A Village Within a Wetland:

A case study of the causeway which brought development to Crooked Tree

Gillian L. Hadley

Osmany Salas, Project Advisor
CSA Belize
School for International Training
Spring 1995

ACKNOWLEDGEMENTS

There are many people who helped to make this project successful. I would first like to thank my project advisor, Osmany Salas, whose advice and suggestions through all phases of the project were much appreciated. Delia Tillet and the staff at the Belize Center for Environmental Studies were assisted me a great deal in the search for background information, in addition to Lydia Waight,the librarian at the Belize Audubon Society, who was very supportive and helpful. In the village of Crooked Tree, there were many who made my month there enjoyable and my research interesting. The wardens at the Sanctuary center, Renny Jones and Steve Tillet, were always there to answer my questions. Finally I would like to thank my host family; Ava, Mike, Lisa, Aisha, Lionel and Michael Jr.. Without their hospitality and endless support, this project would not have been possible.

TABLE OF CONTENTS

1. Introduction.....1

2. Logwood.....3

3. The Crooked Tree Wildlife Sanctuary.....4

4. Functional Aspect of Wetlands.....8

5. Crooked Tree- A Community Within a Wetland.....10

6. The Road to Development.....11

7. The Present Situation.....15

8. Methods.....16

9. Results.....20
   a. What the Causeway Has Meant to Villagers.....20

   b. The Causeway and Water Quality in the Lagoon..28

   c. The Causeway and Vegetation in the Lagoon.....30

10. Conclusions and Recommendations.....33

11. Bibliography.....36

12. Appendix.....37

Introduction

Until 1983, the village of Crooked Tree was only accessible by boat. The lagoon system surrounding the village made it an inland island, and relatively remote. Twelve years ago, however, a causeway was built across the Crooked Tree (North) Lagoon to provide access to the village. This act of building a road, completed in roughly two weeks (pers. comm., Sam Tillet), may not seem like a major development, but the ramifications it has had for both the village, the surrounding ecosystem, and all the organisms within, have been extensive. I felt a need to carry out some sort of documentation of this damage (or progress, depending on one's viewpoint) and felt that much could be learned from such a study, by me, by the villagers, and especially by the people involved in protection of the area. It is a complex issue, and I began my study period planning to focus on just one aspect of it- the logwood stands dying out on the north side of the causeway. As I began my research, however, I realized how many more issues were involved, and the importance of the relationships between them. Talking to inhabitants of the village (many of whom had lived there all of their lives, and had seen the village progress through different stages) made me realize the need to address the more sensitive issues involved, rather than studying one narrow aspect. I also lacked the time, laboratory equipment, and background information to be able to

complete a purely scientific assessment of the damage solely to the logwoods.

As a result, my goal became to observe the changes in the lagoon more broadly, and in order to know the extent of the damage, I needed information from pre-causeway times. Because the Crooked Tree Wildlife Sanctuary was not established at this time, there was no baseline data, or even written descriptions of the lagoon before the causeway with which to compare. Hence, I turned to the people living right here in the village, an obvious source of information. It was their opinions and concerns which sparked my interest in the socioeconomic implications of the causeway, as well as the environmental impact. The fact that my topic developed in this way I feel is reflective of my overall experience this semester in Belize. The cyclical nature of all economic activities and development strategies has been something I have realized and been fascinated by, since coming to this country. People use their environment in various ways to meet their needs and desires, and the result is a changed ecosystem which goes on to affect other economic activities, and the cycle continues. This is not to say that all development should be halted and the environment left untouched. The consequences depend on the scale of the activity and the specific ecosystems involved, which is why specific case studies need to be carried out before decisions about management can be made. My project is as much of a case study as could be carried out in the time available. It is my hope that it will provide a basis for

further exploration and investigation into the issues raised, and ultimately lead to decisions which can benefit the sanctuary as well as the village.

Logwood

In order to fully understand the information included in this study, it is important to know the background and history of the area in which the study was carried out.

It is suspected that Crooked Tree is one of the oldest villages in Belize. It began as a British logging settlement, was the center of the logwood industry since 1650, and was officially established as a village around 1750 (anonymous, BCES, p. 2). Logwood trees (*Haematoxylum campechianum*) contain a reddish heartwood which is a key ingredient in the manufacturing of aniline dyes. Thus, they were very valuable to the British. These trees were actually the initial attraction for the British to settle in Belize, but by the late 1700's synthetic dyes had been developed, and they turned to other timber resources, especially mahogany. There was a brief revival of the logwood industry during World War I when the dyes were again in demand, but for the most part logwood trees are no longer used for this purpose. They are cut today for fenceposts by the villagers, but this activity is monitored and limited within the sanctuary under the Crooked Tree Wildlife Sanctuary Management Plan and the

National Parks Systems Act of 1981. The stands which now remain in the Crooked Tree area are the only ones left in Belize.

The logwood tree is part of the legume family. It is a small tree with a "compressed and fluted trunk", smooth greyish bark, and plenty of short spines. Its leaves are "glabrous and pinnate" with broad, wedge-shaped leaflets (Stanley and Record, p. 78). The distribution of these logwood stands is a factor of its interesting ecological range of tolerance. It thrives on swampy lowlands because its roots must be immersed in water for a certain amount of time during the year, but also need to have time out of the water. This explains why they are usually found in wetland areas like Crooked Tree. The water level naturally increases and decreases during the year, allowing the logwood roots to have their time in and out of the water.

The Crooked Tree Wildlife Sanctuary

These extensive logwood stands were just one of the reasons for the proposal to make this area protected. The region surrounding Crooked Tree has been described as a "network of inland lagoons, waterways and swamps" (anonymous, p. 1). This makes it an ideal place for birds to flock to in the dry season. Food becomes scarce elsewhere, but the various species of migrant and wading birds can still find fish in the lagoons of Crooked Tree. It also serves as a major stopping point for birds on their northern migration in the spring. The logwood swamps are

roosting grounds for Boat-billed Herons, Chestnut-bellied Herons, and Bare-throated Tiger Herons. The Black-bellied Whistling Duck and the Muscovy also nest in trees along the swamp.

The wetland area is located at 17°45′ North latitude and 88° 32′ West longitude, and has an altitude of approximately 45 meters above sea level. It is 45 kilometers northwest of Belize City and consists of land in both the Orange Walk and Belize districts. The actual area of the wetlands is between 8000 and 10,000 hectares, though the area considered protected is only about 1810 hectares (Scott and Carbonell, p. 311). Measurements were made 300 feet inland from each waterway, and this was designated as the Crooked Tree Wildlife Sanctuary. The Sanctuary can be divided into two parts. The larger section is made up of six interconnected lagoons (Revenge, Western, Crooked Tree and Southern lagoons, and Spanish and Poorhaul Creeks) which drain south through the Black Creek to the Belize River (see map- Appendix p. 3). This area comprises 1160 hectares. The smaller part is located east of the Northern highway, and is made up of Mexico and Jones Lagoons- 650 hectares (see map- Appendix p. 4). Birds travel freely back and forth between the two areas.

Part of the site (southern tip of the Northern lagoon and the upper Black Creek) was proposed for protection as a Bird Sanctuary in a 1968 National Parks Study Group (NPSG) Report. A later report by the Food and Agriculture Organization of the United Nations (FAO) proposed that it be declared a National Reserve under the National Park Systems Act (NPSA). In 1981, the

Belize Audubon Society (BAS) proposed a much larger site for a Wildlife Sanctuary under the NPSA, and in 1984 it was officially established.

The large wetland wilderness which is the Crooked Tree Wildlife Sanctuary comprises a variety of habitats: shallow open waters, extensive marshlands, logwood swamps, and the forested region along the banks of the Black Creek. The water emptying from the lagoon system drains through these marshes and forested swamps and becomes the Black Creek, which runs through approximately 10 miles of tropical forest until it makes a junction with the Belize River (anonymous, p. 1). This area has been described as having "a unique and complex hydrology" (Miley, p. 42). During the rainy season (July to January) the area becomes basically one continuous lagoon, which is "filled from all sides with substantial volume" (Miley, p. 42). The high flow of the Belize River during this part of the year causes Black Creek to flow in a reverse direction (south to north). Once the rains stop, the drainage is in a north-south direction to the Belize River and out to the Caribbean Sea.

The principal types of vegetation are the submerged aquatic vegetation in the lagoons, the extensive shrub borders to the lagoons, the forests of *Haematoxylum campechianum*, mixed pine savannah, and some hardwoods along the Black Creek (Scott and Carbonell, p. 311).

The sanctuary is a critical habitat, especially in the dry season because the shallow open water provides feeding grounds

when other feeding grounds are dry. It is also especially critical to wading bird species because there are no steep banks and the water is shallow enough for them to reach the food. Food for birds consists of big apple snails for snail kites or limpkins, water insects, frogs, small fish or freshwater clams for other birds, and water plants for ducks. There is no complete documentation of fish species found in the lagoons, but there are about 16 species which are most representative of the Northern lagoon, and the five most common are the Tarpon (*Tarpon atlanticus*), the blue catfish (*Ictavrus furcataus*), Tuba (*Cichlasoma friedrichsthali*), Chrona (*Cichlasoma uropthalmus*), and Bay Snook (*Petenia splendida*) (Hecker, p. 44).

The lagoon is also home to all of Belize's species of freshwater turtles (including the endangered Central American River Turtle, *Dermatemys mawei* or "hicatee" as it is known locally). Other endangered species found here are Morolet's crocodile (*Crocodylus moroleti*) and the Common Iguana (*Iguana iguana*). Central American Otters (*Lutra anectens*) also swim these waters, and Black Howler Monkeys (*Alouatta pigra*) can be seen and heard in the surrounding forests.

The birds, however, are what most tourists come to Crooked Tree in search of. The wide variety of habitats provided in this wetland area, as described earlier, makes it ideal for a vast array of different bird species. A complete list can be found in the Appendix on page 6, but the most famous is the Jabiru stork (*Jabiru mycteria*), another endangered species. With a wing span

of eight to ten feet, it is the largest flying bird of the New World. There are two pair known to be nesting within the sanctuary (CTWS pamphlet, 1994).

Functional Aspect of Wetlands

Aside from the wildlife it supports, this type of wetland environment is important in other ways. It is essential to have an understanding of the different roles wetlands can play. In Scott Hecker's report, The Freshwater Wetlands of Northern Belize (1987), a wetland is defined as "an ecosystem which has marked features brought about by the presence of water during all or a significant part of the year"(p. 3). There is a broad range of habitats that can make up different types of wetlands. A main characteristic of the northern half of Belize is its flat topography and relative abundance of wetlands. This is reflected in the fact that there is only one major highway, the Northern highway. This type of terrain makes it difficult to build roads. The soil is mostly limestone based, a geologic trend seen throughout Belize. In addition, soils in wetland areas usually have the highest fertility due to the accumulation of fresh alluvium and deposition as velocity slows from flowing river to standing waters of a lagoon. This attractive soil makes for an abundance of good farmland in areas surrounding rivers and lagoons. The availability of this land is a major reason why wetlands in northern Belize have remained for the most part

undisturbed. Often, in other countries, wetlands are drained to provide land for agricultural use, but in this case there has been enough other farmland that the wetlands have been left. The region is sparsely populated with small villages of farmers and fishermen developing along waterways. People are now realizing the advantages of leaving this area undeveloped and unaltered. Wetlands systems have many beneficial functions, such as the control of water pollution. Pollutants contained in sediments settle out as the velocity of the water drops. Wetlands are rich with biological productivity and have a vast array of plant life. These plants serve to trap sediments and decrease the cloudiness of the water. Herbicides, fungicides, and insecticides, as well as excess phosphorous and nitrogen, are all components of agricultural runoff which threaten water supplies. When streams draining agricultural regions pass into wetlands, some removal of nutrients and toxins occurs. Nitrogen can be absorbed by the organic detritus found in wetlands or taken up by plants. Toxins are trapped in sediments, or else rendered into a more innocuous substance through changes of a chemical or biological nature. All of these functions are performed much more efficiently by standing bodies of water than by flowing water. However, an extensive system of wetlands is necessary. Once a wetland is separated from the overall circulatory pattern, these functions can no longer be carried out as well (Hecker, p. 34).

Now that this role of wetlands has been discovered, it seems there have been increased efforts to protect them, due to the ways they can benefit us. In some areas, however, people have long realized their dependence on these ecosystems, and have developed a working relationship with them. A look at the past 200 years of Crooked Tree History shows just this type of interaction between the villagers and the lagoon. In the very beginning, the creeks and lagoons served as transportation- a way to travel inland and reach the logwood forests desired for export to Great Britain. The area surrounding the lagoon gave them a place to build homes and other structures, as well as vegetative materials with which to build them. As mentioned before, this land was very fertile, and therefore was ideal for gardening and raising livestock. The lagoon itself provided them with enough fish to feed their families, and then go on to sell some at the market (which they reached by way of the lagoon, creeks and river). In addition, the water from the lagoon could be used for drinking, bathing, and washing. People even developed their own pharmaceuticals from herbs and plants they found growing in the marsh.

There is yet another way that people have benefitted from these amazing ecosystems. Wetlands function as "big sponges". As we know, Belize has been subject to hurricanes and heavy rainstorms from time to time. Wetlands help to alleviate much of

the damage by absorbing great volumes of water and preventing flooding of the village and surrounding areas.

The Road to Development

So it would seem that villagers in Crooked Tree (and other similar communities) had all that they needed. They had apparently established a harmonious relationship with their lagoon and saw it as an essential part of their existence. Changes must come, however, and frequently do in the form of development. The first development was an access road built west from the Northern highway to the lagoon, but not all the way to the village. Although it provided convenience to the villagers (a much shorter trip by boat), the road made the area much more vulnerable to hunters and fishermen. The increase in commercial fishing of the lagoon significantly depleted the fish resources for the villagers. The next major development came in 1983. A 3000 foot causeway was built across the Northern lagoon. The planning and construction of the road was carried out by the Ministry of Works of Belize. World Bank and the United States Agency for International Development (USAID) provided financial assistance for this and other similar road-building projects as the demand for them was increasing at this time (Hecker, p. 40. The causeway was built without culverts or bridges, and was essentially a dam dividing the lagoon into a northern half and a southern half. According to the Management Plan for CTWS, "no

formal hydrological or other engineering studies were carried out before construction"(p. 6). In his report, Hecker states that the road was "poorly designed" as were others during this period of high demand and rapid development (p. 31). He feels that the causeway to Crooked Tree village has had "severe ecological consequences". These include drastic changes in water chemistry, temperature, and turbidity, and the resultant changes in plant and wildlife communities. The causeway interfered with and blocked the natural drainage pattern of the lagoon system. As a result, this causeway has been a source of much controversy over the past 12 years.

When it was first built, some felt the causeway would be destroyed by the pressure of water building up on the north side, and it was suggested that the causeway be cut in some places to allow drainage. In August of that year, the Executive Committee of the BAS decided that the causeway should be left for one year as it was, and then they would see what action should be taken (BAS Bulletin, August 1983). It ended up being left for three years- until late in 1986 when the water reached unusually high levels in the lagoon. Water was flooding and eroding the causeway, making it dangerous to drive on. In order to make it safe again, the Ministry of Works had to perform some quick repairs to build the road back up again. Public opinion was aroused. People could see that the repairs would not last and wanted a permanent solution. Many felt that bridges should be cut through the causeway to allow drainage. However, not

everyone agreed with this solution. Many people had been enjoying the benefits of a deep reservoir of water year round on the north side- a result of the damming effect.

Around the same time, in 1986, people began to notice another consequence of the causeway. The logwood stands on the north side appeared to be dying out and were no longer as green as those on the south side which were still growing as they normally would. It was a while before people associated this phenomenon with the presence of the causeway. It had taken a few years for the effects to show, but then it was clear. A large percentage of the only remaining logwood stands in Belize were dying out as a result of constant immersion in water. Since the causeway had been built, the roots of these trees had not had a chance to aerate. Instead they had been waterlogged in the increasingly deeper waters of the reservoir. Once this cause-effect relationship was discovered, it provided yet another reason to cut the causeway. People began pressuring for a solution or some sort of action, and the controversy heated up.

The August 1983 issue of the BAS Bulletin described some of the advantages and disadvantages of leaving the lagoon as it was at that time. The village fishermen were some who felt most strongly about it. As a year round reservoir, the north side of the lagoon also functioned as a natural hatchery for fish and turtles, and allowed many more to survive the dry season than would have if the water level decreased as it had in pre-causeway times. This was seen as an economic benefit. The fish caught

would be larger if they were allowed to stay and grow in the reservoir instead of migrating to other deeper waters or dying out when the dry season came. The turtle populations also flourished. They could be caught in abundance and sold to vendors, especially "hicatee", which is a great delicacy to Belizeans. People saw the effects of the deeper side of the lagoon on their wells and water supplies as the water table became higher on the north side of the village. Shallow wells, usually empty in the dry season, could now be used throughout the year. Some saw this abundant water as a potential for small scale irrigation. There was also the attraction of being able to swim and bathe year round.

On the other hand, drawbacks of the uncut causeway were also pointed out. Some people viewed the dying logwood stands as an 'eyesore' and also felt that their demise was adversely affecting the wildlife and fish populations. The damage done to the causeway by high water levels was another prevalent complaint. The unbroken causeway was resented by some because it created a barrier to dories carrying produce from the "plantashes" (farms). And lastly, though some claimed to enjoy swimming year round in the lagoon, others felt that the stagnancy of this still reservoir was unhealthy and that agricultural runoff was beginning to accumulate and make the water unfit for use. There was an increased amount of detritus in the water due to the dying trees and fish.

The CTWS Management Committee met in June of 1987 to try to

provide a solution to the problem. There was no longer an answer which was clearly the right one, and the people of Crooked Tree had very different ideas about what would be best for the lagoon as well as the community. The decision they came up with was to leave the causeway intact, and their justification included the following projections. The dead trees would fall into the lagoon and provide shelter and breeding areas for fish. Birds still roosting in the dead trees would excrete and further enrich the water with nutrients. New stands of logwood would be established further inland where roots could get air. They planned to stabilize the shoulder of the causeway with cover vegetation to prevent erosion, and also suggested building a landing at which the dories could dock and unload produce. The chemical contamination they felt was negligible since there was a creek between the Northern and Western lagoons to provide some cross flow.

The Present Situation

All of these hypotheses are not worth much now because two 20 foot wide bridges were cut through the causeway in 1992, after a recommendation from the First World Congress on Tourism and the Environment which met in Crooked Tree that year. However, it remains to be seen if this was the 'right' decision, or if there even was a 'right' or 'wrong' decision. If the ecosystem *had* begun to adjust to the high water level, as was claimed, then was

it a good idea to drain the area and create another disturbance in an already fragile system? Or was this just an act of returning it to the natural levels it would have without any causeway at all? Through my research I hoped to address some of these questions and find out more about the specific opinions and arguments of people in the village. I also aimed to do my own assessment of the ecological conditions of the lagoon at the present time. These two things would hopefully come together to give an idea of both the negative and positive effects which result from a development such as this causeway, and to show the vast impact and time needed for recovery after such a change.

Research for the project was conducted in Crooked Tree, which presently has a population of about 800. It is nearly 100 percent Creole with small numbers of Garifuna people and refugees from other Central American nations (pers. comm., George Tillet).

Methods

In order to accomplish my goals for this project, I used two very different approaches to obtaining information. There is a side to my research which is more scientific due to my interest in the ecology of the area, and specifically how water quality and vegetation had been impacted by the causeway. I felt a need, however, to explore all sides of the issue, and thus wanted to gain as much information as possible from various people in the village about their relationship with the lagoon and their

feeling about the causeway and bridges, to supplement my own observations. Hence, my research methods can be divided into three categories: interviews and personal communication, water quality testing and analysis, and vegetative plot assessment.

The interviews I conducted were rather informal affairs, rarely lasting more than 30-45 minutes (see Appendix p. 7). Most of the subjects were older men still living in the village, who had been fishermen and had knowledge of the lagoon in the times before the causeway was built. Being fishermen, their livelihoods more or less depend on the conditions of the lagoon, so they were frequently very opinionated about the issues raised. The questions usually asked were along the lines of the following:

1) How would you describe the lagoon and surrounding area before the causeway was built? in the wet season? in the dry season? in terms of fish and bird species? in terms of vegetation?

2) What were some of the changes you noticed when the causeway was first built? How long did these changes take? Were you in favor of the causeway's construction?

3) Do you feel that the bridges improved the situation? Why or why not?

Sometimes subjects would have more knowledge of one question than another, and the discussion would go accordingly, focusing on what they seemed most interested in talking about. In this way I was able to determine what they felt the most important

functions of the lagoon were as well as their more general feelings about human interference with natural ecosystems. In addition to these interviews, much information was gained from just spending time at the sanctuary office and discussing the situation with the park wardens, tour guides, and even tourists. This helped me to discover the different concerns people have, observations they have made, and various points of view and aspects of the issues I had not seen before. I also did not limit myself to interviewing the 'aging fishermen' of the village because farmers and ranchers also have a vested interest in the health of the lagoon. The water supply is essential to them and wetland marsh vegetation is important grazing ground for cattle and horses (see photo 7B on Appendix p. 14).

The second method of research was an attempt to make my own observations by performing water quality tests in the lagoon. By testing samples from both sides of the causeway, insight would be gained into the effect of the causeway on water quality, and subsequently the plant and wildlife that depend on water quality. This process was also a learning process for me, as I had never carried out these tests before and was anxious to learn how. One of the sanctuary wardens was extremely helpful and prevented me from making many errors. Tests were done using the Lamotte Freshwater Aquaculture Test Kit, Model AQ-2. Tests were done for pH, ammonia nitrogen, nitrite nitrogen, alkalinity ($CaCO_3$), carbon dioxide, chloride, and dissolved oxygen. Temperature readings were also taken. Tests for hardness ($CaCO_3$) could not

be completed due to lack of one of the necessary reagents. Procedure for the tests was as follows:

Water samples were collected from the two sites marked on the map (Appendix p. 5), one of which is shown in photograph 6A on Appendix p. 12. Collecting bottles were first rinsed with distilled water, then with the appropriate sample water. A temperature reading was taken at each site. A large bottle was filled with sample water for the various tests. A special, smaller bottle was used to collect the water for dissolved oxygen tests. This bottle was opened and filled underwater to avoid any air bubbles, and the cap was firmly tightened. Samples were carried back to the sanctuary office where the tests were performed.

A third method I used was that of vegetative plot assessment. This was simply a way of making my own observations about the vegetation (especially logwoods) in an organized fashion. Two 20 by 20 foot plots were set up on either side of the causeway at roughly the same distance from the causeway. Measuring tape and string were used to mark out the areas. The plot on the south side of the causeway was the control and represented the condition of the vegetation when water levels increase and decrease naturally and are not affected by the causeway. The concept for this method was taken from the Rapid Ecological Assessment (REA) conducted at Bladen Nature Reserve, Belize. The entire process of REA is "intended to answer a specific need or question such as what the most appropriate

limits are for a protected area if it is to contain a biologically viable ecosystem". In this case, only a small portion of an REA was conducted after the fact, to possibly determine what these limits *should* have been were the area considered protected before the construction of the causeway. These plots are just one component of an REA, the only component realistically feasible for the scope of this project. The process involved mostly just observations and comparisons of soil and vegetation, again with the help of one of the park wardens in identifying species names. Information collected was recorded on REA forms (copied from the Bladen REA book) which can be found in the Appendix.

Results

What the Causeway Has Meant to Villagers

First and foremost, I did not run across a single person in the village who felt that the causeway should not have been built in the first place, and I did not really expect to. The road has brought them many things, most of which are viewed as changes for the better. Primarily it has brought them convenience- the ability to get to Belize City or Orange Walk much more frequently, and on much shorter notice if need be, whereas before they would have had to prepare for a long trip by boat. Electricity 24 hours a day is something the villagers deeply appreciate which might not have happened if it weren't for the

causeway.

It seems to me that the presence of the causeway has made them less self-reliant, which could be viewed as both positive and negative. Food can be bought from the market in Belize City on a semi-regular basis if desired, thus decreasing the amount of food it is necessary for people to hunt, catch, or grow themselves. They can go to the city for any number of services (doctor, repairman, etc.) which makes them less dependent on people and services here in the village. Also, whereas before everyone in the village worked as farmers or fishermen, now some are able to go to work in Belize, Orange Walk or surrounding villages and commute daily or just on the weekends. This situation has increased the financial status of some, a phenomenon also noticed now that family members are able to go to the United States for extended periods of time to work, and send money back to their families in Crooked Tree. There is presently a trend of those living in the U.S. returning to Crooked Tree. I feel this is partly due to the sped up development of the village (a direct result of the causeway). People who left to work in the States are now returning to see changes and an increased standard of living, which was brought about partly by their earnings which they sent to Crooked Tree. The village they left behind now more closely resembles a village they might have inhabited while in the States.

The causeway has also exposed Crooked Tree to a new industry and potential for economic gain- the industry which is sweeping

Belize- tourism. Just as the causeway has 'opened up' Crooked Tree to development, it has also opened it up to foreigners- those who come to Belize seeking adventure and wildlife, and are willing to spend money for it- in other words, the "ecotourist". In a way, it is an ironic relationship. As mentioned before, if the CTWS had been established prior to 1983, the Ministry of Works would have probably gone through a very different process to get the causeway built. More studies would have been conducted, and possibly other alternatives proposed. However, the Sanctuary came after the causeway, and in some ways this is fortunate because those involved in tourism in Crooked Tree now rely heavily on the Belize Audubon Society for the publicity which brings tourists to Crooked Tree (via the causeway). Also, if the area was not protected and hunting continued, there would not be as many birds. In the words of Jerry Enriquez, "birds come, tourists come". As eco-friendly as they are, tourists might be less likely to come if they weren't assured of finding lodging with all the comforts of home. The ability to accommodate tourists in a comfortable way is something else which was realized with the causeway. This made it easier to obtain building materials, showers, electricity and food- the makings of a tourist destination. The increase in tourism also provided an alternative to fishing for a lot of people, many of whom already had extensive knowledge of the area's wildlife and could now use this knowledge to conduct tours of the lagoon.

All of these developments are generally viewed in a positive

way. However, some people did share ways which they felt the causeway was hurting the village. One person explained how (in the time before the bridges were cut) it had created competition and division between those living on the north side and those on the south side. With the tourism business growing, boat tours became popular, but those with boats on the north side could no longer navigate down the lagoon to the Black Creek because the causeway was in the way. It was an inconvenience to have to dock your boat somewhere else and use different transport to get there. On the other hand, there was some bitterness on the part of the south side inhabitants because of the abundant water supply and full wells enjoyed by those on the north side all the way through the dry season.

These feelings changed of course with the cutting of the bridges, but some feelings which remain are those of distrust of outsiders. Sitting at the sanctuary office on a Friday afternoon, I noticed an increased flow of traffic coming into the village. These are people from the city or surrounding area who can now use the causeway to come to Crooked Tree and spend the weekend. This seems to bother some people in the village because one of the benefits of an isolated community (ie; only accessible by boat) is that you can more or less know who is in the village at any given time, and outsiders' trips to the village are monitored and much more obvious. Until recently, Crooked Tree had been a village completely free of crime and thieves, and there was no need to lock doors because everybody knew everybody

else. This has changed with the increase of outsiders coming in to spend short amounts of time in Crooked Tree. There has not been a particularly noticeable rise in criminal activity, but many express concern that this is in their future, along with the infiltration of drugs and illegal substances into their community.

The general feeling is that the causeway has been a vast improvement for Crooked Tree, though some assert that its construction could have been planned in a better way. One subject felt that it was too late by the time they constructed the bridges. The water had already become stagnant and "poisonous". Another blamed the government- he felt they have engineers employed for just this sort of purpose, and someone should have realized the bridges needed to be in place from the very beginning to minimize the disturbance of the lagoon. It is my impression that the lack of study was the result of politics as well as pressure from some villagers. The need for an access road had been expressed, and once the idea was in place in people's minds, it was only a matter of time. One man interviewed felt that as soon as people realized the benefits of such a development, "they wanted it done as quickly as possible".

However, these opinions are expressed only in retrospect, and the fact remains that the causeway was built as a dam and the effects of this on the lagoon were significant. One of the interesting effects was that fish and wildlife actually increased after the construction of the causeway. The amount of fish in

the lagoon had previously been on the decline due to the increase in commercial fishing of the lagoon (a result of the access road which preceded the causeway). There were no controls set or limits established, so fish resources were severely depleted. The dam was seen by some as a "rescue" from this predicament. The deep water on the north side provided a haven for ailing fish populations, and within three years not only were there plenty of fish on the north side (and few on the south side) but freshwater turtles had also returned in great numbers. Some villagers saw this incidental fishery as an opportunity to ensure their fish resources for the future. However, commercial fishermen using nets were anxious to get at these resources despite the opinion of those in the villlage that no nets should be allowed within one mile of the village.

Around the same time that people were noticing the increased abundance of fish, they were also noticing the death of the logwood stands. The fact that it could be related to the dam had not occurred to people. It was felt that because the trees had survived part of the year in water it would not be a problem to go for the whole year. When they began to die, some felt it was a result of aerial spraying being done to kill marijuana plants in the area. When they realized it was a result of waterlogging, the cry went up to cut the causeway.

An interviewee who was opposed to the bridges expressed his opinion that since the damage to the vegetation had already been done, they should appreciate what they still had left as a

consequence of the causeway- a potential fishery in the reservoir. In the end, those in favor of cutting the bridges won out, using the arguments mentioned in section 6 earlier, as well as the 'cattle grazing argument'. The nutrient rich grasses on the north side of the lagoon had always been a prime area for cattle and horses to graze in the dry season. With the dam, it was completely covered with water all year long and could not be used. After the decision to cut was made, this same interviewee made a prediction that fish would be completely gone from the lagoon in five years. He felt Crooked Tree had given up its sustenance for the future.

The first year after the bridges (and subsequent drastic decrease in the water levels on the north side) hundreds of turtles and thousands of fishes washed up dead on the shore (pers. comm., J. Jex). Now, in the second year, fish are even more scarce, with people going as far as four to five miles down the creek to catch fish. Before they had all that they needed right here in the village. This man feels his prediction is coming true.

Others would argue, however, that this is just the period of time necessary for the lagoon to adjust to its new levels. They see it as a natural adaptation of the ecosystem to a disturbance in its function. It is also true that this year has been a particularly dry season- the driest since 1975. Many are proponents of the "hiding hypothesis". When the water levels decrease, fish retreat to source ponds further away where they

can survive the dry (see photograph 7A- Appendix p. 14) and then come back with the rains. Similarly, turtles dig down into the mud, and have been known to do this as deep as 18 inches down. They then return when the water comes back up. Therefore, some believe that their absence is only temporary. But on the other hand, even some of the 'source ponds' are drying out this year. Also, roads that have been established leading to these areas for the purposes of logging are allowing access to some fishermen, who fish these source ponds during the dry season, thus decreasing the amount of fish that can return to the big lagoon in the wet season.

As far as birdlife after the causeway, there was apparently a shift in species due to change in habitat. Species which nested in the logwoods were found less on the north side than on the south side as these trees died out. They needed the shade from the leaves of the live trees to protect their young. There were also more ducks and swimmers and fewer wading birds on the north side once the water got deeper. The wading species could no longer find food near the surface because fish had a chance to retreat to deeper waters and escape predation. When the dry season comes, the waders rely on catching fish that are stranded when the water recedes. This no longer took place north of the causeway.

As I clearly found out, there are many different issues involved, and this is just a summary of what I ascertained to be the varying opinions among those in the village. I had hoped to

gain some insight from speaking to someone at the Ministry of Works and finding out about the causeway from their point of view. It would be interesting to hear what planning went into it and what they expected to happen, but I was unsuccessful in contacting them.

The Causeway and Water Quality in the Lagoon

Having explored how other people felt about the lagoon and the changes that had taken place, I decided it would be necessary to try to determine for myself, specifically what some of the differences are on either side of the causeway 13 years after it was built.

The water quality tests conducted were somewhat inconclusive due to lack of data from before the causeway. Speculations could be made, however, as to the significance of some of the differences observed. My own results were compared with those obtained by the wardens on October 29, 1994 (during the wet season) and on April I&2, 1995 (a few weeks prior to my study. Results are recorded on Appendix p. 15.

Jose Garcia, of Tunich- Nah Consultants, was consulted regarding the test results which were obtained. He found that the pH, alkalinity, and hardness levels were all adequate for the protection of aquatic life, and considered normal. The ammonia and nitrite levels are a source of concern. The maximum recommended level of ammonia for aquatic life is 0.02 ppm. All of the values obtained were much higher than this, meaning that

fish may suffocate (excessive ammonia reduces the oxygen-carrying capacity of their blood). The level of nitrite normally present in surface waters is 0.001 ppm, which is again exceeded by levels found in the lagoon. "The presence of nitrites in water indicates active biological processes influenced by organic pollution" (Garcia, p. 4). It is suspected that the source of this pollution is dying fish, dead trees and human effluents.

The dissolved oxygen levels were on the low side. There is no single recommended dissolved oxygen concentration due to its dependence on temperature and variation from organism to organism. It is generally accepted, however, that concentrations less than 4 ppm are detrimental to most aquatic organisms. Fish depend on certain levels of dissolved oxygen to survive, but these levels can be depleted by the decomposition of organic wastes. In two out of three cases, the dissolved oxygen on the north side was much lower, indicating that the decaying wood from the dead logwood trees was using up the oxygen in the water.

Garcia concluded that "the water quality is adequate only for low protection of aquatic life" (p. 2). Further testing of the oxygen levels in the water would reveal whether the organic pollution is natural or caused by human activity.

The Causeway and Vegetation of the Lagoon

To supplement these conclusions, it was important to look as well at differences in vegetation, and to go deeper than simply noticing brown, leafless trees to the north, and healthy, green ones to the south. For example, no one has ever taken a close enough look to determine if the logwoods are really dead, or if it is possible that they will make a comeback now that the water has been let out. At the outset of the research period, a walk out to the logwood stands past the second bridge (see map-Appendix p. 5) gave a feeling of what the area was like. Some general first impressions of the north side include the abundance of dead branches and twigs on the ground, as well as the fact that many of the dead trees were on their sides and uprooted from the ground. The soil was cracked and gravelly, littered with broken snail shells. Some dry grasses were growing. Many of the logwood brush plants first appeared dead, but tiny green leaflets on some were noticed with a closer look. The logwood brush is different than the logwood tree. It is more like a vine, and apparently is better equipped to withstand immersion in water. I broke off a branch of a seemingly dead logwood tree to examine the cross section. It was indeed dead, with a greyish color throughout. An abundance of bromeliads growing on the dead trees was noted.

On the south side, the ground was cracked but not as dry, and there was more ground vegetation. The logwood trees were clearly flourishing and were much more developed and taller than their counterparts to the north, not having experienced the

disturbance of their natural life cycle. The south side had not experienced any disruptions, only the natural coming and going of the water with the seasons.

Approximately one week later, the vegetation plots were marked out and a more detailed assessment was conducted (see Appendix pp. 15-24). The north side plot contained four dead logwood trees and six dead logwood roots. There was some evidence of human activity in the area, perhaps collecting the wood for some purpose. Four *Mimosa* plants were identified (locally known as "sensible weed"). The ground area of the plot was approximately 80 percent covered with "sour grass", a sharp grass with greenish-yellow, burr-like structures. There were 43 plants locally known as "susumber", and one "ball stomach" (local name) plant with small whitish flowers and needle-like leaves. Logwood brush (alive) with tiny green leaflets was observed, as well as "hicatee berry" (local name), a woody plant with whitish bark and few leaves. There were nine bromeliads growing on two of the dead logwood trees. Ground litter was about two inches deep and consisted of mostly dead twigs, bark and snail shells. Below this layer was a layer of crumbly brown-grey soil, then a more organic, whitish clay soil. The average height of trees in this area was about 12 feet.

On the south side, the plot contained 13 logwood brush plants. There were no logwood trees contained in the plotted area. Due to its location opposite the north side plot it occurred in an area without trees, between ridges of logwood.

There was no sour grass in the plot and the ground cover was instead nearly 100 percent "ball stomach" and slightly greener than on the north side. Also noted were two *Mimosa* plants, seven "hicatee berry" plants, and two "dog tone" plants. There was less ground litter and the soil beneath was the same whitish clay with less organic matter. In general, a lot more logwood brush was observed to the south of the causeway and the logwood trees averaged a much greater height, roughly 30 feet.

From these observations some conclusions could be drawn. The organic nature of the soil on the north side can be attributed to the build up of dead organic matter and subsequent decay of the logwood. Those logwood trees that still remain standing do not look as though they will make any sort of recovery. Other vegetation in the area still survives though, and with more time new communities will be established with new successional patterns which can function within the conditions present. With time, the two sides of the causeway will become more similar due to the equalizing effect of the flow now allowed under the causeway. When the conditions are right, perhaps logwoods will spread back over to the north side and begin to grow again. If the causeway proves to be too great of a barrier to allow this process to occur, artificial reforestation is another possibility. Logwood trees could be planted on the north side once the soil and water conditions were more equal to those on the south side.

Conclusions and Recommendations for Future Study

Although this study may seem slightly disjunct, it was carried out in this manner to illustrate a point. The various aspects of this issue which were focused on really are interconnected, and this connection should be more apparent to all those involved in making decisions such as the decision which led to the construction of the causeway. I came to view this connection as a triangle, with the causeway, the people of Crooked Tree, and the lagoon at the three corners. Arrows point in each direction showing the cause and effect relationships described in this paper.

If studies along the lines of what I attempted (but more in depth) could have been performed prior to the causeway, a lot of the damage may have been prevented. The goal however, is not to cry over spilt milk, but to use this particular situation to show what can happen to an ecosystem, a village and the relationship between them when a major development is not carefully planned out. The people of Crooked Tree have certainly learned a lesson (maybe something which some of them already knew) and hopefully it will be a much different story when next an activity is proposed which will affect their lagoon.

Crooked Tree is just one of many extensive systems of wetlands and lagoons in northern Belize. The drainage pattern and natural flow of these systems is essential to their function. Now that the ramifications of interrupting this flow have been

seen and documented, perhaps it will prevent similar blunders in other wetland areas of northern Belize in the future.

For the present time, it is important to keep monitoring the situation in Crooked Tree. Two possible ways of doing this and gaining valuable information are related to and could stem from the observations made in this paper. One is to perform water quality tests in another area of the sanctuary where the logwood stands remain healthy. This could be used for comparison, to represent what the water quality was most likely similar to on the north side before the causeway. I was unable to do such tests because there was no water to test in these areas due to the extreme dryness of this dry season. When the wet season comes this could be done and compared to results from the other two sites. More conclusive inferences could be drawn as to the specific effects which the causeway has had on water quality in the lagoon.

Another possibility for future study is to continue the plot assessment method, noting any changes that occur in the future. In this way, keeping track of the area from now on, some trends may become apparent. It could be seen whether the predictions made were accurate or not, and could give valuable insight into the ultimate effect of the causeway.

What is most important is the acquisition of accurate baseline data. With a basis for comparison, information gained in the future will be more valuable.

Finally, it is hoped that the collection of all of this

information with the addition of some new insights will lead to a more complete understanding of this particular issue and all of the different forces at work, as well as a clearer look at the bigger picture concerning development versus preservation, or how they can go hand in hand. I definitely gained a more complete understanding and realized what happens when one tries to focus on just one narrow aspect of an issue instead of the broader picture and web of interconnections.

BIBLIOGRAPHY

Anonymous. Unpublished background of Crooked Tree Wildlife Sanctuary, Belize Center for Environmental Studies.

Belize Audubon Society Bulletin, vol. 15 no. 6, Aug 1983.

Directory of Protected Areas and Sites of Nature Conservation Interest in Belize. S. Zisman, Dept. of Geography, University of Edinburgh, 1989.

Forests and Flora of British Honduras. Paul C. Stanley and Samuel J. Record. Chicago, Jan 27, 1936.

Garcia, Jose. CTWS Water Quality Testing Program: Parameter Review-Discussion, Conclusions, and Recommendations. Unpublished, May 1995.

Hecker, Scott S. The Freshwater Wetlands of Belize. Thesis submitted to Antioch University/ New England, March 1987.

Management Plan- Crooked Tree Wildlife Sanctuary. Robert Mackler, Coordinator & Protected Areas Planner and Osmany Salas, Protected Areas Manager. Belize Audubon Society. 1994.

Myers, W. L. and Shelton, R. L. Survey Methods for Ecosystem Management. New York: John Wiley and Sons, 1980.

Rapid Ecological Assessment: Bladen Nature Reserve, Belize

Report of Fisheries Evaluation of Crooked Tree Wildlife Sanctuary. Submitted to: Belize Audubon Society and Florida International Volunteer Corps. Woody Miley.

Scott, Derek A. and Montserrat Carbonell (conpilers). A Directory of Neotropical Wetlands. IUCN Cambridge and IWRB Slimbridge, 1986.

Weyer, Dora. Report on the First World Congress on Tourism and the Environment. Crooked Tree, 1992.

APPENDIX

Hydrology Map of Belize.....1

Wetland Vegetation in Northern Belize.....2

Spanish Creek and Southern Lagoon.....3

Mexico and Jones Lagoons.....4

Crooked Tree.....5

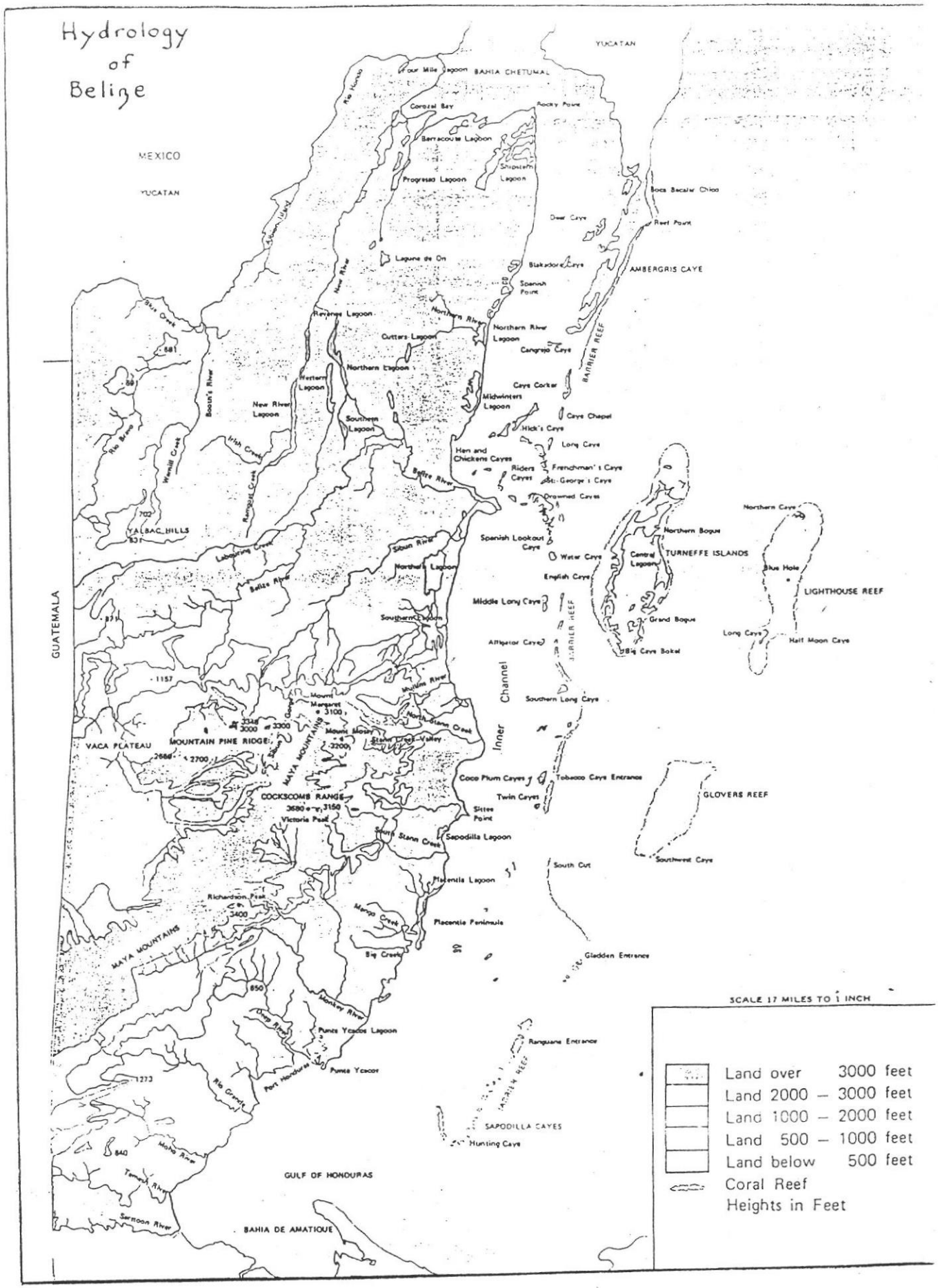
Birds Seen at CTWS.....6

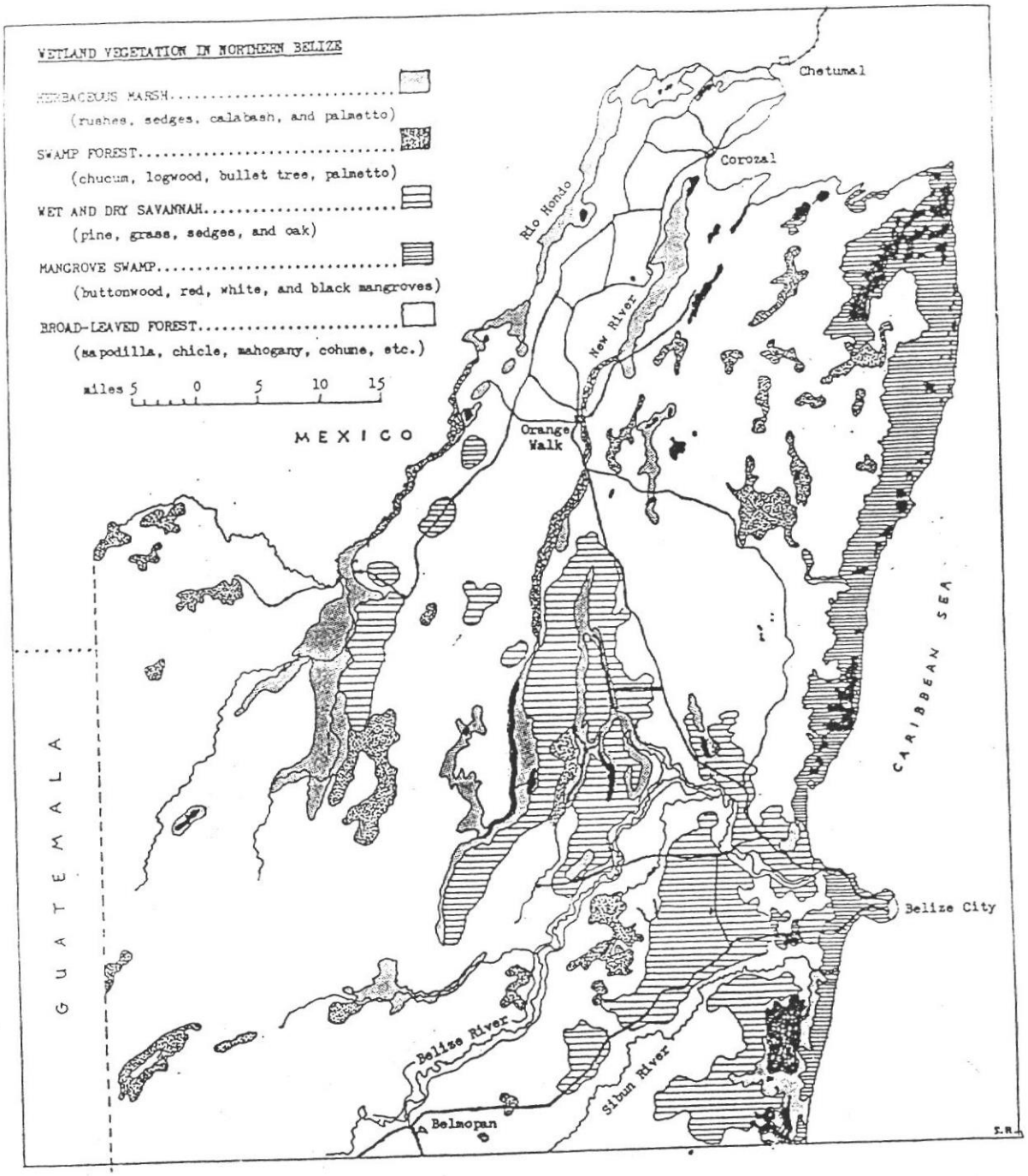
Interview List.....7

Photographs.....8

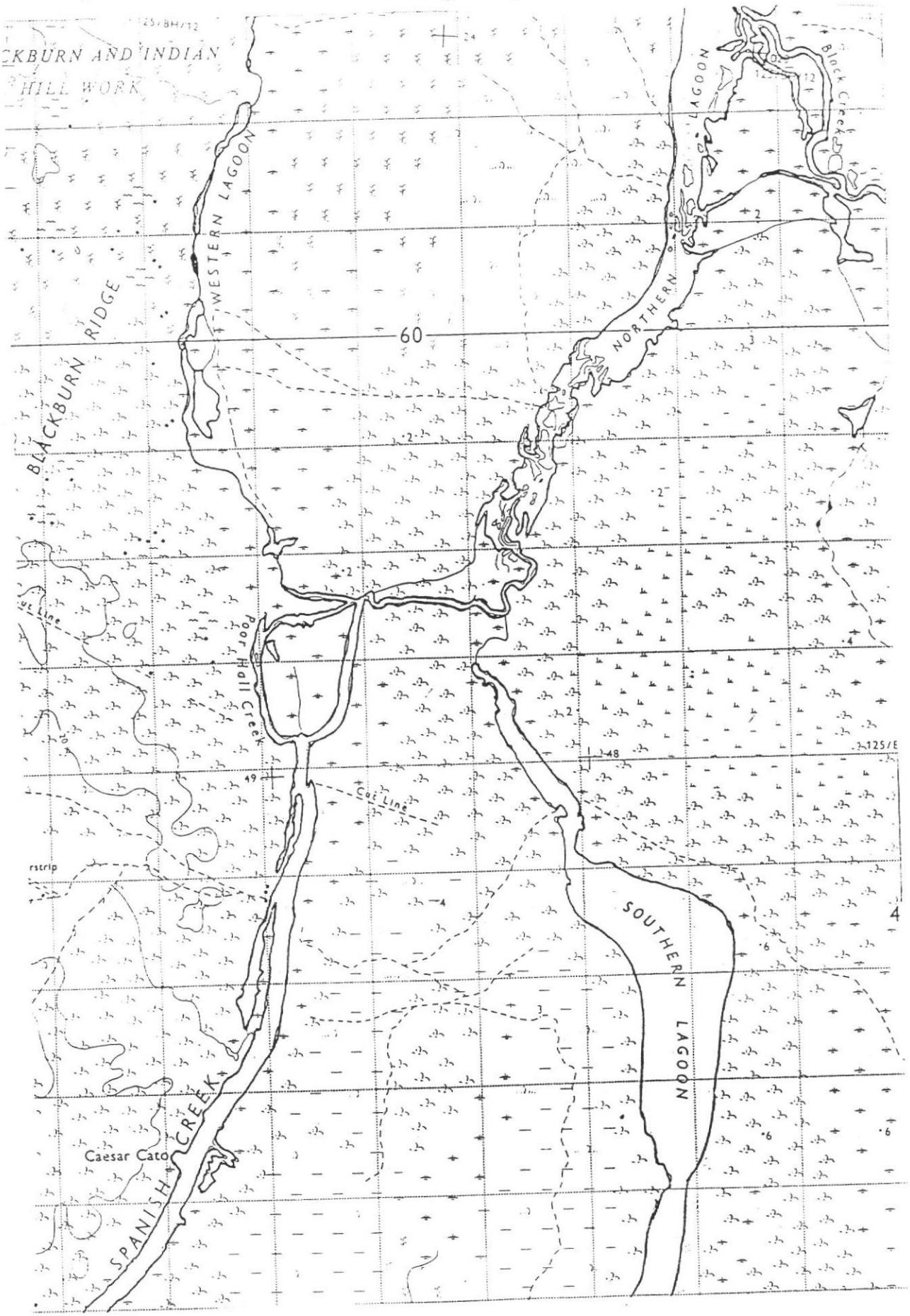
Water Quality Testing Results.....15

REA Forms.....16

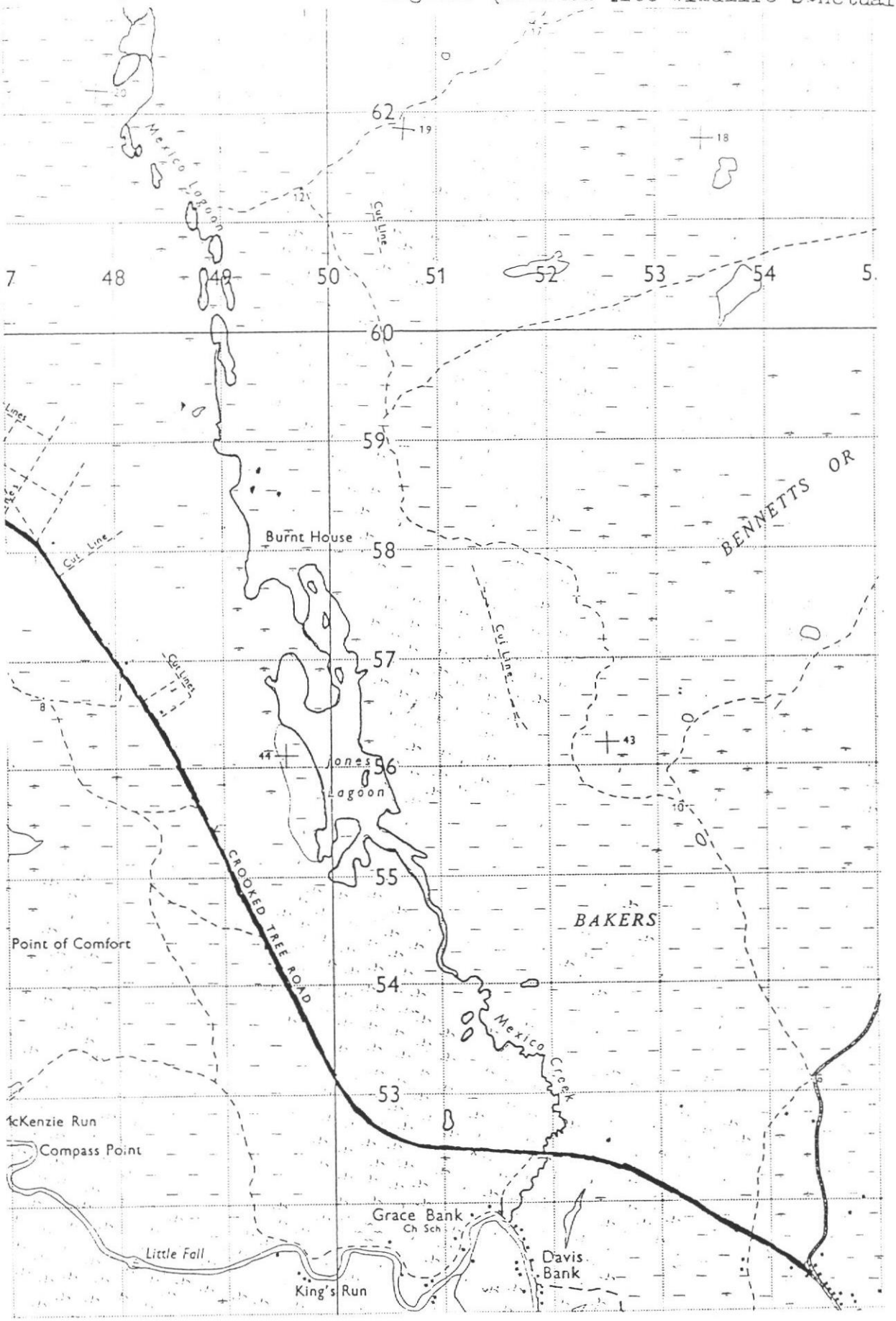

Hydrology of Belize
MEXICO
YUCATAN
GUATEMALA
BAHIA CHETUMAL
Four Mile Lagoon
Rio Hondo
Corozal Bay
Rocky Point
Barracouta Lagoon
Progreso Lagoon
Shipstern Lagoon
Boca Bacalar Chico
Reef Point
Deer Caye
Laguna de On
Blakadore Caye
AMBERGRIS CAYE
Spanish Point
Rio Hondo
Rio Bravo
Booth's River
New River Lagoon
Northern River
Northern River Lagoon
Cangrejo Caye
Cutters Lagoon
Northern Lagoon
Western Lagoon
Southern Lagoon
Caye Carker
Midwinters Lagoon
Caye Chapel
Hick's Caye
Long Caye
Hen and Chickens Cayes
Riders Cayes
Frenchman's Caye
St. George's Caye
Drowned Cayes
Belize River
Spanish Lookout Caye
Water Caye
English Caye
Northern Caye
Northern Bogue
Central Lagoon
TURNEFFE ISLANDS
Blue Hole
LIGHTHOUSE REEF
Middle Long Caye
Grand Bogue
Long Caye
Half Moon Caye
Alligator Caye
Big Caye Bokel
BARRIER REEF
Southern Long Caye
Inner Channel
Tobacco Caye Entrance
Coco Plum Cayes
Twin Cayes
GLOVERS REEF
Southwest Caye
South Cut
Gladden Entrance
Rangoona Entrance
SAPODILLA CAYES
Hunting Caye
YALBAC HILLS
VACA PLATEAU
MOUNTAIN PINE RIDGE
COCKSCOMB RANGE
MAYA MOUNTAINS
Victoria Peak
Sittee Point
Sapodilla Lagoon
Placentia Lagoon
Placentia Peninsula
Richardson Peak
Punta Ycacos Lagoon
Punta Ycacor
Port Honduras
Rio Grande
Monkey River
Big Creek
Moho River
Temash River
Sarstoon River
GULF OF HONDURAS
BAHIA DE AMATIQUE
SCALE 17 MILES TO 1 INCH
Land over 3000 feet
Land 2000 – 3000 feet
Land 1000 – 2000 feet
Land 500 – 1000 feet
Land below 500 feet
Coral Reef
Heights in Feet

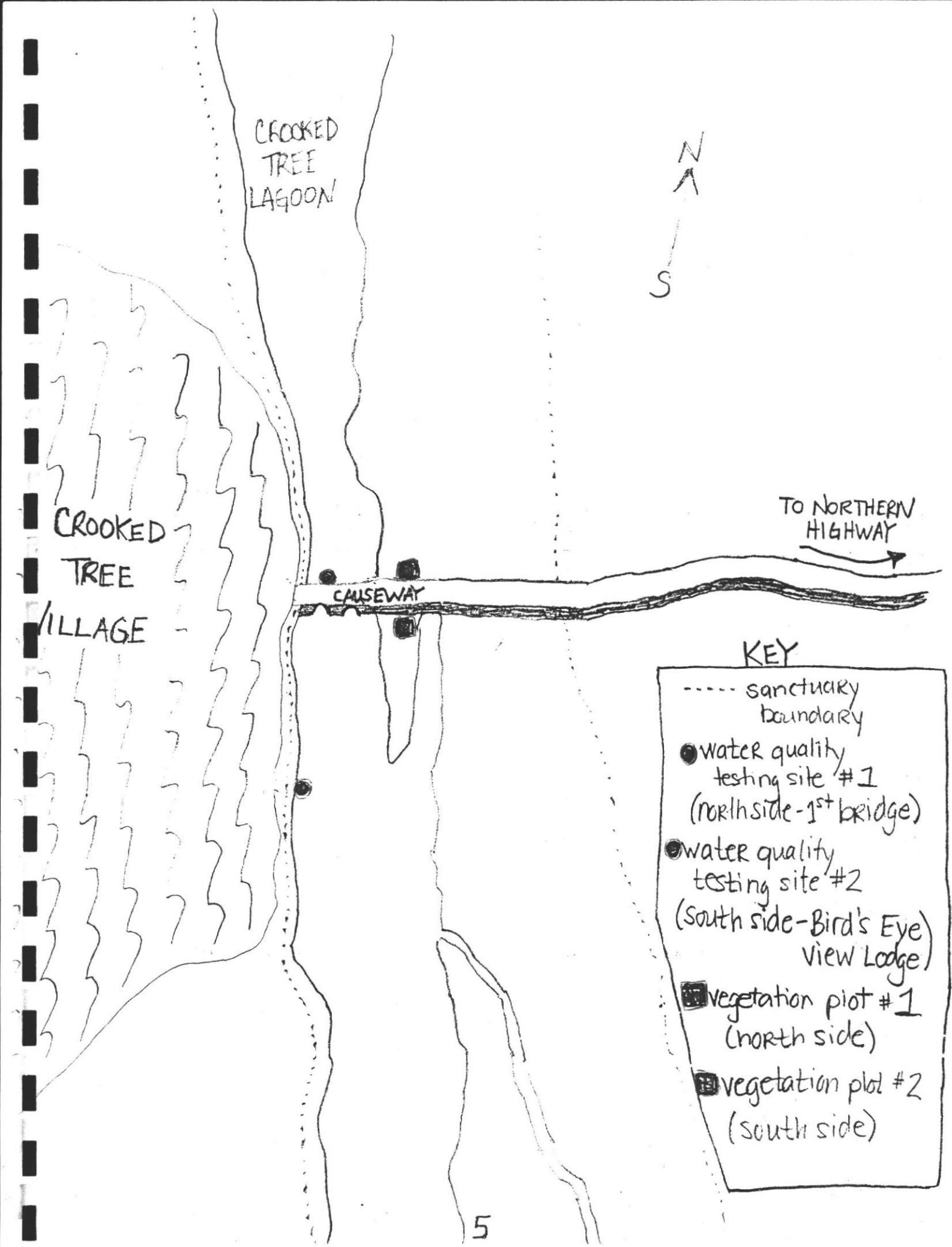

WETLAND VEGETATION IN NORTHERN BELIZE
HERBACEOUS MARSH.....
(rushes, sedges, calabash, and palmetto)
SWAMP FOREST.....
(chucum, logwood, bullet tree, palmetto)
WET AND DRY SAVANNAH.....
(pine, grass, sedges, and oak)
MANGROVE SWAMP.....
(buttonwood, red, white, and black mangroves)
BROAD-LEAVED FOREST.....
(sapodilla, chicle, mahogany, cohune, etc.)
miles 5 0 5 10 15
MEXICO
GUATEMALA
CARIBBEAN SEA
Chetumal
Corozal
Rio Hondo
New River
Orange Walk
Belize City
Belize River
Sibun River
Belmopan

12. Spanish Creek and Southern Lagoon (Crooked Tree Wildlife Sanctuary)



13. Mexico and Jones Lagoons (Crooked Tree Wildlife Sanctuary)




CROOKED TREE LAGOON
N
S
CROOKED TREE VILLAGE
TO NORTHERN HIGHWAY
CAUSEWAY
KEY
----- sanctuary boundary
water quality testing site #1 (north side - 1st bridge)
water quality testing site #2 (south side - Bird's Eye View Lodge)
vegetation plot #1 (north side)
vegetation plot #2 (south side)

SOME BIRDS THAT CAN BE SEEN FROM THE LAGOONS AT THE CROOKED TREE WILDLIFE SANCTUARY

Least Grebe
Pied-billed Grebe
American White Pelican
Olivaceous Cormorant
Anhinga
Least Bittern
Bare-throated Tiger-Heron
Great Blue Heron
Great Egret
Snowy Egret
Little Blue Heron
Tricolored Heron
Cattle Egret
Green-backed Heron
Black-crowned Night-Heron
Yellow-crowned Night-Heron
Boat-billed Heron
White Ibis
Roseate Spoonbill
Jabiru
Wood Stork
Black-bellied Whistling-Duck
Muscovy Duck
Blue-winged Teal
Northern Shoveler
American Wigeon
Lesser Scaup
Black Vulture

Turkey Vulture
Lesser Yellow-headed Vulture
Osprey
Gray-headed Kite
Snail Kite
Common Black-Hawk
Black-collared Hawk
Peregrine Falcon
Ruddy Crake
Purple Gallinule
Common Moorhen
American Coot
Sungrebe
Limpkin
Black-necked Stilt
Northern Jacana
Lesser Yellowlegs
Solitary Sandpiper
Spotted Sandpiper
Least Sandpiper
White-rumped Sandpiper
Baird's Sandpiper
Laughing Gull
Gull-billed Tern
Caspian Tern
Ringed Kingfisher
Belted Kingfisher
Amazon Kingfisher

Green Kingfisher
American Pygmy Kingfisher
Vermilion Flycatcher
Great Kiskadee
Boat-billed Flycatcher
Social Flycatcher
Tropical Kingbird

Tree Swallow
Mangrove Swallow
Northern Rough-winged Swallow
Barn Swallow
Blue-gray Gnatcatcher
Prothonotary Warbler
Red-winged Blackbird

Interview List

The following is a list of people in Crooked Tree who were a source of information to me, either through interviews, or personal communication:

Harry Cadle

Hildebrant Gillet

John Jex

Renny Jones

Ava Tillet

Elvis Tillet

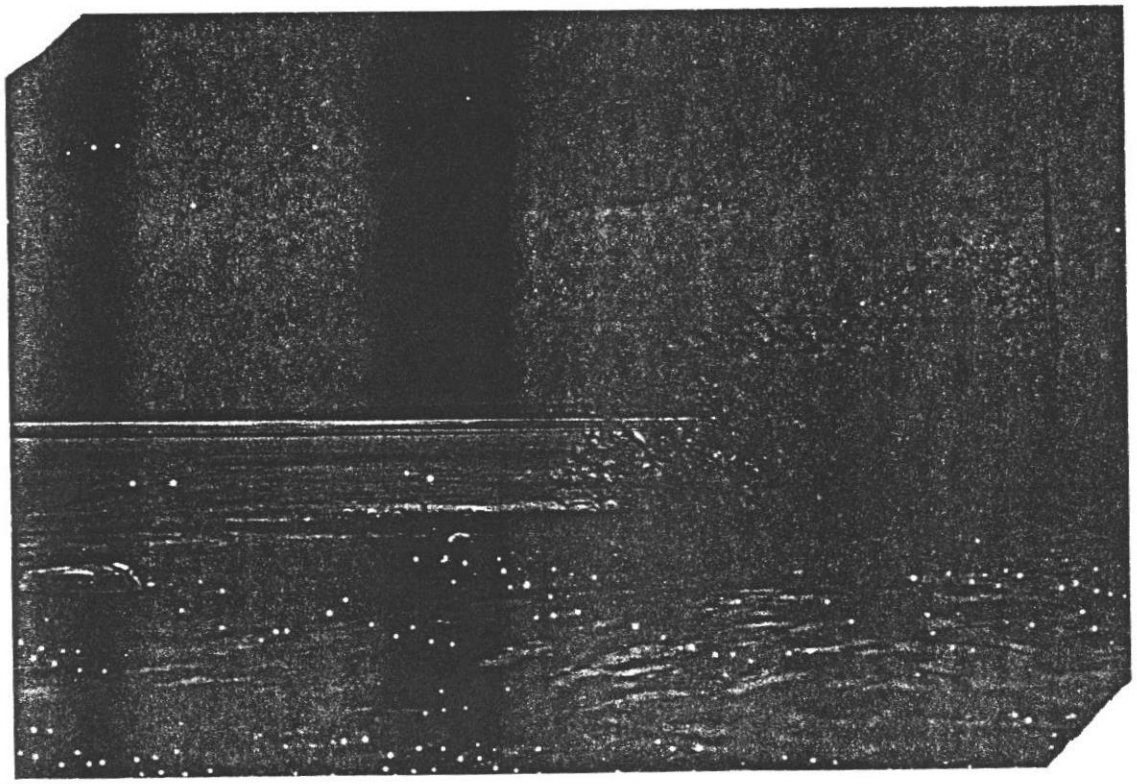
Sam Tillet

Steve Tillet

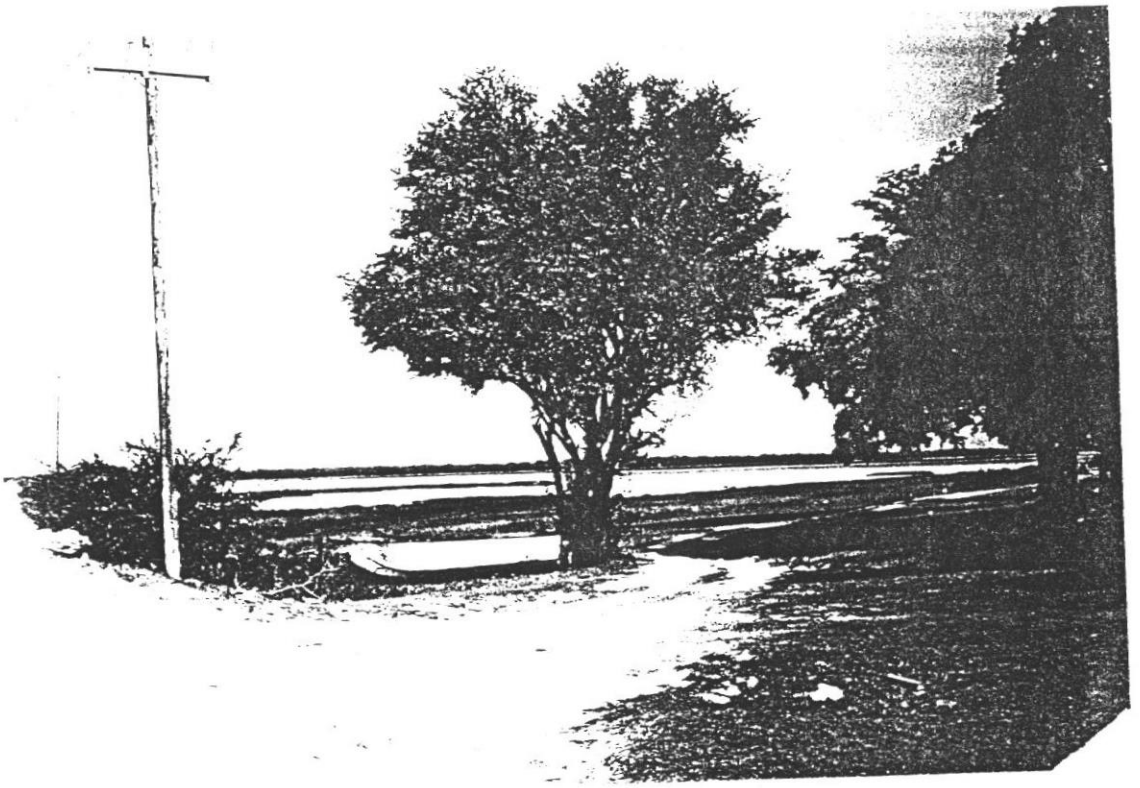
David Wade

Edwin Westby

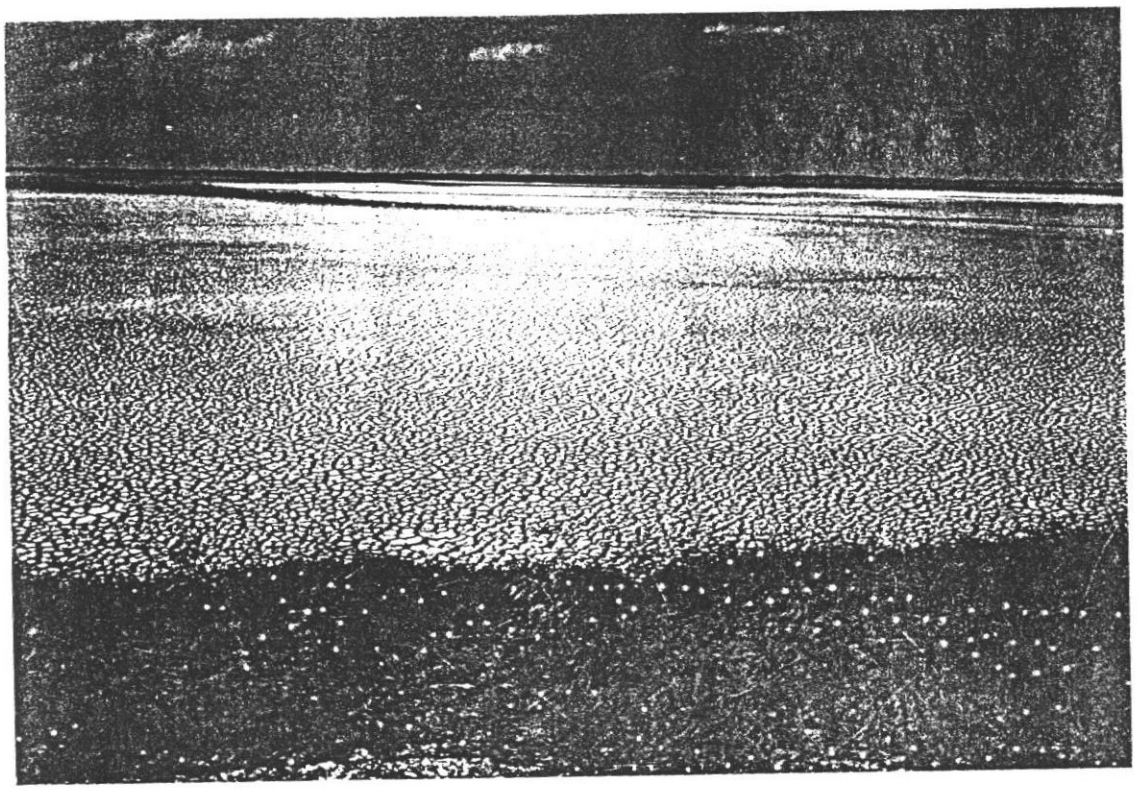
1A A view of the causeway from the intersection at the entrance to the village (North side is to the left)



1B North side of the causeway in the dry season. Lagwood stands can be seen on the horizon

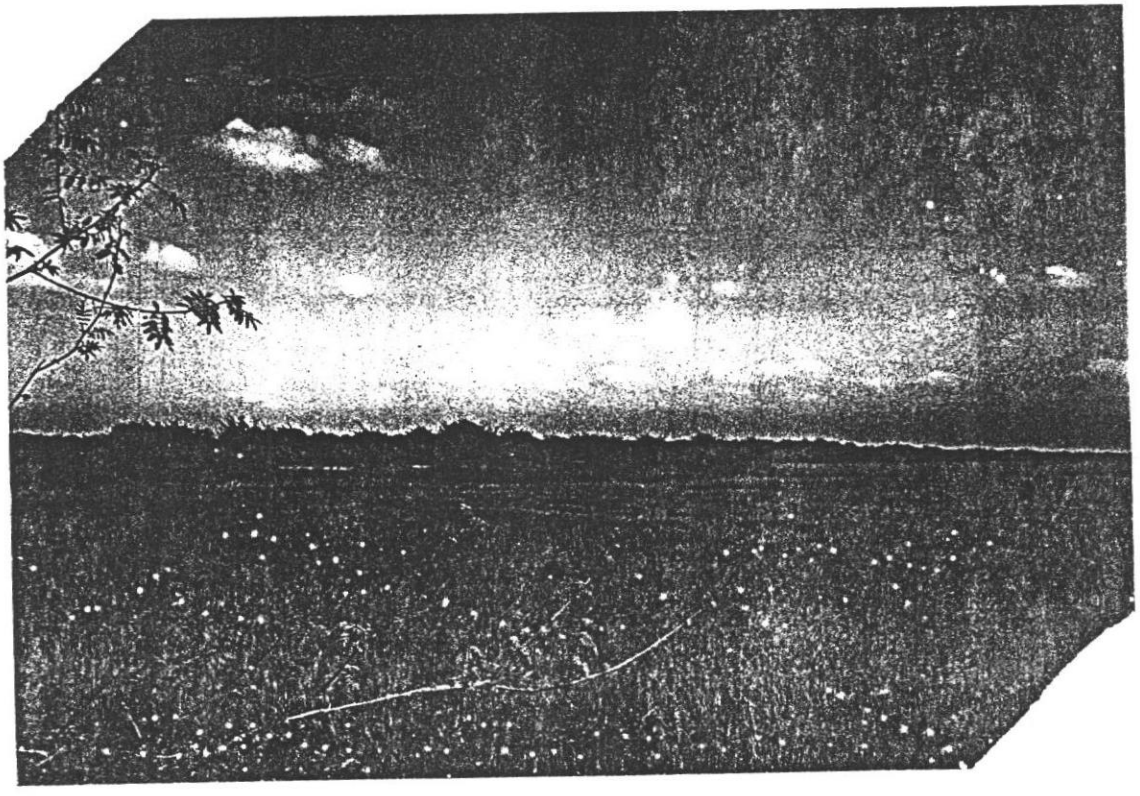


2A South side of the causeway. Logwood trees on the horizon are noticeably greener

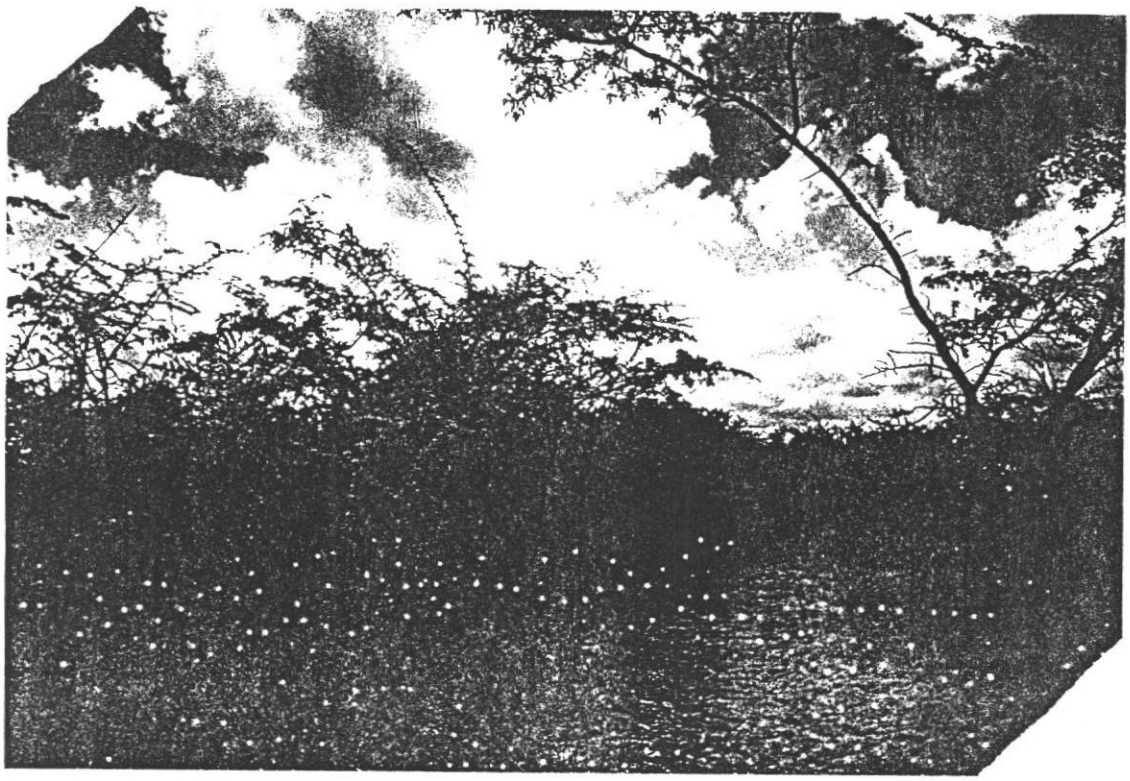


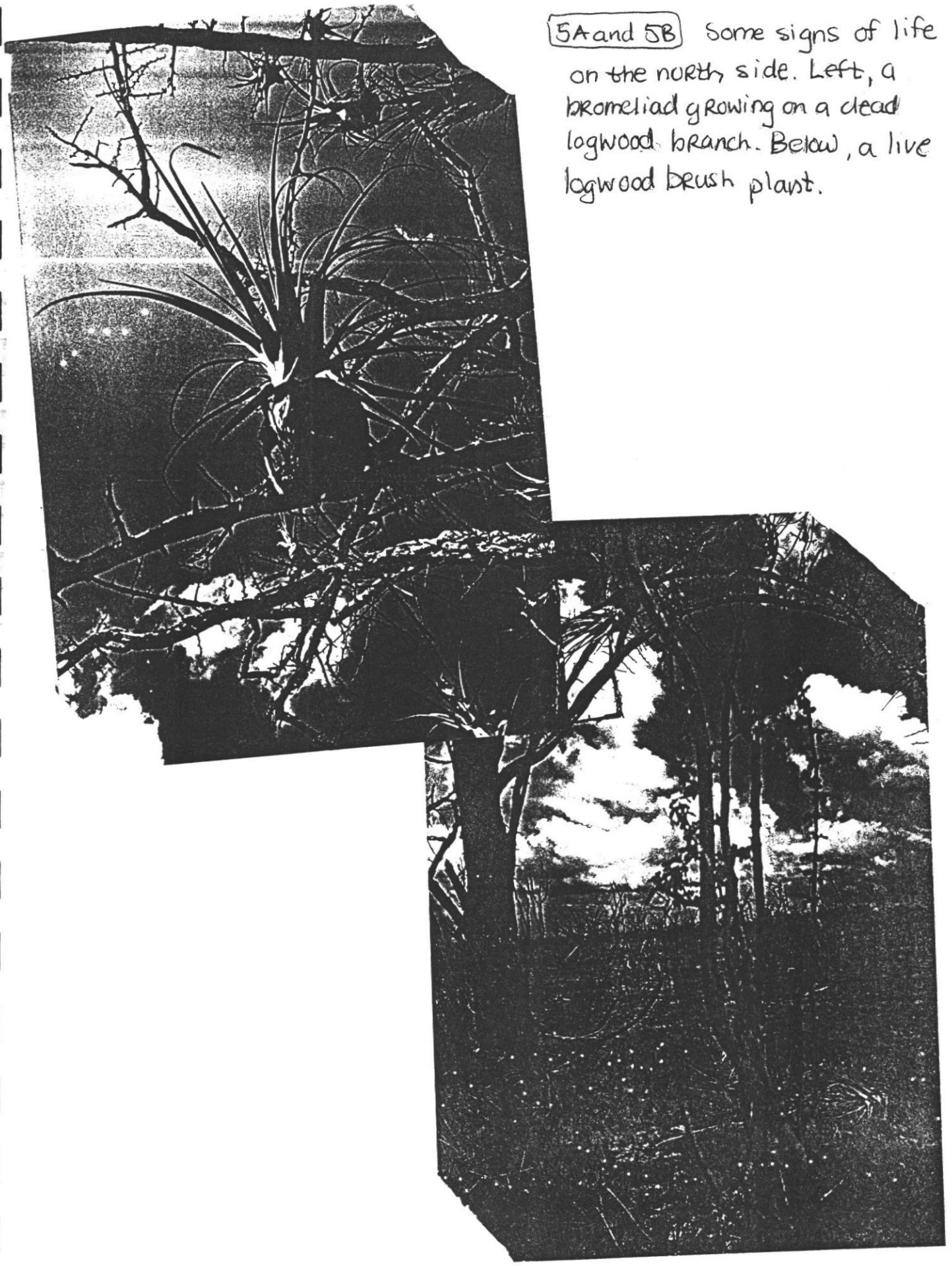
2B The parched cracked soil to the north of the causeway. This area is underwater during the wet season.

[3A and 3B] The logwood stands on the south side (below) are more developed. There is also more ground vegetation showing than on the north side (above).



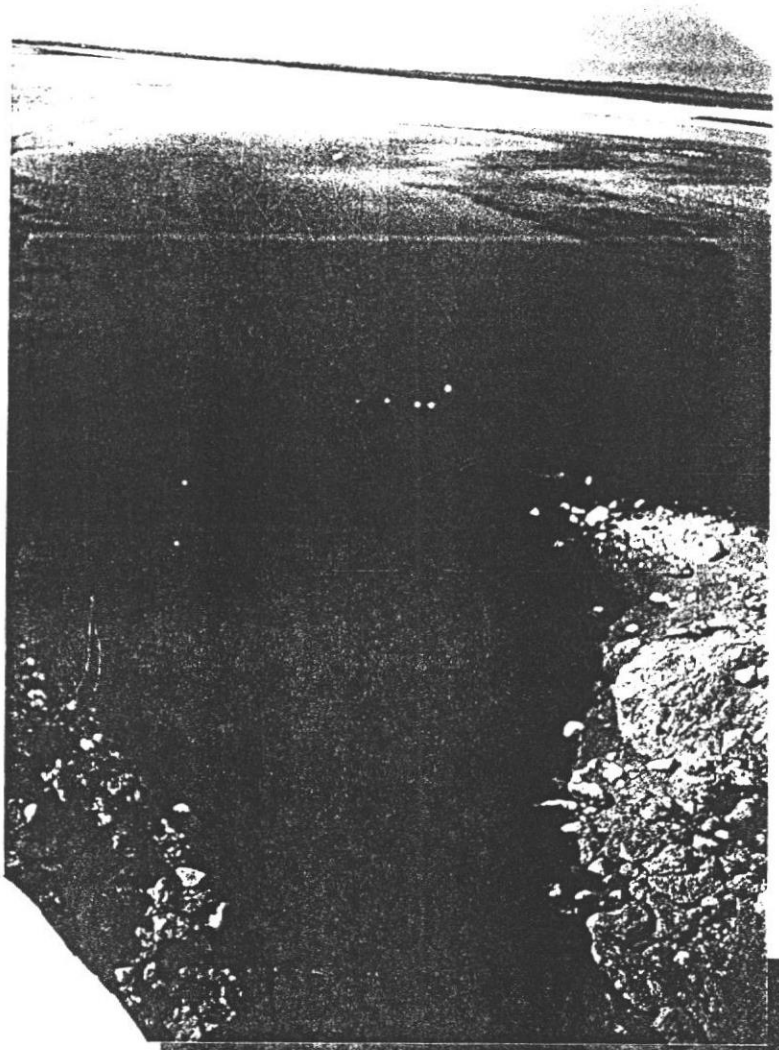
[4A and 4B] A closer look at the contrast between vegetation north of the causeway (above) and south of the causeway (below)





5A and 5B Some signs of life on the north side. Left, a bromeliad growing on a dead logwood branch. Below, a live logwood brush plant.

[6A] Water collecting at the 1st bridge under the causeway - one of the water quality testing sites.



[6B] (below)
South of the causeway

7A One of the "source ponds" found to the western side of the village. Retains more water in the dry season than the Crooked Tree (North) Lagoon.

7B An illustration of one of the benefits of letting water levels decrease naturally - access to fertile grazing ground for horses and cattle.

Water Quality Testing Results

October 29, 1994
Bird's Eye View Lodge

		First bridge- North side
pH	>8.0	8.0
NH3-N	>0.4 ppm	0.8ppm
NO2-N	>0.05 ppm	0.05 ppm
CaCO3	109 ppm	32 ppm
CO2	9 ppm	10 ppm
Cl	57 ppm	56 ppm
CaCO3	162 ppm	356 ppm
Diss. O	5.4 ppm	3.5 ppm
Temp	28° C	30° C

April 1 & 2, 1995
Bird's Eye View Lodge

		First bridge- North side
pH	<9.0	<7.5
NH3-N	<0.6	<0.6
NO2-N	<0.05	<0.05
CaCO3	44	66
CO2	<1	5.1
Cl	96	120
CaCO3	446	508
Diss. O	9.3	3.3
Temp	38° C	28° C

April 11, 1995
Bird's Eye View Lodge

		First bridge- North side
pH	<8.0	9.0
NH3-N	<0.4	<0.8
NO2-N	<0.05	<0.05
CaCO3	108	64
CO2	2	<1
Cl	40	192
CaCO3	-	-
Diss. O	7.8	8.4
Temp	30.5° C	36° C

BELIZE - PROTECTED AREAS

FIELD FORM #1 PROTECTED AREA DESCRIPTION

Identifiers/Location

Protected area name: Cracked Tree W.S. Protected area number: _____

Surveyor: _____ Date: April 13 1995 District: _____ 1:50,000 map number: _____

Belize grid ref: _____ Latitude & Longitude: _____ Elevation range: _____

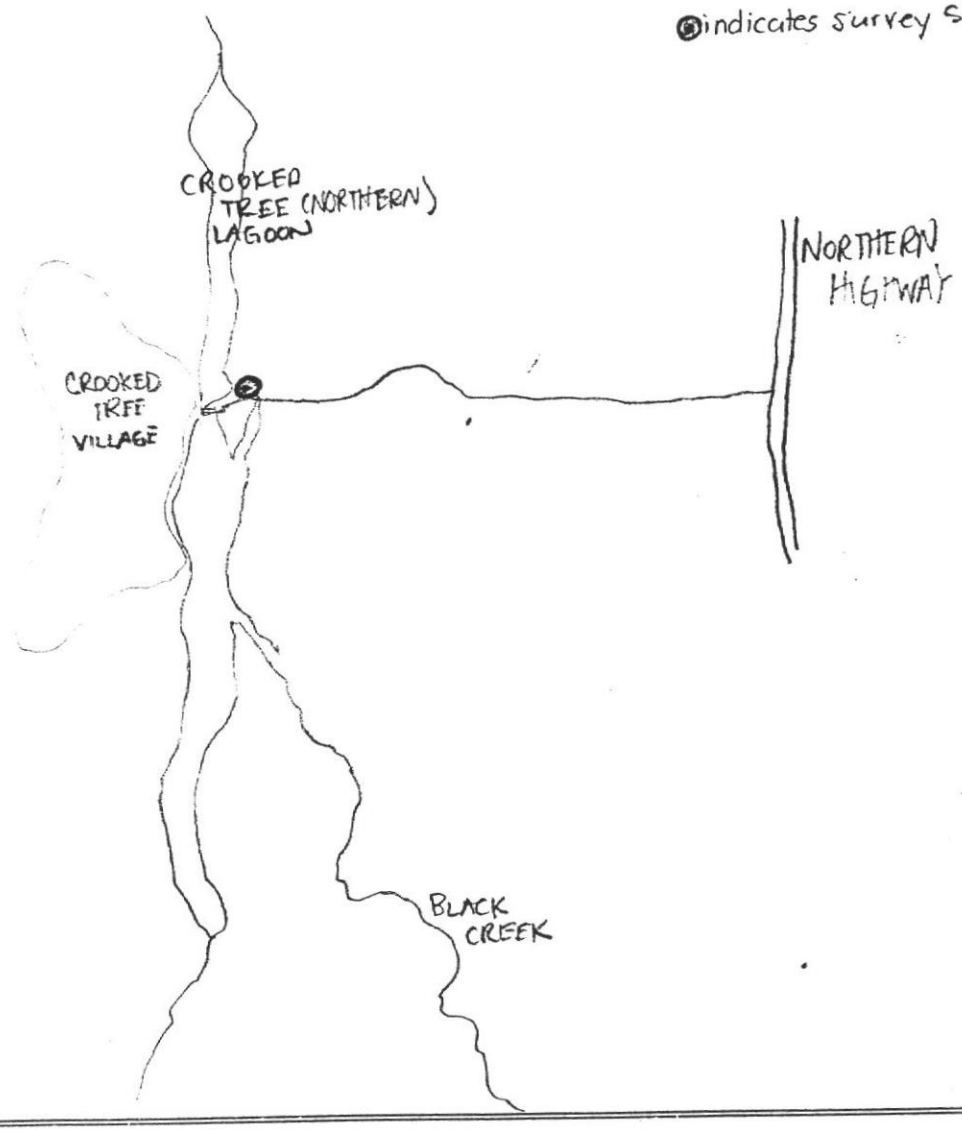
Ownership: _____ Management: Belize Audubon Society

Watershed: _____

Name of principal contact(s): _____

Site location map:

[Append map of area and\or draw diagram indicating numbered survey sites which will correspond to the survey site forms.]



BELIZE - PROTECTED AREAS

FIELD FORM #2 FOR SURVEY SITE INVENTORY

Identifiers/Location

[Cover page for Survey Site Obs Points]
[also for use alone if no Obs Points are recorded]

Protected area name: Crooked Tree W.S. Protected area number: _____

Survey site name: Causeway - North side Survey site number: _____ Surveyor: _____

Date: April 13 '95 1:50,000 map number: _____ Elevation range: _____

Imagery (if used) Type: _____

If aerial photo: roll #: _____ flight line #: _____ frame #: _____ date: _____ 10,10 location: _____

Directions for locating Survey site: Follow causeway out past 2nd bridge. Take path down on left side. Walk in an easterly direction and plot is easily found (marked with string)

Ownership: _____ Management: Belize Audubon Society

Name of principal contact(s): _____

Level of information gathered: Number of Observation Points with species lists: 1 without species lists: _____

If Field form #3 was completed for any Obs. Pts., give Obs. Pt. # and number of Form #3s completed at that Obs. Pt. _____

Miscellaneous comments/observations: _____

Survey site [with observation points]:

[Draw a topographic diagram of the survey site line with observation points and plots (if applicable) marked in.]

OBSERVATION POINT DATA [continuation of field form #2, Page 1 of a set of 3 pages for Obs Point data]

Protected area name: Crooked Tree W.S. Protected area number: _____

Survey site name: Causeway - North side Survey site number: _____

Observation point number: _____ O.P. photograph, photographer: _____ Roll and frame #: _____

Lat. & Long.: _____ Belize grid ref: _____ Elevation: _____

Date: April 13 95 Aspect: (N,NE,E,SE,S,SW,W,NW or degrees of North)_____

Community name:_____ Number of Field form #3 plots: _____

Depth of Information gathered	Topography	Slope (degrees)	Ecological System	Physiognomic class
X general information (field form #2)	___ summit	X flat, 0 - 4	___ estuarine	___ multiple canopy forest
Y general species list (field form #2 list)	___ step in slope	___ gentle, 4 - 5	___ lacustrine	X single canopy forest
___ plot or transect (field form #3)	___ slope	___ moderate, 6 - 14	___ riverine	___ woodland
	___ plateau	___ somewhat steep, 15 - 26	___ palustrine	___ scrub
	___ cliff	___ steep, 27 - 45	X terrestrial	___ tree savanna
	___ valley	___ very steep, 45 - 69	___ subterranean	___ shrub savanna
	___ plain	___ abrupt, 70 - 100		___ grassland
	X other	___ overhanging, >100		___ fernland
				___ mixed herbaceous
				___ sparsely vegetated
				___ non-vascular
				___ non-vegetated
				___ other

SOIL

Bedrock: igneous ____ sedimentary ____ metamorphic ____ Soil type: alluvial

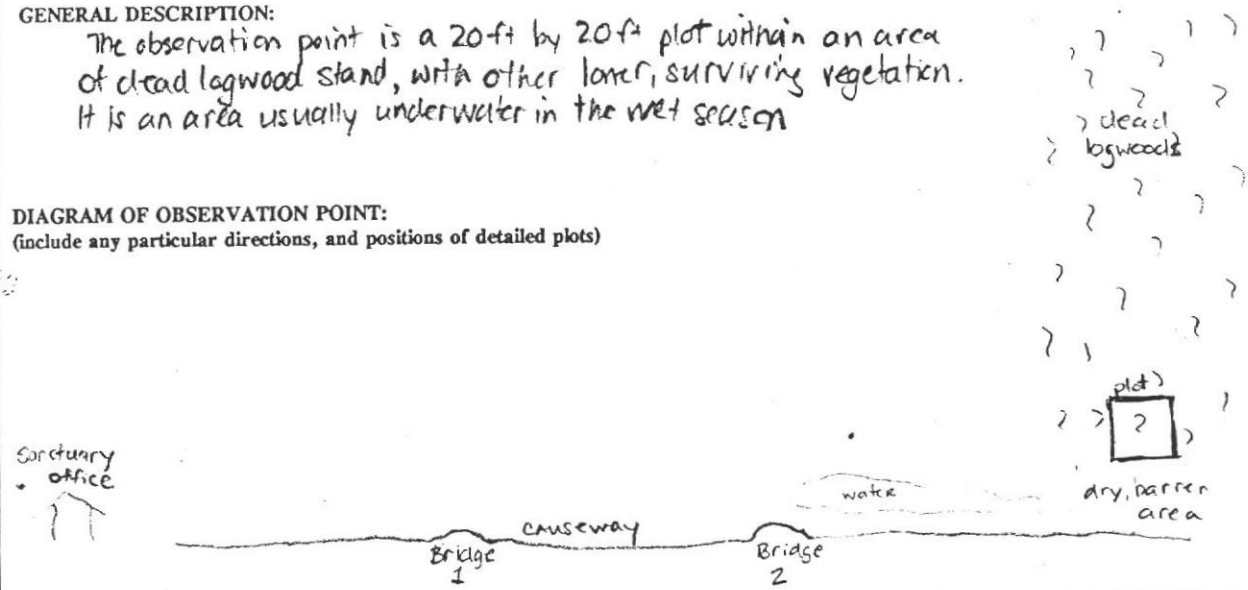
Colour: light brown __ dark brown __ black __ red __ orange__ yellow__ ochre__ other X grey brown Depth of litter layer: Miscont.

Texture		Structure	Drainage
____ clay	____ clay loam	____ blocklike	____ waterlogged
____ silt	____ sandy clay loam	____ platelike	____ very poor
____ sand	X silty loam	X crumb	____ poor
____ loam	X other silty clay loam	____ single-grained	____ moderate
____ sandy loam		____ massive	X well drained

GENERAL DESCRIPTION:

The observation point is a 20-ft by 20-ft plot within an area of dead logwood stand, with other lower, surviving vegetation. It is an area usually underwater in the wet season

DIAGRAM OF OBSERVATION POINT:
(include any particular directions, and positions of detailed plots)



OBSERVATION POINT DATA [continuation of field form #2, Page 2 of a set of 3 pages for Obs Point data]

Survey site name: Causeway - North Side Observation Point number: _____ Date: April 13 1995

CONSERVATION (fill out the options below to indicate the conservation potential or condition of the community (the EO) under study).

EO quality: (ie, how representative is this occurrence? Consider the size of the patch and the vitality and vigour of the plants)
(A) - Excellent B - Good C - Marginal D - Poor

EO condition: (ie, is the community pristine or degraded? Is there a potential for the community to recover from disturbances?)
A - Excellent B - Good C - Marginal (D) - Poor

EO viability: (ie, what are the long term prospects for continued existence of this occurrence at the indicated level of quality?)
A - Excellent B - Good (C) - Marginal D - Poor

EO defensibility: (ie, can this occurrence be protected form extrinsic human factors?)
A - Excellent (B) - Good C - Marginal D - Poor

EO rank: (conservation potential/importance of this community occurence, summary of all criteria above): A B C D

Evidence of disturbance (cut or burned stumps, trails, etc): causeway's interference with drainage pattern; some cut + uprooted stumps

Principal threats: _____

Rare species: _____

STRUCTURAL PROFILE

Leaf type: broadleaf X needleleaf ___ mixed ___

Successional stage: early ___ middle ___ late X Leaf loss periodicity: evergreen X deciduous ___ mixed ___

Stratum	Height (m)	Cover of layer	Dominant species/families--Cover of Dominants
Tree layers	- one layer		Haematoxylum campechianum
Emergent			
Canopy	approx 3 m	minimal	
Subcanopy			
Shrub layers			
1	1 m		logwood brush
2			
3			
Herb layers			
Graminoid	.5 m		Mimosa, Sour grass, susumber, ball stomach, nicatee berry } local names
Forb			
Mixed			
Others			
Bryophytes			
Lianas			
Epiphytes	-		bromeliad / orchid

Unvegetated surface: bare soil X stones & gravel ___ leaf litter ___ bedrock ___ sand ___ woody debris X water ___

Cover: 7=95-100%; 6=75-95%; 5=50-75%; 4=25-50%; 3=5-25%; 2=1-5%, 1=0-1% 6

OBSERVATION POINT DATA [continuation of field form #2, Page 3 of a set of 3 pages for Obs Point data]

GENERAL SPECIES LIST (list animals and plants on separate pages)

Survey site name: Causeway - North side Observation Point number: _____ Date: April 13 1995

Species	Cover-Abundance	Comments
Haematoxylum campechianum	5%	dead, uprooted [illegible] (some), rocks
logwood brush	5%	alive
sour grass	80%	
mimosa	2%	
ballstomach	<1%	
susumber	5%	
hicatee berry	2%	

BELIZE - PROTECTED AREAS

FIELD FORM #1 PROTECTED AREA DESCRIPTION

Identifiers/Location

Protected area name: Crooked Tree W.S. Protected area number: _____

Surveyor: _____ Date: April 13 '95 District: _____ 1:50,000 map number: _____

Belize grid ref: _____ Latitude & Longitude: _____ Elevation range: _____

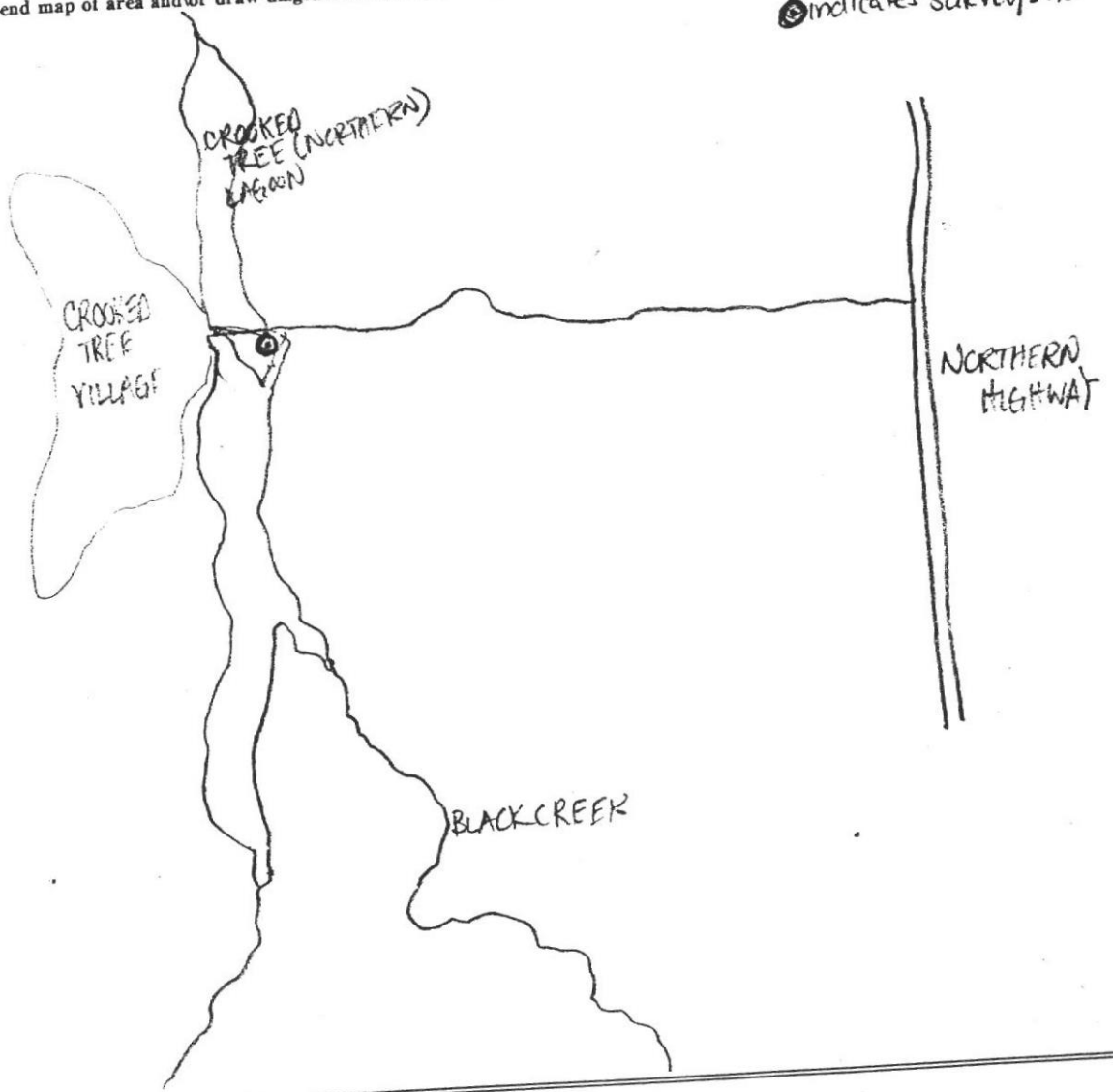
Ownership: _____ Management: Belize Audubon Society

Watershed: _____

Name of principal contact(s): _____

Site location map:

[Append map of area and\or draw diagram indicating numbered survey sites which will correspond to the survey site forms.]



BELIZE - PROTECTED AREAS

FIELD FORM #2 FOR SURVEY SITE INVENTORY

[Cover page for Survey Site Obs Points]
[also for use alone if no Obs Points are recorded]

Identifiers/Location

Protected area name: Crooked Tree W.S. Protected area number: _____

Survey site name: Causeway - South Side Survey site number: _____ Surveyor: _____

Date: April 13 '95 1:50,000 map number: _____ Elevation range: _____

Imagery (if used) Type: _____

If aerial photo: roll #: _____ flight line #: _____ frame #: _____ date: _____ 10,10 location: _____

Directions for locating Survey site: Follow causeway out past 2nd bridge. Take path on right-hand side

Ownership: _____ Management: Belize Audubon Society

Name of principal contact(s): _____

Level of information gathered: Number of Observation Points with species lists: 1 without species lists: _____

If Field form #3 was completed for any Obs. Pts., give Obs. Pt. # and number of Form #3s completed at that Obs. Pt. _____

Miscellaneous comments/observations: _____

Survey site [with observation points]:

[Draw a topographic diagram of the survey site line with observation points and plots (if applicable) marked in.]

OBSERVATION POINT DATA [continuation of field form #2, Page 1 of a set of 3 pages for Obs Point data]

Protected area name: Crooked Tree W.S. Protected area number: _____

Survey site name: Causeway-South side Survey site number: _____

Observation point number: _____ O.P. photograph, photographer: _____ Roll and frame #: _____

Lat. & Long.: _____ Belize grid ref: _____ Elevation: _____

Date: April 13 1995 Aspect: (N,NE,E,SE,S,SW,W,NW or degrees of North) _____

Community name: _____ Number of Field form #3 plots: _____

Depth of Information gathered	Topography	Slope (degrees)	Ecological System	Physiognomic class
X general information (field form #2)	___ summit	X flat, 0 - 4	___ estuarine	___ multiple canopy forest
X general species list (field form #2 list)	___ step in slope	___ gentle, 4 - 5	___ lacustrine	X single canopy forest
___ plot or transect (field form #3)	___ slope	___ moderate, 6 - 14	___ riverine	___ woodland
	___ plateau	___ somewhat steep, 15 - 26	___ palustrine	___ scrub
	___ cliff	___ steep, 27 - 45	X terrestrial	___ tree savanna
	___ valley	___ very steep, 45 - 69	___ subterranean	___ shrub savanna
	___ plain	___ abrupt, 70 - 100		___ grassland
	X other	___ overhanging, >100		___ fernland
				___ mixed herbaceous
				___ sparsely vegetated
				___ non-vascular
				___ non-vegetated
				___ other

SOIL

Bedrock: igneous ____ sedimentary ____ metamorphic ____ Soil type: alluvial

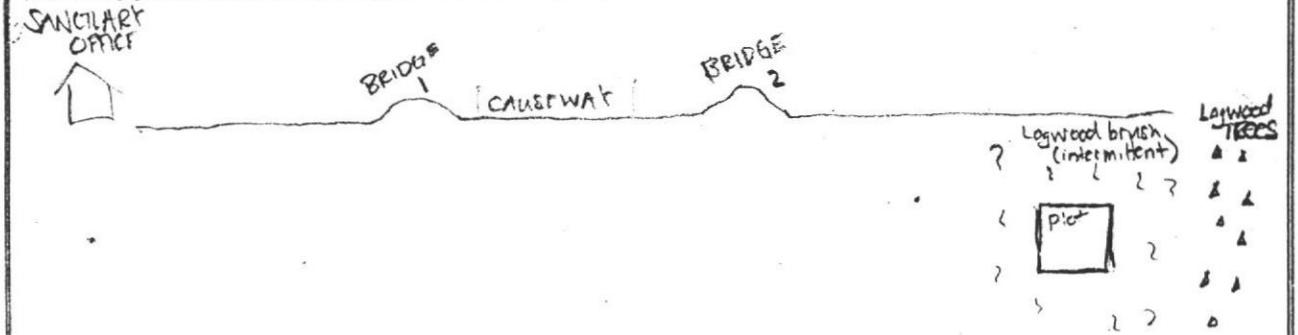
Colour: light brown __ dark brown __ black __ red __ orange__ yellow__ ochre__ other X grey brown Depth of litter layer: discont

Texture		Structure	Drainage
____ clay	____ clay loam	____ blocklike	____ waterlogged
____ silt	____ sandy clay loam	____ platelike	____ very poor
____ sand	____ silty loam	X crumb	____ poor
____ loam	X other silty clay loam	____ single-grained	____ moderate
____ sandy loam		____ massive	X well drained

GENERAL DESCRIPTION:

The observation point is a 20 ft by 20 ft plot within an area of logwood brush, and other scrubby vegetation. Slightly further east and west are located ridges of tire logwood trees. It is an area usually underwater in the wet season.

DIAGRAM OF OBSERVATION POINT:
(include any particular directions, and positions of detailed plots)



OBSERVATION POINT DATA [continuation of field form #2, Page 2 of a set of 3 pages for Obs Point data]

Survey site name: Causeway - South Side Observation Point number: _____ Date: April

CONSERVATION (fill out the options below to indicate the conservation potential or condition of the community (the EO) under study).

EO quality: (ie, how representative is this occurrence? Consider the size of the patch and the vitality and vigour of the plants)
A - Excellent (B) - Good C - Marginal D - Poor

EO condition: (ie, is the community pristine or degraded? Is there a potential for the community to recover from disturbances?)
(A) Excellent B - Good C - Marginal D - Poor

EO viability: (ie, what are the long term prospects for continued existence of this occurrence at the indicated level of quality?)
(A) - Excellent B - Good C - Marginal D - Poor

EO defensibility: (ie, can this occurrence be protected form extrinsic human factors?)
A - Excellent (B) Good C - Marginal D - Poor

EO rank: (conservation potential/importance of this community occurence, summary of all criteria above): A (B) C D

Evidence of disturbance (cut or burned stumps, trails, etc): a few trails through brushy area

Principal threats: _____

Rare species: _____

STRUCTURAL PROFILE

Leaf type: broadleaf____ needleleaf____ mixed____

Successional stage: early ____ middle ____ late ____ Leaf loss periodicity: evergreen ____ deciduous ____ mixed ____

Stratum	Height (m)	Cover of layer	Dominant species/families--Cover of Dominants
Tree layers Emergent	one layer		Haematoxylum campechianum
Canopy	approx	Substantial	
Subcanopy	10m		
Shrub layers 1	1 m		logwood brush
2			
3			
Herb layers Graminoid			ball stomach 3 mimosa nicatee berry dog tone } local names
Forb	.5m		
Mixed			
Others Bryophytes			
Lianas			
Epiphytes			

Unvegetated surface: bare soil X stones & gravel ____ leaf litter ____ bedrock ____ sand____ woody debris ____ water____

Cover: 7=95-100%; 6=75-95%; 5=50-75%; 4=25-50%; 3=5-25%; 2=1-5%, 1=0-1% 7

OBSERVATION POINT DATA [continuation of field form #2, Page 3 of a set of 3 pages for Obs Point data]

GENERAL SPECIES LIST (list animals and plants on separate pages)

Survey site name: [illegible] Observation Point number: ________ Date: [illegible]

Species	Cover-Abundance	Comments
Haematoxylum campechianum		alive
logwood [illegible]	3%	
mimosa	1%	
ball stmoch	94%	
hicatee berry	1%	
dog tone	1%	