

Economic Botany 59(1):66-76 (2005).

PATTERNS OF LOCAL WOOD USE AND CUTTING OF PHILIPPINE MANGROVE FORESTS

BRADLEY B. WALTERS

Walters, Bradley B. (*Geography Department, Mount Allison University, Sackville, N.B. E4L 1A7, Canada; e-mail: bwalters@mta.ca*). PATTERNS OF LOCAL WOOD USE AND CUTTING OF PHILIPPINE MANGROVE FORESTS. *Small-scale wood harvesting from mangrove forests is a commonplace, yet barely studied phenomenon. This paper integrates biological and ethnographic methods to examine local wood use and cutting of mangrove forests in two areas of the Philippines. Findings reveal considerable site variation in cutting intensity, with heavier cutting typically closer to settlements and in forest stands that are not effectively regulated by government or private interests. Overall, cutting is responsible for almost 90% of stem mortality in both natural and plantation forests. Field measurements confirm ethnographic evidence indicating that harvesting for construction wood, but not fuel wood, is both species- and size-selective. Mangrove management and conservation efforts can be made more effective by better understanding how local people are harvesting wood resources from these forests.*

Key Words: anthropogenic disturbance, human ecology, non-timber forest products, selective cutting, mangroves.

INTRODUCTION

Small-scale wood harvesting is one of the most ubiquitous forms of resource use in the tropics (Awasthi et al. 2003; Murali et al. 1996; Nepstad and Schwartzman 1992; Smiet 1992; Ticktin 2004; Uma Shankar et al. 1998a, 1998b). In particular, mangrove forests are a valued source of wood products for many coastal communities (Christensen 1982; FAO 1994; Hamilton et al. 1989; Jara, 1987; Kunstadter et al. 1986; Lacerda 1993). Most mangrove tree species produce wood that is extremely hard and also burns hot. Mangrove wood is often preferred for use as a cooking fuel and for construction of fish traps, wharves, fences and roofing (Brown and Fischer 1918; Lacerda 1993). Basic ecological research on mangroves is extensive, but almost none has examined the ecology of small-scale wood cutting in these forests.

Research presented here is part of a larger study on the causes and consequences of small-scale mangrove cutting and tree planting in the Philippines (Walters 2000, 2003, 2004). This paper examines patterns of local mangrove wood use and forest cutting in two areas of the Philippines. It seeks to answer the following two questions: (1) How intense is the small-scale cutting of mangroves? and (2) Is mangrove cutting selective by tree size or species? The ecological effects of this cutting are examined in depth in a companion paper (Walters 2005).

STUDY AREAS AND RESEARCH METHODS

Field work for this study was conducted in the Philippines between March and December, 1997 in North & South Bais Bay and Bindoy, Negros Oriental (9N/123E) and on Banacon Island, Bohol (10N/124E). Bais Bay is located on the eastern side of Negros Island (Figure 1). Mean temperatures in Bais vary from 25C - 30C and around 1500mm of rain falls annually, mostly during a distinct rainy season from July to December. The Bay occupies an area

of approximately 5400 ha and is divided into North and South by Daco Island. The coastal waters of Bais Bay support a diverse fishery (Luchavez and Abrenica 1997). Fifteen different villages ring North and South Bais Bay, ranging in size from a few dozen to over 500 households.

Seventy percent of the nearly 1000ha of original mangroves in Bais Bay were cleared and developed into fish ponds between 1930 and 1980 (Walters 2003). Today, much of the perimeter of Bais Bay is fringed by narrow bands of mangrove forest. Mangrove stands, ranging in area from 3ha - 30ha, are also found at the mouths of each of four rivers that empty into the Bays, and a particularly large stand of forest, called *Talabong*, extends as a peninsula across the seaward front of South Bais Bay. The 260 ha Talabong was officially designated a marine and wildlife sanctuary by the City of Bais in 1986. Many coastal residents also plant mangroves in Bais (mostly *Rhizophora mucronata* Lamarck), but the distribution of plantations is patchy. Mangrove plantations in Bais are privately owned by individual planters, and most are found immediately adjacent to settlements or along the seaward perimeter of fishponds (Walters 2004).

Figure 1 Here

Bindoy is located 20km north of Bais Bay. An extensive mangrove forest (about 100 ha) is located on the seaward perimeter of a private estate. These mangroves have been protected by the estate's owner and so are little disturbed by cutting. Banacon is a small, coralline island, located 5km off the northwest corner of Bohol Province and about 30km east of Cebu City. Over 95% of Banacon's roughly 500ha size is mangrove forest. There are currently 550 households crowded onto a 15ha dryland area on the eastern tip of the island. Virtually all of these households derive their principal income from fishing and related activities (fish processing, marketing, etc.). Banacon residents have always depended on the harvest of mangrove wood to meet domestic fuel and construction needs. As well, since the 1950's they have planted trees so

that vast expanses of formerly natural forest are dominated today by monocultures of planted *Rhizophora stylosa* Griffith (Walters 2000, 2004). Almost all wood being cut today on Banacon comes from the nearly 400 ha of privately owned plantations. The mangroves of Banacon received national Wilderness Area designation in 1981 (DENR 1990), but this has not effectively precluded local people from continuing to plant and cut them.

Ethnographic information was obtained primarily from semi-structured interviews that I conducted with 202 residents living in 10 different coastal villages in Bais Bay; 10 residents of Banacon Island; and 3 residents of Bindoy. In these interviews, people were asked questions about their occupation and family; their knowledge of mangroves; use of mangrove wood and cutting practices; experience planting mangroves; and so on. The strategy for selecting people to interview reflected a compromise between the desire, on one hand, to discern gross patterns by comparing and contrasting a wide range and number of sites and, on the other, to sample intensively within select villages so as to permit a more subtle examination of specific aspects of mangrove resource use. I thus made an effort to interview at least three or four people from every village in North and South Bais, Banacon and Bindoy, but conducted most interviews in the three largest villages in Bais: San Lagan, Canibol and Olympia.

Interviews were recorded in the field and later transcribed and the texts analyzed. Information that lent itself to ready quantification was coded, entered into a data base, and subjected to quantitative analysis. I compiled the more qualitative kinds of ethnographic information by sub-topic (e.g., historical events, technical knowledge about mangroves, etc.) so that cases could be corroborated, compared and contrasted. Because some interviews were truncated for practical reasons, not all respondents were asked the full array of questions (e.g., only 163 of 215 respondents were asked about their use of mangrove wood; see Table 1).

To assess forest characteristics, I employed the quadrat/census plot method (Cintron and

Schaeffer-Novelli 1984; Peters 1996). Each census plot was 10m x 10m, with corners and boundaries marked using a 50m measuring tape. A relatively small plot size was used because trees in most of the stands surveyed were typically small and densely crowded as a result of their being young or having been highly disturbed from cutting. A stratified random sampling approach was used to select plot sites. I located plots widely in the study areas in an attempt to capture some of the variation due to site-specific differences in ecological conditions and human influences. Slightly greater sampling effort was specifically devoted to plantations to ensure representation from a wide range of stand ages (Walters 2000).

In summary, I surveyed 52 plots: 31 that had been cut (10 in natural forest and 21 in plantations) and 21 that showed little or no evidence of cutting (9 natural and 12 plantations). For natural forests, 13 plots were surveyed across 3 distinct sites in North and South Bais Bay (Dungaun, Dyke and Daus), and 6 plots were surveyed in Bindoy. For plantations, I surveyed one plot in 5 different sites on Banacon Island, and 28 plots in 24 different plantations across 8 distinct sites in Bais Bay. Plantations 5 - 60 years old were surveyed (mean = 30.3 years).

I numbered, mapped and measured every tree (>1.0m tall) in each of the 52 forest plots, for a total of 5,926 trees. Each tree was identified by species based on Calumpong and Menez (1997). Dead stems were classified as “snags”. I measured the diameter at breast height (dbh) of each tree stem following the guidelines of Cintron and Schaeffer-Novelli (1984). Dbh was measured at the highest point possible in cases where stumps were cut below 1.3m. Finally, I documented evidence of cutting by recording for each tree whether it was a cut stump or had either a cut branch or cut root. If a tree had both a cut root and a cut branch, it was counted for each measure. Where evidence of cutting was not obvious, I assumed it was not cut. This likely meant that measures of cutting were underestimated since evidence of cutting on older, decayed stumps may well have eroded. All quantitative data were analyzed statistically using SPSS

(version 9.0). Forest plot data were log transformed for statistical analysis when they did not meet the test for homogeneity of variances (Zar 1984).

RESULTS

Intensity of Wood Use and Forest Cutting

Mangroves are sometimes cut for construction wood used to build fences, houses and livestock pens, but mostly they are cut for fuelwood and posts used in the construction of fish corrals, called *bunsod* (Table 1). Thirty-five percent of all respondents used mangrove as fuelwood at least sometimes, and 25% used it for *bunsod* posts. Wood use for fuel and *bunsod* is greater than simple frequency data might suggest because consumption *rates* of firewood and *bunsod* wood far exceed those for house or fence construction (firewood and *bunsod* posts being replenished at a much faster rate than housing or fencing stock). Mangrove firewood is consumed by many homes every day for general domestic cooking. Consumption is dramatically increased during fiestas and other holidays when households (including many that normally do not use mangrove wood for cooking) collect it specifically for pig roasting (called *lechon*).

Likewise, consumption of wood for *bunsod* construction is considerable: 435 different *bunsod* were counted during a bay-wide survey. Interviews indicated that *bunsods* range in size from 10 - 700 posts each, with a mean of 186 ($n = 54$). *Bunsod* posts are typically replaced every 6 - 12 months depending on the quality of the wood and duration of continuous use (submergence in water accelerates rotting). The estimated annual turnover of posts is 104 per *bunsod* ($n = 27$ respondents), which equals a bay-wide consumption rate of about 50,000 posts per year. While not all of these posts are mangrove wood, the large majority are (Table 2).

Measurements of cutting in forest plots indicate that almost one-third (31.7%) of all stems measured in natural forest and 8.9% of stems in plantations were cut stumps, and over 90% of all stumps in both natural and plantation forests had obviously been cut (Table 3). The

density of cut stumps is only slightly higher in natural forests compared to plantations, but mean dbh and basal area of cut stumps in natural forests are significantly higher (Table 4). By contrast, stems with cut branches or cut roots were more abundant in plantations, although not statistically so.

Considerable spatial variation in mangrove wood use and cutting intensity was found. For example, compared to total frequencies of use, significantly more respondents than expected use mangroves for fuelwood in the village of Sanlagan ($X^2 = 13.45$, $df=1$, $p<0.001$), and significantly fewer respondents use mangrove for either fuelwood or bunsod posts in Canibol ($X^2 = 16.78$, $df=1$, $p<0.001$ and $X^2 = 14.41$, $df=1$, $p<0.001$, respectively; Table 1). Likewise, individual plot measures show great variation in the proportion of cut to live stems, ranging from 2% - 70% of total basal area. This variation can be further illustrated with reference to plot data that have been aggregated by site for natural forests. Cut stumps and branches are rare in Bindoy mangroves; more common in Dyke mangroves; and abundant in Daus and Dungan (Table 5).

Selectivity in Forest Cutting

Interview data on fuel wood consumption suggest little or no preference among the common mangrove species (Table 6). Relatively high percentages of respondents also indicated that they use non-mangrove wood for fuel, especially “ipil-ipil” (*Leucaena leucocephala*) and “palwa” (coconut fronds). By contrast, respondents showed strong preference for “bakau” (*Rhizophora* spp.) in the construction of bunsods (Table 2). Eighty-two percent of bunsod fishermen (49 of 60) use *Rhizophora* spp., and only 7% (4 fishermen) use other mangrove species (i.e., “piapi” = *Avicennia marina* (Forsskal) Vierhapper and pagatpat = *Sonneratia alba* J. Smith and *S. caseolaris* (Linnaeus) Engler). Some use non-mangrove wood, notably ipil-ipil (35%) and bamboo (15%).

Forest assessments reveal that all of the common species have been heavily cut. Table 7

presents cutting data, expressed in terms of the percentage of stems that have had either their main stem or a major branch cut from them. Among the most common species, cutting intensity in natural and plantation forests combined ranges from 24.7% of stems for *R. mucronata* to 71.4% of *Sonneratia* spp., with *A. marina* and *Rhizophora apiculata* Blume at 30.6% and 39.5% cut, respectively. The intensity of cutting for *Ceriops decandra* (Griffith) Ding Hou and *Bruguiera* spp. is 19.1% and 36.4%, respectively, but these data are less noteworthy because of the small samples and localized distribution of these species in the study areas. For all species except *C. decandra*, cutting intensity is higher in natural forests than in plantations (Table 7).

The basal area of cut stumps for each species in both natural and plantation forests in Bais is roughly proportional to the basal area of live stems in these forests (Table 8). The one notable exception in the natural forests is the very high basal area of cut *Sonneratia* stumps as compared to the basal area of live *Sonneratia* trees. Whereas the basal areas of *Rhizophora* and *Avicennia* stumps are only 15-20% the basal area of live trees, the basal area of *Sonneratia* stumps is about 80% the basal area of live *Sonneratia* trees (Table 8).

The size distribution of live and cut stems in mangrove forests in Bais (natural and plantation combined) is presented by species in Figures 2 - 4. These show that demographic peaks for cutting tend to follow peaks for live stems for each species, although *Rhizophora* demonstrates the most distinct peak (Figure 2), with most cut stems 3.0 - 5.9 cm dbh. By contrast, the size distribution of cut stems of *A. marina* is less distinct, with many between 2.0 - 6.9 cm (Figure 3). The distribution of cut *Sonneratia* stems shows the least size-specificity, with a broadly rounded peak and wide range of sizes, including a number of very large (20 - 45cm) diameter stems (Figure 4). Finally, measurements of 27 cut bunsod posts -- all *Rhizophora* -- from 6 different fishermen reveal a mean size of 3.7cm dbh and range of 2.3 - 5.0cm.

Figures 2, 3, & 4 Here

DISCUSSION

The cumulative impact of selective wood cutting on the mangroves in this study have been dramatic (Walters 2005). Older residents speak of trees that stood up to 30m tall, twice as high as the tallest trees remaining today. Evidence of cutting is apparent on virtually every tree in many stands (personal observation). Measurements clearly show high levels of cutting intensity in these forests (Table 3 and 4). I am not aware of any studies that present quantitative measures of small-scale cutting in mangroves, but several have done so in terrestrial forests. For example, Murali et al. (1996) found cutting intensities of 0.3% and 5%, respectively, for stems (>10cm dbh) in dry scrub forests in India. These figures are comparatively low, but may reflect that Murali et al. do not present cutting data for smaller stems of the size often found here. Likewise, Awasthi et al. (2003) found evidence of cutting on 20-25% of trees in Himalayan oak forest, and Suzan et al. (1997) recorded human damage on 25 - 72% of ironwood trees in the Sonoran Desert, although definitions of what constituted “cutting” and “damage” are vague in these cases (i.e., not clear if includes cut stems or cut branches, or both). The only study which permits accurate comparison is that of Smiet (1992) done in montane forests in Java. He found cut stump basal area as a percentage of total basal area to range from 0.9% to 77% (mean of 37%), remarkably similar to measures found in this study (2% - 70% with a mean of 25.5%).

A striking finding from this study is that over 90% of stumps in both natural and planted forests showed evidence of having been cut (Table 3), evidence that people are a profound biotic factor in these ecosystems (Walters 2005). It is possible that some trees were cut *after* they had already died from natural causes, but evidence suggests this was not common. Specifically, cut stems were larger diameter than snags found on these sites (Table 4) and data on size distribution of live and cut stems (Figures 2 - 4) suggest that trees selected for cutting were typically of the size range characteristic of canopy trees, and so were probably living when they were cut.

The percentage of cut stems in natural forests (31.7%) was higher than in plantations (8.9%), which is unexpected given the relative proximity of plantations to settlements and the fact that they are often subject to intensive management for wood production. In part, the greater evidence of cutting in natural forests is an artifact of plantation management since mangrove planters typically remove the stumps of cut *Rhizophora* to facilitate replanting. I found no evidence of such intentional stump removal in natural forests.

Nonetheless, that cutting intensity is lower in plantations even for species whose stumps are not typically removed by planters (*Avicennia* and *Sonneratia*; Table 7) suggests that natural forests may be subject to greater cutting intensity. The main reason for this is that plantations are often created and managed for their storm protection value, and so are intentionally not cut (or are little cut) by their owners, who also prevent cutting by others (Walters 2004). This contrasts with many natural forests in the area which, even if located further distance from settlements, are viewed by locals as open access resources and subject to intensive wood harvesting. Having said this, rates of cutting in natural forests have been in decline since the early 1990s following legislative changes and increased policing efforts by the local government (Walters 2003).

In contrast to cut stems, the density of trees with cut branches and cut roots was higher in plantations than in natural forests (Table 4). Unlike stems which are cut almost always for construction materials, branches and roots of planted mangroves are usually cut for firewood or to clear the understory for easier movement within a plantation. As well, many owners will cut tree branches and roots, even as they resist cutting whole stems, because doing so will not likely undermine the value of a plantation for storm protection.

Spatial variation in cutting (Table 5) reflects both geographic and socio-political factors. All things being equal, people usually harvest wood from mangroves that are near to their homes. Such proximity-based harvesting was, in fact, documented by LeBlanc (1997) in her

study of shellfish gleaning in Bais Bay, and has been found in studies of forest cutting in Java (Smiet 1992) and India (Awasthi et al. 2003; Murali et al. 1996). But all things are not equal and decisions to cut from particular forest stands also reflect the perceived risks associated with getting caught where it is no longer permissible to cut. The lower levels of cutting in mangroves from Dyke and Bindoy reflect this as both areas are informally claimed and protected by adjacent landowners, whereas Dungan and Daus mangroves are not (Table 5).

Most fish pond owners have claimed mangroves adjacent to their ponds and often guard against cutting, and the local government of Bais has recently increased efforts to enforce cutting restrictions over mangroves in Bais Bay. Such restrictions serve as a deterrent, especially to those who must travel longer distances to and from mangrove areas and so face a greater likelihood of detection (Walters 2003). Thus, villages located close to natural stands, like Sanlagan, still collect much wood from these areas, whereas villages located more distant, like Olympia and Canibol, tend not to (although these residents may still harvest from nearby plantations).

Studies of highly valued forest resources (e.g., rattan and ironwood) show that people forage considerable distance to find particular species in particular size classes (Kartawinata et al. 1989; Peluso 1992; Vayda 1999). Alternatively, less valued resources tend to evoke a more generalist foraging response, whereby people collect whatever is readily available. For example, in research that included many of the same villages as in this study, LeBlanc (1997) learned that most shellfish gleaners collected a wide variety of species from areas that were closest to their homes. The exception to this was a small number of gleaners who sought the valued *embao* shell (*Phacoides philippinarum*), which is found only in certain mangrove areas. Studies from India similarly found that wood cutting and non-wood forest product collection affected a large number of tree species and were correlated with species availability (based on access and/or

abundance), even though interviews of resource users suggested size- and species-specific preferences (Awasthi et al. 2003; Murali et al. 1996; Uma Shankar et al. 1998a, 1998b). Smiet (1992) found in Javan mountain forests that proximity to the forest edge (i.e., accessibility) was highly correlated with cutting intensity, and that only the more valued timber species were harvested selectively (Smiet 1992).

In this study, fishermen usually indicated a preference for *Rhizophora* spp. in bunsod construction because it rots less quickly and is heavier, so anchors into the bottom. A range of sizes of *Rhizophora* is harvested for home construction, but far more *Rhizophora* are cut for bunsod posts and, not surprisingly, the size class of cut stems of *Rhizophora* corresponds with measures of bunsod posts. The demographic peak for cut *Rhizophora* stems (3.0 - 5.0 cm) also follows closely behind the demographic peak of live stems (1.0 - 3.9 cm), suggesting that a large proportion of live *Rhizophora* stems in the study areas are being cut for bunsod just as they grow into the desired size range, and a relatively small proportion is surviving beyond it.

In contrast, there was little evidence of size or species selectivity in cutting for firewood. In both Bais and Banacon, all common mangrove species in a wide range of stem sizes, were cut under commercial firewood concessions that were operational in the 1960s and 1970s. I did not measure wood currently used by households for firewood, but it was apparent that a range of small and medium size stems and branches are being consumed: small branches for indoor cooking, and larger branches and stems for outdoor barbecues (personal observation). Mangrove wood is unanimously viewed as superior for firewood to non-mangrove wood, but few persons indicated a preference for particular mangrove species. What differences exist in reporting reflect availability more than strong species preference (e.g., many consume *Rhizophora* because of its readily available in backyard plantations). Such harvesting based on availability rather than species selectivity also likely explains why *Sonneratia*, in particular, shows the highest intensity

of cutting (Table 7 and 8). *Sonneratia* are especially common on the seaward edge of the forest where they are easily accessed and cut by boaters at high tide (personal observation). These findings are consistent with Eusebio et al. (1986), who found in Mindinao and Palawan that *Rhizophora*, *Ceriops tagal* (Perrottet) Robinson and *Bruguiera* spp. were more highly selected because of their construction wood value, whereas all species were harvested for firewood.

Policy makers and researchers alike have overlooked small-scale wood harvesting in mangrove forests. Management strategies are thus often developed without regard to either the ecological or economic significance of such activities. Where such harvesting is significant, conservation efforts may encounter much opposition from local people. Forest biodiversity may also be eroded over the long term by continued, selective removal of some species more than others, and by the varied responses of species to cutting disturbance (Walters 2005).

At the same time, understanding patterns of wood use can inform management planning so that it is compatible with existing resource use practices (ITTO 2002; Tickten 2004). For example, well-managed mangrove plantations provide abundant construction wood that can reduce harvesting pressures on natural forests, so long as the plantations are not permitted to encroach too much into natural forests (Walters 2004). The dependence of local communities on mangrove resources can also be tapped to support efforts aimed at preventing the wholesale clearing of mangroves and, perhaps, the implementation of sustainable harvest and income-generating strategies (e.g., Fong 1992; Smith and Berkes 1993; Walters 2004).

ACKNOWLEDGMENTS

I am grateful to Andrew Vayda, John Parrotta, Steward Pickett, Bonnie McCay and Tom Rudel for their support and advice on this project. I thank my friends and colleagues in the Philippines, especially Emma Melana, Jurgenne Primavera, Nida Columpong, Alix Yao,

Ginggay Alveola, Boy Villaneuva, Fred Maturan, Sally Alcazar, Douglass Cancio, Bordit Erejil, Norman Laurente, Jason Jamito, Riza Sanguenza, and the Alveola and Paden families. The suggestions of an anonymous reviewer are also much appreciated.

LITERATURE CITED

Awasthi, A., S.K. Uniyal, G.S. Rawat and A. Rajvanshi. 2003. Forest resource availability and its use by the migratory villages of Uttarkashi, Garhwal Himalaya (India). *Forest Ecology and Management* 174:13-24.

Brown, W.H., and A.F. Fischer. 1918. Philippine mangrove swamps. Bulletin No. 17, Bureau of Forestry, Department of Agriculture and Natural Resources, Manila.

Calumpang, H.P., and E.G. Menez. 1997. Field guide to the common mangroves, seagrasses and algae of the Philippines. Bookmark, Inc., Makati City, Philippines.

Christensen, B. 1982. Management and utilization of mangroves in Asia and the Pacific. FAO Environment Paper No. 3, Food and Agriculture Organization, Rome.

Cintron, G., Schaeffer Novelli, Y. 1984. Methods for studying mangrove structure. Pages 91-113 in S.C. Snedaker and J.G. Snedaker, eds. *The Mangrove Ecosystem: Research Methods*. UNESCO, Paris.

DENR. 1990. Compilation of mangrove regulations. Coastal Resources Management Committee, Department of Environment and Natural Resources, Quezon City, Philippines.

Eusebio, M.A., F.O. Tesoro and D.M. Cabahug. 1986. Environmental impact of timber harvesting on mangrove ecosystem in the Philippines. Pages 337-354 in *National Mangrove*

Committee, ed. *Mangroves of Asia and the Pacific: Status and Management*. Natural Resources Management Center, Ministry of Natural Resources, Quezon City, Philippines.

FAO. 1994. *Mangrove forest management guidelines*. FAO Forestry Paper 117, Food and Agriculture Organization of the United Nations, Rome.

Fong, F.W. 1992. Perspectives for sustainable resource utilization and management of nipa vegetation. *Economic Botany* 46:45-54.

Hamilton, L.S., J.A. Dixon and G.O. Miller. 1989. Mangrove forests: an undervalued resource of the land and of the sea. Pages 254-288 in E.M Borgese, N. Ginsburg and J.R. Morgan, eds. *Ocean Yearbook* 8. University of Chicago Press, Chicago.

ITTO, 2002. *ITTO guidelines for the restoration, management and rehabilitation of degraded and secondary tropical forests*. ITTO Policy Development Series No. 13, International Tropical Timber Organization, Yokohama, Japan. 84pp.

Jara, R.S. 1987. Traditional uses of the mangrove in the Philippines. Pages 114-130 in C.D. Field and A.J. Dartnall, eds. *Mangrove Ecosystems of Asia and the Pacific: Status, Exploitation and Management*. Australian Development Assistance Bureau and Australian Committee for Mangrove Research, Townsville.

Kartawinata, K., T.C. Jessup and A.P. Vayda. 1989. Exploitation in Southeast Asia. Pages 591-610 in H. Lieth and M.J.A. Werger, eds. *Tropical Rain Forest Ecosystems*. Elsevier Science

Publishers, Amsterdam.

Kunstadter, P., E.C.F. Bird and S. Sabhasri, eds. 1986. Man in the mangroves. United Nations University, Tokyo.

Lacerda, L.D., ed. 1993. Conservation and sustainable utilization of mangrove forests in Latin America and African regions (Part 1: Latin America). Mangrove Ecosystem Technical Reports 2, International Society for Mangrove Ecosystems and International Tropical Timber Organization, Tokyo.

LeBlanc, S. 1997. Gleaning in Bais Bay: A case study on an informal sector coastal activity in the Philippines. Masters Thesis, Saint Mary's University, Halifax, Canada.

Luchavez, J.A., and B.T. Abrenica. 1997. Fisheries profile of Bais Bay, Negros Oriental. Silliman Journal 37(3/4):93-171.

Murali, K.S., Uma Shankar, R. Uma Shaanker, K.N. Ganeshiah and K.S. Bawa. 1996. Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. 2. Impact of NTFP extraction on regeneration, population structure, and species composition. Economic Botany 50:252-269.

Nepstad, D.C., and S. Schwartzman, eds. 1992. Non-timber products from tropical forests. Advances in Economic Botany 9, New York Botanical Garden, Bronx, New York.

Peluso, N.L. 1992. The ironwood problem: (Mis) management and development of an extractive rainforest product. *Conservation Biology* 6:210-219.

Peters, C.M. 1996. Beyond nomenclature and use: a review of ecological methods for ethnobotanists. Pages 241-276 in M.N. Alexiades, ed. *Selected Guidelines for Ethnobotanical Research: A Field Manual*. The New York Botanical Garden, Bronx, New York.

Smiet, A.C. 1992. Forest ecology on Java: human impact and vegetation of montane forest. *Journal of Tropical Ecology* 8:129-152.

Smith, A.H., and F. Berkes. 1993. Community-based use of mangrove resources in St. Lucia. *International Journal of Environmental Studies* 43:123-131.

Suzan, H., D.T. Patten and G.P. Nabhan. 1997. Exploitation and conservation of ironwood (*Olneya tesota*) in the Sonoran Desert. *Ecological Applications* 7:948-957.

Tickten, T. 2004. The ecological implications of harvesting non-timber forest products. *Journal of Applied Ecology* 41:11-21.

Uma Shankar, R. Hegde and K.S. Bawa. 1998a. Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. 6. Fuelwood pressure and management options. *Economic Botany* 52:320-336.

Uma Shankar, K.S. Murali, R. Uma Shaanker, K.N. Ganeshiah and K.S. Bawa. 1998b.

Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. 4. Impact on floristic diversity and population structure in a thorn scrub forest. *Economic Botany* 52:302-315.

Vayda, A.P. 1999. Finding causes of the 1997-98 Indonesian forest fires: problems and possibilities. WWF Indonesia Forest Fires Project, World Wide Fund for Nature (Indonesia), Jakarta.

Walters, B.B. 2000. Local mangrove planting in the Philippines: are fisherfolk and fishpond owners effective restorationists? *Restoration Ecology* 8:237-246..

Walters, B.B. 2003. People and mangroves in the Philippines: Fifty years of coastal environmental change. *Environmental Conservation* 30:97-107.

Walters, B.B. 2004. Local management of mangrove forests: Effective conservation or efficient resource exploitation? *Human Ecology* 32:177-195.

Walters, B.B. 2005. Ecological effects of small-scale cutting of Philippine mangrove forests. *Forest Ecology and Management* (forthcoming).

Zar, J.H. 1984. *Biostatistical analysis*, 2nd edn. Prentice-Hall, New Jersey.

TABLE 1. SUMMARY OF MANGROVE WOOD USES BY VILLAGE. DATA REPRESENT THE PERCENTAGE OF RESPONDENTS (N) INDICATING THAT THEY USE MANGROVE WOOD FOR SAID PURPOSE. STATISTICAL TESTS BASED ON CHI-SQUARE COMPARISONS BETWEEN VILLAGES BY DIFFERENT WOOD USES -- I.E., COMPARING OBSERVED WITH EXPECTED FREQUENCIES IN DIFFERENT VILLAGES IN BAI S BASED ON TOTAL COUNTS FOR ALL VILLAGES.

Village	Mangrove Wood Uses						
	Bunsod Posts	Fuel wood	House Construction	Fence/Pen Construction	Nipa Roofing	Miracle Hole ¹	Xmas Tree
Banacon (n = 5)	40	100	100	100	100	N/A	N/A
Sanlagan (n = 37)	27	74**	11	16	42	6	3
Canibol (n = 63)	6**	5**	3	2*	29	0	18
Olympia (n = 21)	48*	29	5	0	64*	14	14
Other Bais (n = 37)	54**	32	8	30	17*	4	0
Grand Mean (n = 163)	28	35	10	15	18	4	10

¹ Locally called *amatong*, the miracle hole is a small fish trap that makes use of abundant mangrove branches piled in and around an excavated pit set in the lower intertidal zone.

* $p < 0.01$; ** $p < 0.001$.

TABLE 2. TREE SPECIES USED IN BUNSOD CONSTRUCTION IN DIFFERENT VILLAGES.
 DATA REPRESENT THE PERCENTAGE OF RESPONDENTS (N) INDICATING THAT THEY USE
 GIVEN SPECIES.

Village	Species ¹ Used in Bunsod Construction				
	<u>Mangrove Wood</u>			<u>Non-mangrove Wood</u>	
	Bakau	Piapi	Pagatpat	Ipil-ipil	Bamboo
Banacon (n = 2)	100	0	0	0	0
Sanlagan (n=11)	100	0	0	0	0
Canibol (n = 7)	71	0	0	57	29
Olympia (n = 14)	86	0	0	79	7
Others (n = 26)	73	15	4	23	23
Grand Mean (n = 60)	82	7	2	35	15

¹ Local names used for wood types: bakau (*Rhizophora* spp.), piapi (*A. marina*), pagatpat (*Sonneratia* spp.) and ipil-ipil (*L. Leucocephala*).

TABLE 3. CUTTING INTENSITY EXPRESSED AS A PERCENTAGE OF WHOLE STEMS CUT OUT OF THE TOTAL NUMBER OF STEMS (LIVE AND DEAD) AND STUMPS MEASURED (SAMPLE SIZES IN BRACKETS). STATISTICAL TESTS BASED ON CHI-SQUARE COMPARISONS BETWEEN NATURAL AND PLANTATION FORESTS.

	Natural Forests	Plantation Forests	Total
% Stems Cut	31.7 **	8.9	13.3
	(1152)	(4774)	(5926)
% Stumps Cut	92.3	92.0	92.1
	(352)	(448)	(800)

** p<0.001.

TABLE 4. SELECT MEASURES OF CUTTING IN MANGROVE FOREST PLOTS, COMPARING MEAN VALUES (PLUS STANDARD DEVIATIONS) FOR NATURAL AND PLANTATION FORESTS. AREA MEASURES CONVERTED TO HA'S.

	Natural Forest Plots (n = 19)	Plantation Forest Plots (n = 33)	F-value (df = 1, 51)
Live Stem Density (/ha)	4,210 (3280)	13,060 (9940)	24.39**
Cut Stump Density (/ha)	1,920 (1830)	1,290 (1540)	1.73
DBH Live Stems (cm)	9.3 (6.8)	4.7 (2.2)	14.98**
DBH Cut Stumps (cm)	9.0 (5.8)	5.2 (2.6)	12.35**
Live Stem Basal Area (m ² /ha)	33.2 (28.9)	21.8 (3.44)	3.44
Cut Stump Basal Area (m ² /ha)	11.3 (14.3)	2.7 (2.7)	10.79**
Density of Stems with Branches Cut (/ha)	780 (630)	2,230 (4270)	2.30
Density of Stems with Roots Cut (/ha)	0.0	1,740 (4650)	2.63
Snag Density (/ha)	220 (440)	420 (550)	4.06*
DBH Dead Snags (cm)	1.2 (0.4)	1.4 (0.6)	0.99

*p<0.05; **p<0.005.

TABLE 5. SELECT MEASURES OF CUTTING IN NATURAL FOREST, COMPARING MEAN PLOT VALUES (PLUS RANGE) AT FOUR DIFFERENT SITES. AREA MEASURES CONVERTED TO HA'S.

	Natural Forest Sites (No. plots)			
	Dunguan (n = 4)	Dauis (n = 5)	Dyke (n = 4)	Bindoy (n = 6)
Live Stem Density (/ha)	4,050 (1700-5800)	4,340 (1000-11200)	8,150 (6100-10200)	1,670 (800-2800)
Cut Stump Density (/ha)	4,250 (3200-5100)	2,280 (500-4100)	1,720 (500-3600)	200 (100-300)
Cut Stump Basal Area (m ² /ha)	27.6 (11.5 - 58.8)	13.1 (1.1 - 28.0)	2.8 (1.2 - 4.9)	4.5 (0.4 - 11.2)
Density of Stems with Branches Cut (/ha)	780 (200-1200)	680 (200-1000)	1,700 (1300-1900)	250 (0-900)

TABLE 6. TREE SPECIES USED (MANGROVE AND NON-MANGROVE) FOR FUELWOOD IN DIFFERENT VILLAGES. DATA REPRESENT THE PERCENTAGE OF RESPONDENTS (N) INDICATING THAT THEY USE LISTED SPECIES.

Village	Species Used for Fuelwood						
	<u>Mangrove Wood</u>			<u>Non-mangrove Wood</u>			
	Bakau	Piapi	Pagatpat	Ipil-ipil	Palwa	Coco	Bamboo
Banacon (n=5)	100	20	0	0	0	0	0
Sanlagan (n = 34)	76	79	59	47	26	9	12
Canibol (n = 50)	4	2	0	42	72	0	0
Olympia (n = 21)	29	0	0	48	62	19	0
Others (n = 30)	40	13	10	43	37	7	3
Grand Mean (n=140)	36	24	16	43	49	6	4

¹ Palwa = coconut fronds; coco = coconut wood.

TABLE 7. CUTTING INTENSITY BY SPECIES FOR NATURAL AND PLANTATION MANGROVE FORESTS. FIGURES EXPRESSED AS A PERCENTAGE OF TOTAL STEMS (SAMPLE SIZE IN BRACKETS) WITH EITHER THEIR MAIN STEM OR AT LEAST ONE SIGNIFICANT BRANCH CUT. STATISTICAL TESTS BASED ON CHI-SQUARE COMPARISONS BETWEEN NATURAL AND PLANTATION FORESTS.

Species	Percentage (%) of Stems Cut		
	Natural Forests	Plantation Forests	Combined
<i>R. mucronata</i>	30.9 (42)	24.6 (4238)	24.7 (4280)
<i>R. apiculata</i>	44.7 (103)	19.2 (26)	39.5 (129)
<i>A. marina</i>	37.3** (552)	22.2 (446)	30.6 (998)
<i>Sonneratia</i> spp.	72.4 (326)	50.0 (14)	71.4 (340)
<i>C. decandra</i>	13.2 (68)	38.1* (21)	19.1 (89)
<i>Bruguiera</i> spp.	14.3 (7)	7.7 (26)	9.1 (33)
Grand Mean	46.5** (1098)	24.4 (4771)	28.5 (5869)

* $p < 0.025$; ** $p < 0.001$

TABLE 8. BASAL AREA (M²/HA) OF LIVE AND CUT STEMS OF DIFFERENT SPECIES IN NATURAL AND PLANTATION FORESTS IN BAIS BAY.

Species	Basal Area (m ² /ha)			
	<u>Natural Forests</u>		<u>Plantation Forests</u>	
	Live Stems	Cut Stems	Live Stems	Cut Stems
<i>R. mucronata</i>	0.15	0.01	15.50	1.83
<i>R. apiculata</i>	4.03	0.72	1.14	0
<i>A. marina</i>	7.15	1.49	3.28	0.41
<i>Sonneratia</i> spp.	11.76	8.80	0.12	0
<i>C. decandra</i>	0.65	0.08	0.01	0.13
<i>Bruguiera</i> spp.	0	0	0.12	0
<i>Xylocarpus granatum</i> Konig	0.58	0	0	0
<i>Osbornia octodonta</i> Mueller	1.35	0	0	0
<i>A. lanata</i> Ridley	0.13	0	0	0
<i>A. officinalis</i> Linneaus	0.02	0	0	0
All Species	25.82	11.10	20.17	2.37

Figure 1. Location of study sites in the Philippines.

Figure 2. Size distribution (dbh) of live and cut *Rhizophora* stems in natural and plantation forests (combined) in Bais.

Figure 3. Size distribution (dbh) of live and cut *Avicennia* stems in natural and plantation forests (combined) in Bais.

Figure 4. Size distribution (dbh) of live and cut *Sonneratia* stems in natural and plantation forests (combined) in Bais.