Chapter 6: CASE STUDIES IN SUSTAINABLE DEVELOPMENT

What follows below are descriptions of a series of case studies of projects in sustainable development carried out in Sittee River village. All of these projects have involved students in travel-study courses taught by the first author and coordinated by the second and third authors of this book during visits to the Possum Point Biological Station from 1991 to the present. Each case represents a particular effort at raising the level of development for people living in the village. Students interacted with the people in the village to a greater or lesser degree in the projects and thus, they became participants, at least during the visits to the biological station but sometimes for extended periods after the travel-study courses had ended.

The case studies arose opportunistically over the years that travel-study courses have been taught by the first author. In fact, the students themselves asked to become involved in this way during one of the early courses. Perhaps this was inevitable. The students were being lectured to about abstract ideas in sustainable development while living in a village that was in a state of underdevelopment. Some came to care about the people in the village and suggested that they be allowed to go beyond the lectures and get involved in actions. This kind of suggestion from students is, of course, just what a teacher hopes for and from that time forward a component of each of the first author's travel-study courses has involved a class activity in participatory learning about sustainable development.

Existing concepts in tropical conservation and sustainable development provide the basis for most of the case studies but at least one new idea has emerged (electronic sustainability). Most of the interaction pathways shown in Figure 5-1 are represented by the case studies and out of the collective efforts, a new model of sustainable development has emerged (the hypercycle). Although several of the case study projects have essentially failed to achieve their objectives, some minor success stories have arisen and the process of identifying limiting factors to conservation and sustainable development in Sittee River should be useful to others who test the concepts in other locations.

Sittee River Trading Company: An experimental rain forest business

The first economic analysis undertaken in this study was done for a business venture initiated in 1990 by the Shaves with a local farmer to produce jams, preserves and marmalades for sale within Belize, especially in towns such as Dangriga, San Ignacio and even Belize City. These food items had been used in the dining hall at the Possum Point Biological Station and it was felt that a business could be made from the local sales. The Shaves invested the money to start the business, the farmer provided the fruit from his farm in Sittee River village and several local people were employed to make the food items and to sell them. Unfortunately, the business lost money due to marketing and other problems and operations were stopped after the second year. Although not successful, this business represented a potential example of sustainable development, which was useful for discussion in the travel-study courses. The farm where the fruits were grown was a low input, polycultural operation with good soil conservation practices. The student groups visited the farm to learn about local agriculture and, with

this experience along with the economic analysis, they were able to gain perspective on the business side of sustainable development.

In 1994 Kangas and three Maryland students who had participated in the travel-study course decided to resurrect the original business but this time with sales of the jams, preserves and marmalades in the United States. The basis of the new venture, which was titled the Sittee River Trading Company, was that students would play key roles at least initially in forming and operating the business. Although there was much naïve optimism about the future success of the business, from the start this activity was envisioned as a unique opportunity for education. Instead of just passively learning about sustainable development, the students would become actively involved in the long run, after they had retuned from Belize. The jams, preserves and marmalades were now being made on a part-time basis for use at the biological station by a husband and wife team who were employed as staff but who also operated a family farm. This was a side business for the couple since they were paid by the Shaves to make the food items separately from their jobs as staff members at the biological station. The Sittee River Trading Company would then sell these food items in the U. S. and send money back to Belize.

The venture was formulated to be a kind of "rainforest business" both in concept and in operation. This kind of business had emerged in the early 1990s as an activity for fostering sustainable development and conservation, especially by international NGOs (Clay 1992 a, b). The general concept was to sell items that were either harvested sustainably from intact tropical forests (such as tagua nuts) or, at least, produced sustainably in tropical forest areas (such as coffee) to consumers in the temperate zone. One of the keys to this kind of business is to market the rainforest connection. In other words, consumers buy the items sold by the rainforest business in part because they know their money will support sustainable development and tropical conservation. In order to operate in this way, the business must develop a marketing strategy that communicates the sustainability/conservation aspects of the overall operation. Figure 6-1 illustrates the conceptual basis for the Sittee River Trading Company as a kind of rainforest business. Local people in Sittee River would produce products that the company would buy and, in turn, sell to consumers in the Maryland/Washington DC area. Part (or all) of the profits of the Sittee River Trading Company itself would be used to purchase and send back educational materials that would support conservation/bioliteracy. The marketing strategy of the business relied on three components noted on the diagram: 1) the items for sale were produced sustainably from tropical forests or farms, 2) the sales generated income for local people in Sittee River village, and 3) profits would be used to support conservation education in the village.

Over the next four years (1994 – 1998) a variety of activities were undertaken to initiate and operate the Sittee River Trading Company (Table 6-1). University of Maryland students completed a number of studies either as part of the tropical ecology course or for independent study credit on topics such as marketing, international trade regulations and food quality. Initially the business was an informal organization coordinated by Kangas with students but in 1995 Mr. Richard Stevenson of a Maryland parks and planning commission became involved. Kangas and Stevenson knew each other from participation on the board of the Park and Resource Conservation (PARC) Foundation, which was a local NGO that fostered conservation activities within Maryland. Mr. Stevenson brought a great deal of business knowledge to the Sittee River

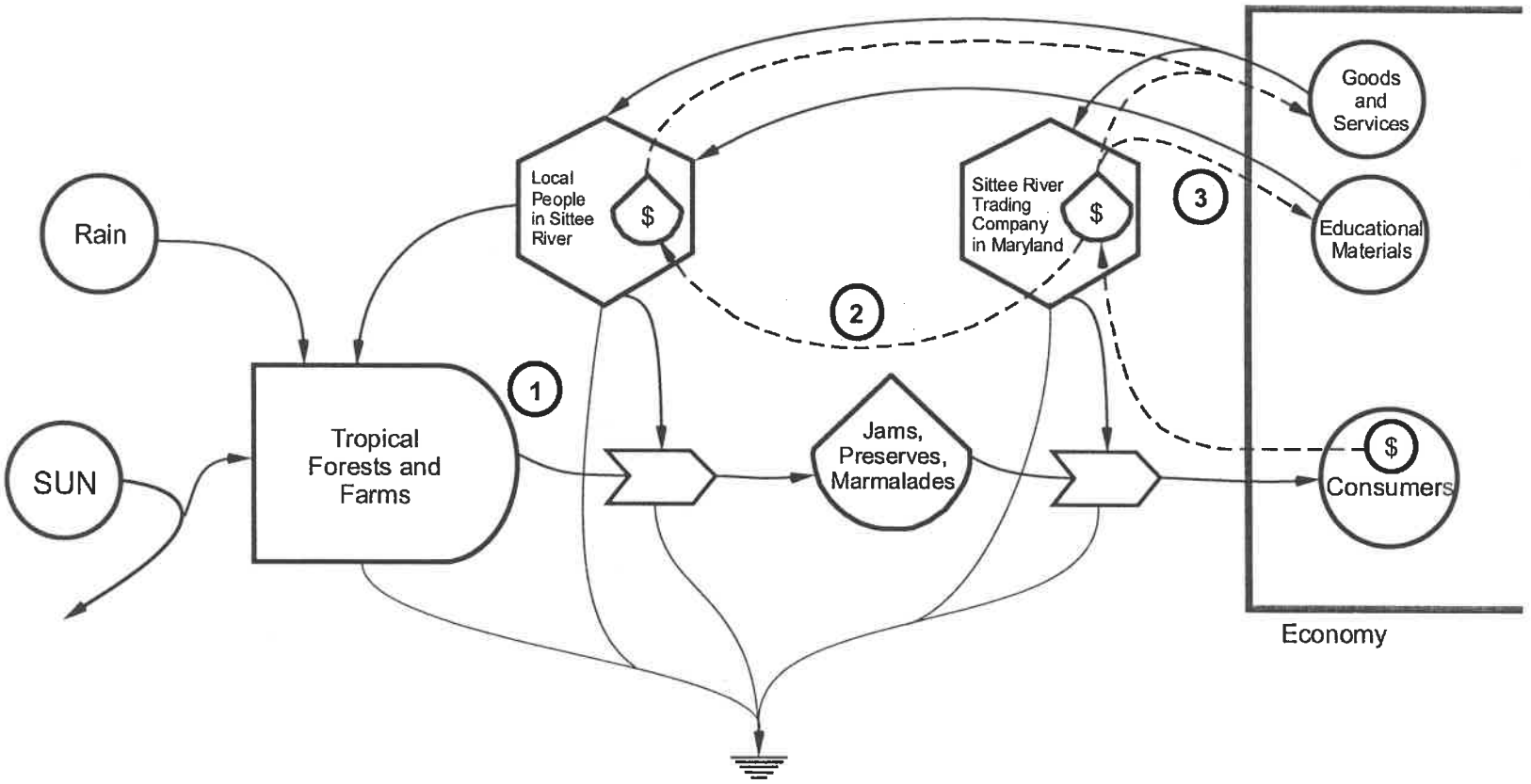

Figure 6-1. Energy circuit diagram for the Sittee River Trading Company as a "rainforest business". See the text for a description of the pathways.

Table 6-1. Time line of activities of the Sittee River Trading Company.

September 1992	School for Field Studies Report on the Tropical River Ecology summer course includes an analysis of the original business for 1991 which shows it was losing money
September 1994	R. Fouts, P. May and T. Fields (all University of Maryland students who were veterans of the Belize travel-study course) tentatively form the Sittee River Trading Company and make up a list of possible markets for the marmalade in the Baltimore/Washington D. C. area
December 1994	R. Fouts, P. May and T. Fields make up a first draft of a brochure for the company
May 1995	E. Bloodsworth, C. Lieberman, Monisha Kral and J. Padilla (all veterans of the travel-study course) write up a course report on U. S. Food and Drug Administration aspects of the business, especially in terms of regulations that the company would have to adhere to
May 1995	B. Cruz (a UMCP undergraduate student) completes an independent study on importing and business incorporation for the company
October 1995	The Park and Resources Conservation (PARC) Foundation organizes a trip to Belize for ecotourism and several member begin an involvement with the business
January 1996	K. Kimmel (a veteran of the travel-study course), now working for Domino's Pizza, Inc. in Ann Arbor, Michigan, has the marmalade analyzed for standard food quality parameters
April 1996	S. Bensen (a veteran of the travel-study course) completes an independent study on marketing and prices
April 1996	C. Lukehart (a veteran of the travel-study course) completes an independent study on fruit use by local people in Sittee River Vilage

Table 6.1. Continued.

February 1997	Sittee River Trading Company becomes incorporated with R. Warfel, R. Stevenson, W. Johnson, P. Kangas (all of the PARC Foundation) and R. Fouts on the Board of Directors
May 1997	A shipment of 24 cases from Sittee River is picked up at the docks in Miami by Kangas
May 1997	Labels are finished and W. Johnson gets them printed
May 1997	A. Abdel-Hafez (a UMCP Graduate Student) completes an independent study on food quality issues
June 1997	Labels placed on jars from the first shipment by R. Fouts and her daughters (who were photographed for the marketing brochure)
September 1997	R. Stevenson, R. Fouts and P. Kangas visit the Belize Embassy in Washington D. C. to discuss business options and opportunities
Fall 1997	Sales are begun at the Smile Herb Shop in Berwyn Heights and at the Natural Resources Management Program Office on the University of Maryland campus
Fall 1997	Board of Directors of the Sittee River Trading Company decide not to market through youth groups until liability insurance is acquired
Spring 1998	Through R. Stevenson's efforts it is learned that liability insurance can not be purchased in Belize for U. S. sales, coverage must come from a U. S. insurance company
Spring 1998	P. Kangas helps staff at Possum Point to produce a cookbook for foods from Sittee River Village, which represents a new product for sale through the company. Program Assistants in the Natural Resources Management Program office at the university (first Barbara Germann and later, Kimberly Monahan) type, organize and produce the cookbooks

Table 6-1. Continued.

May 1998	S. Fox (a veteran of the travel-study course) completes a course paper on mango jam production in Sittee River
August 1998	A. Abdel-Hafez (a UMCP Graduate Student) completes an independent study on food safety and liability issues
December 1998	Cookbook sales begin at Possum Point Biological Station
January 1999	First draft of a web page is produced by L. Robles and C. Streb (UMCP Graduate Students) for the Sittee River Trading Company

Trading Company from his years of experience in creating and maintaining park and recreation facilities in the metropolitan Washington DC region. With Stevenson's direction and help, the Sittee River Trading Company was formally incorporated and a small amount of capital was raised to test market sales of the jams, preserves and marmalades in Maryland. Before this time marketing had dealt only with what jars of the food items that Kangas could bring back as personal luggage from Belize when returning from research or teaching trips. However, in 1997 an order of 15 cases, containing 360 jars of the jams, etc. was purchased in Belize and shipped to Maryland for testing marketing. This order contained jams, preserves and marmalades made from citrus, guava, cashew, mango and gooseberry fruits and it provided what was felt to be sufficient variety and volume of the product to critically evaluate the marketing potential of the business. By the time the shipment was received, the students had done enough research to confirm that the receipt of the food items and their sales were in compliance with U. S. Food and Drug Administration requirements. It was felt that the food items were safe to sell because the fruits were thoroughly cooked and hermetically sealed in Belize before shipment. Also, the normal acidity of the jams, preserves and marmalades was low which inhibits any growth of pathogenic microbes.

Jars from the shipment were distributed to a number of people for sampling and sales were made at a local specialty food shop (The Smile Herb Shop in Berwyn Heights, Maryland). Labels were attached to the jars that described the mission statement of the company (Table 6-2) and brochures describing the company were given out with the jars. These materials were written by students and they provided the "rainforest" marketing message that was intended to boost sales. All of this test marketing was successful and indicated that people like to buy and eat the jams, preserves and marmalades from Sittee River. Based on this experience the company was poised to begin commercial-scale operations. The main initial marketing strategy was to target fundraising events, especially by youth groups (such as boy scouts) or similar organizations. There were several advantages of this approach. First, fundraising events were periodic and would not require a steady supply of product. Thus, one large shipment from Belize might be obtained and stored without much effort or cost (for example, in someone's garage or basement) and portions of the shipment could be sold at the periodic events. Another advantage was that through the PARC Foundation, the company would have contacts to many local youth groups that might make sales in their fundraising events. Finally, a particularly convenient aspect of this marketing approach was that the young people themselves would be the salespeople for the food items from Sittee River, with extra incentives from their groups to make sales. The Sittee River Trading Company would earn a small percentage of each sale by the youths, which would cover costs and provide a small profit that could be used for conservation purposes back in Sittee River village. Eventually, it was thought, the business could develop other marketing approaches, if the initial strategy was successful.

Unfortunately, at this point the business plan stalled for lack of liability insurance. Even though there was confidence that the jams, preserves and marmalades were safe to eat, it was felt that the company needed to have liability insurance in the case someone might become ill which eating the product and sue the company. Much effort was made to obtain the insurance, especially by Mr. Stevenson, but it became an essentially insolvable limiting factor to sales of the food items. Of course, the insurance

Table 6-2. Text of the label that was attached to jars of jams, preserves and marmalades distributed by the Sittee River Trading Company.

THE MISSION OF THE SITTEE RIVER TRADING COMPANY

The Sittee River Trading Company was formed to help market products made in the Sittee River watershed of central Belize. Development of the company was the result of a long-term project on the ecology of the Sittee River by University of Maryland faculty and students that began in 1990. The need for conservation along the river became apparent early in the project and the company was organized as a sustainable development opportunity for the local people. We support the local economy by purchasing products directly from people who live along the river and we are committed to returning a portion of the profits for conservation education activities in the Sittee River watershed. For more information on the Sittee River Trading Company, contact us at ---------- (phone) or ---------- (e-mail).

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theoretically could be obtained but ultimately the business was a part-time activity for those involved and with the time, energy, contacts and financial resources available, this task could not be completed. This conclusion was a disappointment to everyone who had been involved in the development of the Sittee River Trading Company, including the people in Sittee River village, the Maryland students and the professional people from the PARC Foundation who had helped. However, some accomplishments had been made. Although the company was not successful in developing commercial-scale sales in the Maryland/Washington DC area, many aspects of the business plan had been tested and proven. Also, a modest accomplishment in Belize was demonstrating to the producers that more profits could be realized by selling in smaller-sized jars, which allowed a higher price per unit volume to be charged. The Belizean couple still produce and sell the jams, preserves and marmalades locally so this aspect of the business can produce a small financial benefit to them.

Emphasis shifted in the company in the late 1990s to the development of a cookbook, based on recipes for local Belizean foods. The primary marketing outlet was seen to be students who passed through the biological station each year. All of the foods featured in the cookbook were served in the dining hall at the biological station so it was felt that a certain number of students would be interested in purchasing a cookbook of the local foods. The original cookbook was written with seven of the cooks from the biological station as authors with 56 recipes. The first versions were typed, edited and produced by Barabara Germann and Kimberly Monahan of the Natural Resources Management Program at the University of Maryland in order to facility involvement of the travel-study course. Several runs of 50-100 sample cookbooks have been printed in the U. S. and taken to Sittee River during visits. Sales of these cookbooks have been successful, indicating another possible direction for the Sittee River Trading Company. One of the Possum Point Staff has taken over the cookbook and it continues to develop as a document. In the long run the goal is for printing to be done in Belize but cost-effective local printing services have not yet been found.

A future direction for the Sittee River Trading Company is to explore the possibility of making sales of jams, preserves and marmalades along with the cookbook over the internet. Marketing would focus initially on the groups of students who have visited the Possum Point Biological Station but other people might make purchases as the website becomes better known. Ultimately, all of the past and future activities of the Sittee River Trading Company have been good learning opportunities for the students involved and business opportunities remain to be explored.

Mahogany Plantings: small scale restoration of a high-quality timber tree population

The most recent project undertaken by students in the travel-study course has been an effort at planting mahogany trees around the village. This project can affect the system of man and nature in Sittee River in several ways. The most obvious and direct purpose is to restore mahogany back to a density that characterized the population before these trees were logged out of the area in the 1700 and 1800s. This kind of restoration is an important conservation action (Lamb et al. 2005) that feeds back from man to nature (pathway # 6 in Figure 5-1) to increase the supply of natural capital. However, it is also hoped that the mahoganies being planted now might one day be harvested in a sustainable

way to generate income for people in the village (pathway # ___ in Figure 5-1). Mahogany has long bee highly valued as a wood for furniture making and other special purposes and a market for its timber will likely always be strong. Current estimates indicate that the timber in a mature mahogany tree is worth approximately 1500US$ (Botkin and Keller). Mahogany is the national tree of Belize so this species has symbolic value in addition to monetary value to Belizeans. In fact, the tree is represented on the national flag, forming a protective canopy over the image that proclaims in Latin "Sub Umbra Florea" or "under the tree we flourish". Thus, an indirect purpose of the planting project is to foster an environmental ethic in the local people for forest values (pathway # ___ in Figure 5-1). Finally, over time the mahogany planting project will generate scientific data on the autecology of this important tree species. Measurements of growth rates and survivorship of the plantings on different soil types and microhabitats will provide useful information about the ecology and forestry potential of the species in the Sittee River area.

The basic biology and ecology of mahogany are fairly well known and this knowledge forms a basis for the planting project. Of the three species of mahogany (family Meliaceae) in the neotropics, broadleaf mahogany (Swietenia macrophylla) is found throughout Central America and it has been critical to the history of Belize in particular as discussed in the beginning of this book. Broadleaf mahogany occurs from southern Mexico, through Central America to the upper reaches of the Amazon in South America. The trees can be large, sometimes 150 ft. (45 m) in height and 6 ft. (2 m) or more in diameter, often with heavy buttresses at the base of the trunk.

The ecological amplitude of broadleaf mahogany is broad with good tree growth occurring on a variety of soil types from sea level to 1000m in altitude. In terms of succession, mahogany seems to be a pioneer species based on its ecological adaptations. The species is wind dispersed and the seedlings are shade intolerant. Natural regeneration, or growth and development from seed to mature, seed-bearing tree, probably occurs in large-scale openings in the forest formed by disturbances that kill multiple trees, rather than small-scale gaps in the otherwise intact canopy formed by disturbances that kill only individual trees. The opening in the forest in the gaps allows sufficient light to be available for juvenile trees to grow into adults. A model of this process of gap-phase regeneration is shown in Figure 6-2. In the model at the broad scale the gap compartment is formed from the forest compartment by the disturbance of blow down by hurricanes, shown as an outside energy source. Gaps eventually convert back into forest through regeneration of trees. Adult trees are found in the forest compartment and they produce seeds that can germinate into juveniles in either the forest (low light) or the gap (high light). Juveniles only recruit into the adult age class in the gap compartment where there is sufficient light. A key process is the dispersal seeds from the forest to the gap, which is shown in the model to be driven by the outside energy source of wind. All of these ecological qualities suggest that bigleaf mahogany is adapted to the early stages of succession in tropical forests after hurricanes where blow-downs of patches of the forest might occur randomly on any soil type. This hypothesis is also consistent with the fact that hurricanes are a common form of disturbance over much of the species' geographic range. However, if this were a full explanation of mahogany's adaptations, it would be expected that they would occur in somewhat dense patches of even-aged individuals and that the species might be expected to grow well under

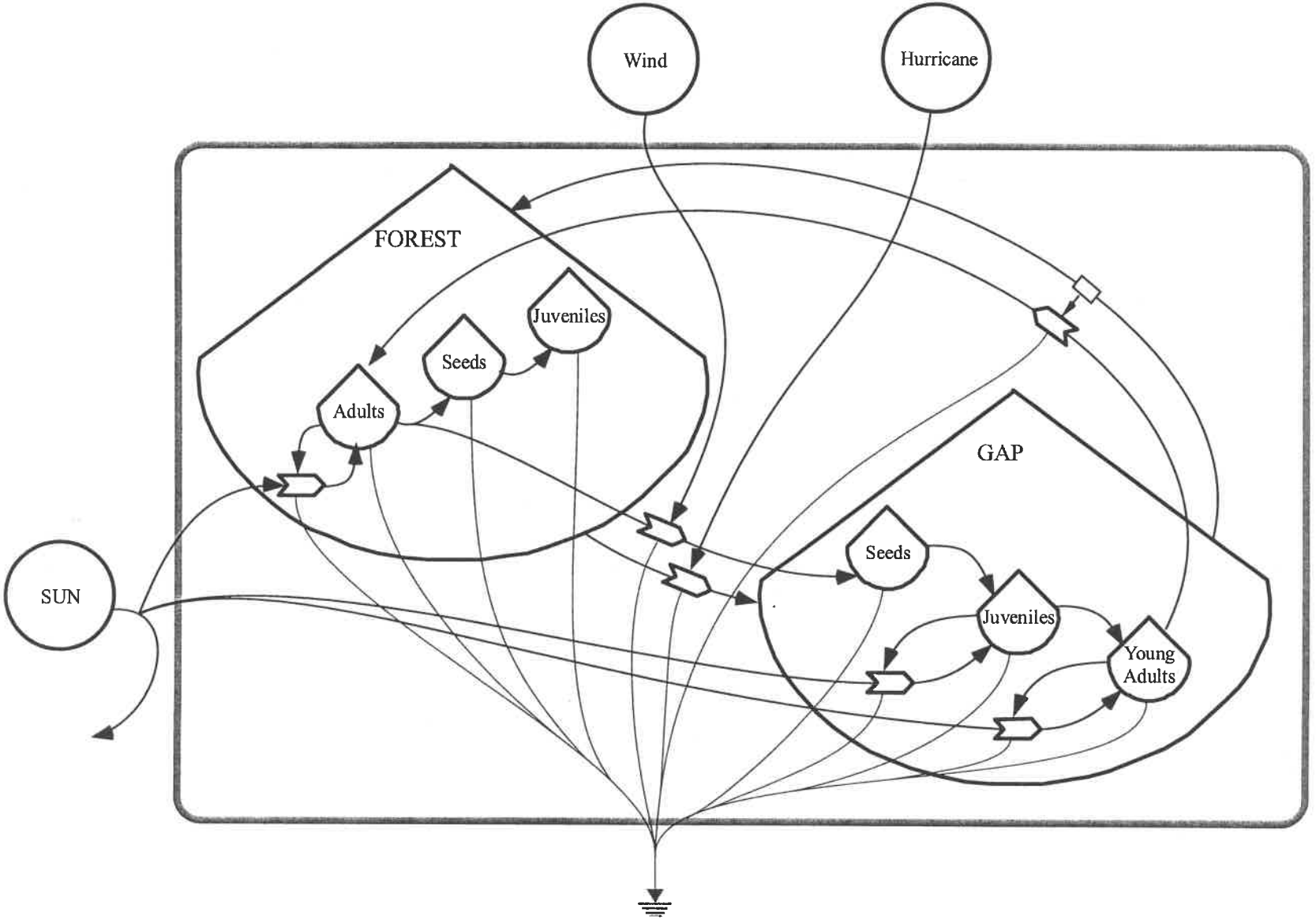

Figure 6-2. Energy circuit diagram of gap-phase regeneration for a tropical tree population. The diagram is for a wind-dispersed tree species such as mahogany.

plantation conditions where trees are grown together in artificial plantings. Instead, under natural conditions mahogany is found as a population of widely scattered individuals in the forest, usually with only about one to three trees/ha or 2.5 acres (Lamb 1966, Whitmore 1983). This spacing seems to be caused by host-specific herbivores that are more likely to find prey with clumped distributions than those with widely dispersed distributions (Janzen 1970). In the case of mahogany the main herbivore is a moth (family Pyraulidae) the mahogany shootborer, Hypsipyla grandella, which attacks and kills the tender terminal shoots of the tree. As an aside, the family Pyraulidae of this herbivore is also found as aquatic larvae in the Sittee River (see Table 4-), though more research is needed to know if this taxa is actually the mahogany shootborer.

A complete understanding of mahogany's regeneration thus requires knowledge of both its ecological adaptations and its vulnerability to a host-specific herbivore. Mahogany probably does regenerate following hurricane disturbance but only when scattered individuals can escape pressure from herbivory. Thus, the general gap-phase regeneration model, shown in Figure 6-2, needs to be overlain with a herbivory sub-model to more fully describe the natural history of the species. The practical significance of this natural history is that mahogany can not be grown artificially in clumped distributions such as occurs in typical plantations. This natural history also dictates strategy to our efforts at replanting mahogany in and around Sittee River village.

Starting in the spring of 2005 several travel-study groups began planting mahogany seedlings around the village with help from staff at the biological station. These seedlings were dug up from the base of local seed trees and they were replanted on the grounds of the biological station, around the school in the village and on private property with permission of the owners. Some trees had recently been planted by home owners independently, so the trees planted by the travel-study groups are adding to what constitutes an artificially enhanced local mahogany population. Most of these trees are on developed land but some have been planted within existing forests, in an effort to study the effects of shade and microhabitat on tree survivorship and growth. To some extent these are like "enrichment plantings" (Weaver 1987, Ramos and del Amo 1992) and they represent an example of one of the new management techniques being tested in forestry throughout the world (Noble and Dirzo 1997, Hartshorn 1995, Drengson and Taylor 1997).

An effort is being made to map the plantings done by travel-study groups and by some of the home owners so that measurements of the trees can be made. Survivorship is being monitored by the continued survival of individuals after planting and growth is being monitored by periodic measurements of the height of planted individuals. Table 6-3 presents the early results of the plantings after about two years. Significantly, all of the trees planted in the forest at Possum Point died, verifying that mahogany needs high light environments to grow. In general, survivorship has been moderate to good and actually height growth is relatively fast, up to a maximum of nearly 25 cm/month! Eventually, these measurements will be contrasted on different soil types and from different microhabitats to derive information on the autecology of the species. An inventory of large trees found throughout the village is also being made (Appendix Table 6-1). These trees are all located on private land so they may be cut down at any time. While standing though, they are an important resource to the replanting project because they are a source of seedlings to be used in the artificial plantings. It is interesting to note that, at least to

Table 6-3. Survivorship and growth of mahogany trees planted along Sittee River. All of the trees were planted in 2005 except for the ones at Flap Doodle Farm which were planted in late 2004.

Planting site	survivorship	growth, cm/month (range)
Possum Point grounds: originals	5/15 = 33%	12.5 (-0.1 to 19.1)
Possum Point grounds: replants	6/7 = 86%	9.4 (2.4 to 18.4)
Possum Point in forest	0/15 = 0%	----------
Flap Doodle Farm	12/14 = 86%	15.5 (9.9 to 24.8)
Around village	4/5 = 80%	5.1 (0.6 to 15.6)
School yard	3/9 = 33%	13.2 (4.7 to 20.0)
Near school	2/6 = 33%	9.1 (5.1 to 13.2)

some extent, all of these trees are approximately the same size and are therefore probably of similar age. Perhaps they represent a cohort of individuals that all regenerated after a particular hurricane, maybe Hurricane Hattie that passed through the area in 1961. More likely however, they were planted by humans in old home gardens and they are not the product of natural regeneration.

Obviously, this is intended to be a long-term project and it is clearly premature to evaluate the early efforts and results. However, the prospects are encouraging that the forestry resource of mahogany is increasing in Sittee River village. Lamb (1966) suggested that "mahogany deserves a prominent place" in sustainable development plans of people who live within the species geographic range because of its direct and indirect benefits to the local economy. Thus, the combined efforts of scattered plantings and periodic monitoring of mahoganies will continue. Care must always be taken so that the plantings are not too dense to attract the shoot borer moth herbivore. If this link in the forest food web can remain unconnected, then both trees and a conservation ethic may grow in Sittee River village.

In the future it is hoped that replantings of logwood might also take place. This species probably has no direct economic value but there would be social value in restoring this species that was cut out of the forest 300 years ago as noted in the beginning of the book. Prospects of other "secondary hardwoods" which have market value might also be tested (Furley 1989).

Sittee Point: an attempt at old growth mangrove preservaton

A project to attempt to establish a preserve at Sittee Point, the delta at the mouth of the Sittee River, emerged after measurements made by students in the travel-study course showed that the forest of the point had some of the tallest mangroves ever recorded in the Caribbean, along with other old growth characteristics (see page _____). A preserve at Sittee Point would bring attention to this extraordinary forest both by local people and by ecotourists and also a preserve would protect the forest from development which is encroaching for all directions. From the beginning, it was recognized that the establishment of a preserve would be a major undertaking and that success would require considerable effort and luck for several reasons. Mangrove forests are well known to be endangered world wide (Farnsworth and Ellison 1997, Valiela et al. 2001) and experience has shown, especially in south Florida, that a balance between conservation and economic development is difficult to achieve in the coastal zone, where wealthy people like to live. In general, Belize stands out among the countries of the world as a place where conservation and economic development are reaching a balance. However, even though Belize has a tremendous amount of land set aside in various types of preserves and reserves, very little of this land is directly in the coastal zone. The establishment of a preserve at Sittee Point would fill a major gap in the conservation network of Belize, by protecting old growth mangrove forest directly on the coast. The delta at Sittee Point is an important geological feature formed by two interacting factors: an inorganic sediment source eroding from the Maya Mountains and shelter from wave energy by the off shore barrier reef. These two factors create conditions at the mouth of the Sittee River for maximum growth of mangroves, whose organic detritus combines with the inorganic sediments to form the delta landform. This pattern of ecological development became

clear as the study of the Sittee River ecosystem has continued over the years and the idea of attempting to establish a preserve at the point originated with students in the travel-study course. Their efforts started the process which has been taken up by some of the local people in Sittee River village and in nearby Hopkins. If ultimately successful, this project would represent a feedback from man to nature (pathway #6 in Figure 5-1) since the land would be set aside as natural capital for the present and future generations of people along the river.

One factor limiting the establishment of a preserve at Sittee Point is the perception that the land will be locked up and will no longer be able to generate value to the local people. Preservation is seen as being anti-development in this view and as being detrimental to the local economy. This perception is not unique to the issue of preservation of Sittee Point but rather it is a problem with conservation efforts globally. To counter this fear many efforts at articulating the multiple values of intact ecosystems are coming from the new field of Ecological Economics. The values of mangrove forests have been identified for some time (Lugo and Snedaker 1974, Odum et al. 1982, Lugo and Brinson 1978) and they include such qualities as shoreline stabilization, habitat value to wildlife, value to sport and commercial fisheries and aesthetics. More recently, these values are being quantified in various ways. The value of intact tropical forests as a source of non-timber products was discussed earlier in relation to the coconut oil operations but many other values are beginning to be accounted for (Kremen et al. 2000, Katzman and Cale 1990) in order to inform land use decisions, such as the establishment of a preserve at Sittee Point. One new approach is to consider environmental values to be "ecosystem services" which are benefits supplied to human societies for free by natural ecosystems (Daily 1997). Figure 6-3 shows an aggregated model of the Sittee Point mangrove ecosystem to illustrate the services it provides. Four services are depicted: 1) carbon sequestration by absorption of the outside source of CO2, 2) storm flood attenuation by the drain (work gate symbol with minus sign) on the outside source of floods by biomass, 3) hurricane wind attenuation by the drain on the outside source of wind by biomass and 4) detritus output from biomass driven by tides that supports fisheries. Costanza et al. (1997b) estimated the annual value of ecosystem services for forests in general to be 969 US $/ha. Using this figure and assuming an area of 100ha at Sittee Point, the value of the mangrove forest would be nearly a million US$ per year! This quantification is useful to provide perspective on the value of Sittee Point but it would probably be seen as being more theory than reality to the local people. It is easy to take these kinds of values for granted since they are provided for free by intact ecosystems. However, they are real values and they are often only appreciated after they are lost.

The value of mangroves in shoreline stabilization and storm protection serves as a particularly relevant example for Sittee Point. Mangroves and other coastal wetlands protect land from storm surge and high winds throughout the tropics where hurricanes and typhoons regularly occur by dissipating the energy of water and wind with their above and belowground biomass (Fosberg 1971, Carlton 1974). These values have been recently demonstrated in dramatic fashion in the tsunami of December 26, 2004 in southeast Asia and in Hurricane Katrina of August 23-31, 2005 in the U. S. Gulf Coast. In both cases evidence has shown that damages due to these storms was increased by degradation of coastal wetlands that otherwise would have provided protection from the

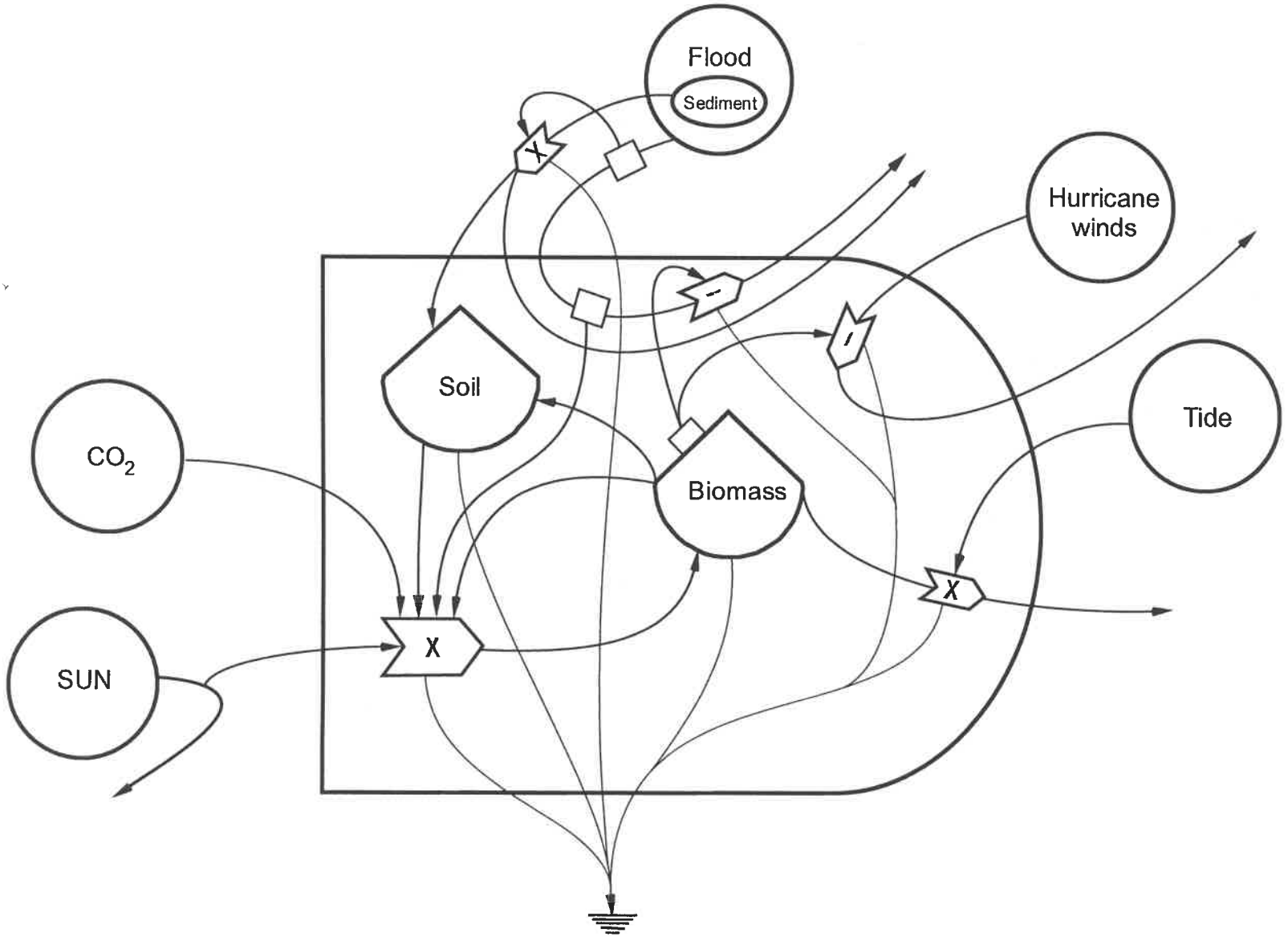

Figure 6-3. Energy circuit diagram for the mangrove forest at Sittee Point, illustrating several forms of ecosystem services provided by the ecosystem.

storms (Danielson et al. 2005, Stokstad 2005). The mangroves of Sittee Point obviously provide at least some protection for the people in Sittee River from hurricanes due to their massive ecological structure. In fact, this forest seems to have withstood Hurricane Hattie of October 30-31, 1961. This hurricane made landfall just north of Dangriga (Stoddart 1963) and thus passed quite close to Sittee River. Interviews with some of the older people in Sittee River who were living in the village at the time of the hurricane verify that the mangroves of Sittee Point survived with canopy damage while other upland forests were blown down over large areas by the strong winds. (Shellmadene Robinson, Personal Communication).

A small scale study at Wee Wee Caye demonstrated the effect of mangroves on storm wind dissipation. The island consists of an overwash mangrove forest (see Table 4-___). Most of the developed facilities are located on the leeward side of the island in a cleared area that was built up slightly with sand brought in by boat from the mainland. The mangrove forest was preserved during construction of the marine laboratory and only three mangrove trees were cut in order to site the buildings. Wooden, elevated boardwalks were built through the mangroves to some of the dormitory rooms, outhouses and to a dock on the windward side of the island as part of the plan to preserve the forest. Overall, the Wee Wee Caye lab is a model for how to develop a barrier reef island because of the design which preserves the overwash forest. The study of storm wind attenuation reported here was conducted along a transect that extended from the end of the dock on the leeward side of the island to the middle of the clearing where the dining/lecture hall is located. The transect passed from the portion exposed to the wind on the dock, through a fringe of mangrove forest that attenuated the wind, into the clearing where the buildings are located. The study was conducted on November 17, 2002 when a storm cell caused high winds to blow from the northwest so that the force of the wind hit the leeward side of the island. Wind velocity measurements were made along the transect over a five and one half hour period as the storm dissipated. Measurements were made with a hand-held Dwyer Wind Meter (Dwyer Instruments, Inc., Michigan City, Indiana, USA), which is a pressure-tube anemometer. The meter has two ranges: the low range records velocities from 2 to 10 miles/hour (MPH) and the high range records velocities from 4 to 66 MPH. Wind speed measurements were made at 1.4 m elevation (shoulder height) facing into the wind. Wind velocity was measured at four times as the high winds dissipated (Appendix Table 6-2). The highest velocities probably occurred during the night but the first measurements were made in the morning. Velocities decreased throughout the day at all points along the transect (Appendix Table 6-2). Figure 6-4 plots velocities across the transect at 9:00AM when the highest values were recorded. The mangrove trees (from 20 m to 30 m on the transect) reduced the wind velocity by a maximum of 90 percent, from 20 MPH to 2 MPH for average velocity and from 30 MPH to 3 MPH for gust velocity. The pattern for both average and gust velocities was similar with high values along the dock (from 30 m to 60 m on the transect) and low values behind the mangroves on the island (from 0 m to 20 m on the transect). The attenuation was dramatic in occurring over a very short distance along the transect. The mangrove trees absorbed the energy of the wind resulting in the attenuation of its velocity. They therefore protected the structures in the clearing. The effect was to create a pleasant environment for people working at the biological station.

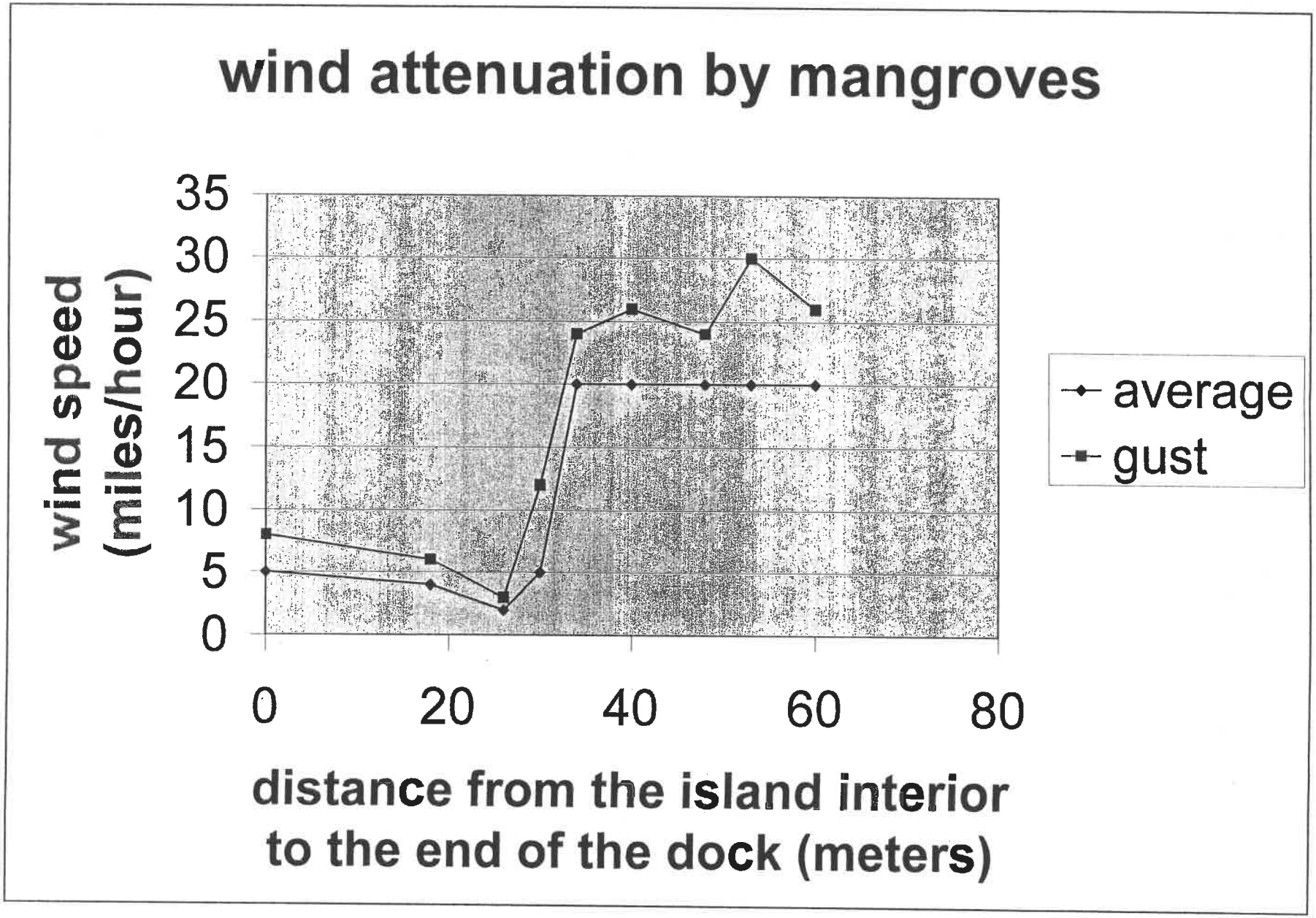

Figure 6-4. Data illustrating the role of mangroves (between the 20m and 40m marks) in dissipating wind energy during a storm event.

The preservation of mangroves at Wee Wee Caye contrasts with the condition found on many other small islands occupied by humans on the Belizean barrier reef. For example Carrie Bow Island, where the Smithsonian Institution's marine station is located, has no mangrove fringe and it is completely exposed to wind (see drawings in the Preface of Rutzler and Macintyre (1982)). Coconut palms are found on Carrie Bow but their density is not sufficient to attenuate storm winds. It is well known that mangroves reduce erosion, especially during hurricanes (Carlton 1974, Fosberg 1971, Savage 1972) and the wind attenuation demonstrated here is one mechanism for this effect. The results of this small study thus demonstrate the role that mangroves can play in protecting coastal developments of human occupation.

With all of this background in thinking about the values and importance of Sittee Point as a stimulus, the effort to establish a preserve began. A time line of events and actions is shown in Table 6-4. The first measurements of the forest at Sittee Point were made by students in 1998 with additional sampling done by classes in 2002 and 2004. All of this data quantified the ecological structure of the forest in terms of basal area, density, diversity and height of the tree community. By comparing this data with reports in the scientific literature it was clear that the forest has old growth characteristics and some of the tallest mangroves ever measured in the Caribbean region.

Students of the travel-study course in 2002 composed a letter about the significance of the forest at Sittee Point, the growing threats from encroaching development and the need for preservation. This letter was sent along with a report on the ecological data to eight addresses in the Belize Government and to Belizean non-governmental organizations. Somewhat remarkably, four responses to the letter were received in short order including a letter from he Prime Minister's office! In general, these responses indicated appreciation for the data report and the sentiments of the letter. The response from the Prime Minister's office indicated that the report would be forwarded to the country's chief environmental officer for further review. The responses from such high offices were gratifying and offered encouragement that preservation of Sittee Point might be possible.

In the early 2000s when the preservation efforts began it was known that the north side of the river mouth was owned by a development company named The British American Cattle Company. This company had owned the land for some time but only recently had begun active development. A road was built into the mangroves of the point, a canal was excavated and a number of lots were cleared and surveyed. Properties were marketed with glossy brochures and on the internet. One advertisement read:

"tracts on the sea $ 35,000 USD and up; on the Sittee River (ideal for boat dockage) $ 25,000 USD and up; . . . "

These developments were alarming but the advertisement indicated that the majority of the land on the north side of the river at the point would remain an "eco-preserve" without development. This designation may well have been a concession to conservation by the developer but in reality the land at the point is essentially tidal and the costs of filling it to an elevation suitable for building houses appeared to be exorbitant.

The south side of the river at the point was completely undeveloped and it was assumed to be owned by the Belize government. There were no immanent threats to this

Table 6-4. Time line of events concerning the conservation status of Sittee Point.

October 30, 1961	Hurricane Hattie strikes the Belizean coast, just north of Dangriga. Many trees along the coast are blown down but the mangroves at Sittee Point remain standing after the storm, based on interviews with local people who were living in the area at the time.
2000	The land owner of the lower portion of Sittee River on the north side of the river advertises an ecopreserve of about 50 acres at Sittee Point in a sales brochure. This is intended to boost the sale of plots of land for house construction and it provides some conservation protection for Sittee Point.
March 2002	Students in a travel-study course from the University of Maryland measure forest structure of the mangroves at Sittee Point. The results from this study indicate that the forest has old-growth characteristics.
November 14, 2002	A packet about preserving Sittee Point consisting of a cover letter from P. Kangas, a research report entitled "Mangrove Forest Structure on the Sittee River, Belize" and a letter from the Maryland students in the March travel-study course is sent to eight addresses in the Belize government and to Belize NGOs.
Starting November 26, 2002	Four return letters are received from the mailing on November 14 listed above. Return letters come from: the Office of the Deputy Prime Minister and Minister of Natural Resources, the Ministry of Agriculture, Fisheries & Cooperatives, the Office of the Prime Minister and the Belize Tourism Board. All of these letters express appreciation for the information and promise that the matter will receive attention.
September 25, 2003	A document entitled "A Preliminary Management Plan for Sittee Point" is prepared and circulated locally to help outline what a preserve at Sittee Point might be like.

Table 6-4. Continued.

July 12, 2004	Mr. Rich Dolesh, from the U. S. National Recreation and Park Association, provides a letter of support for the Sittee Point Proposal, written to Mr. Ismael Fabro of the Ministry of Natural Resources and the Environment. This letter is based on Mr. Dolesh's visit to the site in the Fall of 2003.
August 4, 2004	A visit is made to the Lands Office in Dangriga and in Belmopan by P. Shave, S. Robinson and P. Kangas to investigate land ownership of the south side of Sittee Point. Maps available to the public in Belmopan verify that the land is owned by the Government of Belize.
August 5, 2004	Paul and Mary Shave write a letter to Mr. John Briceno of the Ministry of Natural Resources and the Environment about preserving Sittee Point. The letter mentions the response made by the Ministry to the letter sent in 2002 and is accompanied by the student report on mangrove forest structure and the preliminary management plan for Sittee Point. The letter notes about the south side of Sittee Point: "A visit to the Lands Office in Belmopan on 4 August 2004 confirmed that the land is indeed owned by the Government and it is our hope that we can move ahead with the proposed protection of this site."
December 2004	Sittee Point land on the south side of the river is sold to an acquaintance of one of the Lands Office staff. The sale is made in just one month between the request for and the transfer of ownership from the government to the individual, which is much faster than normal. The sale of 43 acres is made for 5,059$.
Fall 2005	Scientific studies of the Asian tsunami of December 26, 2004 and of Hurricane Katrina of August 23, 2005 are published which document the value of coastal vegetation in mitigating the impacts of storm winds and surges.

Table 6-4. Continued.

January 2006	Land on the south side of Sittee Point (purchased for about 5,000$) is offered for sale on the internet for $3.5 million$.
January 2006	Land on the north side of the river at the mouth is sold to a new developer, who decides not to keep his side of Sittee Point as an ecopreserve. This means that the north side no longer has any conservation protection. Also, some of the people who bought land from the old owner feel that their purchases were made based on false advertising, since they expected the land at the point would be preserved.
Starting in February 2006	A number of public meetings are held by local residents about the issues of land management and conservation at Sittee Point. Also, discussion over the internet is held on the electronic bulletin board "Belize Forum". A few local people support the development of Sittee Point without protection but the majority of people involved are dissatisfied with the actions of the private land owners and the Government of Belize in not providing for adequate stewardship of the land, especially in regard to potential hurricane damage in the future.

land because of its relative isolation. While the north side of the point could be accessed from the road network at Hopkins, there were no roads anywhere near the south side of the point. Thus, our strategy was to focus efforts at getting preservation status from the government for the south side of the point. In August of 2004 we made formal inquiries about the ownership status of the land on the south side of the point, first through the local office of the Ministry of Lands in Dangriga and then through the main office in Belmopan. No maps were available in the Dangriga lands office that showed ownership but in Belmopan maps verified that the land was owned by the government. Thus, as of August 2004, it seemed that the south side of the rivermouth relatively easily could be established as a preserve, assuming government officials could be convinced of its significance, because the land was owned by the government. However, this prospect quickly disappeared as the land was sold to a private individual in December of 2004. This land transfer was remarkable in terms of the speed with which transfer paper work was completed. Surprisingly the land was transferred from the government to the private individual in less than one month, as was later verified by dates on the paperwork, while such transfers normally take at least six months for completion. Perhaps coincidently, the private individual who purchased the land on the south side of Sittee Point was related to the Lands Officer in Dangrigia where we first inquired about ownership. While it is tempting to suspect some kind of corruption here, all that is known for certain is that land transfer took place very soon after we visited the office in Dangriga and that the paperwork mysteriously took much less time than usual. By the end of 2005 the land on the south side of Sittee Point was being offered for sale at the amazing price of 3 million USD! Clearly, we made a mistake in not trying to buy the land as soon as we learned it was available from the government, but we were not prepared in any way at that immediate moment with a financial plan. In fact, our inquiries seem to have precipitated exactly the opposite of what we had hoped for, namely transfer to private ownership and land speculation!

If this situation wasn't bad enough, the land on the north side of the river mouth was sold to a new developer in late 2005 who has done away with the "eco-perserve" and has started to clear the mangroves and fill in the land over much of the point. While this new land owner seems to be open to ideas of conservation, he also seems to have more resolve than even the British-American Cattle Company to develop Sittee Point.

The developments at Sittee Point are certainly disappointing from a conservation perspective. From the start our intention was not necessarily anti-development. Rather we hoped preservation of Sittee Point would actually enhance local development prospects by acting as an attraction for ecotourists, as a focal point for environmental education and as a source of pride for Belizeans in Sittee River and throughout the country. Janzen (2001) has termed this "biodevelopment" because it intends to preserve biological values while encouraging compatible economic development. A preliminary management plan for Sittee Point was prepared (Appendix 1) which outlined how the multiple benefits of preservation at the point could be realized. If the land is developed, as apparently is intended by the present land owners of both the north and south sides of the rivermouth, values to the general public will be limited to employment benefits of laborers who cut the trees, fill the land and build the houses of the presumably wealthy foreigners that ultimately will but the land. Some people think these employment benefits that a few local people can enjoy out weigh the values that many local people

and foreigners could enjoy if the land was preserved. A "grass-roots" type of effort has emerged by people who are writing letters of support to the government about preservation at the point and who are holding public meetings to discuss this and other development issues affecting Sittee River. People involved include local Belizeans, foreigners who live in the area and even owners of some of the local hotels in Hopkins. This is an active issue of debate which seems likely to continue. Thus, even though a magnificent, old growth forest may be lost to development, a new sense of civic pride and a new kind of environmental ethic may emerge from the effort to preserve Sittee Point that will be important to the people in Sittee River in the future.

Partners in Art: a migatory bird art exchange program

In response to declining populations of certain neotropical migratory bird species, a large-scale international conservation program was initiated in 1990. The program arose from a workshop organized by the National Fish and Wildlife Foundation (Anonymous 1990) and originally was known as Partners in Flight or Aves de las Americas. The goal of Partners in Flight was "to conserve, enhance or restore declining populations of neotropical land birds before they need Endangered Species Act protection". Great coordination was needed to meet this goal since neotropical migrants breed in the temperate zone during the summer and spend the winter in the tropics. Thus, these birds often are exposed to environmental impacts on the one hand and to management actions on the other hand in different countries during different times of the year. The system is modeled in Figure 6-5 with mirror image structure in the temperate zone and the Tropics. Migration is stimulated by environmental cues, such as day length. The birds move from the Tropics to the temperate zone in the Spring and they move in the reverse direction in the Fall. Figure 6-5 represents the system for a bird population that utilizes forest as habitat (eg., the wood thrush) but birds that utilize other habitat types also are migratory. Declines in the populations can occur for a number of reasons (Terborgh 1989) and in this model birds are threatened by loss of forest land which is converted to cleared land through development. Deforestation takes place both in the Tropics where the birds overwinter (right-hand side of the diagram) and in the temperate zone where the birds breed during the summer (left-hand side of the diagram), which can make the cumulative impact quite significant. Kim, who participated in the Belize travel-study course in 1991, developed and simulated a similar model for her Master of Science Thesis at the University of Maryland (Kim 1995).

As the name implies, partnerships between agencies and between countries have been developed through the Partners in Flight Program to work towards conserving populations of the approximately 250 species of neotropical migrants. With coordination of an international committee of agencies, a number of activities have been initiated including monitoring, management, research and education. The purpose of this section is to describe one example of an educational partnership that has been implemented between sister schools in Maryland, USA and Belize, Central America. This activity is part of a sub-program entitled Partners in Art in which elementary school children located in both the summer breeding grounds (eg., Maryland) and the overwintering grounds (eg., Belize) exchange drawings of and stories about migratory birds. This kind

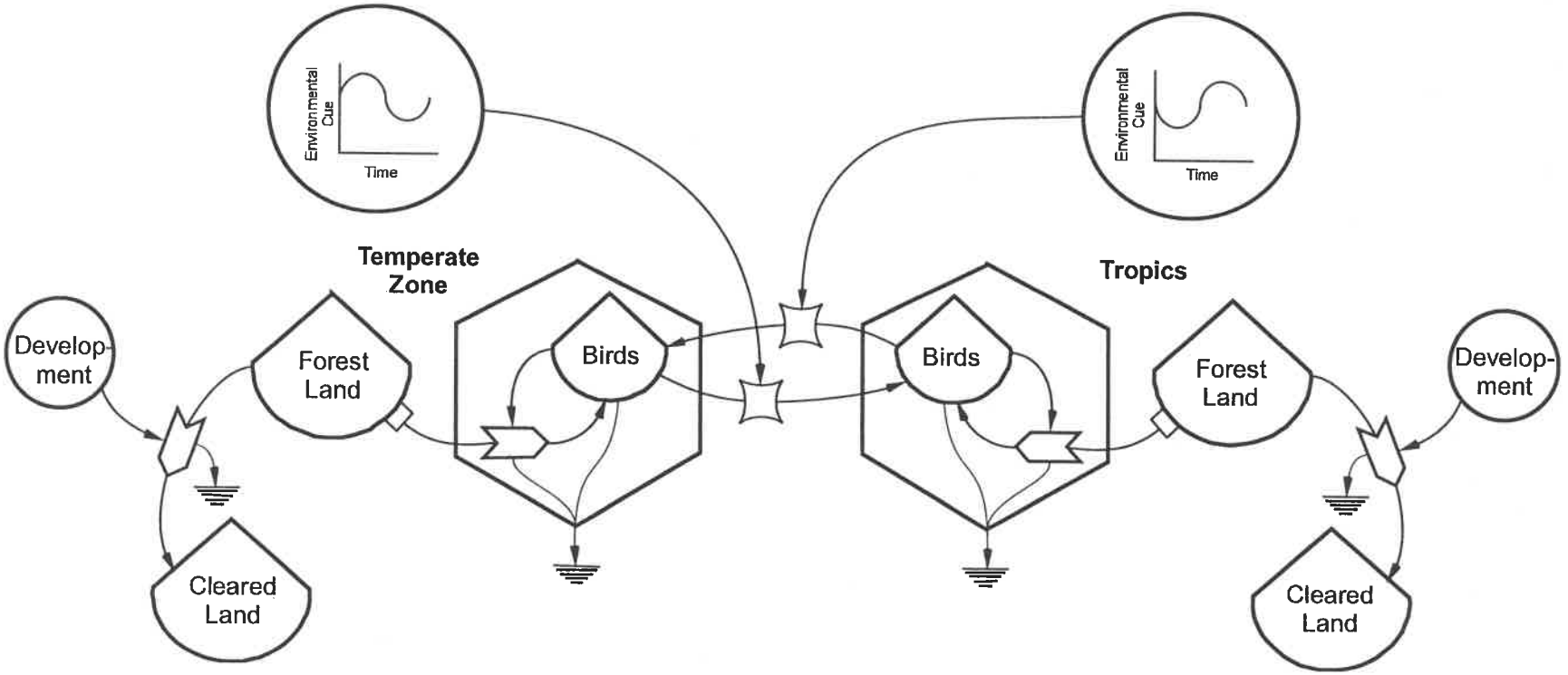

Figure 6-5. Energy circuit diagram for a population of neotropical migrant birds.

of exchange can be undertaken by any interested teacher, who can contact local representatives of the Partners in Flight Program for background and assistance. Contacts can be made through the Smithsonian Institution Migratory Bird Center, National Zoological Park, Washington, DC 20008 or the Office of Migratory Bird Management, USFWS, 4401 North Fairfax Drive, Room 634, Arlington, Virginia, 22203.

The choice of the local elementary school as a site for a Partners in Art exchange was consistent with the conservation connection already established between the Possum Point Biological Station and Sittee River village. The local school is a Methodist school and it is typical of schools in Belizean villages. It consists of seven classrooms with an office and a small library. Classrooms contain only chairs and a blackboard. Three or four teachers including the principal, teach six grades plus a kindergarten class with a total enrollment of about 60-80 students. All normal subjects are covered within the school (math, language, history, science, etc.) and this is the standard education that most local people receive. High school education is provided at a regional location in Dangriga about 25 km from Sittee River but only a small percentage of graduates from the elementary school go on to high school because of the costs involved.

The sister school in Maryland was University Park Elementary School which is located in a suburb of Washington, DC near the University of Maryland. This school was chosen due to its proximity to the university and because a number of collaborative environmental education projects had been conducted there between the school and the university. It is a typical suburban public school with about 650 students in six grades. As might be expected, University Park Elementary School has much more educational infrastructure compared to Sittee River Methodist School, including an auditorium, many classrooms, audio-visual equipment, a large library and many computers. The staff includes a number of teachers, a principal and a secretary along with several support staff for school maintenance, etc. However, despite of the differences in infrastructure and culture, the children in both of the sister schools are basically similar: active, enthusiastic, and receptive to innovative teaching concepts and techniques. Since Belize is an English speaking country, language is not a barrier in the partnership.

Teachers in the sister schools were given packets of information on the neotropical migratory bird populations in order to prepare a lesson plan on Partners in Art. These packets consisted of a variety of information including booklets on birds, bird lists, posters, drawing sheets, etc. Crayons also were provided to the Belizean teachers.

Two slide shows were given to the participating class at University Park Elementary School. The first slide show was given before the children drew their pictures, to provide background on the project. It consisted of a standard slide show provided by the Ornithology Laboratory at Cornell University on the neotropical migratory bird issue. The second slide show was given after the students had drawn their pictures and it consisted of a presentation on Sittee River village and local tropical environments and species, which provided the students with some first hand views of Belize and their sister school. Both slide shows were given by University of Maryland students who had visited Belize on a travel-study course. While this level of effort was not possible in Sittee River

Methodist School, the background of the project was described to the participating class and photographs of the sister school and students were displayed to provide a first hand view of Maryland and the sister school there.

Exchanges of bird pictures and stories were done from 1995 to1998 between classes of children who were 9-11 years old (Standard Four in Belize and Fourth Grade in Maryland) each year. During 1995 exchanges were done through the mail but the Belizean pictures were lost and not received by the Maryland class. Thereafter, pictures were hand-carried between Belize and Maryland on University of Maryland travel-study courses during the early Spring (January-March). Annual exchanges consisted of 15-25 pictures with paragraph to page-long stories about individual bird species from each school. Although 30 species of birds are known to migrate between Maryland and the Sittee River area, based on bird lists from Possum Point (Appendix Table 6-3) and a published list on Maryland birds by the Partners in Flight committee, children chose a wide variety of birds to draw. In Belize bird books from the biological station were loaned to the school to aid the children in selecting species to draw and describe. In Maryland children relied on their school library and the internet on computers for help in selecting bird species to draw and describe. The results were collections of wonderfully colored, migratory and non-migratory birds for the exchanges. In general, the children worked hard on producing attractive drawings and graphic descriptions of the birds to exchange with their sister school. Use of art is one of the strengths of the Partners in Art project because it allows personal expression by the children which aids in holding their interest and in making them attentive to the overall conservation lesson plan.

Although neotropical migratory birds are the focus of the exercise, the lesson plan dealt more broadly using the birds as a metaphor for introducing conservation themes about biodiversity, habitats, and landscapes. These qualities of the project are similar to those in the US Fish and Wildlife Service Program on Junior Duck Stamps which helps in waterfowl and wetland conservation in the United States. The cultural connection in Partners in Art was another aspect of the project that made learning more effective. In a sense the cultural connection had a multiplier effect on learning by improving the conservation lesson and including the message that people in different parts of the world have similar problems and must work together to solve them.

Several practical problems did arise during the exchanges that limited the effectiveness of the project. Elementary school teachers are extremely busy with many activities required by larger-scale education policies and directives (National, State, District, and Church in the case of the Methodist School in Sittee River). Thus, it was difficult to find time during the full school days to fit in a new initiative such as Partners in Art. It also was one more set of knowledge that the teachers had to learn and integrate into the lesson plans. The materials in the teachers' packets helped in this regard, but a significant time commitment on their part was still required.

There also were problems with the depth and breadth of the lesson plan. Activities that compliment the art exercise are needed to support the overall conservation message. These might include such related activities as local bird watching trips, construction of

nest boxes on school grounds, additional audio-visual materials and pen-pal letter exchanges. In the project described in here, pen-pal exchanges were attempted in 1997 but they were not sustained beyond the initial form letters that the teachers devised. Again, these related activities require time and energy by teachers and students which is always limited in any school setting.

Without significant efforts by the first author of this book and the participating elementary school teachers, the direct exchanges between the specific schools could not have been maintained for four years. Unfortunately, both elementary school teachers (in Belize and Maryland) moved to new schools in the 1998-1999 school year and the exchanges were not sustained.

The exchange described in this paper is just one of between 15-20 partnerships annually undertaken within the state of Maryland alone as part of larger Partners in Flight initiative. Thus, there are many opportunities for interested teachers to become involved and for new ideas to be tested. One new direction for the effort described here is to establish computer linkages between schools in the Sittee River watershed and schools in Maryland. With computer linkages children can exchange e-mail messages about neotropical migratory birds and pen-pal connections will be facilitated. Access to internet over the computer also will expand the related activities that can be drawn into the lesson plan. The educational use of computers adds another dimension to the project to compliment the aspects of birds, art and culture that are already inherent strengths.

Setting up computers in Belize and linking them to existing computers in Maryland schools will be a major challenge because of the general lack of support for this technology throughout the country (see pages ____).

If computer linkages can be established, teacher workshops would be held in Belize for taking advantage of the technology. These workshops would join Belizean and Maryland teachers together to review and expand lesson plans in Partners in Art. Information would also be included on bird watching, habitat relations and basic ecology to provide teachers with additional activities that might be combined with the art exchange. The computer linkages and teacher workshops would help overcome some of the problems with the project and aid in making it an important tool for conservation and cultural education.

Computers in the Jungle: towards electronic sustainability

The idea to bring used computers to Sittee River from the U. S. arose directly from the Partners in Art project. Originally, the hope was to set up computers in the local school and to have them connected to the internet so that the experiment with pen pal letters described earlier could be expanded to e-mail exchanges. Of course, it was recognized that computers could have other beneficial uses if they were available to the school children (eg. Papert 1980, 1993).

This plan also seemed to be a good idea because of the relative inaccessibility of computers in Sittee River in particular and Belize in general (see for example Table 1-3).

At the time this project was begun in the mid-1990s there was only a single computer in the entire village. A small apple computer had been donated to the school by a researcher from Woods Hole, Massachusetts who worked on the nearby coral reefs, but this machine was basically under-utilized primarily due to a lack of training in computer use by the school teachers. For Belizeans computers were costly to buy and to maintain and they simply were not even available for purchase in the rural areas such as in the Stann Creek District. In contrast, computers have been readily accessible and widely used in the U. S. For example, at the University of Maryland, where the first authors works, all faculty and staff use computers in their daily work and training program and technical support are an integral part of the university's infrastructure. The steep gradient in computer technology between under-developed countries (Belize) and developed countries (U. S.) and its associated social consequences have been described with metaphors such as the digital divide (Norris 2001, Wresch 1996) and the thought that we could bridge this gap in some small way by bringing computers to Sittee River was an exciting motivation for this project.

A broad program of activities with Sittee River could be supported if computers were accessible and easy to use. We envisioned this program as a kind of electronic sustainable development whereby at least certain needs of the people could be met electronically over the internet (Figure 6-6). Interactions relating to conservation and environmental education at the school, such as the Partners in Art Program, would be only one of several activities facilitated by computers. For example, opportunities in adult education would become available over the internet. Computer skills and information derived from the World Wide Web could lead to better jobs and richer lives for local people. Also, electronic marketing of local products such as jams and marmalade or the cookbook of the Sittee River Trading Company would be possible over the internet which would improve business prospects and lead to increased income. Eventually, as skills developed, local people might even create new forms of indigenous software such as game programs or field guides based on folk taxonomy. All of these possible activities could potentially generate new sources of income and lead to "development without growth" (Costanza and Daly 1992) since the basis of the development would be information associated with or stimulated by the World Wide Web, rather than by material goods or financial investment.

Thus, in the late 1990s six used computers and a variety of additional equipment (phone modems, a printer, connector cables, monitors, how-to manuals, memory upgrades, etc.) were brought to Sittee River from the University of Maryland. It was fairly easy to acquire used computers and equipment at the university because a stream of old machines was continually generated as up-grading to new machines periodically took place. The used computers that had market value were sold in a clearinghouse operation (named the Terrapin Trader after the school mascot – a diamond-backed terrapin) and those without market value were disposed of. Over the time period of this project, used computers and other equipment were acquired then, either through donations or through purchases at reduced rates from the university's clearinghouse operation. This acquisition stage was actually the easiest part of the whole project. Once acquired, all of the equipment had to be carefully packed in boxes with much padding in order to survive the trip from College Park, Maryland to Sittee River, Belize. In fact, the packaging and transport stages of the process of bringing computers to Sittee River was actually more

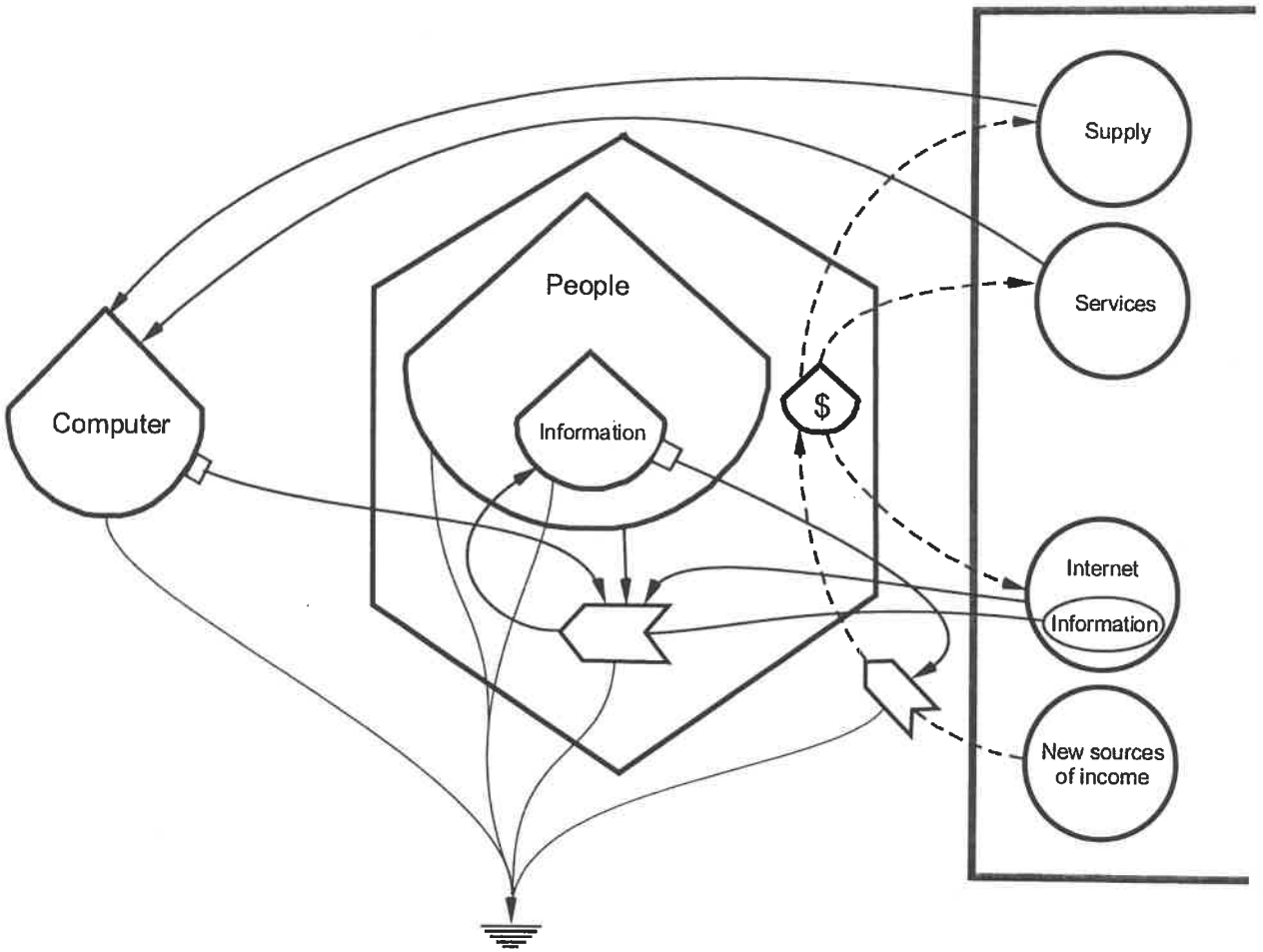

Figure 6-6. Energy circuit diagram showing the support needed and the feedback value of computers in Sittee River village.

costly than the equipment itself, given the used computer market system in the U. S. It was also difficult to physically move the boxes, which were often rather large and heavy, through airports and down dirt roads, in various modes of transport (planes, trucks, and even boats). This part of the project was usually aided by a graduate student from Maryland (Alfredo Nava-Tudla and David Blersch). These students were recruited based on their computer knowledge and interest in the project. They were critical to the project in a number of ways, from selecting equipment to packing and transport and finally to setting it up and providing training to local people in computer use.

Initially, computers were set up in the Methodist School in the village in the room that contained a small library. The machines were installed, checked for operation and demonstrated to one of the teachers that had been designated by the principal of the school over a several day period by the Maryland graduate student. This initial part of the project worked well and the teachers always found uses for the computers in their school, based on feedback we received over time. Students, aged about 10-12 years old, quickly learned how to use the machines, sometimes even faster that the teachers.

However, we were never able to connect the computers to the internet. At the start of the project there were only two telephones in the village and even after many requests both by the authors and by teachers in the school, to government officials and to the telephone company of Belize (BTL), we were never able to have a phone line wired to the school so that the computers could be connected to the internet through modems. If a connection had been made we intended to raise funds to pay for the hookup and internet use fees but the project never got that far along.

This phase of periodically setting up computers in the school and attempting to develop an internet connection lasted several years. During this time it became apparent that the computers in the school quickly broke down after about 6 months, due to heavy use and/or due to environmental conditions of high humidity and dust which were deleterious to the electronics. Once broken, the computers could not be repaired because no one in the area knew how to fix computers and, if even this expertise was available, replacement parts were not. In an attempt to circumvent the problem of rapid breakdown of computers in the school, we set up several computers in homes of some of the biological station staff who had children in the school. The basis of this strategy was that computers would get less use and be better cared for in individual homes and therefore they would remain operational longer, than if located in the school. It was recognized that the strategy would eliminate access to the computers by the majority of the school children but we hoped that the computers could still be used for special purposes such as pen pal letter exchanges by e-mail. This strategy was initially successful in that the computers did remain operational longer but, as before, we were never able to get the computers connected to the internet so the electronic pen pal letter exchange never took place. Furthermore, these computers eventually broke down too (after about a year of use) and, like the earlier experience in the school, they could not be repaired.

During these years of trial and error one application for sustainable development was tested in the travel-study course in spring 2001. As a part of this course students were required to make up web pages on topics that would be of potential interest to people in the village. The students would make up the web pages after their trip to Sittee River, once they had returned to Maryland. During the trip they would make observations and

talk to local people about their needs in order to choose the topic for the web pages. We hoped that the web pages could eventually be loaded on to a web site which the local people would have access to after internet connections were made. In the interim the web pages would be put on compact disks and sent back to Belize after the course for preliminary review by staff at the biological station. Web pages were constructed by the student on the following topics: tropical fruits, tips on computer care, growing tomatoes in Belize, bicycle repair and maintenance, medicinal plants, birds of Sittee River and a history of sugar plantations in the Americas. Generally, the students did a good job in preparing the web sites which included text, photographs and links to other relevant web sites. The CD with the web pages was reviewed by the second author and the materials were to be loaded on to the web site of the Natural Resources Management Program at the University of Maryland. We hope to continue this activity with future classes and over time a library of useful and interesting web pages should be generated by students in the travel-study courses.

In overview, this project of bringing computers to Sittee River did not achieve the original goals of creating a form of electronic sustainable development. In retrospect, the project fell victim to a classic trap of tropical development aid. In this trap technology from the developed, temperate zone is introduced into the under-developed, tropical zone with the intention of raising standards of living of local people. However, the technology ultimately fails to work because it requires a massive support system to function properly. This support system is taken for granted in the temperate zone where the technology was developed and was successful, but the support system is lacking in the tropics and so the technology fails when applied there. The best example of this trap has been the failure of temperate zone agricultural practices, based on mechanization and purchased inputs of chemical pesticides and fertilizers, which often fail when introduced to the tropics (Fosberg 1973) but many other examples of this kind of "careless technology" (Farvar and Milton 1972) have occurred and continue to be tried. Our computer project seems to fall into this category. The computers were initially successful and useful to the local people but ultimately they failed. The Belize Government also purchased four computers for the school in about 2004 but these have had the same problems as those from the University of Maryland. It is clearly recognized that access to computers would improve the quality of life and educational potential of the local people but the resources to support them are lacking. There were hidden costs of the concept of electronic sustainable development, especially in terms of a support system of supply, repair and training services (Figure 6-6). These services are affordable and accessible in the temperate zone, but lacking in the rural tropics to local people. It may be possible to avoid this trap with the development of cheap computers that are easy to repair and there are indications that this trend may be occurring in the computer industry (Surowiecki 2006, McGray 2006). In fact, the computers that the first author brought to Belize were not appropriate for the needs of the local people since they were designed with much more hardware and software than were necessary for the intended uses. Thus, electronic sustainable development may not be feasible until the computer industry produces simple, easy to use, inexpensive computers that can easily be connected to the internet, that can be easily repaired in remote locations and whose electronics can withstand heat, humidity and dust. Criteria for the possible success of the concept of electronic sustainability are shown in Figure 6-6 by the balance of economic flows. Ultimately, the

monetary outflows for supply, services and for the internet fee must be exceeded by the monetary inflow from new sources of income for electronic sustainability to be effective.

The story of computers in the jungle, however, doesn't end with our failure to achieve success. At about the same time we finally realized the limits of our project, computers were being brought into Sittee River by an entirely different process. Several of the foreigners who were buying land and taking up residence in Sittee River brought computers with them. Moreover, two internet cafes were actually set up in the village in the early 2000s, that provided public access to multiple machines connected to the internet. These internet cafes are businesses, mostly supported by foreign tourists staying in nearby Hopkins, but they do provide internet access to the local Belizeans. The owner of one of the cafes is even providing free training in computer use to local children for free.

There are now many more computers in Sittee River than ever before (Figure 6-7). A digital divide still exists however, having moved from the global scale down to the local scale, since the computers are owned by foreigners living in the village. Will these computers create opportunities for electronic sustainable development by local people or will they turn out to be another example of a "careless technology" in the long run through some process that can not be anticipated over the short term?

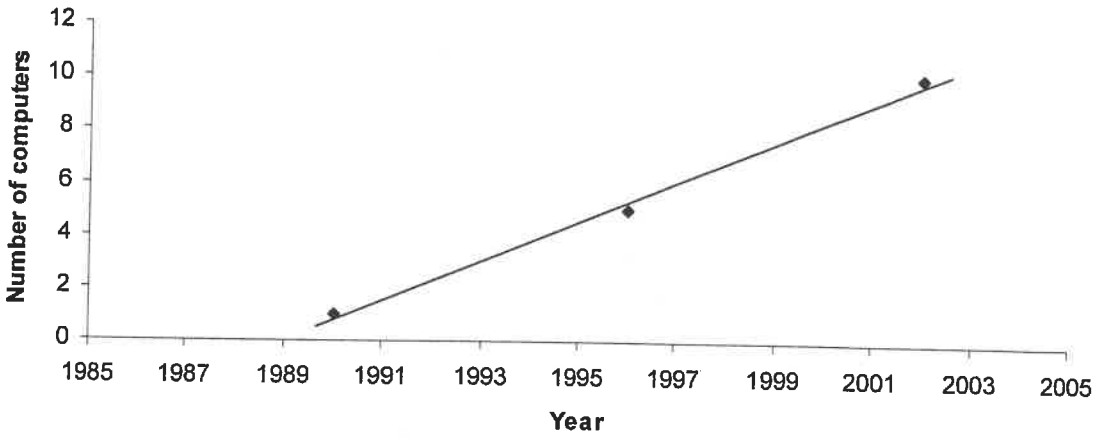

Figure 6-7. Increase in the number of computers in Sittee River village over time. Most of these computers are owned by foreigners rather than native Belizeans.