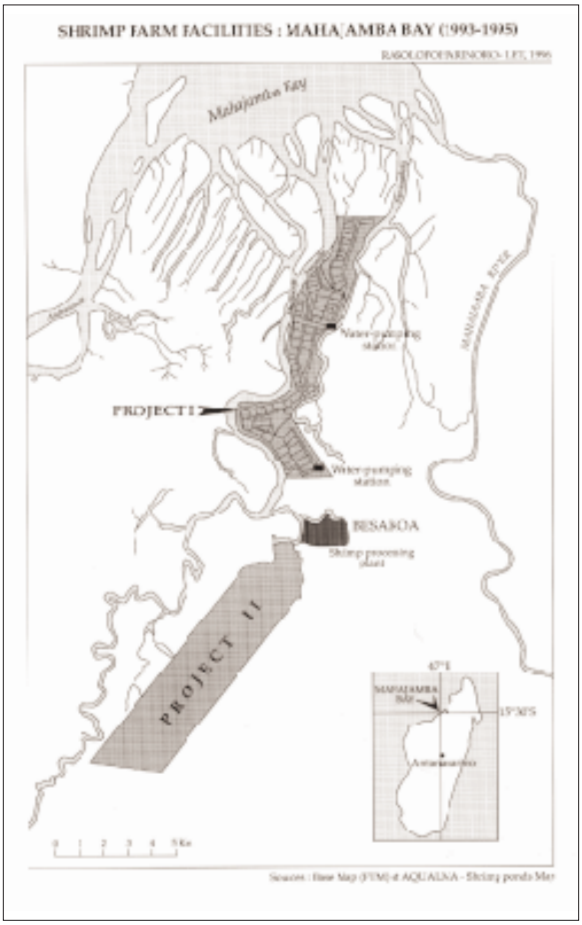
By M. Rasolofoharinoro, F. Blasco and J. Denis

Aquaculture in Madagascar's Malagasy mangroves has provided a boost to the local economy, but problems in the form of mangrove destruction and increasing pollution threaten the area. A bibliographic and photographic analysis (aerial photos from 1992 and SPOT imagery from 1993) and field studies, however, suggest some solutions.

National operators and foreign investors in Madagascar are increasingly exploiting the coast because of the depletion of forest, agricultural and pastoral areas. The Malagasy mangroves, covering some 400,000 hectares (ha), provide optimal conditions for aquaculture, particularly in estuaries and embayments.

The western coast of Madagascar could potentially produce 58,000 tons of crustaceans per year, but aquaculture is a still recent development. It started with a pilot hatchery project in 1990 at Nosy-Be, which was followed in 1993 by a shrimp farming operation of over 3,995 ha, established by a fishery company in Mahajamba Bay. A number of natural, social and economic factors have contributed to aquaculture's success:

- The extensive salt-flat areas, called "tannes," which occupy the middle and upper courses of channels of the Masokoenja and Marovoaikely Rivers. These are formed by the high spring-tide range of 3.5 meters, and are protected by a screen of mangrove trees. The permanent flow over the tannes provides organic and mineral-enriched soft water, which helps to make the area a good nursery for many aquatic species, particularly shrimps and prawns.
- The clay-like texture of the tannes provides an impermeable substrate, favorable to shrimp-pond construction.
- The use of the bare tannes means that there is no need to clear vegetation for ponds.
- The Mahajamba mangroves have been protected for many years, as they are considered inviolable and have been a factor in the social unity of local communities.
- There is a plentiful workforce for the aquaculture facility, though people had been forced to emigrate when a starch factory closed down, and land and agricultural opportunities became scarcer.
- Some employment opportunities have been created by the aquaculture operation-cutting mangrove trees for timber, transport of motor-fuel, tool repairing and improvements to the local infrastructure.
- There are business opportunities for collaborative efforts by groups which specialize in oceanographic, marine and biochemical resources to produce marine products which must meet the strict industrial standards of the international market.
- The aquaculture facility provides foreign currency to the Malagasy economy and permits the import of feed, disinfection products and other items.



Shrimp farm facilities: Mahajamba Bay (1993-1995) ***Sources: Base map (FTM) et AQUALMA - Shrimp Ponds Map***

From 1993 to 1995, 644 ha were used for assay and exploitation of ponds, the shrimp processing plant and reception infrastructure. Eighty ponds are situated in dry tannes, previously occupied by *Salicornia pachystachia* (*Chenopodiaceae*), and are being protected from erosion by herringbone woodstakes work until the planted mangroves, *Avicennia marina*, have grown. It is an intensive aquaculture system. The ponds, which average over 0.5 ha, are equipped with water-pumps, filters and aerators, adapted to suit the diverse requirements of each stage in the growth of the shrimps (e.g. artificial feeding, water quality monitoring). The reproduction rate is relatively high (above 80 percent) and, since 1993, staggered crops have been produced regularly. Methods in the processing plant are prepared, using perfected fittings and a research laboratory. This success provides encouragement for the continuation of shrimp farming at other sites and for similar projects elsewhere

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Madagascar

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in the country.

Nevertheless, several environmental impacts are already being felt which threaten the facility:

1. Mangrove destruction is widespread, even in dense mangrove areas, as dikes and embankments have to be constructed.

2. Sensitive sites, notably silting zones, are being used which increase the extent of tannes.

3. The safety measures taken are not sufficient to prevent risks from natural disasters or disrupting flows (e.g., filling up of channels, inundation).

4. Dredging is increasing water turbidity, as the current patterns are not taken into consideration; dredging on potential acid sulfate soils accelerates their acidification, and salts are rising to the surface, rich in chlorides and sulfates, forming a whitish powder.

5. Pollutants (e.g., waste-water, wastes of farming and processing, disinfection products, engine oil) are degrading water-quality. Rising temperatures, oxygen saturation reduced to less than two percent, high salinity, weak flow of tides, abundance of whitish froths and foul smells are emitted by wastewater even after decanting.

6. Noise caused by pumps and shipping, and turbulence movements around ships can disturb the flora and fauna (e.g., juvenile fishes, seedlings growth, subsidence of banks).

7. The weak bearing capacity per unit of area of mangrove soils requires the widespread use of dikes and intensification of embankments to the detriment of the mangroves.

8. The aquaculture activity has some flow-on effects endangering the mangrove ecosystem: for example, permanent occupation, more cutting for timber, firewood, smoking of fish, collieries, more fishing and/or conversion of mangrove into rice fields.

Aquaculture may be a suitable land use for some less productive parts of the mangrove ecosystem, but better data are required to assess aquaculture work and impact to control environment effects. Otherwise, the inadequate legislation and the lack of access prevents effective control of the milieu.

At the national level, a policy for coastal facilities, notably aquaculture operations, is urgently needed. New legislation is also needed. The forest legislation, dating from 1930, covers mangroves but was formulated for terrestrial forests. The legislation for aquaculture is recent (1985), but is mainly concerned with fishing. In addition, there needs to be more effective enforcement of the legislation and provision of the necessary enforcement personnel and methods of transport, as well as involvement of the local communities to avoid any conflict. Sensitive zones have to be defined and delineated with the collaboration of local communities, and the number and types of occupation per site and the resort calendar must be respected. Replanting (particularly with *Avicennia marina*) must be done and controlled, to ensure the regeneration of mangrove and the protecting of its ecosystem. Planning must include the treatment of pollutants (incineration and burial of wastes, complete treatment of waste-water before discharging into channels or rivers). An improved database on the mangrove ecosystem and the results of impact studies is needed, updated by remote sensing.

At the regional level, infrastructure must be improved to reduce the occupation of mangroves, for example by constructing and maintaining roads in other areas, particularly in agricultural and pastoral areas. In the same way, social equipment and land reliability in traditional spaces must be rehabilitated. Forestry should be encouraged and the establishment of new operations should be restricted to avoid increasing environmental impact. At the local level the topographic lines must be taken into account by all facilities, particularly creeks, channels favoring drainage, or for laying out dikes or banks. Imperatives for protecting mangroves include:

- Respect for current patterns in dredge works.
- Control and survey of all intervention in the mangrove (fishing, wood exploitation, salt extraction).
- Removal of cutting licenses and clearing areas in the mangrove.
- Control and survey of navigation and fuel transport.

Aquaculture is a good use of the tannes and promotes regional development by creating local employment and improving infrastructure, but its future depends on better mitigation of the environmental impacts. The destruction of mangroves, falling banks, alteration of the quality of water, disorganization of the flow, and the acidification of the soils certainly endanger shrimp farming.

A database updated by remote sensing and an impact study will allow the mangrove ecosystem to be surveyed and controlled.

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seedling nursery. Although it may be possible to create financial disincentives to prevent or limit future habitat destruction (by making the costs of destroying or denuding a habitat match or exceed the cost of keeping or replacing it), this would not speed the redevelopment of unproductive ponds. Consequently other means of catalyzing and funding rehabilitation or restoration activities must be found.

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Majagual: The Tallest Mangroves in the World

By Emilio Ochoa

Majagual is an estate in the north of Esmeraldas, the northernmost province of Ecuador. It lies in the estuary of the Cayapas-Santiago-Mataje Rivers, on the border with

Colombia, an area which encompasses almost 22,000 hectares (ha) of mangrove and some 50,000 inhabitants. Some of the tallest mangrove trees in the world are found here, reaching over 60 meters in height. Several of these are on private property and could be felled at any moment. The forest is mature and very dense, with very little light penetrating the foliage of the canopy. Some of the trees are about 100 years old and, seen from the distance, appear as tall, thin columns.

The traditional uses of mangroves (charcoal, fuel wood, collection of shellfish and shrimps) gave way in recent years to the harvesting of large trees for posts and to clearing for shrimp pond development. The growth of both traditional and modern pressures is damaging the structure of the mangrove forest in such a way that its

fauna and flora is now declining at a rate faster than it can naturally recover. Timber harvesting brings in a revenue of 400,000 sucres/hectares(ha)/yr (10-15 m^3/ha/yr) and some 500,000 crabs and mollusks are collected each week, with a value of about 5,000,000 sucres (US$1,500 approx.).

Part of the estate was bought by a company, Purocongo, and in 1993 shrimp aquaculture ponds were constructed amidst major protests, suspicion and initial concern by the local community. Tension rose considerably when various NGOs and the press reported that the company had cut the mangroves to open a canal to bring in water. The Programa de Manejo de Recursos Costeros and the Fundacion Maldonado intervened and the company agreed to draw up an agreement with the community and authorities to develop its ponds and at the same time protect the mangroves. Majagual is now the site of a controversial experiment, so far successful, where shrimp farmers are learning to co-exist with mangroves. The Foundation was given the mangroves by Purocongo in order to ensure their protection, and the company and the local community negotiated a deal with the following conditions:

- All shrimp ponds to be located 50 meters behind the mangroves in order not to affect the root systems.
- No alteration of the mangrove cover.
- No alteration of the natural water flow with dams, walls or by diverting water courses.
- Traditional use of and access to the mangrove area to be guaranteed to the local population.
- Ecotourism activities and research to be encouraged.

The pressure to build shrimp farms in Esmeraldas is intense and the need for practical approaches to conserving mangroves and their traditional uses is urgent.

Since 1990, shrimp production in the Gulf of Guayaquil has been unusually low: mortality of juvenile shrimp is high

and the adults have slow growth. These are both considered symptoms of the "Taura Syndrome." The causes of this and other production problems for shrimp farmers are much debated. Some argue that the problems are related to the use of agrochemicals by nearby banana growers, while others believe that the causes are diseases specific to shrimp. Whatever it may be, many shrimp farmers are having to withdraw their investments and transfer them to areas that are environmentally healthy. Esmeraldas makes an inviting target.

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Market Opportunities for Addressing the Environmental and Social Impacts of Wild-Captured and Pond-Produced Shrimp

By Jason W. Clay

The Commodities Program of WWF-US is producing an extensive report which analyzes the environmental and social impacts of wild-caught and pond-raised shrimp, and the structure of the shrimp market chain, shrimp consumption, and trade. The goal is to improve understanding of trade and environment linkages, and to formulate policy recommendations for improving the environmental sustainability of shrimp production systems.

Both shrimp mariculture and harvest of wild shrimp pose different but equally troubling environmental impacts. Export-oriented shrimp farming has led to large areas of coastal mangrove being cleared for the construction of shrimp ponds with important impacts on estuary systems and the coastal environment. In Bahia de Caraquez, a large bay in Ecuador, for example, 95 percent of the mangroves have been destroyed to make way for shrimp ponds. Other environmental impacts involve the by-catch from capture of fry, and the use and discharge of large volumes of water with heavy chemical loads. The main environmental impacts of wild-caught adult shrimp are the by-catch, the highest of any fishing industry, and the routine and systematic disturbance of the ocean floor by nets and runners.

The social impacts of the two shrimp production systems are similar. In both cases, destructive practices erode the livelihoods of coastal residents causing hardship and further environmental degradation as they seek new ways to make a living. In the Honduran portion of the Gulf of Fonseca, for example, shrimp pond development has an important impact on mangrove ecosystems and is creating conflict among shrimp farmers and traditional coastal communities.

Analysis of the shrimp market chain will give an indication of where, in the current system, it might be possible to intercede in ways that could create more sustainable shrimp production by addressing both environmental and social impacts. The report will offer a comprehensive set of conclusions and recommendations regarding both wild-caught and pond-raised shrimp production systems.

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If you've missed any recent issues of Intercoast Network, you can catch up on back information and opinions by visiting the University of Rhode Island's Coastal Resources Center home page on the World Wide Web at <http://brooktrout.gso.uri.edu>. Past issues of Intercoast are available under CRC's information services, along with other resources and publications, including:

- A country-by-country global Data Base on coastal management initiatives worldwide.
- "Educating Coastal Managers," the proceedings of a 1995 workshop held in Rhode Island, which provides a call to action for new and improved ways of educating and training coastal practitioners and evolving the discipline into a professional career field with enhanced educational opportunities.
- Opinion and editorial pieces by Intercoast's co-editor Stephen Olsen, which have been appearing on a regular basis in the U.S. press.

We welcome suggestions or comments on CRC's World Wide Web page that will help improve dissemination of information and news on coastal management. Contact: Chip Young, Managing Editor, Intercoast Network, Coastal Resources Center, University of Rhode Island, South Ferry Road, Narragansett, RI, 02882 USA. Phone: (401) 874-6630; FAX: (401) 789-4670; E-mail: <cyoung@gso-sun I.gso.uri.edu>.

A Comparative Assessment of Remote Sensing for Mangroves

by E.P. Green, P.J. Mumby, A.J. Edwards and C.D. Clark

Decision makers interested in adopting remote sensing are faced with a variety of satellite and airborne systems. Choosing the most appropriate systems will depend on the objectives of the study and size of the budget but few, if any, guidelines exists to facilitate this process. A joint project between the Universities of Newcastle and Sheffield (UK) seeks to critically evaluate these issues for a suite of mangrove management objectives. Satellite (SPOT XS and Landsat TM) and airborne multispectral (CASI, Compact Airborne Spectrographic Imager) data have been acquired for mangroves in the Turks and Caicos Islands, British West Indies. These data cover a spectrum of resolution and cost, and their ability to achieve different management objectives has been evaluated.

Sensor	Coverage of Image			Resolution	Cost*
	Spatial	Spectral	Radiometric		
Landsat TM	185 x 185km	30m	7 bands	8 bit	1
SPOT XS	60 x 60km	20m	3 bands	8 bit	11
CASI **	variable	3m	15 bands	12 bit	4630
CASI**	variable	1m	8 bands	12 bit	4630

** Costs are for imagery alone, and exclude costs of fieldwork, processing, accuracy assessment etc.*
*** CASI can be configured with different spectral resolutions. Spatial resolution depends on aircraft altitude. Users define the area of CASI coverage according to their needs - the width of a flight line of imagery depends on spatial resolution and therefore aircraft altitude.*

The western coast of the Caicos bank is inhabited by three species of mangrove. Stands were surveyed for species composition, tree height and density. These variables, when classified, identified six mangrove habitat categories. This habitat scheme was then used to direct a classification of the remotely sensed data by five different methods (visual interpretation; classification after conversion to a vegetation index; unsupervised classification; supervised classification; band-rationing and principal component analysis). Supervised classification of CASI data mapped the six habitat categories to an overall accuracy of 78.2 percent but all classifications of SPOT XS data failed to discriminate satisfactorily between mangrove and non-mangrove vegetation. Classification accuracy of the Landsat TM data was dependent upon the method used. Only one processing method (band-rationing and principal component analysis) accurately discriminated between mangrove and terrestrial vegetation (92.3 percent) but just two of the six mangrove classes could be distinguished. The superior spatial and spectral resolution of the CASI allows mangrove areas to be assessed to a greater level of detail and accuracy than with satellite sensors.

Field data have also been used to model the relationship between the imagery-derived normalized difference vegetation index (NDVI) and leaf area index (LAI) of the mangrove canopy. The importance of measuring LAI stems from its relationship with a range of biological processes including rates of photosynthesis, transpiration and evapotranspiration, net primary production and rates of energy exchange. Measurements of LAI have also been used to predict future growth and yield and to monitor changes in canopy structure due to pollution and climate. The ability to estimate LAI is therefore a valuable tool in modeling the ecological processes occurring within a forest and in predicting eco-system responses. NDVI was derived for Landsat TM and CASI bands and regresses against field measurement of LAI which were obtained from in situ measurement of light transmittance through the canopy. An independent data set was then used to test the accuracy of this prediction. Accuracy was found to be high for both Landsat TM and CASI (88 percent and 95 percent respectively). In addition, the mean difference between predicted and measured LAI error was low (5 percent and 13 percent respectively). These results show that remote sensing is a powerful tool for estimating the spatial distribution of LAI throughout large areas of mangrove. The assessment of LAI can be conducted with minimal field data which is particularly desirable for dense mangrove stands where logistical and sampling difficulties can be severe. The comparative approach to remote sensing for mangrove management will be discussed in the book *Practical Remote Sensing for Tropical Coastal Management* which is to be completed in autumn 1997 (similar chapters will address remote sensing of coral reefs, seagrass beds and bathymetry). The cost effectiveness of different sensors in relation to specific management applications, such as habitat mapping and the prediction of ecological data across whole ecosystems, will be presented in a manner which is designed to facilitate informed choices by potential users of remote sensing.

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The Global Distribution and Status of Mangrove Ecosystems

by Mark D. Spalding

Where Are Mangroves Found?

Probably the earliest known reference to mangroves is that of Nearchus and Theophrastus who described the mangroves of the Arabian Gulf over 2,000 years ago. The first known use of the term mangrove is an early 16th century chart of Brazil which marks "manguez" along the coast of the Golfo de los Reyes, just south of Rio de Janeiro. Charts of the Moluccas (Indonesia) from the same period show forest areas marked as "alagados" ("inundated"), which were undoubtedly mangroves. A recent worldwide review of the distribution and status of mangrove forests, compiled by the World Conservation Monitoring Centre and the Institut de la Carte Internationale de la Vegetation, to be published in 1996 by the International Society for Mangrove Ecosystems, with support from the International Tropical Timber Organization, provides what is probably the most thorough survey of mangrove distribution undertaken to date.

Mangroves occur in 112 countries and territories and are largely confined to the regions between 30' north and south of the equator. Notable extensions beyond this are to the north in Bermuda (32'20'N) and Japan (31'22'N), and to the south in Australia (38'45'S), New Zealand (38'03'S) and on the east coast of South Africa (32'59'S). Within these confines they are widely distributed, although their latitudinal development is restricted along the western coasts of the Americas and Africa compared to the equivalent eastern coasts. In the Pacific Ocean, natural mangrove communities are limited to western areas, and they are absent from many of the more eastern islands.

Modern distribution patterns of mangroves are the result of a wide range of historical and contemporary factors. The most obvious distribution patterns, the latitudinal limits, are largely set by low sea surface and air temperatures, and particularly by temperature extremes. Rainfall also has a strong influence through the reduction of salinity. Although mangroves are adapted to saline or brackish environments, the high salinity of seawater, and the sometimes higher salinities associated with intertidal areas, particularly in arid countries, frequently restrict growth. In areas with low, irregular or limited seasonal rainfall, the number of mangrove species which can survive is limited and there is sparse mangrove development as on the coast of the Arabian peninsula. Historical and tectonic factors are probably responsible for the easterly limit of mangrove development in the Pacific, although the exact mechanisms are unclear. At the national and local level, many other factors influence the distribution of mangroves, including soils, tides, geomorphology, mineral availability, soil aeration, winds, currents and wave action. Most significantly now, human activities are affecting mangrove distribution patterns at all scales.

How Much Mangrove Is There?

The amount of mangrove in any country or region, and the rate of its loss or deterioration, is important for policy-making, planning and resource management. Unfortunately, generating such figures is a difficult exercise, particularly making them comparable between countries or regions. This is because there is wide variability both in the spatial scale and accuracy of different studies, and in the way in which people define mangroves. Some definitions of the ecosystem include areas of salt-flats and open water; others cover only fully developed trees of specified density or canopy height. The mangrove palm *Nypa fruticans*, found in monospecific stands in many areas, is excluded from some definitions but not others. In some areas there may be further problems of misidentification. For example, figures for mangrove area in Venezuela (given as over 6000 square kilometers {sq km}) may be overestimated by over 100 percent as they are based on remotely-sensed images in which it is difficult to distinguish true mangroves from *Symphonia globulifera*, a swamp-forest species.

The best-available estimate of global mangrove coverage, calculated for the *World Mangrove Atlas*, is just over 180,000 sq km (Figure 1), a tiny area compared with other forest types (Figure 2), or with coral reefs which may cover three times as much (based on Smith's 1978 estimate of 600,000 sq km). Most mangrove is found in the south and southeast Asian regions, with Indonesia alone accounting for 23 percent of the world's total. Just four countries (Indonesia, Brazil, Australia, Nigeria) have some 43 percent of the world's mangroves and each has between 25 percent and 50 percent of the mangroves in their respective regions (Figure 3).

How Fast Are Mangroves Disappearing?

Accurate figures for total mangrove loss are unavailable for most countries, although there is a considerable wealth of anecdotal figures and "guesstimates". Where data are available, major declines in mangrove coverage can be seen, as exemplified in southeast Asia:

- Philippines - 60 percent (from 4,000 sq km originally to 1,600 sq

km today)

- Thailand - 55 percent over 25 years (from 5,500 sq km in 1961 to 2,470 sq km in 1986)
- Viet Nam - 37 percent (from 4,000 sq km originally to 2,525 sq km, today).
- Malaysia - 12 percent (540 sq km lost between 1980 and 1990)

These figures suggest a loss of some 7,445 sq km of mangroves in four countries alone, representing over four percent of the current global total. There are very few national accounts which do not show similar declines. On a more positive note, the area of mangrove re-planting has increased in several countries. Plantations in Bangladesh, Viet Nam and Pakistan now cover over 1,700 sq km in total, while Cuba is reported to have planted some 257 sq km of mangroves.

How Much Mangrove Is Protected?

Worldwide, there are about 685 protected areas containing mangroves, distributed between 73 countries and territories (note that these figures refer to the legal status of sites, and many may be "paper parks" with no real management). Compared with other habitat types, this is a large number: up to nine percent of the total mangrove area may lie within gazetted protected areas. For example, there are only about 350 marine protected areas with coral reefs, despite the high profile of the latter habitat and the larger total area of coral reefs in the world.

There are few figures for the area of mangrove habitat within each protected area, but it is possible to get a very general picture, and more particularly to draw attention to the obvious holes in the protected area network. Most of the countries with very large areas of mangroves have a significant number of protected areas, notably Australia (180), Indonesia (64) and Brazil (63). Conversely there are some, such as Nigeria, with very large areas of mangroves which have no gazetted protected areas containing this habitat. Legal protection is, of course, only one tool for the conservation and sustainable use of mangroves and many other legal, industrial or traditional management regimes are also used with considerable effect. Australia, Indonesia, Brazil and Nigeria clearly have a key role to play in sustainable mangrove management, and political and management decisions relating to mangroves in each of these countries will have a significant effect on the global status of mangrove ecosystems in the future.

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Figure 1: Areal coverage of mangrove forests

Region	Mangrove Area (sq km)	percent
South and Southeast Asia	75,172	41.4
The Americas	49,096	27.1
West Africa	27,995	15.4
Australasia	18,788	10.4
East Africa and the Middle East	10,348	5.7
TOTAL	181,399	100

Figure 2: The total global area of different forest-types

Figures have been rounded to the nearest 100,000 sq km
(source: World Conservation Monitoring Centre)

Forest Type	Area (million sq km)
Temperate needle-leaf forest	13.9
Tropical moist forest	11.2
Temperate broadleaf/mixed forest	7.2
Tropical dry forest	0.8
Mangrove	0.2

Figure 3. Area of mangrove in top eight countries

	sq km	percent of world total
Indonesia	42,550	23.5
Brazil	13,400	7.3
Australia	11,500	6.3
Nigeria	10,515	5.8
Cuba	7,848	4.3
India	6,700	3.7
Malaysia	6,424	3.5
Bangladesh	5,767	3.2
Other countries	76,697	42.3

Management of Resources in the Sundarbans Mangroves of Bangladesh

by Neaz Ahmad Siddiqi

The Sundarbans is the largest continuous mangrove forest in the world, and covers an area of about 10,000 square kilometers (sq km). Of this, 62 percent lies in Bangladesh at the southern end of the Ganges River (see map) and comprises 44 percent of the productive forest of the country, contributing about one-half of forest-related revenue. Internationally, the Sundarbans are renowned for their abundant wildlife: 32 mammal species, at least 186 bird species and 43 reptile and amphibian species inhabit the area. Several large species, such as the Javan rhinoceros and the water buffalo, have disappeared since the beginning of this century, but a number of other endangered species, notably the tiger (with a population of about 350), survive. Over 120 species of fish are caught by commercial fishermen, and the area is an important nursery for both offshore and nearshore marine and brackish fish species, with crustaceans accounting for the largest proportion of animal biomass.

Figure 1. Map of Bangladesh showing the location of the Sundarbans, largest continuous mangrove forest in the world.

The flora is rich, with 69 species; a number are commercially important. The mangrove trees *Heritiera fomes* and *Excoecaria agallocha* are the dominant species in the forest and provide high quality timber for newsprint, match sticks and boxes. *H. fomes* alone constitutes 63.8 percent of the total marketable timber. Non-timber products contribute significantly towards the overall productivity of the Sundarbans. Leaves of *Nypa fruticans* are traditionally used for roof thatching and house walls. Trunks of *Phoenix paludosa* are in great demand as house posts. *Ceriops decandra* and *Cynometra ramiflora* yield high quality fuel wood. An estimated 185,000 kilograms (kg) of honey and 44,400 kg of wax are harvested each year in the western part of the forest.

The entire area is flat and intersected by a complex network of streams and rivers, with the salinity increasing from east to west and towards the south. Salinity plays an important role in the growth, species distribution and productivity of the forest, and vegetation tends to be more luxuriant at lower salinity levels.

Management Problems

The Sundarbans has been managed for over 120 years as a commercially exploited Reserved Forest. The original intention was for a 20-year felling cycle, with "improvement felling" consisting of removing dead, dying and unsound trees and thinning congested areas. Different exploitable diameter limits are enforced for different species in various quality classes, largely determined by salinity. Diameter limits and felling cycles have been adjusted over this time, and improvement felling is no longer carried out. *Nypa fruticans* leaves are harvested once a year, and the central leaf and leaf next to it are retained. Fuel wood and pole species are harvested on a 20-year cycle.

Management of the Sundarbans faced a process of continuous change, much of which has been beyond the control of the Forest Department. Salinity levels have increased, lowering productivity, as a result of diversion of fresh water upstream. Silt is deposited in the northeast portion of the forest, causing the forest floor to rise, which stresses mangrove plants. Productivity has declined significantly over the last few decades and the average yield of wood is only 1.12 cubic meters/hectare/year (cu m/ha/yr). The standing stock of *H. fomes* and *E. agallocha* was depleted by 40 and 45 percent, respectively, between 1960 and 1985. A number of factors, including over-exploitation, may have contributed to this. There may be a need for revision of the current silvicultural system in order to maintain a sustainable level of production.

At present, the Sundarbans is entirely dependent on natural regeneration. Seedlings are abundant throughout most of the forest, averaging 27,750/ha per year, but their survival is a major problem for most species at all levels of salinity. An additional problem is "top-dying," a phenomenon that causes death of trees from the top downwards and that is increasingly affecting *H. fomes*; 17 percent of trees are moderately or severely affected. The cause of this is not known, but it could be the result of stress from a variety of factors such as changes in salinity, reduction in flooding levels, loss of canopy leaves in storms or siltation of the pneumatophores.

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Management of Living Resources in the Matang Mangrove Reserve, Perak, Malaysia

By N. Gopinath and P. Gabriel

The Matang Mangrove Forest Reserve in Perak, Malaysia, is valuable for its timber products, which in 1992 amounted to 451,196 metric tons (mt) with a value of 17.7 Malaysian rupees (MR). However, the reserve's natural heritage also contains other socioeconomic and environmental benefits, such as fisheries, tourism and wildlife that go far beyond the traditional mangrove resource uses for charcoal and poles. However, the present management strategies, with a focus on extraction of timber, do not totally address management of the reserve's resources.

The absence of a comprehensive strategic plan is a serious shortcoming where forestry resources are concerned. The working plans have never set quantitative productive targets for sustained forest production. Targets were set on an area basis, or according to the size of the industry to be supported, rather than in terms of the inherent productive capability of the forest. This has skewed the plan toward simply setting area quotas (coupes), with less emphasis on improving forest production or evaluating industry skills and potentials. The earlier plans did not institute a standardized methodology for establishing yields. As such, yields were not seriously monitored as an indicator of management success, and though some authorities suggest there is a decline in forest productivity, data are inadequate for a rigorous assessment.

The financial sustainability of the present management regime is also doubtful. All indicators point to a declining economic output, as well as declining revenues to the state. Such a decline was, in fact, alluded to by several kiln owners, who maintained that while demand for charcoal was good, they had made "better" money in the 1960s.

The social value of mangrove-based forestry is also declining. The need for charcoal and firewood as domestic fuel has all but ended. Charcoal is in demand for the manufacturers of briquettes and activated carbon. While the former is for domestic use, it does not represent an indispensable part of an average household's energy requirements. In the context of the current economic growth of the country, which emphasizes manufacturing and service-related industries, the labor-intensive nature of charcoal production is untenable. Though both the people that operate and those that work at the charcoal kilns have been doing so for decades, and the workers may be unable to find alternate work elsewhere, employment in itself would be insufficient justification for maintaining the kilns. If anecdotal information is correct and the kilns are seriously bereft of young workers, then it may not be too far in the future when the kilns will either have to close down or

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An area of felled mangroves in the Matang Mangrove Reserve, Malaysia.

Mangroves of Bangladesh

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Reforestation, or supplementing natural regeneration by planting, may be necessary. Other species could be planted on elevated soils, and trials are underway.

The Forest Department also regulates fishing within the Sundarbans, but there is no information on the status of fishery resources. There is no regulation of the collection of shrimp fry, and the use of set-bag nets destroys fish larvae and depletes juvenile fish. Stock assessments of commercially important fish, crustaceans and mollusks are urgently needed for developing a management plan. Similarly, although three wildlife sanctuaries covering 32,386 ha were established in 1977 in the southern part of the Sundarbans, the research necessary to determine appropriate management actions for wildlife has not been carried out.

Despite its international importance and its long management history, there are still outstanding needs for the long-term survival of the Sundarbans. The two main ones are need to investigate the potential for developing ecotourism, as the Sundarbans could be a major attraction; at present the lack of accommodation and transport means that tourism is not a feasible source of revenue for local people. Second, management-oriented research is required, particularly on wildlife and threatened species; on the causes of low mangrove productivity, die-off and seedling failure; and on the fisheries.

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Malaysia

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upgrade by mechanizing their manufacturing operations. Mangrove products such as thatch are also of little use and of local importance only, having largely been replaced by galvanized iron, asbestos and tiles. The production of poles is still of major importance, though that market is also likely to decline in the future.

The development of alternative forestry activities would slow the decline of the charcoal and pole trade. A study discovered that the dryland forest in Matang had substantial wood resources that could be exploited. Another 1991 report recommended that the establishment of indigenous plantations of *Oncosperma tigillarium*, *Xylocarpus ssp.*, *Intsia bijuga* and rattan in an unproductive dryland forest. While some of these are not commercially exploited at the present time, they have long-term potential in the furniture and construction industries. The report also recommended apiculture in the *Avicennia* forest.

Fisheries is another industry that relies on the reserve for its sustenance. In 1993, the waters off the reserve yielded 50,073 mt of fish valued at MR117.1 million. The industry provided direct employment to 1,954 people and at least twice that number were involved in associated occupations. Though there has been a decline in the coastal fishing population of the district, a move that is openly encouraged by the authorities, total landings of marine fish have not declined. The role of the Matang mangrove ecosystem in maintaining the coastal fishery has not been elucidated, but prudence dictates that management of the reserve take into account maintenance of this productive fishery.

Aquaculture, specifically the farming of the blood clam, is probably the only activity that does not face an uncertain future. In 1993, an estimated 34,183 mt of blood clam, valued at MR13 million were produced in Matang. The mudflats off the reserve are not open to any other kind of economic activity. Blood clam farming is not particularly labor-intensive, and markets are not limited. Under these circumstances, the long-term prospects of the industry appear bright.

Tourism is the latest development in Matang. Estimates from anecdotal information indicate that tourist arrivals may contribute at least MR1.7 million annually to the local economy. Tourist infrastructure must be upgraded if this sector is to further develop. Tourism, if properly planned, would allow the reserve to be exploited on a nonconsumptive basis, without economic loss to either the state or the reserve's current users.

In regard to the socioeconomic value of the forest, of an estimated MR 151 million annual output during 1992-93, 77 percent came from fisheries, nine percent came from aquaculture and 12 percent from forestry. (Fisheries and aquaculture figures consider the Larut Matang district, which should closely approximate those for the Matang Reserve. The mangrove forest provides other benefits and services, whose value and social impact have not been adequately documented). Even with the limited information at hand, it is obvious that forestry represents only a small proportion of the economic value of the forest. Forestry output is far surpassed by fisheries landings and almost matched by aquaculture. Tourism is still small, but has a promising future.

Management of the forest should give increased attention to biodiversity conservation. The virgin jungle reserves, the Avicennia-Sonneratia belt, has been set aside mainly because it is of no use from a forestry standpoint. Further research is required to establish its contribution to the nearshore marine environment and determine if the present extent is sufficient. More generally, it has not been possible to assess the environmental impact of the working plans and forest management regime because of the lack of baseline data and the absence of monitoring of key components of the Matang mangrove ecosystem in general. The charcoal industry for which Matang is being largely managed is a tradition-bound industry that may eventually be phased out. This would effectively undermine the present rationale for its management, and open it to other, more destructive options, such as pond-based shrimp farming. The full range of socio-economic benefits of the reserve must therefore be considered in setting management goals.

While the present management regime has its weaknesses, it does not mean that it is ineffective. Nevertheless, a fundamental review of the plan and its objectives is needed so that management is relevant to contemporary Malaysian needs.

Given the enormous significance of the Matang Mangrove Reserve for both its biodiversity and diverse economic values, it may be worthwhile to revoke its status as a forest reserve, including some of the foreshore areas, and redeclare it a national park. Though Malaysia has several parks, administered both federally as well as by the states, none of them would fit the profile of a mangrove environment. Matang could thus stand out as the first national mangrove park. Designation as a park would need to include provisions for resource use by local communities, and may need to be implemented incrementally in step with the declining needs of the charcoal industry. Such an approach would enable the holistic management of Matang's resources as well as facilitate the gradual phasing out of economically untenable activities. In this manner, the Matang Mangrove Reserve can continue to serve the nation, and indeed, the world, as a showcase of mangrove wealth.

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The Role of the Ramsar Convention in Mangrove Management

by Peter R. Bacon

Much has been written about mangrove management but there is still too little positive action. This results partly from the persistence of an approach which considers all mangrove ecosystems to be similar and thus subject to generic guidelines for mangrove management (for example, Hamilton and Snedaker, 1984), and partly from the lack of a rational framework for management action, particularly one based on clearly identified objectives.

In 1971, a convention to protect "Wetlands of International Importance" was adopted in Ramsar, Iran. It was unusual because it focused on specific wetland sites which were considered to be of importance especially as waterfowl habitat. To become a signatory to the Ramsar Convention, a country had to designate at least one such site and guarantee its protection. Thus, even though it was an international convention, Ramsar stimulated national action at specified sites while providing an international framework against which local management planning could be assessed. That Ramsar is an intergovernmental treaty is significant, because successful wetland management requires political commitment in order for appropriate land-use policies, legal instruments and technical agency support to be available.

By March 1996 (when the sixth meeting of the contracting parties was held in Brisbane, Australia), 93 countries had become signatories. Some 830 "Ramsar sites" had been designated by these countries covering over 53 million hectares (ha). About a third of these contain mangroves, so Ramsar and its partners have embarked on the protection and wise use of over 15 million ha of mangrove wetland. Sites with mangroves include: 596,000 ha of the Sundarbans of Bangladesh which is one of the largest continuous blocks of mangrove in the world; the 35,042 ha Manglares Churute site in Ecuador; Coppenamemonding in Suriname (12,000 ha) and 54,400 ha in the Caicos Islands.

In 1990, Ramsar adopted a number of criteria for identifying wetlands of international importance, based on representative or unique wetlands, plants and animals, and waterfowl. An appreciation of other wetland values led to the development of further criteria in 1996 on fish and fisheries values. Spelling out criteria has not only helped define international status, but provided a means of prioritizing sites nationally. It has underlined the need to work on a site by site basis, since not all sites will meet all criteria, and some may not meet any. It has also meant that the reasons for mangrove site management have to be made explicit. Ramsar sites are not "prohibited areas" and a wise-use policy is stressed at all sites. Guidelines have been prepared for wise use and management planning of sites and attention is being paid to community participation in management.

A sign in Penang, Malaysia describes various fin fish, shellfish and crustaceans which inhabit mangroves for all or part of their life cycle.

Ramsar requires further steps in developing a scientific management process for a designated site, as follows:

(a) The "ecological character" of the mangrove must first be defined, because the type of management most appropriate to that site will depend on the nature of the system to be managed. The site-specific management approach has been supported by the groundbreaking inventory work of the International Waterfowl and Wetlands Research Bureau (IWRB) (now part of Wetlands International) and some regional projects, for example in the British Virgin Islands. Although this might seem obvious, far too little attention has been paid to the ecological differences between mangrove areas. Despite earlier attempts to distinguish mangrove system types, the tendency to generalize about structure and functions has hampered conservation efforts in many countries. Coastal managers need to understand that not all mangrove swamps serve as fishery nurseries, support high biodiversity or protect coasts from storms. Not all are worth preserving where there is the possibility of productive aquaculture development and only some have ecotourism potential. As with other natural systems, their ecological and economic values are determined by their character.

(b) Secondly, procedures have been put in place through Ramsar to identify change in ecological character. If change is taking place in a site, there

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Mangrove Management in Brazil

by Christian von Dorrien

In 1988, preliminary studies by the Conselho Interministerial dos Recursos do Mar in Brazil led to legislation for the development of a National Management Plan for the 7,500 kilometer coastline. This would provide for zoning of the entire coast with the aim of improving the living conditions of the coastal population as well as protecting important natural resources. Mangroves have been protected since 1965 under forestry legislation, but this has been poorly enforced.

The highly productive and extensive mangroves in northeast Brazil (in the states of Amapa, Para and Maranhao) have been not as well studied as the less productive ones in the south. The "Mangrove Dynamics and Management" project is a cooperative initiative be-tween the University of the State of Para and the Goeldi Museum, both in Belem, Brazil, and the Center for Tropical Marine Ecology in Bremen, Germany, with financial support from the German Ministry for Research. The main objective is the sustainable development and protection of mangroves near the city of Braganca in the state of Para, within the context of integrated coastal zone management. The first stage of this long-term (10+ years) project is research-oriented, but local agencies will subsequently be involved.

The research program involves a study of abiotic factors, biodiversity, socio-economy, natural resources, primary production, energy and nutrient flux. The investigations will include studies on climate, soils, vegetation, resources, productivity, linkage with and exchange processes between neighboring ecosystems, and institutional, cultural, economic, social and political conditions. The data obtained will be used for modeling the ecosystem and developing a management plan.

For more information contact: Kontakstelle fur Tropische Kustenforschung (Contact Office for Tropical Coastal Research), ZMT - Center for Tropical Marine Ecology, Fahrenheitstrasse 1, D-28359 Bremen, Germany, Tel: +49-421-2208 326, FAX: +49-421-2208 330; E-mail: <kontaktstelle@zmt.unibremen.de> WWW Site: http://www.zmt. unibremen.de.

Ramsar

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are management implications. For many Ramsar sites, the nature and rate of the change determine the type of intervention required. The Ramsar Convention Bureau has therefore set up a monitoring procedure to assess and make recommendations concerning changes which the host country believes may be occurring, and it may also assist the host country in obtaining help to carry out this procedure. A host country can benefit from the tremendous pool of expertise, and possibly funding, available by networking internationally through the convention.

This approach has been very effective in defining objectives and strategies for mangrove and other wetland management. It continues to evolve as a result of feedback from governments and Ramsar Site managers and through inputs from a Scientific and Technical Review Panel of internationally recognized wetland experts. Consultations are in progress for the next meeting of contracting parties in Costa Rica in 1999. These include follow-up to recommendations from Brisbane for the use of integrated coastal zone management principles for coastal wetlands and the listing of more coral reefs and associated seagrass beds as Ramsar Sites. To benefit from 25 years of experience gained since the convention was adopted, mangrove managers are urged to familiarize themselves with the progress and methodologies of the Ramsar Wetlands Bureau.

For more information contact: Ramsar Wetlands Bureau, Rue Mauverney 28, CH-Gland, Switzerland. Tel:(+41)22/999 01 70; FAX: (+41)22/999 01 69; E-mail: <ramsar@hq.iucn.org>; or for information on new Ramsar sites: Scott Frazier, Wetlands International, 11 Marijkeweg, P.O. Box 7002, 6700 AC Wageningen, Netherlands. FAX: (31) 317 474712; E-mail: <frazier@wetlands.agro.nl>.

Ecuador Working Toward a National Strategy for Mangrove Management

By Alejandro Bodero and Donald Robadue, Jr.

"*Ecuadorian law has created a legal regime in which the proliferation of often contradictory rules impedes law enforcement and makes the job of the agencies with jurisdiction [over mangroves] more difficult to implement.*" Workshop on Mangrove Management, July 1993, sponsored by the Ecuador Armed Forces and the National Forestry Institute.

The rate of illegal cutting of mangroves has begun to slow in Ecuador.

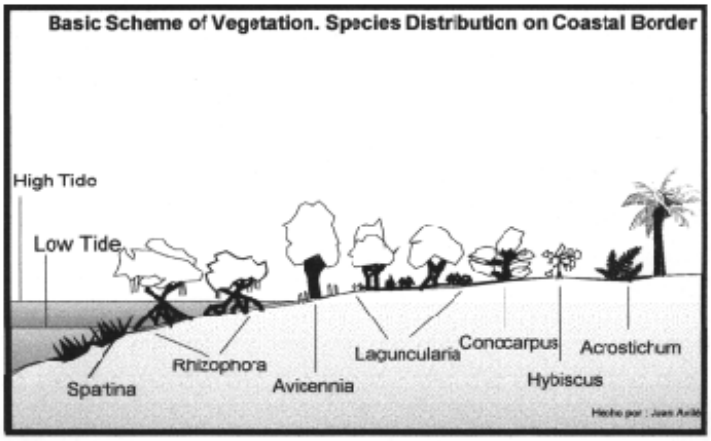
Between 1969 and 1996 Ecuador lost 25 percent of its 204,000 hectares of mangroves. In some estuaries, however, the loss has been nearly complete. In the same period, more than 90 percent of Ecuador's salt flats have become occupied or converted to other uses.

The destruction of mangroves is not a recent phenomenon. Since the beginning of the century, the largest mangrove trees were used as pilings for constructing piers and buildings. Ecuadorians have long used mangroves for charcoal making and to produce tannin for curing leather. These practices did not eliminate the mangrove ecosystem or replace it with other uses. Starting in the 1940s, the creation of coconut palm plantations was the first wide scale cause of mangrove wetland losses. Later on, many mangrove swamps were converted for cattle grazing and urban development. Since 1969, however, it is the construction of shrimp farms which has been the major factor in the continuing damage to mangrove ecosystems. The rate of cutting continued to increase until 1991. The most recent data suggest that the rate of conversion is now declining.

The importance of the goods and services provided by mangroves demands that damage to the ecosystem be curtailed.

The most valuable service provided by Ecuador's mangrove ecosystem is believed to be its role in the life cycle of shrimp, which is especially significant since shrimp mariculture is one of the country's largest export industries.

The shrimp mariculture sector has an installed production infrastructure of 140,000 hectares of ponds with an annual production of 115,000 metric tons. This production depends on the water quality of the estuaries the in which ponds are located as well as on the supply of some 7,650 to 8,925 million shrimp post-larvae which are used to seed the ponds.



A general distribution scheme of Ecuador's mangroves.

Other uses of mangroves include:

• Supplying mangrove pilings, which continue to be important as a construction material. They now are taken from the last remaining pristine mangrove system in the Santiago-Cayapas-Mataje river system in northern Esmeraldas province, which borders Colombia.

• Providing wood for building the shacks in which the poorest people on the margins of coastal cities of Guayaquil and Machala (some 300,000 families) live. This wood comes from the mangrove fringe around these urban centers.

• Providing the material for firewood, as well as charcoal and furniture, which people throughout the coast still make.

• Harvesting shellfish, crabs and fin fish in estuaries, which appears to be most abundant where mangroves are present.

The great challenge is to overcome the weaknesses of the legal and administrative systems of the country in order to control the forces of mangrove destruction.

Ecuador's current legal regime and administrative arrangements continue to impede the creation of an integrated approach to coastal management and proper stewardship of the mangrove resource. For example, the Subsecretary of Fisheries has jurisdiction over the harvesting of bio-aquatic species and the operation of shrimp farms. The Navy controls construction in the narrow (eight-meter) beach and bay zone, above mean high water. The National Water Resources Institute manages the use of water where the fisheries exist; the National Public Works agency addresses contamination problems in fresh and coastal waters; and the National Forestry Institute is responsible for tree harvest and management. Individual municipalities also make decisions on these matters.

Ecuador's public institutions continue to be constrained in their ability to manage resources for sustainable use and conservation, since they are underfunded, understaffed and poorly equipped. For example, during the 1980s and early 1990s, when mangrove loss was increasing, the National

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Ecuador's Strategy

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Forestry Institute had only 10 part-time inspectors to monitor and enforce mangrove protection laws covering 162,000 hectares located along the country's 2,800 km coast-line.

Mangrove policy has evolved in response to increased public awareness and the growing pressure on the resource. In 1978, the National Forestry Agency prohibited the use of mangrove areas for shrimp farms and declared as well that shrimp ponds could not be built in lands suitable for agriculture. In 1981, power was given to the Ecuador Navy to control mangrove uses and confiscate the equipment, tools and wood of anyone caught illegally cutting mangrove trees.

In June 1985, in response to more rapid cutting and greater national concern, the Government of Ecuador declared that it was in the national interest to conserve, protect and restore the mangrove forest. Shrimp farmers were given the responsibility of replanting mangroves on the borders of their ponds. These measures failed to halt the increasing rate of cutting.

The Ecuador Coastal Resources Management Program (PMRC) was created in 1989 to carry out pilot projects in coastal management and improve the enforcement of coastal laws through a new mechanism, the Ranger Corps. The Rangers are inter-agency teams comprised of the different units with legal authority to enforce mangrove laws. These new coordination units have not only carried out more patrols but have experimented with innovative measures such as the negotiation of formal agreements among resource users and the use of conflict resolution techniques to resolve individual cases, for example, disputes between shrimp farmers and traditional users.

The PMRC has subsequently worked with more than 200 user groups throughout the coast in its five special area management zones. These groups have a total of 8,000 members, including shrimp larvae fishers, hotel owners, food vendors, shellfishers, crab fishers, charcoal makers, tourist guides, artisans and ceramists. By working together they have become a force for coastal management many times greater than the total staffing of the agencies charged with enforcing various coastal laws and implementing conservation measures.

The PMRC brought together the Ecuadorian Armed Forces, the several government agencies responsible for parts of the mangrove management problem, researchers, professors, non-governmental organizations, communities and user groups to workshops that examined the situation in the mid-1990s and to debate new, more effective mangrove management strategies. Five policy proposals resulted from these meetings:

Policy 1: Conserve the mangrove ecosystem and promote non-destructive uses of these areas.

Three types of uses should be recognized:

- Uses which are always allowed and encouraged, such as honey production, passive recreation, flood hazard protection (buffer zones), subsistence fisheries and non-destructive types of aquaculture such as shellfish repopulation
- Uses which could be accepted only when permitted and carefully monitored, such as ecotourism and education activities, and selective harvest using acceptable cutting and rotation techniques
- Uses which are permissible only if an overriding public benefit has been demonstrated in a proposal to create a canal for water circulation to an aquaculture project, piers, buildings or a non-renewable form of wood harvest

Policy 2: Every mangrove-dominated estuary needs its own management plan and special actions, developed with the participation of local people.

Specific actions are required that include:

- A management plan for every designated protected area
- Impact assessment studies when infrastructure must pass through a mangrove
- Special reviews as existing concessions for use of the beach and bay zone (including shrimp farms) are renewed every 10 years
- Municipal ordinances, user group agreements and conflict resolution techniques applied where there are problems with loss of fishing or passage rights to mangroves or other modifications to a mangrove area
- Buffer zones to protect a mangrove ecosystem from damage by surrounding activities

Policy 3: Strengthening government capacity to enforce mangrove conservation laws through the Ranger Corps and other mechanisms.

- Increase the number of patrols and inspections
- Involve local authorities in permit reviews and in the preparation of mangrove management plans
- Carry out public education and training activities targeted to the most critical mangrove ecosystems

Policy 4: Promote transparency in decision making and a free flow of information to the public and resource users.

- Establish clear and fair rules for how concessions, mangrove management plans and other management initiatives will be approved
- Target priority areas for preparing detailed management plans

Policy 5: Ensure that management decisions are based on unique local conditions and the active involvement of local people.

The emphasis in these policy proposals on careful attention to local conditions and the vital role of local resource users in decision making derives from the fact that the current Ecuador policy was based on two faulty premises: 1) Mangroves can never be used for any purpose and 2) that a centralized government

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Mangrove Training Workshop in Belize

By Dylan Gomez and Gail Bradley Miller

"This is the first workshop that I have ever attended where I feel as though I have come away actually learning something." This was the enthusiastic comment of one of the participants at the mangrove training workshop held in Belize in July 1996, sponsored by University College of Belize (UCB) and the Smithsonian Institution and funded by the John D. and Catherine MacArthur Foundation.

Coastal development in a mangrove ecosystem in Belize.

This was the fourth workshop of its kind held in Belize. The lecturers came from several institutions in both Belize and the US, including the Fisheries Department in Belize City, the Smithsonian Institution, St. Mary's College of Maryland and Louisiana State University. The participants also came from a range of backgrounds including government agencies (the Fisheries and the Forestry Departments), non-governmental organizations, (Belize Center for Environmental Studies and Program for Belize), teachers representing most of the Districts in Belize, and a few junior college students. Despite their varied level of education (from high school diplomas to post-graduate degrees) and work experience (from a few months to several years) they were united in their common interest and involvement in mangrove education and protection in Belize.

The aim was to provide information and first-hand experience in mangrove ecology and a thorough background in mangrove biology and conservation. The workshop stressed the importance of mangroves as nurseries and feeding grounds for commercially important species and to human economic development in the coastal zone. The workshop was held at UCB's Marine Research Centre (MRC) located on Calabash Caye, at Turneffe Atoll. Each participant was provided with a training manual, a variety of research papers related to Belizean coastal ecosystems, a set of the Paul Humann reef identification educational guides and a slide set with script to be used for future presentations on mangroves.

Each day began with a lecture, followed by a field activity, which not only provided hands-on involvement, but also reinforced the lecture and provided experience in the scientific collection of data. The participants then met to review the day's activities and discuss the notes gathered in the field. This approach ensured that everyone understood the concepts being promoted-if not immediately in the classroom, then out in the field or through interaction with the other participants. After dinner, it was back to work again in a make-shift laboratory, using a variety of equipment including advanced technologies such as the spectrophotometer. The participants also took part in an actual research project where they exercised their knowledge of the scientific method, and helped to establish a CARICOMP site adjacent to the MRC to measure mangrove productivity.

The workshop sparked the formation of a national network called the Coastal Marine Ecology Program Network (CMEP) consisting of members from the participants. It is hoped that CMEP will provide easy access to information; publish relevant materials on mangroves, seagrasses, and reef ecosystems; assist in the development of curriculum guides based on the manual and the workshop; and assist national agencies and NGOs involved in coastal and marine activities. In addition, there are plans for the translation of the manual into Spanish. Plans are being made to continue the workshop in Belize and possibly other interested countries, but constraints such as funding and manpower need to be addressed.

Mangrove growth in Belize.

Destruction of mangroves in Bacalar Chico, Belize.

For more information contact: Dr. Ilke Feller, Smithsonian Environmental Research Center, Edgewater, MD. USA. E-mail: <feller@serc.si.edu>. For more information on CMEP contact: Gail Miller, University College of Belize, P.O. Box 990, Belize City, Belize, Central America.

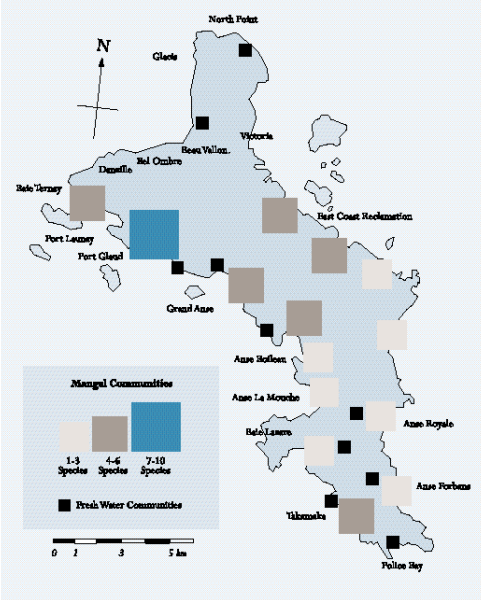
The Status of Mangroves in the Seychelles

By Nirmal Jivan Shah

Mangroves in the Seychelles, a group of 115 coral and granitic islands in the southwestern Indian Ocean, have been progressively destroyed since earliest human colonization. Mangrove wood was used in the past for construction and, until recently, a stain derived from mangrove bark was used to polish wooden floors. Some low-level harvesting of mangrove crabs (*Scylla serrata*) still continues. The main threat now is rapid urbanization and development in the granitic islands, particularly as the lack of flat land leads to much reclamation for construction. In the past some mangals were drained for agriculture, and now a development aid project for agricultural improvement is proposing the drainage of many wetland areas on Mahe, one of the granitic islands where 90 percent of the human population of the Seychelles is located.

Between seven and 10 mangrove species occur on the granitic islands and 12 on the coralline islands where the largest stands now occur, in particular Aldabra (which has 800 ha), Cosmoledo and Astove. On Mahe, some 120 ha still exist and recent coastal reclamation has led to the reinvasion of five mangrove species on the east coast.

There is no national management plan or specific legislation for mangroves, but a proposal to the National Environment Advisory Council (NEAC) recommends the development of a full strategy for wetland management. Marshes and wetland habitats have been classified as ecologically sensitive areas under the Environment Protection (Impact Assessment) Regulations, 1996, and guidelines for development of sensitive areas have been issued by the Division of Environment. Some mangals lie within protected areas, for example on Curieuse and Aldabra. A mangrove boardwalk was built on Curieuse as part of a nature trail established by the Conservation and National Parks Service and has been recently refurbished through a development aid project. Tourists visiting Aldabra also occasionally enter mangroves, in particular to view seabirds. Curiously, the La Plaine mangal, the largest on Mahe, is not included in the Port Launay Marine National Park although it is adjacent to it. The Forestry Service has attempted to replant small pockets.



Principal Wetlands Communities on the Coastal Zone of Mahe. ***Source: ENVIRO DATABASE #10***

Educational programs have been sporadic. The Ministry of Education included a chapter on mangroves in a textbook and the local television station produced a 30-minute documentary on the mangroves of Seychelles in 1988. A non-government organization, the Partnership Foundation, released a color poster on "Mangroves of Port Launay" in 1991. A major new project, expected to start by the end of 1996, under the regional Commission de l'Ocean Indien will use mangroves and their associated ecosystems at Grand Anse, Mahe, as a pilot site for Coastal Zone Management planning.

For more information contact: Nirmal Jivan Shah, ENVI.R.O, P.O. Box 699, Seychelles.

Ecuador's Strategy

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agency could exercise all the controls necessary to prevent any modification to a mangrove ecosystem.

Such rigid, impractical premises have not succeeded in any country. For example, the Philippines lost 50 percent of their mangrove forest while similar centralized policies were applied. Puerto Rico lost 75 percent of its mangroves before it began to develop a regulatory and zoning regime to control uses such as construction, but it has not solved its problems completely.

The Ecuador Coastal Management Program has assimilated many of the lessons of international experience and understands that sustainable use of mangroves has to be based on the special characteristics, both physical and social, of each site. To advance effective forms of management, it is necessary to experiment and learn what will work in each situation, and day by day assess those which work and set aside management techniques which prove to be less effective.

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The Diversity of Mangrove Wetlands and Ecosystem Management

By Robert R. Twilley

The environmental and economic values of mangroves are well known. Human use of mangrove wetlands are linked to the goods and services that they provide, as modified by the constraints of local cultures and economics. Thus the use and value of mangroves are a combination of both the environmental setting of these ecosystems and the patterns of human exploitation. Any ecosystem management plan designed to provide for the sustainable utilization of these coastal wetlands has to consider both the ecological and social constraints of the region. Ecosystem management therefore requires policies that seek to control the actions of society within limitations that are imposed by the processes of nature.

The use of mangrove resources by humans can have negative effects on the ecological processes of mangrove ecosystems. These effects can be indirect. The diversion of freshwater, for example, can cause changes in the productivity, litter export, and the biological and geological chemistry of mangroves. Direct impacts may include inputs of excess nutrients or toxic substances such as oil that limit the ecological processes in mangrove wetlands, which compromises the value of these natural resources. Human use of mangrove wetlands is inextricably linked by the nature of these environmental effects to the sustainable goods and services that these forested wetlands can provide. Sustainable development of mangrove wetlands may be viewed as a balance between environmental and social constraints that accommodates long-term use and values of these natural resources in regional economic development.

The diversity of mangrove wetland structure and function is linked to the geophysical and geomorphological processes that can be classified through what might be described as the eco-geomorphic description of coastal environments. Each mangrove ecosystem has its own unique eco-geomorphic structure.

The landform characteristics of a coastal region together with its environmental processes control the basic patterns in forest structure and growth. The two basic types of geomorphological settings are those with inputs derived from the land and sediments, and those in carbonate environments (Figure 1). Within each of these two categories, there are different types of settings depending on the nature of circulation, sediment transport, regional topography and physical processes. Carbonate systems include continental margins and islands that differ depending on the soil type and amount of freshwater flow from upland watersheds. Continental regions include those with peat and marl sediments, whereas islands can have either large or small catchments (high and low islands). The thinking involved in using this type of classification is that variations in the unique geophysical processes of a coastal region will result in different energy flows and material cyclings of mangrove wetlands. This will be seen in different patterns of forest structure, biomass, productivity, bio-geochemistry and exchange of nutrients and organic matter with coastal waters. Thus both the structure and function of mangrove ecosystems are linked to the distinct geomorphology and geophysical processes of a coastal environment.

A combination of the physiographic and structural attributes of mangrove wetlands, together with local conditions of topography and hydrology, were used to formulate the classic ecological classification system by Lugo and Snedaker (Figure 1, midsection-next page). This ecological scheme uses the dominant environmental factors of the Caribbean Sea, such as soil resources and stressors, to classify mangrove forests into four types. These are riverine, fringe, basin and dwarf forests.

The formation and physiognomy of these forest types appear to be controlled strongly by local patterns of tides, surface drainage, soil characteristics and biological interactions. Along an inland transect, tidal frequency changes and changes in slope may cause an increase in salinity and other soil-related factors that limit the development of mangrove forests. These are known as mechanisms of mangrove zonation. Other ecological factors are associated with the biology of these systems such as crab predation on propagules and leaf litter consumption. The effect of these ecological factors on forest structure are twofold: 1) they decrease the maximum development of mangrove forests allowed by the existing constraints of the geomorphological subclass; and 2) they control the relative zonation of mangrove species.

A combination of ecological types of mangroves can occur within any one of the settings described above depending on the distribution of soil resources and toxic stressors. These ecological types are based on micro-topographic and biological factors that can influence the structure and function of mangroves from shoreline to more inland locations. Local patterns in tidal inundation have long been related to the structure and species colonization of mangrove forests.

This eco-geomorphic classification system of mangrove wetlands includes two important identifying factors: (1) the location of the wetland within a specific type of environmental setting; and (2) the location of the wetland

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The Global Environmental Facility Tropical Project

In 1991, the Global Environmental Facility (GEF) funding of one million U.S. dollars was approved to develop a regional investment project proposal for the conservation of mangrove biodiversity in the tropical Americas in collaboration with the United Nations Development Programme and the United Nations Educational, Scientific and Cultural Organization. The concept for this project grew in part from a workshop held in Niteori, Brazil in May 1992 as part of the International Tropical Timber Organization/International Society for Mangrove Ecosystems Project on Conservation and Sustainable Utilization of Mangrove Forest in Latin America and Africa Regions.

The pre-investment project will involve two levels of activities. A series of case studies in Brazil (which has the largest area of mangrove in the tropical Americas) and other countries in the region will be developed to illustrate models of sustainable mangrove management. These will also strengthen community and non-governmental organization (NGO) participation in mangrove management, and identify training and institutional strengthening needs. The second activity is the updating of a series of regional assessments of mangrove status, relevant policies and legislation, and institutional capabilities and coordination which will provide information for determining priorities for further activities. In order to identify the Brazilian case studies, a temporary National Mangrove Committee will be formed in Brazil, with governmental and NGO representation.

For further information on mangrove research and management activities in Brazil, contact: Prof. Luiz Drude de Lacerda, Departamento Geoquimica, Universidade Federal Fluminense, Centro Niteroi, 24210 RJ Brazil. Tel. 717-1313. FAX 717-4553.

Diversity of Mangrove Wetlands

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zone along a transect perpendicular to shore (topographic setting). Thus a fringe, basin, or dwarf mangrove within a specific type of geomorphological setting may have somewhat different ecological characteristics. In addition, the response of these eco-geomorphic types of mangroves to regional land use management plans are specific to the two landscape parameters in this classification scheme.

The eco-geomorphic classification of coastal environments helps to develop proper ecosystem management goals for the diverse types of mangrove wetlands around the tropical and subtropical coastlines of the world. The exploitation of mangrove goods and services depends on both the environmental and social constraints of a region. Thus no single ecosystem management goal applies to all mangrove wetlands. An understanding of how mangrove properties vary along gradients is important when formulating a management plan. As we better understand the functional ecology of mangrove wetlands in diverse environmental settings, the selection of proper ecosystem management goals can be refined.

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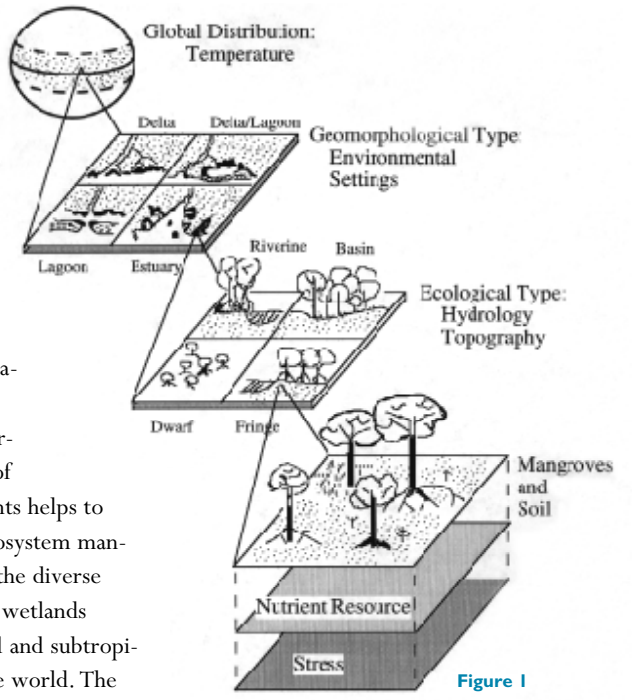

Figure 1

Mangrove Forests in Koh Kong Province, Cambodia

by Oum Pisey

The Province of Koh Kong lies in southwestern Cambodia, bordering the Gulf of Thailand, and covers 9,260 square kilometers (sq km). About 70 percent is forest; the remainder is comprised of farmland, estuaries, mudflats and islands.

The coastal forest includes 31,100 hectares (ha) of mangrove, which plays a significant role in the coastal economy, although many activities involving mangrove utilization are now having major environmental impacts.

Forest areas are divided into coastal forest and upland mountainous forest areas. Coastal forests consist of 31,000 ha of mangroves. This region is impacted by the Indian and Siberian monsoons. The temperature varies from 25.1 to 29.4Þ C, with an annual rainfall of 2,000-4,000 millimeters (mm).

The Importance of Koh Kong's Mangroves

Economic Importance:

■ Fisheries: Mangrove ecosystems are important to inshore and offshore fisheries. Organic matter and nutrients are supplied to ecosystems by a variety of flora species, while providing nurseries and shelters for important marine stocks. The value of mangrove forest as a food source as well as shelter and nurseries for both culture and capture fisheries along coastal areas of Koh Kong is not well understood, but is certain to be very high.

■ Fuel: Mangrove species are valuable as a direct source of fuel wood energy, both as firewood and through charcoal production. In particular, mangrove species such as *Rhizophora apiculata* and *Rhizophora mucronata* are especially valued for their high caloric content and prolonged burning capability.

■ Charcoal Production: The mangrove forest in Koh Kong covers 16,000 ha. The charcoal export in 1994 was 10,000 tons, while the number of kilns increased from 224 in 1993 to 1,000 in 1994. About 94 percent of charcoal exported went to Thailand, Malaysia and Singapore.

■ Construction material: Mangrove forests are used for building houses, boats, fences and fish traps. Mangrove trees are used for poles, roofing shingles, timber, beams and wood chips. *Nypa fruticans* is valuable for many purposes. The leaves are used for shelter on the roofs of houses as well as materials for crab traps. In addition, mats are made from Nypa palms. Nypa leaves are also used as a cover for num chak (a local cake) or num an sam (a traditional cake).

■ Medicine: Coastal people have traditionally used various resources extracted from mangroves for medicinal and other purposes. In Koh Kong, the species *Exciecaria agallocha* is used as an anti-diarrhea treatment. A fungus called sam bok sramoch ("Home of the Ant") is dried and used as a medicine for lung disease.

■ Other uses: In the past, mangrove barks from *Rhizophora spp.* and *Ceriops spp.* were used in tannin production for dyeing of fish nets but this practice has been replaced by the use of nylon fishing nets, which do not require dyeing.

Ecological Importance:

■ Shoreline stabilization: A healthy mangrove ecosystem helps to stabilize shorelines and protect soil erosion. Mangroves help to trap and stabilize sediments, thereby reducing river bank and shoreline erosion. The stability of Koh Kong's coastline, that would otherwise be subject to great erosion, is dependent largely upon a stable ecosystem.

■ Protection from wind and storms:

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Mariculture in floating cages.

The Gulf of Guinea Project: Managing Mangroves to Protect Biodiversity in West Africa

By Peter Saenger, Yacouba Sankare, Marcel Baglo, Catherine Isebor, A.K. Armah and Martin Nganje

The trading patterns around the Gulf of Guinea in West Africa are such that nearly all major cities, harbors, airports, industries and plantations are located in the coastal zone—the most densely settled in Africa. This illustrates the significance of the lagoons, estuaries, creeks and inshore waters to the well-being of the population. But pollution from these various sources has affected the waters of the Gulf of Guinea, resulting in habitat degradation, loss of biological diversity and productivity, and degenerating human health.

The Global Environmental Facility's (GEF) Gulf of Guinea project, "Water

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Cambodia

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Mangrove trees serve as natural barriers against strong winds, tidal bores and waves. The buffer zone offered by shoreline mangroves in Koh Kong protects the area from the damaging effects of large storm and tidal surges.

■ Coastal ecosystem stability: Mangroves serve as a link between marine and terrestrial ecosystems. They are of integral importance to the stability and maintenance of adjoining ecosystems such as seagrass and coral reefs. The organic matter that originates from mangrove habitats is essential to inhabitants of lagoon and estuaries as well as other near-shore environments such as seagrass meadows and coral reefs.

■ Biodiversity: Mangroves are important habitats for biodiversity. They provide physical habitats for a large variety of coastal species, including birds, monkeys, shellfish, fish and other animals and invertebrates.

Current Threats

Koh Kong coastal areas have been in good condition until recent decades. However, due to political change and population increase as well as the economic growth of the neighboring countries, detriments to environmental economic recovery are imminent.

Logging, intensive shrimp culture, charcoal production and Klim Chan production are booming and result in significant environmental impacts on the ecosystem.

■ Intensive shrimp farming: The conversion of mangroves to shrimp farms is now on the rise with the latest total area of shrimp farm covering more than 1,000 ha. This increase adversely affects the coastal people and coastal biodiversity.

■ Charcoal production: The number of charcoal kilns is increasing even in the Peam Krasop wildlife sanctuary. This increase in charcoal production is destroying large areas of mangrove forests. Latest estimation showed the number of charcoal kilns increasing five-fold from1993-94.

Other illicit activities such as Klim Chan production and logging are also taking place even inside the Koh Kong protected areas.

The current threats to the mangrove should be prioritized. Intensive shrimp farming is one of the greatest threats. Of the 16,000 ha of mangrove forest in Koh Kong, 840 ha were devoted to intensive shrimp farming in early 1994, with 105 entrepreneurs taking part. By the end of 1994, 63 entrepreneurs were applying for licenses, and a total of 1,240 ha had been converted for shrimp farm use. Charcoal production, commercial fishing, family fishing and the export of illegal products (sandalwood) round out the top threats to the mangroves of Koh Kong.

Environmental Conservation and Management Promotion

Seeing the importance of the biodiversity of the coastal ecosystem and its endangered situation, the Ministry of Environment has proposed a Royal Decree on the Designation and Creation of the Protection Area System which was signed by the King Sihanouk on November 1, 1993. The Protected Area System covers forests nationwide, totaling 3,402,200 ha (including Koh Kong), under three categories. Kirirom and Botum Sakor, totaling 35,000 ha, some of which is shared with Kompong Speu province, have been designated as national parks. Peam Krasop (23,750 ha), Phnom Aural (253,750 ha shared with Kompong Chang and Pursat) and Phnom Samkos (333,750 ha) have been designated wildlife sanctuaries. Dang Peng (27,700 ha) has been designated a multiple-use area.

Based on recent ground and aerial surveys, the mangrove area in the Koh Kong vicinity is proposed for inclusion in the list of Wetlands of International Importance as a waterfowl habitat under the Ramsar Convention. This move should provide the visibility necessary to attract support for conservation from the international community.

Proposed Actions Against the Destruction of Coastal Ecosystems

To ensure the sustainable development and conservation of the coastal ecosystem, the Ministry of Environment, calling for support from the Royal Government, and in cooperation with the relevant ministries, set up several

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The Gulf of Guinea

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Pollution Control and Biodiversity Conservation in the Gulf of Guinea Large Marine Ecosystem", is an initiative by Benin, Cameroon, Cote d'Ivoire, Ghana and Nigeria, with Togo expected to join in the near future.

The underlying rationale is that marine pollution and living marine resources respect no political boundaries, and few geographical ones, and require a large scale, concerted and holistic approach for assessment and control. Embedded within this large integrated project is a component which is aimed at assessing the status, uses and values of existing mangroves. The potential for protecting particularly significant and representative areas will be assessed as well, and the potential for rehabilitation and sustainable use for cleansing waste water discharges and for increased mangrove fuel wood production.

The mangroves of the Gulf of Guinea are an important resource for the coastal communities not only for firewood but also for building materials, salt production, oysters and fisheries. However, overuse and pollution have had adverse effects. For example, early accounts show that well-developed mangrove communities were associated with, and largely confined to, semi-enclosed coastal lagoons or embayments, generally with constrained tidal exchange and limited (and markedly seasonal) freshwater input. Today, as a result of the development of large urban centers with sig-nificant industrialization, the extent of these lagoon mangroves has been much reduced and several species that could be expected to occur are no longer to be found. In many instances, the mangroves have been reduced to saline grasslands of *Paspalum vaginatum*. Sewage treatment facilities are very limited throughout the region and raw sewage is discharged both into coastal lagoons and the rivers flowing into them. For example, it is estimated that 186 m^3 of untreated sewage flow into Ebrie lagoon from Abidjan each day. As a result of this and the limited tidal exchange of the lagoons, eutrophication is widespread.

The mangroves of the Niger delta, estimated to cover approximately 7,000km^2 comprise a significant regional resource, with fishing being a major activity. The pressure of a subsistence population has adversely affected these mangroves but the discovery of hydrocarbon reserves in the mid-1950s in and around the delta may have been the final straw. Nigeria currently produces around 1.6 million barrels per day from more than 4,000 oil wells spread within the Niger delta and adjacent coastal areas. Twenty-three out of 62 oil fields are within the mangroves. Oil terminals are spread throughout the delta while 8,000 km of seismic lines (20-30m wide) and oil pipelines criss-cross the mangroves. Oil spills are common; according to the best figures available, between 1970 and 1982 alone, there were 1,581 oil spills involving a total of two million barrels. While most of the spills have been small, they have tended to occur within the mangrove waterways. As a result, many of the surface waters are contaminated and undrinkable, localized fisheries production has declined and, in many instances, the inhabitants have been forced to emigrate to other areas.

Cameroon, with its humid tropical climate, has luxuriant deltaic mangroves. However, the Douala port extension, urban expansion, sand extraction and industrial pollution have caused damage to the mangroves of the Wouri estuary. More importantly from a biodiversity perspective, the mangrove palm (*Nypa fruticans*) has recently become distributed throughout this area, invading and replacing native mangrove species. Although *N. fruticans* is known from the fossil record from throughout the Niger delta, the current present populations were introduced to Nigeria early this century from Singapore. Since then, it has spread throughout the Niger, Imo, Bonny and Cross Rivers and while the spread has been slow, it appears to be accelerating, facilitated by local villagers who value its thatching properties. Most recently, it has been reported to be growing in and around the mouth of the Volta River in Ghana.

To restore the lagoon mangrove systems, three separate initiatives need to be addressed. Mangrove cutting needs to be controlled and regulated, at least, in some areas of the lagoons. Pollution inputs need to be reduced either by treatment facilities or by deep ocean discharges. Thirdly, mangrove habitat conversion needs to be drastically reduced and active replanting programs initiated in those areas where restoration is feasible. At a recent workshop in Abidjan, government and NGO representatives identified a number of immediate measures. One of the first steps has been to establish a pilot project to use mangroves as a productive wetland to prduce wood on the one hand, while reducing the effects of sewage pollution to the lagoons on the other. The Abidjan project will be the first. Similar projects have already been identified in Ghana and Cameroon. In Benin, a large scale replanting program has been running for some time and the local expertise developed there will be used in other replanting programs in the region. Thus, although the problems of the region are im-mense, coordinated action between government and research institutions as well as regional NGOs, provides some optimism.

For more information contact: Peter Saenger, Consultant to the Gulf of Guinea Project, Centre for Coastal Management, Southern Cross Universi-ty, P.O. Box 157, Lismore, NSW 2480, Australia. Phone: 61-66-203631. FAX: 61-66-212669. E-mail: <psaenger@scu.edu.au>. Yacouba Sankare is Project Officer for Cote d'Ivoire; Marcel Baglo is Project Officer for Benin; Catherine Isebor is Project Officer for Nigeria; A.K. Armah is Project Officer for Ghana; and Martin Nganje is Project Officer for Cameroon.

Who Does What in Mangrove Management?

The International Society for Mangrove Ecosystems (ISME)

ISME was inaugurated in Japan in 1990, following a 1989 international meeting held under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Development Programme (UNDP) and the Japanese government, and aims to continue the work started by UNESCO. It promotes the study of mangroves in order to encourage their conservation, rational management and sustainable utilization, ensures that mangroves are featured on international environmental agendas and ensures that the public remains aware of this ecosystem. It works at regional and national levels and worldwide, with funding agencies and non-governmental organizations (NGOs), private concerns and individuals and has over 700 members in about 70 countries. In 1991, ISME adopted a "Charter for Mangroves" which was presented at the United Nations Conference on Environment and Development (UNCED) in 1992. The 1996 General Assembly was held in Thailand in August.

Regional reviews of mangroves have been produced for Asia, Africa and Latin America and Caribbean. Three publications are being funded by the International Tropical Timber Organisation: *Journey Among Mangroves*, aimed at high school students and the educated lay person, which is regarded as one of the best popular accounts of mangrove management issues available; a technical manual on restoration (covering species and site selection, site preparation, nursery and planting techniques, husbandry, pests and diseases); and the *World Mangrove Atlas*, due to be released shortly (see publications). ISME has sponsored the publication of practical booklets or manuals in local languages and has produced a slide set for the education of children. A video on the mangroves of Fiji has been produced and a second video project is underway in Thailand. ISME has also carried out projects in Vietnam, Pakistan, Japan, Ecuador, parts of Indonesia and some African countries.

Membership costs US$20 for individuals and US$250 for institutions. Members receive the newsletter. Payment may be made by credit card, international postal money order or UNESCO coupon.

For more information contact: ISME Secretariat, c/o College of Agriculture, University of the Ryukyus, Okinawa 903-01, Japan. FAX: (81) 98-895-6602. E-mail: <mangrove@ii-okinawa.or.jp>.

United Nations Educational, Scientific and Cultural Organization (UNESCO)

In the 1980s, UNESCO took the lead in mangrove management under its Coastal Marine (COMAR) program and, with UNDP, launched the "UNDP/UNESCO-COMAR Regional Project in Asia and the Pacific on Mangrove Ecosystems." This was primarily an effort to gather scientific information for management, focusing on training, field workshops and research. It stimulated much activity, particularly in Asia. Also, in several countries, it encouraged the formation of national mangrove committees which lobby governments for improved mangrove management, resulting in a significant increase in public awareness about mangroves. The COMAR program has been replaced with UNESCO's transdisciplinary and cross-sectoral Coastal Regions and Small Islands (CSI) program, but a number of mangrove activities are still underway, many in collaboration with ISME.

UNESCO projects have included: a COMARAF program on ichthyoplankton of mangroves in West Africa, with UNDP; PROBIO - Sustaining Productivity of West and Central African Coastal areas; the CARICOMP productivity monitoring program in the Caribbean; and a GEF/UNDP/UNESCO project on preserving biodiversity and socio-economic value of mangrove ecosystems in the tropical Americas which is in preparation. UNESCO has also been involved in climate change work through the UNEP/UNESCO-COMAR Task Team on "Impact of Expected Climate Change on Mangroves." A 400-page volume of about 30 papers on the status of mangroves and relevant research in Latin America and Africa will be published shortly.

For more information contact: Gary Wright, UNESCO, Coastal and Marine Science Publications, 1 Rue Miollis, 75732 Paris Cedex 15, France. Tel. (33)1 -4568-3971; FAX: (33) 1 4449-0014/ 4783-5940. E-mail: <g.wright@unesco.org>.

IUCN-World Conservation Union (IUCN) Wetlands Programme

The IUCN-World Wetlands Union Programme coordinates and reinforces IUCN's activities relating to wetland management, in collaboration with its members and partners, particularly Wetlands International and the Ramsar Convention Bureau. The core of the program is a series of field projects which are developing methodologies for wetland management, largely in developing countries. IUCN has long played an important role in mangrove management, supporting many projects involving protected area establishment and management, monitoring, data gathering etc. It has also published a number of key texts, particularly relating to management of mangroves in Asia and Africa (see Publications) and produces a newsletter.

For more information contact: IUCN Wetlands Programme, IUCN, Rue Mauverney, 1196 Gland, Switzerland. FAX:(41) 22 9990002. E-mail:<jyp@hq.iucn.org>.

Wetlands International

This organization was formed in October 1995 through the merger of three existing organizations: the Asian Wetlands Bureau (based in Malaysia),

the International Waterfowl and Wetlands Research Bureau (based in the UK), and Wetlands for America (based in Canada). The Asian Wetlands Bureau in particular has had a long involvement in mangrove management which is continuing, with a particular focus on the waterfowl associated with this ecosystem. Wetlands International has 47 member countries.

For more information contact: Wetlands International, Institute of Advanced Studies, University of Malaysia, 59100 Kuala Lumpur, Malaysia. FAX: 60-3-7571225. E-mail: <awb@pop.jaring.my>.

The Mangrove Action Project (MAP)

Founded in 1992, MAP is dedicated to reversing the degradation of mangrove forest ecosystems worldwide. One of MAP's main objectives is to promote local community land use rights, whereby local people are directly involved in, and responsible for, sustainable management of their own coastal resource base. MAP provides four essential services to grassroots associations and other proponents of mangrove conservation:

- A unique international NGO network and information clearing house on mangrove forests;
- Public awareness of mangrove forest issues;
- Technical and financial support for NGO projects; and
- An outlet for public expression of the basic needs and struggles of Third World coastal fishing and farming communities affected by the consumer demands of the wealthy nations.

MAP's international network includes over 300 NGOs and 200 scientists and academics from nearly 50 nations. It is currently expanding the effectiveness of its coalition work by solidifying ties with other major environmental and activist groups in both the southern and northern hemispheres. Through this wide network, it hopes to stimulate the exchange of ideas and information for mangrove forest protection and restoration.

MAP will also work to promote effective regulations and enforcement to ensure sustainable shrimp aquaculture practices which include participatory coastal resource management, responsible consumer choices, and strategies for the implementation of these and other solutions. For example, MAP wishes to create a dialogue on certification of shrimp products.

Annual membership is $25 for individuals, $100 for organizations; members receive the quarterly newsletter.

For more information contact: Alfredo Quarto, Kate Cissna, Co-Directors, Mangrove Action Project, 4649 Sunnyside Ave N., Ste. 321, Seattle, WA 98103 USA. Tel./FAX: 206-545-1137. E-mail: <mangroveap@aol.com>.

Caribbean Mangrove Network

In August 1996, over 25 mangrove specialists attended the inaugural meeting of the Caribbean Mangrove Network (CMN), jointly sponsored by the Commonwealth Secretariat's Science Council and the University of West Indies Centre for Environment and Development. The network aims to promote conservation and sustainable management of Caribbean mangroves by pooling expertise and linking institutions and resource people.
It will operate as a forum for disseminating research results, broadcasting best management practices, and sharing education, information and research resources already available. Its intention is to reach the widest regional audience, including countries such as Guyana and Belize, as well as non-commonwealth countries.

To avoid duplication, established means of communication, such as the regional round-up sections of the newsletters of the International Society for Mangrove Ecosystems and the IUCN Wetlands Programme, will be used for information exchange. The mangrove Internet list, while of value, was not considered accessible enough at this stage to play more than a supplementary role. Mangrove specialists in the region are encouraged to ensure they have access to at least one of these communication channels (see listing under "Periodicals"). The inaugural meeting's outcome was the identification of management-oriented research for which funding could be immediately sought. Papers on the status of mangrove management in several Caribbean countries were also prepared, forming a useful synthesis.

For more information contact: Prof. Peter Bacon, Zoology Dept., University of West Indies, St. Augustine, Trinidad and Tobago. FAX: 809-625-4161 or Gerard Alleng, Institute of Marine Affairs, Hilltop Lane, Chaguaramas, P.O. Box 3160 Carenage, Trinidad and Tobago. Tel: 809-634-4291. FAX: 809-634-4433. E-mail: <GALLENG@IMA.GOV.TT >.

Philippines

(continued from page 5)

increased economic rent for leases is on the verge of approval and, where communities have been organized and given responsibility for management, mangrove degradation has slowed or stopped. Stewardship agreements are proving to be a primary tool for protecting mangrove resources. It is also intended that as integrated coastal resource management plans are developed for particular areas, all mangroves and their resources will be included and targeted for sustainable use in their original state. National economic policies must also now be shaped to encourage improved management.

These experiences have led to recommendations for the following new policies to be adopted by DENR and other agencies:

- The basic bio-physical and environmental factors that support mangrove ecosystem growth and sustenance must be considered in all project areas.
- Priority must be given to saving and managing existing forest and habitat.
- Communities must strengthen their will and capacity to protect and use the resource wisely. This requires a lengthy process of community organization and training through government, NGO and other assisting organization support using integrated approaches.
- Assisting organizations in mangrove management efforts requires a full-time, live-in person to take responsibility for community organization and training.
- Mangrove Stewardship Agreements (MSAs) should be used to promote local responsibility for maintaining permanent mangrove forested areas, replacing the previous DENR mangrove reforestation contracts.
- MSAs should allow limited but sustainable use in some cases to promote forest succession and provide economic incentives to local community managers.
- Mangrove areas released for fish pond but not used for that purpose and that meet certain criteria should revert to DENR for rehabilitation and management.
- All mangrove resources in any given area should be included in the management plans for that area regardless of any previous classifications.
- Local government units should lead or participate in community planning and help to coordinate other government services; the DENR and other government personnel should provide technical assistance but not lead the field projects.
- Accurate mapping of mangrove resources and the immediate uses of land such as for fish ponds should be the responsibility of the DENR and the BFAR.
- The DENR should monitor each stewardship area to determine the level of compliance with the area management plan.
- Sanctuaries should be established over mangrove areas as determined by local communities with guidance from DENR or BFAR and legal support of local government.

Photo by Alan White

Abandoned fishponds on old mangrove habitat are common in the Philippines.

For more information contact: Alan T. White, Coastal Resources Management Project, 5th Floor, CIFC Towers, North Reclamation Area, Cebu, Philippines. FAX: 6332-232-1825; E-mail: <prcce-bu@usc.edu.ph>; or, Roy Olsen D. De Leon, Marine Laboratory, Center of Excellence in Coastal Resources Management, Silliman University, Dumaguete City 6200, Negros Oriental, Philippines. FAX: 6335-225-4608

Acknowledgments: Contributions and assistance were provided by Dr. Fred Vande Vusse (USAID), Ms. Betty Dar (DENR), and Mr. Sonny Gendrano (DENR). The references of Dr. J. H. Primavera were helpful.

INTERCOAST SIDER FORMATION

Publications

Assessment and monitoring of climatic change impacts on mangrove ecosystems. 1994. UNEP Regional Seas Reports and Studies no. 154.

Mangrove Ecology Workshop Manual. C. Feller (ed.). Smithsonian Environmental Research Center.

Mangrove Forest Management Guidelines. 1993. FAO, Rome.

The Mangroves of Zanzibar. 1996. J.P. Shanula and A. Whittick. Institute of Marine Sciences, USDM. 65 pages. Describes flora, ecosystem, uses for the non-specialist. ISBN 0-88901-308.

An Overview of the World's Ramsar Sites. 1996. S. Frazier. Wetlands International. 56 pages. Illustrated analysis of Ramsar sites by wetland type, human use, geographic distribution etc. Available in English, French and Spanish. Contact: Natural History Book Service Ltd, 2-3 Wills Road, Totnes, Devon TQ9 5XN, UK. Tel (44) 1803-865913. FAX (44) 1803-865280; E-mail: nhbs@gn.apc.org. UK Pounds 20.00.

Proceedings Gulf of Mexico and Caribbean Oil Spills in Coastal Ecosystems: Assessing Effects, Natural Recovery and Progress in Remediation Research. C.E. Proffitt and P.F. Roscigno (eds.). OCS Study/MMS 95-0063. US Dept. Interior, GOM Region, New Orleans, LA. 245 pages. Contact: US Dept of Interior, Minerals Management Service, Gulf of Mexico OCS Region, Mail Stop 5034, 1201 Elmwood Park Blvd, New Orleans, LA 70123-2394. Tel: 1-800-200-GULF. US$7.00.

Societies and Mangroves in the Southern Rivers. DUM programme book, with proceedings of workshop. M-C. Cormier-Salem.

Tropical Mangrove Ecosystems. 1992. D. Alongi and A. Robertson (eds.). 336 pages. Available from the American Geophysical Union, this book is founded on the work done on Hinchinbrook Island and elsewhere in the tropics of Northeastern Australia. Contact: AGU-Orders, 2000 Florida Avenue NW, Washington, DC 20009 USA. Tel: 1-800-966-2481 (North America) or 1-202-462-6900 (elsewhere). FAX: 1-202-328-0566. E-mail: service@kosmos.agu.org. Web Site: http://earth.agu.org/pubs/. List– $37.00; AGU member– $25.90.

Available from ISME:

Conservation and Sustainable Utilization of Mangrove Forests in the Latin America and Africa Regions. Part 1. Latin America. 1993. L.C. Lacerda. (ed.). Mangrove Ecosystems Technical Reports, Vol.2, ISME/ITTO. 272 pages. Out of print.

Conservation and Sustainable Utlisation of Mangrove Forests in the Latin America and Africa Regions. Part 2. Africa. 1993. Mangrove Ecosystems Technical Reports, Vol.3, ISME/ITTO. 262 pages. Out of print.

The Economic and Environmental Values of Mangrove Forests and Their Present State of Conservation in the South-East Asia and Pacific Region. 1993. Mangrove Ecosystems Technical Reports. Vol.1, ISME. 202 pages.

Journey Amongst Mangroves. 1995. C. Field. A handbook on mangroves, first volume. Fully illustrated text of 140 pages designed for people with no prior knowledge of mangroves.

For ISME titles contact: ISME, c/o College of Agriculture, University of the Ryukyus, Nishihara, Okinwa 903-01, Japan. FAX:(81) 98-895-6602.

Available from the IUCN:

The Directory of Wetlands of International Importance: An Update. Ramsar, 1996. S. Frazier (ed.). 236 pages. Provides data for the nearly 200 Ramsar sties designated since publication of the 4-volume directory published in 1993. UK pounds 12.50; US$18.75.

Ecology and Management of Mangroves. 1993. Aksornkoae, IUCN, Bangkok, Thailand. 176 pages.

Mangrove Forests, Climate Change and Sea Level Rise. [Hydrological Influences on Community Structure and Survival, with examples from the Indo-West Pacific.] 1993. J.C. Pernetta. A Marine Conservation and Development Report. IUCN, Gland, Switzerland.

Mangroves of the Sundarbans. 1994. Vol. 1 India. A.B. Chaudhuri and A. Choudhury. IUCN, Bangkok, Thailand.

Mangroves of the Sundarbans. 1994. Vol. 2. Bangladesh. Z. Hussain and G. Acharya. 257 pages. IUCN Publications. UK pounds 10.00; US$20.00.

Le Manuel de la Convention de Ramsar. 1996. This is an updated French translation of the English manual (T.J. David, ed. Ramsar, 1994). Both versions are available and cost 21 pounds sterling or US$32.25.

Manuel de Formation a la Gestion des Zones Humides Tropicales. 1994. J. Skinner, N. Beaumond and J.Y. Pirot. 272 pages. This book is a training manual for wetland managers, based on West African experience. IUCN Publications. UK pounds 13.50; US$20.00.

Proceedings of the 6th Meeting of the Conference of the Parties, Brisbane, Australia. Ramsar, 1996. UK pounds 40.00; US$60.00

For IUCN titles contact: IUCN Publications Services Unit, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom. Tel. 44 1223 277894, FAX. 44 1223 277175. E-mail: iucn-psu@wcmc.org.uk.

FORTHCOMING PUBLICATIONS

World Mangrove Atlas. World Conservation Monitoring Centre/ISME/ITTO.

Restoration of Mangroves. C. Field. ISME.

Economic Valuation of Wetlands. E. Barbier, M. Acreman, D. Knowler.

Guidelines for environmentally sound management of river basins in Asia - utilizing functions and maximizing wetland benefits. T. Hollis. UNEP/Asian Wetland Bureau.

Guidelines for Improved Conservation and Sustainable Use of Tropical and Sub-tropical Wetlands. OECD. Produced by IUCN Wetlands Programme and FINNIDA. Aims to provide task managers in development assistance agencies with information on improved screening procedures, project implementation practices and mitigation measures.

Management of Living Resources in the Matang Forest Reserve, Perak, Malaysia. G. Nagaraj and P. Gabriel. Case study to be included in WWF-US report on sustainable use of wild species.

UNESCO/ISME 400 page compilation of 30 papers on status of mangroves in Latin America and Africa. B. Kjerfve, L. Drude de Lacerda, and S. Diop (eds.). French and English.

Fish eggs and larvae from mangrove waters. J. Prince Jayaseelan. UNESCO/ISME. Drawings and descriptions of developmental stages of about 70 species.

Periodicals

MAP Quarterly News.

IUCN Wetlands Newsletter. Contact: Cécile Thiéy, Librarian. Tel. 41 22 999 0135. FAX. 41 22 999 0010. E-mail. cet@hq.iucn.org.

The Ramsar Newsletter. This is the newsletter of the Convention on Wetlands of International Importance, and is published by the Ramsar Bureau, Rue Mauverney 28, CH-1196 Gland, Switzerland. FAX: (41) 22-999-0169. Tel: (41) 22-999-0170. E-mail: ramsar@hq.iucn.org.

Mangroves and Salt Marshes. A new international journal concerned with the interdisciplinary science and management of tidal wetlands; it will cover pure and applied sciences and include studies on siltation, fisheries, forestry, aquaculture and the sustainable use of mangroves and saltmarshes. Contact: Daniel Childers, Associate Editor, Southeast Environmental Research Program, OE 148 University Park, Miami, Florida 33199. Tel. (1) 305-348-3095; FAX (1) 305-348-4096.

Conferences

April 6-9. **International Conference on the Biology of Coastal Environments**. Bahrain. Contact: Dr. Jameel Abbas, Dept. of Biology, College of Science, University of Bahrain. E-mail: icbce97@internic.uob.bh. One of the main themes is mangroves.

May 5-7. **Annual Meeting, Pacific Northwest Chapter Society of Wetland Scientists**. Corvallis, Oregon. Contact: Emily Roth, NRCS, Portland, Oregon. Tel: 503-235-6272.

May 15-16. **24th Annual Conference on Ecosystems Restoration and Creation**. Tampa, Florida. Contact: Frederick J. Webb, Dean of Environmental Programs, Hillsborough Community College, Plant City Campus, 1206 N. Park Rd., Plant City, FL 33566 USA. Tel: 813-757-2104. E-mail: webb@mail.hcc.cc.fl.us.

May 21-23. **1st International Conference on Sustainable Tourism in Vietnam**. Hue, Vietnam. Russell Arthur Smith, Coordinator, Vietnam Tourism Development Program, Hanns Seidel Foundation & Nanyang Technological University. Tel: +65 799 4836. FAX: +65 791 3697. E-mail: arasmith@ntu.edu.sg. Web Site: http://edge.tamu.edu/waves97/.

June 2-6. **Coastlines '97: Connecting European and Mediterranean Coasts**. 6th EUCC International Conference. Naples, Italy. Contact: Dr Giovanni Randazzo, Instituto di Scienze della Terra, Université di Messina, Salita Sperone, 31-C.P.24, 98166 - S. Agata di Messina, Italy. Tel. +39 90 6765095. FAX: +39 90 392333. E-mail: randazzo@labcart.unime.it.

July 7-9. **Air-Sea-Land Interaction Processes in Estuaries**. Melbourne, Australia. Contact: M. Cintia Piccolo and Gerardo M. E. Perillo, Instituto Argentino de Oceanografia, Av. Alem 53, 8000 Bahia Blanca, Argentina. Tel: (54-91) 23555/20254/558431. FAX (54-91) 88-3933/20254.

August 5-8. **U.S.-China Conference on the Environment**. Beijing. Contact: Global Interactions Inc., 14 West Cheryl Drive, Phoenix, AZ 85021-2481. Tel: 602-943-3922. FAX: 602-943-4458. E-mail: global@goodnet.com. Web Site: http://www.goodnet.com/~global.

August 18-23. **1997 European Marine Biological Symposium**. Kristineberg Marine Research Station, Sweden. Contact: EMBS Secretariat, Drs. Susanne Baden, Lief Pihl and Rutger Rosenberg, Kristineberg Marine Research Station, S-450 34, Fiskebackskil - Sweden. FAX: +46 (0) 523 18503. E-mail: s.baden@kmf.gu.se.

September. **VII Latin American Congress of Marine Science (COLACMAR)**. San Paulo, Brazil. Contact: Dr. Alfredo Martins Palva Pihlo, Presidente de la Comision Organizadora, COLACMAR, Centro de Convencoes, SESC-Santosrua, Conselheiro Rivas, 136, CEP: 11.040-900 Santos, Sao Paulo, Brasil. This meeting will be held in English, Spanish, and Portuguese and has a theme devoted to mangroves.

September 16-19. **Fifth Symposium on the Biogeochemistry of Wetlands**. Royal Holloway College, University of London. Contact: Royal Holloway Institute for Environmental Research, Royal Holloway University of London, Huntersdale, Callow Hill, Virginia Water, Surrey, GU25 4LN, UK. Attn: Tony Weir. FAX 44(0)1784 477427. E-mail: rhier@rhbnc.ac.uk.

September 18-20. **Fourth Underwater Science Symposium**. Newcastle-upon-Tyne. Contact: Jean Pritchard, Conference Organiser, Society for Underwater Technology, Innovation Centre, Exploration Drive, Offshore Technology Park, Bridge of Don, Aberdeen, AB23 8GX, UK. Tel: 01224 823637. FAX: 01224 820236. Web Site: http://www.soc.soton.ac.uk/OTHERS/SUT

September 22-24. **International Council for Exploration of the Sea International Symposium**. Recruitment Dynamics of Exploited Marine Populations: Physical-Biological Interactions. Baltimore, Maryland. Contact: ICES, Palægade 2-4, DK-1261 Copenhagen K, Denmark. Tel: (+45) 33 15 42 25. FAX: (+45) 33 93 42 15. E-mail: ices.info@ices.dk. Web Site: http://www.ices.dk/symposia/rp_sym.htm.

September 22-27. **International Marine Biotechnology Conference.** Sorrento, Italy. Contact: Dr. Alan M. Kuzirian, Marine Biological Laboratory, Woods Hole, MA 02543. Tel: 508-289-7480, -7368. FAX: 508-540-6902. E-mail: akuziria@mbl.edu.

October 12-16. **State of Our Estuaries ERF '97.** Biennial Estuarine Research Federation, Providence, Rhode Island. Contact: Patricia Kremer, Scientific and Technical Program Chair, Department of Marine Sciences, University of Connecticut, Avery Point Campus, Groton, Connecticut 06340-6097 USA. Tel: 860-446-1020, ext. 266. E-mail: pkremer@uconnvm.uconn.edu.

November 3-7. **Waves 97: Third International Symposium on Ocean Wave Measurement and Analysis.** Virginia Beach, Virginia. Contact: Dr. Billy L. Edge, Ocean Engineering Program, Department of Civil Engineering, Texas A&M University, College Station, TX 77843-3136. Tel: 409-845-4515. FAX: 409-862-1542. E-mail: b-edge@tamu.edu.

1998. **26th International Coastal Engineering Conference.** Copenhagen, Denmark. Contact: Dr. Billy L. Edge, Head, Ocean Engineering Program, Environmental, Ocean, and Water Resources Division, Department of Civil Engineering, Texas A&M University, College Station, TX 77843-3136. Tel: 409-847-8712. FAX: 409-862-1542. E-mail: b-edge@tamu.edu.

May 22-September 30, 1998. **Expo '98: The Oceans, a Heritage for the Future.** Lisbon, Portugal. Contact: Parque Expo '98, S. A., Av. Marechal Gomes da Costa, 37, 1800 Lisboa. Tel: 01-831-98-98. FAX: 01-837-00-22. E-mail: info@expo98.pt. Web Site: http://www.expo98.pt.

July 19-25, 1998. **INTECOL VII International Congress of Ecology.** Florence, Italy. Contact: Almo Farina - Vice-President INTECOL, Secretariat VII International Congress of Ecology, Lunigiana Museum of Natural History, Fortezza della Brunella, 54011 Aulla, Italy. Tel. + 39 - 187- 400252. FAX + 39 - 187-420727. E-mail: afarina@tamnet.it. Web Site: http://www.tamnet.it/intecol.98.

August 22-28, 1998. **World Deltas Symposium.** New Orleans, Louisiana. Contact: James M. Coleman. Tel: 504-388-4028. E-mail:chanjc@lsuvm.sncc.lsu.edu

1998. **International Workshop on Ecology and Management of Mangroves.** Colombia. Hosted by RED Estuarios/Univ. S. Carolina. Contact: Enrique J. Pena, Dept Biology, Universidad del Valle, Cali, Colombia. E-mail: enripena@biomarina.univalle.edu.co.

1998. **Shrimp Farmers and Mangroves.** To be hosted by CODDEFFAGOLF, Honduras. Goal: to devise strategies to encourage shrimp businesses to avoid damaging mangroves in the Golf of Fonseca. Contact: Jorge Varela Marquez, Director Edificio Fiallos Soto, #204, P.O. Box 3663, Tegucigalpa M.D.C. Tel: (504)38-0415. FAX: (504)38-0415. E-mail: coddeffagolf%cgolf%sdnhon@sdnhq.undp.org.

Mangrove Electronic Resources

Cairns On-line Environment Guide-Mangroves. Detailed description of mangroves. Address: http://www.cairns.aust.com/Environ/mangroves.html.

Center for Tropical Marine Ecology (ZMT) and the Contact Office for Tropical Coastal Research. Web Site: http://www.zmt.uni-bremen.de.

Coral Health Related Abstracts. Web Site: http://coral.aoml.noaa.gov/bib/authors.html.

Coral Reefs and Mangroves: Modelling and Management - Australian Institute of Marine Science. This site describes a three-year study sponsored by the Australian Institute of Marine Science and the IBM International Foundation. Web Site: http://ibm590.aims.gov.au/.

Creating a mangrove tree–Grades K-8. This is a blueprint of a grammar school project. Address: http://www.sptimes.com/aquarium/FA.4.2.1.html.

Diversification of Gulf/Caribbean Mangrove Communities through Cenozoic Time. (Research paper.) Web Site: http://simon.kent.edu/Biology/Research/Alan_Graham/Mangrove.html.

The Florida Mangrove Forest. Describes mangroves and some of their inhabitants for a lay audience. Web Site: http://www.sptimes.com/aquarium/FA.2.1.html.

Fundacíon Humedales/Wetlands Foundation. (in English and Spanish) Web Site: http://www.humedales.org/.

Inside the Mangrove Jungle (Florida). Describes mangroves for a lay audience. Web Site: http://www.flsun.com/wild _eco/mangrove.htm.

Sewri Mangrove Park. This site describes the efforts by the Bombay Port Trust to protect 15 acres of mangroves between Sewri and Trombay. Web Site: http://theory.tifr.res.in/bombay/leisure/travel/mangrove.html.

MANGROVE. Mangrove Research Discussion List. Provides a global forum for the discussion of all aspects of mangrove biology and the ecology and management of mangrove ecosystems. To subscribe, send a message to: majordomo@essun1.murdoch.edu.au with the line <subscribe mangrove> in the body of the message.

Mangrove Action Project. Web Site: http://www.earthisland.org/ei/map/map.html.

Mangroves and Shrimp-Answers to the Most Important Questions. (On Contessa Farm Raised Shrimp Page.) Web Site: http://www.zbindustries.com/mangrove.html.

Mangrove Forest Management. Web Site: http://www.metla.fi/conf/iufro95abs/d1pap135.htm.

Mangrove Replenishment Initiative. This site details Florida's programs to develop self-sustaining, shoreline revegetation in Florida's intracoastal waters and lagoon system from Cape Canaveral to Biscayne Bay. Web Site: http://mangrove.org/.

The Mangrove Web. The aim of this site is to provide information on techniques and other information relating to mangrove research. Includes links to MANGROVE discussion list, bibliography, and related sites. Web Site: http://possum.murdoch.edu.au/~mangrove/.

Online Coral Researchers Directory. Web Site: http://coral.aoml.noaa.gov/lists/directory.html.

Ramsar Convention. This page contains a list of Ramsar sites. Web Site: http://iucn.org/themes/ramsar/.

Roots. Web Site: http://www.sptimes.com/aquarium/FA.2.1.4a.html.

Salt Marshes. Web Site: http://atlas.ksc.nasa.gov/./vegetation/saltmrsh.html

WCMC/ISME World Mangrove Atlas. Web Site: http://www.wcmc.org.uk/infoserv/marine/mc_mang.html.

Training

May 6-8. **Introduction to Image Processing and Geographic Information Systems (GIS).** Athens, Georgia. Offered by the Center for Remote Sensing and Mapping Studies. Contact: Georgia Center for Continuing Education, The University of Georgia, Athens, GA 30602-3603. Tel: 706-542-2134 or 800-884-1381. FAX: 706-542-6596 or 800-884-1419. E-mail: Register@gactr.uga.edu.

June 16-July 18. **Maritime Archaeology Techniques course.** Hawaii. Offered by The Marine Option Program at the University of Hawaii at Manoa. This graduate-level course will include remote sensing and scuba-assisted surveys. Contact: Marine Option Program, 1000 Pope Rd. #229, Honolulu, Hawaii 96822. Tel: 808-956-8433. FAX: 808-956-2417. E-mail: mop@hawaii.edu.

August 14-18. **Management of mangrove systems workshop.** Leon, Nicaragua. Contact: Taller manejo productivo de manglares, Proyecto Manglares, 7170 CATIE, Turrialba, COSTA RICA. E-mail: xrobles@catie.ac.cr.

Mangrove Management

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the greening of arid coasts and the fixation of accretion areas.

In Bangladesh, a vast program has been underway since the late 1970s to consolidate the mud banks and deltaic islands of the east coast of the Sundarbans and to develop a protective green belt against cyclones and tidal bores through accretion of new land. Hundreds of hectares have been turned over to agriculture and many others are now managed as production forests under the auspices of the Forest Research Institute and Forest Department of Bangladesh. These, with the Chittagong Sundarbans of Bangladesh and the Sundarbans of West Bengal (India) are managed locally with occasional assistance from foreign experts. The Sundarbans of West Bengal have become particularly well known for the forestry techniques practiced there, as well as the additional focus on biodiversity protection ranging from the Tiger Project of WWF to the study of the microflora and microfauna, including fungi and plant diseases.

The Indus delta mangroves of Pakistan have been managed since the early 1980s and the program of greening the arid coasts of the northern Arabian Sea extends westward from the delta and the Karachi area, towards Miani Hor. *Rhizophora* wood because of its high caloric value, had been selectively harvested here for the boilers of the locomotives of the newly built railways in Sindh, causing the conversion of the area to a monoculture of *Avicennia*. Restoration of the original mixed forest is now underway and tall *Avicennia* and *Rhizophora* forests and experimental plantations of *Ceriops* and other species now cover hundreds of hectares of the previously desert tidal belt, as a result of the efforts of the Forest Department of Sindh Province with UNESCO, ISME and IUCN support. UNESCO's major regional projects, planned in the 1970s and implemented since the 1980s in collaboration with UNDP, contributed greatly to rescuing mangroves from oblivion and neglect and helped them find their rightful place in today's worldwide concern for the environment. Their importance has been universally recognized, at long last and their previously hidden benefits are now as well known as their more obvious ones. Many scientists, managers and politicians have supported mangrove projects in Asia and the Pacific, and work is now being extended to Africa and Tropical American and Caribbean countries. Mangrove managers are now talking to NGOs and local people, and politicians are beginning to take interest. The UNESCO initiative has taken root and developing countries are receiving aid from several countries and international agencies to manage their mangroves. The International Society for Mangrove Eco-systems, founded in 1990, is playing a major role in this movement.

Much remains to be done, however, and there is no reason for complacency. Unfortunately destruction is still far ahead of conservation and management for long-term sustained production. Mangroves are varied and there is no simple or single paradigm for their management. Scientists must learn from those for whom the mangroves are home and who are thus true "ecologists" (a word that comes from the Greek word for home: *oikos*).

For more information contact: Marta Vannucci, ISME Secretariat, c/o College of Agriculture, University of the Ryukyus, Nishihara, Okinawa 903-01, Japan. FAX:(81) 98-895-6602.

Stewardship

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conjure up an image to convey the idea of stewardship. One image is of a person responsible for a piece of agricultural land and the families who work it. The steward knows each field, each bit of woodland, even each fruit tree, and their individual strengths, weaknesses and needs. The steward is no less knowledgeable of each family, their history and aspirations and their individual and collective skills and failings. The steward's responsibility, delight–and sometimes the price he or she must bear–comes from how he or she balances among the needs of the land, and the needs and desires of the people from one generation to another.

At the heart of stewardship is a profound, detailed and accurate knowledge of both nature and a society, of the many processes at work and the values that must be kept balanced. Stewardship is about creating the beauty that comes when such balance is achieved and maintained. Particularly in poor countries, where many people depend upon the natural resources in their immediate surroundings for their livelihoods and survival, a one-size-fits-all policy prohibiting for example, the cutting of mangroves or promoting the building of shrimp ponds, seldom produces positive outcomes. Contributing writers Alejandro Bodero and Alan White, in recounting the experiences of Ecuador and the Philippines demonstrate the importance of assuming that the communities affected must assume the lead in shaping a responsible and equitable relationship with "their" mangroves. This, in turn, requires knowing how the local human societies function and the nature of the forces that are shaping how they change. Robert Twilley and Colin Field reinforce from different perspectives the equal importance of understanding the combination of factors that give an individual mangrove wetland its unique identity and therefore the informed parameters for its effective stewardship.

A second characteristic of stewardship is careful attention to and clarity in the objectives of management. Why are we managing, who are we managing for, what values are important, what forces are we trying to keep in balance and what are the time scales?

A third feature of stewardship is that the greatest challenges lie with controlling and directing the power of people which, at least over the short term, usually outweighs the forces of nature in shaping ecosystem change. Population growth in the tropics combined with the power of the chain saw, the bulldozer and world commodity markets can quickly destroy or degrade mangroves that may have existed for millennia.

Finally, the steward is a local person. He or she is of the place, lives there, applies their knowledge and confronts those who threaten the hope for balance. Such knowledge and responsibility can be informed and encouraged from afar – but like the declarations of central government in most developing nations – technical knowledge and exhortations have little effect without sustained local commitment and action. This does not imply that the roles of advisors and the natural scientists working to better understand the ecological process, values and trends in mangroves are secondary. The point is that their work must connect to stewardship practice.

These papers suggest that the research and technology is indeed being better communicated and offered as support to the individuals and groups who are struggling to be more effective stewards. These trends give reason to hope that the drastic losses in mangroves often seen in the last few decades will not continue, and that restoration at significant scales may even occur.

Cambodia

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actions to:

- Issue a moratorium against the increasing development of shrimp farms until further studies have been conducted.
- Obligate existing shrimp farm entrepreneurs to renovate their infrastructure.
- Develop a master plan for the coastal area.
- Develop the coastal zone for tourism, and ecotourism in particular.
- Control charcoal production by prohibiting illegal exports of charcoal.
- Stop the illegal trade of mangrove and marine products with neighboring countries.
- Promote community awareness and community-based management of local resources.
- Create a permanent office in each wildlife sanctuary, patrolled by local environmental staff to curb illegal activities.

Recommendations

- Carefully study the mangrove forest in Koh Kapik in terms of aquatic flora and fauna protection and coastal community stabilization.
- Build a research station and education center.
- Establish a master plan for sustainable development, protection and conservation of coastal ecosystems.
- Collect aquatic biodiversity, and create a management plan for the Koh Kapik Ramsar site.

For more information contact: Oum Pisey, Ministry of Environment, 48 Samdech Preah Sihanous St., Chamkarmon Khan, Phnom Penh 3, Cambodia. FAX: (855) 23 427137. E-mail: wetlands@forum.or.kh.

Upcoming in Intercoast

Indicators for Learning and Evaluation will be the special focus of the Spring, 1997 edition of *Intercoast Network* (No. 29). Measuring real progress in integrated coastal management (ICM) has become a key issue in the field. Coastal practitioners worldwide are looking for reliable methods to evaluate and learn from the work being done in ICM, and turning that assessment into productive input for their work. Editor Stephen Olsen has recently given keynote presentations in China and at the World Conservation Union Congress in Canada, addressing the development of a common methodology for evaluating the critical role of governance in the ICM process. He and other noted contributors will explore many of the vital questions surrounding indicators, learning and evaluation in ICM around the world.

If you are interested in contributing, contact Intercoast Managing Editor Chip Young at *Intercoast Network*, c/o Coastal Resources Center, University of Rhode Island, Bay Campus, South Ferry Road, Narragansett, RI, USA 02882. Phone: (401) 874-6630; FAX: (401) 789-4670; E-mail: <cyoung@gsosun1.gso.uri.edu>.

Intercoast Network

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The objective of Intercoast Network is to facilitate the exchange of information, experience, and ideas on coastal management. Readers are encouraged to write to the Coastal Resources Center with comments on the newsletter and its effectiveness as a source of information for coastal managers.

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