PREDICTIVE MODEL FOR ANCIENT MAYA SETTLEMENT: THE ARCHAEOLOGICAL RESOURCES OF THE RIO BRAVO CONSERVATION AREA, BELIZE

BY

Anabel Ford
Community and Organization Research Institute
University of California, Santa Barbara

Scott L. Fedick
Department of Anthropology
University of California, Riverside

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ABSTRACT

The Programme for Belize is a consortium of Belizean and international organizations dedicated to the preservation of natural and cultural resources within Belize, Central America. The Coca-Cola Foods Corporation has donated 42,000 acres of tropical forest and wetlands to the Programme, and an additional 110,000 adjacent acres are being purchased. This property, called the Rio Bravo Conservation Area, is situated within the eastern periphery of the central Maya lowlands. The Programme for Belize recognizes archaeological resource management as an important aspect of conservation planning, and, as a first step, has sponsored a preliminary archaeological reconnaissance project, described herein. This project involved aerial and ground survey, and the mapping of a major center known as La Milpa. The results of the reconnaissance, as well as background research, indicate an abundance of archaeological resources including prehistoric Maya centers, habitation sites, and agricultural features. These resources are described with reference to more comprehensive surveys in other areas of the central Maya lowlands, and recommendations for future management and research are presented. It is suggested that knowledge of associations between prehistoric Maya settlement and land resources will be very useful in the prediction of site density distributions for management purposes.

INTRODUCTION

The tropical lowlands of Belize, now a sparsely settled region with an average of 6 persons per km2 (World Bank 1984), was the homeland of one of the most accomplished civilizations of the prehistoric world: the ancient Maya. The Maya initially settled in the lowlands more than 3,000 years ago and over the course of prehistory were able to support populations which may have been more than twenty time those of today (see Turner 1990). This ancient civilization was an agrarian one which was dependent upon the natural resources of the area as the basis for their subsistence economy. For the ancient Maya, knowledge of natural resources--and how to manage them to assure sustained subsistence production--was a vital component of their complex society.

The Rio Bravo Conservation Area, administered by the Programme for Belize, offers a unique challenge for archaeological resource management. This area is situated within the eastern periphery of the central Maya lowlands (Figure 1), and is characterized by a great deal of environmental diversity (Wright et al. 1959:195-211). The Programme for Belize recognizes archaeological resources management as an important aspect of conservation planning, and as a first step, has sponsored an archaeological reconnaissance project that was carried out in August of 1988, and reported herein. The Programme for Belize is a consortium of Belizean and international organizations dedicated to the preservation of natural and cultural resources within Belize. Coca-Cola Foods Corporation has donated 42,000 acres of tropical forests and wetlands to the Programme, and an additional 110,000 adjacent acres are being purchased. Belizean land owner Mr. Barry Bowen has volunteered to apply the conservation guidelines of the Programme for Belize to his 130,000 acres of land situated adjacent to, and south of, the Rio Bravo Conservation Area.

Long term archaeological and environmental research in the Rio Bravo Conservation Area promises a major data base that will allow refinement of our understanding of past land use and settlement organization, and will help structure future development of the area for natural history and archaeological tourism and appropriate agroforestry projects (see Garrett 1989). The conservation and management goals of the Programme for Belize are very much in accord with a human systems ecology approach to the study of prehistoric Maya resource management and political economy (Bennett 1976, 1985; Burton et al. 1986).

This preliminary archaeological study of the Rio Bravo Conservation Area is designed to provide a general basis for the management of cultural resources. After a general background on Maya prehistory, we describe the land resources of the Conservation Area and what they signify for ancient Maya settlement. We then describe the field work which focused on gathering preliminary information on archaeological site distribution. Following this is a discussion of the results of the field work. These results and the expectations based on them are compared with adjacent areas in an effort to develop an initial basis for understanding the nature and distribution of archaeological resources in the region. Finally, we present a series of basic recommendations for management of cultural resources in the Rio Bravo Conservation Area. An earlier draft report of our findings was provided to the Programme for Belize and the Belize Department of Archaeology (Ford and Fedick 1988), and a summary of that report has been presented to the archaeological community (Ford and Fedick 1989).

BACKGROUND ON MAYA PREHISTORY

Scholars studying Classic Maya development (Table 1) suggest that early expansion of pioneer farmers moved from coastal areas up rivers into the interior (Puleston and Puleston 1971, 1972; Rice and Puleston 1981; Voorhies 1982; see also Adams 1977). Subsequently, population growth in the central lowlands has been documented in all investigated areas from initial occupation in the Middle and Late Preclassic through the Late Classic periods (Ashmore 1981; Ford 1986; Fry 1969; Puleston 1973; Rice 1976; Turner 1990). Administrative centers emerge in the Late Preclassic, and the first dated monuments mark the beginning of the Early Classic period in the interior core and the lakes areas to the south (Rice 1976; Marcus 1976). The Late Classic period witnesses acceleration of building at centers all over the central lowland area.

Notable local variations in settlement chronology and patterns (Ashmore 1981) are evident for the three major areas of the central lowland region: the peripheral riverine, southern lakes, and interior core areas. Major centers of the core area generally were composed of more than 20 courtyard complexes (e.g., Tikal, Uaxactun), centers of the lakes areas averaged from 10 to 20 courtyards (e.g., Yaxha, Tayasal), and the centers of the eastern riverine areas had only around 5 courtyard complexes (Adams and Jones 1981:305). These data suggest regional variations in economic and political relations among distant hierarchically organized communities during Classic times. It appears the variability in settlement organization and land use is, to a large extent, dependent upon the distribution and nature of land resources in the different areas (Fedick and Ford 1990).

CULTURAL RESOURCE MANAGEMENT, PREHISTORIC SETTLEMENT, AND LAND RESOURCES

In planning for the management of archaeological resources, initial concerns of the Programme for Belize are the potential number and distribution of archaeological sites within the area. Recent research has demonstrated that the general pattern of prehistoric Maya settlement in the central Maya lowlands was strongly and consistently structured by land resources (Fedick 1989; Fedick and Ford 1990; Ford 1986; see also Bullard 1960; Green 1973; Puleston 1973; Rice 1976; Sanders 1973, 1977). The diversity of land resources in the Rio Bravo Conservation Area holds significant implications for studying prehistoric Maya settlement and land use. In this report, we provide a tentative evaluation of settlement and land resource relationships within the Rio Bravo Conservation Area which is based on the available land resource data (Wright et al. 1959) and our studies of prehistoric Maya settlement in other parts of the central Maya lowlands (Fedick 1988a, 1989; Fedick and Ford 1990; Ford 1981, 1985, 1986). The environment and settlement relationships we identify provide the basis of an archaeological resource management program which can be tested and used in the area.

Hypothesized settlement and land resource relationships have been tested and proven to be highly successful in the prediction of archaeological site densities in the upper Belize River area, situated immediately south of the Rio Bravo Conservation Area (Fedick 1985, 1988a, 1989). Modeling of settlement patterns for the upper Belize River area was based on the evaluation of land resources in terms of agricultural capability under hand-cultivation technology. Evaluation of land resources is a form of economic analysis in which potential productivity of land types are assessed by comparing the required labor and capital inputs with the potential goods produced (see Davidson 1980; FAO 1976). After land types are evaluated, their extent, or relative abundance, figures predominantly in the assessment of their potential contribution to the subsistence economy of an area.

The patterned relationship between settlement and land resources enables predictions to be made regarding site densities among various land types, while simultaneously providing a basis for studying Maya social organization and agricultural development. Predictive modeling is of tremendous value to the development of cultural resource management plans, and has been applied to many areas of the world (Judge and Sebastian 1988; Kohler and Parker 1986). The adaptation and application of predictive modeling will be of great value to cultural resource management for the Programme for Belize.

THE PHYSICAL SETTING OF THE RIO BRAVO CONSERVATION AREA

Introduction

The Rio Bravo Conservation Area is situated in northwestern Belize between the Guatemalan border and the New River (Figure 2). This zone is inland from the coast, where some of the earliest Maya occupation has been identified, and on river routs which likely were used to reach the core area around Tikal. The terrain of the area descends from west-northwest to east-southeast, with gradual dipping of the limestone bedrock accompanied by faulting. Three main faults running generally north-northeast and south-southwest form distinct escarpments and define the courses of the Rio Bravo, Booth's River, and the New River (Figure 2).

The Rio Bravo Conservation Area is included within the Gallon Jug Development Region, as defined originally by the British Honduras Land Use Survey Team (Wright et al. 1959:195-211). The survey team report (ibid.) divided the Gallon Jug Region into eastern and western subregions. The Booth's River Escarpment forms the boundary between the two subregions: the Hills Subregion to the west, and the Lowlands Subregion to the east (Figure 2). These two subregions differ markedly in terrain, hydrology, soils, and vegetation. As a result of these environmental differences, these two physiographic subregions present significantly different settings for the study of prehistoric Maya development.

The Hills Subregion

The limestone of the Hills Subregion is deeply but incompletely weathered. As a result, the Eocene limestone bedrock is covered by a deep mantle of limestone gravel and boulders. The soils formed on top of this mantle are primarily shallow gravelly clays with good drainage, workability, and fertility characteristics.

The hilly terrain provides for a great deal of small-scale variability in soil and vegetation patterns. The highest terrain, reaching over 200 m above sea level, is found between the Guatemalan border and the Rio Bravo Escarpment. The steeper hill slopes of the area have quite thin soils of only 10-15 cm depth, while the more level areas have soils up to 50 cm deep. The vegetation in this area is dominated by deciduous seasonal forest between 20 and 30 m in height. This forest is characterized by numerous species of large trees including mahogany (Swietenia macrophylla), sapodilla (Manilkara zapote), and Ramon (Brosimum alicastrum).

Small swamps and seasonally inundated areas are found in shallow depressions, supporting in turn low and high marsh forest vegetation associations. Low marsh forest, referred to locally as "akalche", is characterized by

logwood (Haematoxylon campechianum) and chucum (Pithecolobium albicans), while high marsh, known as "bajo", is dominated by botan palm (Sabal mauritiiformis), chichem (Metopium brownei and Cameraria belizensis), and cohune palm (Orignya cohune).

The terrain between the Rio Bravo Escarpment and the Booth's River Escarpment is gently undulating, with a greater proportion of both low and high marsh forest than is found in the rest of the Hills Subregion. Also characteristic of this area are patches of flat land strongly dominated by cohune palm (Oribignya cohune).

The Lowlands Subregion

The 45-60 m Rio Bravo Escarpment marks the boundary between the Hills Subregion and the Lowlands Subregion. Minor scarps are also found within the Lowlands Subregion, such as one running along the northern and western sides of Irish Creek. Colluvial swamps have formed at the foot of these minor escarpments. Most of the bedrock in the subregion is hard limestone of the Paleocene or Lower Eocene epoch, capped by softer Miocene limestone with a few remnant patches of Pleistocene coastal deposits (Flores 1952; Wright et al. 1959:205). The terrain of the area is flat to very gently undulating, and soils are mostly clays with impeded drainage.

Vegetation of the Lowlands Subregion is primarily low to high marsh forest, with restricted patches of deciduous seasonal forest and cohune forest. Extensive areas of herbaceous swamp, known locally as "sibal", are associated with the colluvial deposits along Booth's River and Irish Creek. Savanna vegetation associations containing oak (Quercus oleoides), palmetto (Acoelorraphe wrightii), and pine (Pinus caribaea), occur within the Pleistocene coastal deposits found east of Booth's River in the northern part of the Lowland Subregion.

LAND RESOURCES OF THE RIO BRAVO CONSERVATION AREA AND THE IMPLICATIONS FOR PREHISTORIC MAYA SETTLEMENT

Prior to the initiation of our archaeological reconnaissance, a preliminary map and land resource evaluation of the Rio Bravo Conservation Area was prepared as a field-guide (Fedick 1988b) using the currently available data (Wright et al. 1959). Modified versions of the land evaluations based on the soils (Table 2) and map (Figure 2) are presented here. The land resources of the Gallon Jug Region and the Rio Bravo Conservation Area can be divided into six general land types, each of which carries different implications for prehistoric Maya land use. These land types consist of 1) well-drained uplands, 2) slow-drained lowlands, 3) riverine-associated swamps, 4) closed-depression seasonal swamps, 5) savannas, and 6) escarpments. Land resource types are distributed differentially over the Rio Bravo Conservation Area and are detailed below. The identified variations have specific consequences for Maya land use and settlement distribution.

Well-Drained Uplands

The well-drained uplands consist of rolling limestone hills and ridges with relatively shallow but fertile soils. Although depth to bedrock limits the potential for development of these soils for modern mechanical cultivation, they hold high productive capacity under hand-cultivation systems, such as used by the ancient Maya. The main hazard to cultivation is erosion resulting from forest clearance, particularly on steep hill-sides.

Modern Maya farmers consider well-drained upland soils to be the most productive for "traditional" wet season swidden (slash-and-burn) cultivation (see Carter 1969:20-31). Within the well-drained uplands, a variety of intensive cultivation methods can be applied which, if properly managed, would maintain productivity. These methods include sustained yield multi-crop swiddening, fixed plot cultivation incorporating soil amendments to sustain fertility and structure, terracing, arboriculture, and various forms of forest management (see Gomez Pompa 1987; Nations and Nigh 1980; Netting 1977; Puleston 1982; Turner 1983a; Wilken 1987).

Archaeological surveys within well-drained uplands in other areas of the central Maya lowlands have documented settlement densities averaging 138 structures per km2 in the upper Belize River area, and 178 structures per km2 in the Tikal core zone of the Peten, Guatemala (Fedick and Ford 1990). The well-drained uplands make up slightly less than half of the Gallon Jug Region (42%) as a whole. This proportion of well-drained uplands is comparable to the Tikal core area and the upper Belize River area of the central Maya lowlands (Figure 3). However, the distribution of this important resource on the east and west of the Booth's River Escarpment is significant. The majority of the Hills Subregion (72%) is classified as well-drained uplands while only 7% of the Lowlands Subregion is classified as such (Table 3). This makes the Hills Subregion particularly attractive for ancient Maya farmers.

Slow-Drained Lowlands

Slow-drained lowlands are found in flat to gently undulating areas, with soils developing from soft Miocene limestone and marl. The soils are slow to poorly drained, and are characterized by heavy clays which are of moderate to deficient fertility status. As such, they are very difficult to work under hand-cultivation technology available to the

ancient Maya. During the rainy season, the slow-drained lowlands are saturated or flooded and, as a result, they are not suited to wet season swidden cultivation.

Modern Maya farmers often use slow-drained lowlands for low intensity production of a dry season crop either as a back-up to guard against poor wet season harvests or as a means of increasing production (Carter 1969:113-119; Culbert et al. 1978; King et al. 1986; Wilk 1985; Wright et al. 1959). Optimum planting times for, and workability of, slow-draining lowlands vary from area to area and from year to year, depending on local precipitation patterns; this poses serious risks for cultivation. Intensifying the cultivation of the slow-draining lowlands would necessitate the construction of drainage ditches and improvement of soil texture and fertility through addition of organic matter.

Archaeological surveys within slow-drained lowlands in other areas of the central Maya lowlands have documented settlement densities averaging five structures per km2 in the upper Belize River area, and 46 structures per km2 in the Tikal core area (Fedick and Ford 1990). This implies that these areas were used, to a greater or lesser extent, in a secondary capacity by the ancient Maya. The slow-drained lowlands make up a relatively large portion of the Gallon Jug Region (36%), close to the proportion of well-drained uplands. The distribution of these slow-drained areas, however, is disproportionate between the two subregions (see Table 3). The Hills Subregion has very little slow-drained lowlands (13%), far less than other areas of the central Maya lowlands (see Figure 3), and they are found in small patches scattered throughout the area. The Lowlands Subregion, on the other hand, is dominated by the slow-drained lowlands (63%), similar to the conditions of Northern Belize (see Figure 3).

Riverine-Associated Swamps

Riverine-associated swamps of the Rio Bravo Conservation Area are found primarily along Booth's River, Irish Creek, and Rio Bravo. Annual fluctuation of the water level within these swamps is minimized by the slow and consistent flow rate of the drainages to which they are linked. Vegetation within the riverine-associated swamps is dominated by a rush-sedge community. Soils of these swamps are primarily peaty clays of moderate to high fertility status.

The prehistoric Maya are known to have developed riverine-associated swamps for agriculture in other areas of northern Belize such as along the New and Hondo Rivers (Bloom et al. 1985; Turner and Harrison 1983). Agricultural development of these swamps by the prehistoric Maya required the construction of drainage facilities such as canals and raised cultivation platforms. Drainage systems such as those built by the prehistoric Maya can be developed incrementally, and high returns to labor can be assured by the inherent suitability of the soils for agriculture when properly drained (Darch 1983; Miksicek 1985; Pohl and Miksicek 1985; Turner 1983b).

Archaeological surveys in areas immediately adjacent to Pulltrouser Swamp in northern Belize, a riverine-associated swamp with ancient Maya field systems next to the New River and north of Orange Walk Town, have documented ancient communities adjacent to the swamp and an overall settlement density for the vicinity averaging perhaps 26 structures per km2 (Turner and Harrison 1983:263). Thus, even where these zones are available, they support relatively low settlement densities. Riverine-associated swamps make up 8% of the Gallon Jug Region, equal to that of northern Belize, and represent a potentially important agricultural resource in the area. Not surprisingly, this resource is underrepresented in the Hills Subregion (4%), which is characterized by good drainage, but is more prevalent in the Lowlands Subregion (12%) and represents proportionately more of the area than found in northern Belize (see Figure 3).

Closed-Depression Seasonal Swamps

Closed-depression seasonal swamps are karstic depressions filled with deep deposits of impermeable clays. These seasonal swamps are not linked with river systems. During the rainy season, closed-depression seasonal swamps hold significant amounts of water but, during the dry season, they desiccate except for occasional sinkholes (see Cowgill and Hutchinson 1963; Lundell 1937; Siemens 1978). Even though these zones are seasonally inundated, the low marsh forest vegetation of these seasonal swamps is adapted to very low moisture requirements in order to survive the desiccation of the dry season. Soils of the closed-depression seasonal swamps are heavy clays with severe limitations to agricultural development related to both chemical and physical factors (see Fedick and Ford 1990; Pope and Dahlin 1989).

The exceedingly poor agricultural environment offered by the soils of the closed-depression seasonal swamps would have made even extensive cultivation by the prehistoric Maya a very risky, low-return endeavor. If developed for agriculture through drainage canals and raised platforms, the unfavorable nutrient, hydrologic, and mechanical soil environment of closed-depression seasonal swamps would produce substantially inferior returns to labor in comparison to similar systems developed in riverine-associated swamps. Whether or not closed-depression swamps were developed for agriculture by the prehistoric Maya is a matter of considerable debate among current researchers (Adams

1980, 1982; Adams et al. 1981; Dahlin 1979; Fedick and Ford 1990; Pope and Dahlin 1989; Puleston 1978; Sanders 1979; Turner and Harrison 1978; Wiseman 1983). This debate, however, is focused on the core area where closed-depression swamps make up over a quarter of the area (see Figure 3). In areas where these zones do not represent a large fraction of the area, they could not present a significant agricultural resource.

The relationship between prehistoric settlement and closed-depression seasonal swamps is in need of further investigation, although recent studies suggest that the prehistoric Maya generally avoided settling in areas adjacent to these types of swamps (Fedick and Ford 1990; Ford 1986). Closed-depression swamps are not a significant portion of the Gallon Jug Region (6%). Yet, this land resource is distributed in greater proportions in the Lowlands Subregion (8%) than in the Hills Subregion (4%), and its presence in close association with riverine-associated swamps is distinct from other areas of the central Maya lowlands.

Savannas

Savannas of the Rio Bravo Conservation Area, and elsewhere in Belize, are associated with Pleistocene coastal deposits (Birchall and Jenkin 1979; Jenkin et al. 1976; Wright et al. 1959). The savannas are characterized by poorly drained, infertile soils supporting a sparse vegetation association of grasses and sedges with palmetto, oak and pine.

Savannas are avoided by the modern Maya for agriculture, although they are used for hunting, as they may have been by the prehistoric Maya (see Rice and Rice 1980; Zeitlin 1984).

The savannas make up 4% of the Gallon Jug Region (Table 3), a much larger proportion of the area than in other areas of the central May lowlands. Savannas are not present to any significant extent within the Hills Subregion, but represent 8% of the Lowlands Subregion. Although no prehistoric settlements were found in savannas of the upper Belize River area, structural remains and other features have been reported in extensive savanna areas of the central Peten, Guatemala (Rice and Rice 1980).

Escarpments

The sharp ridges and steep sides of the major escarpments support only skeletal soils, and do not represent a viable agricultural resource. Escarpments are found throughout the region, but are larger and more concentrated in the west.

Major escarpments with skeletal soils make up 4% of the Gallon Jug Region, contributing to the unique characteristics of this area within the Maya lowlands (see Table 3 and Figure 3). No major escarpments are included within the Lowlands Subregion, but 7% of the Hills Subregion is classifiable as such. In the upper Belize River area, several prehistoric centers are located on escarpment tops, providing excellent views of the surrounding terrain and other centers, but the escarpments themselves would be avoided by settlement because of there extreme slopes.

Implications

The evaluation of land resources of the Rio Bravo Conservation Area suggests that a major difference will be found in the pattern of prehistoric settlement and land use between the Hills Subregion and the Lowlands Subregion (see Appendix I). Average settlement density is expected to be quite high in the Hills Subregion, probably in the vicinity of 100-150 structures per km2 or more in well drained uplands of moderate relief (compare with Ford 1986). Numerous centers can also be anticipated within the Hills Subregion, and are most likely to be found on hill-tops within the well-drained uplands. Minor centers may be spaced approximately 3-5 km apart, with major centers such as La Milpa spaced at greater intervals of perhaps 25-30 km. These estimates for the spacing of centers are based on observations in the upper Belize River area and other areas of the central lowlands (see Hammond 1974, 1981; Harrison 1981).

Within the Lowlands Subregion, overall settlement density is expected to be low, perhaps in the vicinity of 25 structures per km2. Any centers that may exist would be expected within the larger of the scattered patches of well-drained uplands found in the subregion. Well-drained areas would also serve as the most likely areas for residential settlement concentrations. Settlements, and perhaps minor center, would also be present in parts of he slow-drained lowlands. Some of the riverine-associated swamps in the area may have been developed for agricultural production; if this is the case, then associated settlements should be located adjacent to those swamps. It is unlikely that settlement would be found within the savannas, although evidence for some form of prehistoric use may be present.

These general resource and settlement expectations guided our preliminary archaeological assessment of the Rio Bravo Conservation Area. Our survey time was concentrated in zones with the highest potential settlement densities, the well-drained rolling uplands in and around the center of La Milpa. Secondary attention was given to the steeper hilly uplands and areas of slow-drained lowlands in order to assess the comparability of the Rio Bravo Conservation Area with adjacent areas. Due to the extent of inundation in the eastern section of the area, only air surveys were practical over the swamp zones. These were successful in identifying gross features in swamps, but could not be used to directly assess the nature of ancient Maya settlement in the area.

The Archaeological Project

The preliminary archaeological survey of the Rio Bravo Conservation Area was accomplished over a week period beginning on the 15th of August, 1988, with a crew of five archaeologists: Anabel Ford, Director, Scott Fedick, Field Director, and Michael Glassow, Lisa Moore, and John Steinberg as field crew. Our schedule included (1) general reconnaissance adjacent to the main road of the area to gain a familiarity with the terrain, (2) air survey to obtain an appreciation of the Gallon Jug Region and to ascertain the location of unusual surface features, (3) ground survey of the center La Milpa, and (4) settlement survey in the vicinity of La Milpa and other areas representative of the region and accessible from the road. The combination of these activities provided a balanced preliminary review of the archaeology of the Rio Bravo Conservation Area and a basis for developing an archaeological management strategy.

General Surface Reconnaissance

The first project objective was to familiarize ourselves with the survey area. Using the main road that links Gallon Jug to north Blue Creek, our first day of work was spent locating topographic features and plotting the course of the main road and lateral trails on our topographic maps. Each day we were on this road we were able to increase our knowledge of the natural and cultural resources on either side of the road. This gave us the requisite information for the selection of several settlement survey areas.

Air Survey

Our study of the topographic maps including the Rio Bravo Conservation Area indicated a fundamental distinction between the western and eastern sections of the area, as discussed above. We determined that features of the eastern Lowlands Subregion were analogous to zones to the north, with riverine associated swamps, and that aspects of the western Hills Subregion were analogous to the areas south and east, with well-drained uplands. Given the diversity of the Rio Bravo Conservation Area, we felt that it was imperative to gain a general air survey overview of the context of the Conservation Area as well as air survey concentrated within the study area.

The air survey included the mornings of August 17th and 19th, 1988. The first morning involved a review of the Rio Bravo Conservation Area as well as adjacent areas to the north and south for comparative purposes. The second morning focused specifically on the Rio Bravo Conservation Area with special attention to the eastern, and inaccessible, Lowlands Subregion. These surveys were very useful in gaining an overall perspective of the Rio Bravo Conservation Area and provided a basis for comparison with adjacent, better known, areas.

During the first morning of air survey, our first objective was to review areas in Northern Belize where raised and drained fields had been securely identified in zones surrounding specific riverine swamps. These swamp situations are similar to several areas within the Rio Bravo Conservation Area. Air reconnaissance of those previously recorded areas provided the key to identifying similar feature signatures in archaeologically unknown zones. The second objective was to review a known upland area around El Pilar in the upper Belize River area, where a comprehensive archaeological survey had been conducted (Ford 1990). This provided a comparison of upland forested zones where ancient Maya settlement densities could be as high as 200 structures per km2. The initial air survey, in short, provided the comparative basis for evaluating features observed in the Rio Bravo Conservation Area.

The second morning's air survey focused on the lands within the project boundaries. Features identified in the first air survey were reviewed and examined, and other topographic features were identified. Special effort was made to view areas with riverine swamp associations, tops of escarpments, and the known La Milpa area of the western section of the Conservation Area. In all, it was very difficult to identify features in the air over the vast, forested Hills Subregion in the western part of the property. The eastern Lowlands Subregion, however, was very easy to review from the air, and, given the inaccessibility of that region during the wet season, this visibility enhanced our ability to asses the archaeology of the area.

La Milpa

The site of La Milpa is located approximately 4.9 km by a jeep trail west of the main Gallon Jug-Blue Creek road at c.ÿ6.9 km north of Cedar Crossing (Figure 2). The Loran coordinates, fixed during the air surveys by Mr. Barry Bowen and Javier's Flying Service, are 17049.16' latitude by 89003.21' longitude. Situated on a limestone promontory and following an approximate N-S direction, this ancient Maya center covers an area of about 500 m by 800 m (Figure 4). Notable features of the site include its enormous main plaza (c. 130x160m) surrounded by large pyramids (one over 25m high), at least 7 visible stela (one with carving), a ball court in the north, and a major acropolis complex to the south.

This is possibly the same site visited and reported by Thompson (1939), called La Milpa (Pendergast, personal communication 1988). The informal report by Thompson occurs in an inventory of archaeological sites in the appendix of his San Jose report (1939:278-282). The site is tersely described as one with "pyramids, mounds, nine sculptured and three plain stela, plain altars" (Thompson 1939:280). Thompson's 1938 field notes, on file at the British Museum, contain additional information on the site (L. Harrington, personal communication 1990) which we plan to review and develop.

We were only able to devote a day and a half to the review and sketch mapping of this large center. Our first visit to La Milpa afforded us with the time to get our bearings. We were accompanied by two workers assisting the Programme for Belize, Emiterio Cobo and Ambrosio Enriquena, who were stationed at the clearing where the La Milpa road takes off to the west. These workers guided us around the site and oriented us to features they had observed. It was clear on this first visit that looting was a serious problem and that evidence indicated some of it was relatively recent.

The next visit to La Milpa consumed an entire day. Separating into two teams, we made a series of sketch maps of the different parts of the site using the pace and compass method. The composite map was compiled the night after the initial mapping and the final map prepared in the U.S. The resultant map of the site is not accurate in matters of detail, but, as field checks in 1989 demonstrate, it provides an accurate visual impression of the site layout. The La Milpa map depicts the complexity of the site and one may use this map to orient themselves at the site as well as to locate features around the site. The map also can serve as a guide for the transit mapping, which would logically follow this phase of investigation.

Settlement Survey

During the course of the project, we performed formal and informal settlement surveys in the western section (Hills Subregion) of the Rio Bravo Conservation Area. Much of the informal survey included trail walking off the road, trail blazing to points of study, and observations along the La Milpa road which traverses the western uplands of the Hills Subregion, while formal surveys were positioned in different upland zones deemed representative of the landforms of the area (Figure 2).

General trail reconnaissance surveys were initiated to determine aspects of terrain and locations of ancient Maya settlement. Through this method, we were able to locate zones for the formal grid survey. Zones where no settlements were noted were not mapped. They included surveys of some slow-drained areas in the south of the study area between the Rio Bravo and the main escarpment.

The formal settlement surveys involved plotting ancient Maya structural remains with reference to a baseline within two 100 by 100 m (1 ha) grids (Figures 5 and 6). One of the grids was adjacent to and north of La Milpa, and the other was on a ridge 300 m east of a point 5.9 km north of Cedar Crossing in a hilly zone just west of the main Rio Bravo escarpment.

Air surveys assisted in the identification of potential relic field locations in the eastern section of the Rio Bravo Conservation Area. The most conspicuous features that are likely ancient Maya raised and/or channelized fields are located on the northern side of Irish Creek, just below a minor escarpment of uplands in the Lowlands Subregion (see location in Figure 2). This is the site of a probable field system larger than, but analogous to, the Pulltrouser field features (Turner and Harrison 1983). The Loran cooridinates of these features is 17037.99' latitude by 88049.17' longitude. The Irish Creek field site is within a riverine-associated swamp regime. Other potential riverine swamp locations were reviewed by air, but did not reveal any similar patterns. These swamps should be the subject of additional aerial reconnaissance during the dry season.

Another significant feature identified in the swamp zone was a canal associated with the historic logging enterprises that figured importantly in the last century. This canal runs from Booth's River Escarpment to Canal Bank at the New River Lagoon. There are likely other historic sites and features dating to the early logging days of the Belize Estates that ought to be researched and identified, such as those known to and described by Mr. Barry Bowen (personal communication August 1988).

Results of the Archaeological Survey

The results of the preliminary archaeological survey fall into two realms: the extent of major monumental public architecture and the distribution of residential settlement. The sketch map of La Milpa (Figure 4) and the settlement survey grids (Figure 5 and 6) provide the quantitative basis for comparing the Rio Bravo Conservation Area with other areas of the central Maya lowlands.

The Rio Bravo Conservation Area is situated between Northern Belize, one of the first Maya areas to become settled, and the core area, one of the last to be settled. The Conservation Area is topographically very diverse, including all major landforms found in the Maya lowlands (compare Table 3 and Figure 3). This area has a relatively

large proportion of well-drained uplands, those resources were favored for ancient Maya occupation. These lands are predominantly located in the western section, where the major center of La Milpa (possibly La Milpa [Thompson 1939]) had been reported by Thompson in the 1930's. Aside from the obvious visits by looter's, reported site visits have occurred at infrequent intervals since Thompson's time: one visit by archaeologists David Pendergast and Stan Loten in 1974, several visits in the 70's and 80's by Bill Wildman of Consejo Shores, and by Logan McNatt of the Belize Department of Archaeology in 1984. Due to the inaccessibility of the area until very recently, no major archaeological studies have been undertaken.

The Major Center of La Milpa

Prior to the initiation of this preliminary archaeological survey, there had been no mapped location or site map for the major center of La Milpa. Since the efforts of the Programme for Belize to make the site accessible, fly-overs have been able to position accurately the site on a promontory above a drainage running north towards Blue Creek and the Rio Hondo. The monumental public architecture of the center covers from 32-40 hectares (80-98 acres) and includes at least 18 plazas and 60 major structures, many estimated to be between 18 and 25 meters in height (see Figure 4).

La Milpa is a Classic Maya center of the highest size and rank, comparable to many centers in the core area. Considering the number of plazas, La Milpa is on a par with major centers around Tikal, including Yaxha and Uaxactun. Of its know near neighbors in the eastern periphery, it covers twice the area of El Pilar, in the upper Belize River area. When fully surveyed, La Milpa will probably be a rival to Caracol, far to the south in the Maya mountains. While there has been no bona fide archaeological research at La Milpa as of our brief visit in 1988, there has been a tremendous amount of illegal excavations identified by looter's trenches. We recorded 41 looter's trenches among the ruins of La Milpa. Considering the size and extent of this center, there are fewer trenches than at the center of El Pilar, to the south, which has more than 60 looter's trenches. The heavier looting at El Pilar is probably due to its accessible location just off an all-weather road servicing two agricultural cooperatives north of the center. La Milpa has been relatively inaccessible until recently, when Mr. Barry Bowen reestablished the Gallon Jug road. It is important to indicate that, while there are fewer trenches counted at La Milpa than at the center of El Pilar, many of the trenches are much larger and deeper. Some of these trenches are so deep that they penetrate major structures in such a way as to seriously affect their stability.

Investigations within some of the looter's trenches and in their backdirt piles revealed sherds representative of periods beginning c. 250 B.C. in the Late Preclassic through c. A.D. 900 in the Late Classic Period (see Table 1). Included among the observed sherds was one diagnostic of the Early Classic style of Teotihuacan, in central Mexico. This period is particularly elusive outside the Tikal core area within the eastern periphery of the Maya lowlands, including the upper Belize River area and Northern Belize.

In sum, the center of La Milpa must be included as one of the major centers of the Maya lowlands. It is likely one of the largest centers of the area, equal to, if not larger than, its distant neighbors of Rio Azul, Lamanai, and Nohmul. Sitting as it is surrounded by an expanse of well-drained uplands, La Milpa would have been associated with dense settlement and intensive agricultural production.

Settlement Distribution and Density

The first mapped survey grid (Figure 5) was located just north of the center of La Milpa. The majority of settlement within the survey grid was recorded in a portion of slightly greater relief to the east of the baseline. West of the baseline, land was dominated by Cohune palms, suggesting that the area could experience some degree of inundation from time to time. We recorded 10 large and 14 small structures, grouped into ten residential units, all within a 100 by 100 m grid. The larger mounds were from 1-3 meters in height, indicating that considerable effort had been devoted to their construction. The structure density in this survey grid is extremely high, 240 structures per km2 with an average of 2.4 structures per residential unit. This density and residential unit composition is similar to the settlement adjacent to centers in the core area (Table 4).

The second mapped survey grid (Figure 6) was located east of the main road near the main Rio Bravo escarpment. This area has fairly steep relief. Settlement was recorded only at the ridge top, as the slope dropped sharply on either side. All four mounds recorded in this area were small, solitary structures, and none was greater than 0.4 meters in height. The structure density of this area is 40 structures per km2, less than one fifth the density of the La Milpa area, and there was an average of one structure per residential unit. No agricultural terraces were observed on the hill slopes.

Other surface surveys focused on zones of slow-drained lowlands near some minor closed-depression seasonal swamp zones in the Hills Subregion just north of Cedar Crossing. None of these zones had visible settlement. The

absence of settlement is consistent with the situation in other areas of the Maya lowlands, where settlement also tends to avoid margins of closed-depression seasonal swamps (see Ford 1986).

A final zone of consideration is the area north of Irish Creek, observed during the air surveys. The location combines a small zone of uplands associated with a minor escarpment adjacent to a riverine-associated swamp. This swamp zone has rectilinear features which resemble the field systems identified in riverine associated swamps in Northern Belize (see Siemens 1982). The area of rectilinear features appears to be more extensive than those recorded in the north. If these features are relic fields of the ancient Maya, then there should be identifiable settlement in the adjacent uplands.

ARCHAEOLOGICAL IMPORTANCE OF THE PROJECT AREA

Archaeological research in the central Maya lowlands has traditionally focused on the grandiose at the expense of the more mundane. However, recent research in the region has gone a long way to correct this bias (Bullard 1960; Ford 1981, 1985, 1986; Fry 1969; Haviland 1963; Puleston 1973; Rice 1976; Webster and Gonlin 1988; see also Wilk and Ashmore 1988). Many of these and other studies have pointed to the strong relationship between the natural environment and ancient Maya settlement. From the earliest settlement pattern research in the area (Bullard 1960), the importance of well-drained uplands to the ancient Maya was recognized. More detailed local studies (Fedick 1988a, 1989) and regional comparisons (Fedick and Ford 1990) have demonstrated that the relationship is a significant one and correlates directly with the agricultural capability of the land resources. The small amount of data collected during our field work indicates that this model for ancient Maya economy of the central lowlands is appropriate for developing expectations for settlement locations and densities in the Rio Bravo Conservation Area. This model assumes the ancient Maya had a detailed knowledge of their resources and used them optimally. The relationship of settlement to land resources should change with population fluctuations (either growth or decline), and these changes should be detectable in the archaeological record.

The Rio Bravo Conservation Area represents a unique case because it contains the full range of resource variability found within the entire central Maya lowlands. The current land resource data suggest that the overall settlement densities will be relatively high, due to the high proportion of well-drained uplands. The distribution of the highest settlement densities and most complex residential and public architecture should be concentrated in the Hills Subregion, the very area where La Milpa is situated. Since there is such a high proportion of well-drained uplands in the Hill subregion, the density of centers could be higher than other areas (see Ford 1986). Depending on the land resource distribution, there should be secondary centers in the area immediately surrounding the major center of La Milpa, but there could be some centers which have more equal relations with La Milpa. Understanding size, extent, construction sequences, and settlement densities among centers in the area will begin to address this problem. Settlement densities in the Hills Subregion beyond the centers will vary widely, however, according to the extremes of the slopes (compare the differences in density and settlement configuration between Figure 5 and 6). In addition, the earliest settlement in the area is expected the Hills Subregion, due to the high proportion of excellent land resources for early pioneering farmers. This could mean that centers were also established early on in Maya prehistory.

Low settlement densities and simpler residential unit compositions should be most characteristic of the sites in the Lowlands Subregion, as there are large expanses of land which are not suitable for residential occupation at all. Pockets of uplands and accessible areas adjacent to riverine-associated swamps should experience settlement after the Hills Subregion was initially settled. Those scattered areas of well-drained uplands in this subregion should contain concentrations of Late Classic settlement. These uplands should be the location of local centers which may be tied into a subregional hierarchy or into a major center, such as La Milpa. Also, settlements would be expected where intensive field systems can be securely identified. Such intensive field systems of the riverine-associated swamps in the Lowlands Subregion would be expected to have later occupations than the well-drained uplands of both the Lowlands and Hills Subregion because they require the greatest labor investment to develop.

The two distinctly different environmental zones represented by the Hills Subregion and the Lowlands Subregion comprise a natural laboratory for the study of prehistoric Maya cultural ecology and economic organization, and provide a prime opportunity to address research questions that are at the forefront of current Maya studies (see Ashmore 1981). In establishing the locations suitable for ancient Maya residential settlement, criteria of drainage, fertility, workability, slope, and area are critical. Well-drained uplands of moderate relief are preferred over zones of slight or sharp relief for residential settlement and are the locations of most centers. Uplands zone of slight relief will experience drainage problems and zones of sharp relief will suffer erosion. Slow drained lowlands figure as secondary resources and will be used when there is competition for the most desirable lands. Swamp zones will be used only as a last resort when other resources are all in use. Combining precise soil data (see Appendix I) and topographic data will produce a cultural resource picture which, when tested, will be an effective management tool. Such coordinated,

complementary research within these two subregions of the Rio Bravo Conservation Area will not only provide essential data for a management program but will contribute significantly to our understanding of prehistoric Maya development.

MANAGEMENT RECOMMENDATIONS

There is no doubt that the archaeological resources of the Rio Bravo Conservation Area are vast and important to archaeologists as well as to local Belizeans and foreign visitors. By Belizean law, all archaeological resources are protected by the broad and sweeping Ancient Maya Monuments and Antiquities Ordinance (Government of Belize). While government enforcement is variable due to financial resources, the Programme for Belize is obliged to set an example of compliance to all stipulations. These laws affect development activities, such as road and building construction, as well as archaeological studies. Archaeological research must be approved and permitted beforehand by the Belize Department of Archaeology. Archaeological resources are non-renewable. Once they are destroyed, there is no way to regenerate them. Avoidance of archaeological destruction should be considered the optimal management objective. In cases where destruction is unavoidable, measures to mitigate the effects of destruction need to be taken.

Involving an archaeologist at the outset of development planing will assist the management process. For example, plans for establishing a research station were underway at the time of our field work in the Rio Bravo Conservation Area. We noted that some large elite residential units were being cleared with the aim of establishing the station. With the philosophy of avoiding archaeological sites implemented in planning stages, areas could be targeted for construction and an initial archaeological survey could be made to identify the potential archaeological impacts. If the impacts were significant, the area could be avoided and another area selected.

Our primary recommendation with respect to the archaeological resources concerns the education of Programme members in Belize. Archaeological conservation efforts should be integrated into the operation so that archaeological resources rank equally with other resources on the Rio Bravo Conservation Area. Arrangement should be made for the training of Programme managers and grounds personnel in basic principles of archaeological site preservation and management. This may be accomplished through the Belize Department of Archaeology or with a professional archaeological consultant.

There should be formalized affiliation with a professional archaeological consultant or consultants who will coordinate archaeological management of the property in cooperation with Programme for Belize managers and the Belize Department of Archaeology. This archaeologist would contribute to the process of obtaining research grants, advise on potential impacts of any development within the property (such as road building, construction of support facilities, etc.), coordinate development of large sites for tourist visitation, and assist in the inventory of sites within the property.

There should be continuing concern to develop and maintain a cooperative and mutually beneficial relationship with the Belize Department of Archaeology, Association for Belizean Archaeology, Belize Center for Environmental Studies, and other archaeological and environmental organizations. Also, coordination with researchers of the Overseas Development Natural Resources Institute (United Kingdom) should be encouraged as the results of their research in the region will assist in the development and implementation of the management program (see Gray 1989; King et al. 1986, 1989). Further, effort should be made to share data of specific research efforts, for example between forestry, botany, biology, agronomy and archaeology, in order to maximize their value.

Open interaction among interested groups fosters an atmosphere of sharing, important to the ongoing operation of the Programme for Belize. To this end, effort should be made to prepare a pamphlet for local distribution and an article for a popular journal which would communicate the concern of the Programme for Belize with the protection of archaeological resources and the steps being taken to manage sites within the Rio Bravo Conservation Area. Archaeological activities of the Programme for Belize should be fully reported to the international archaeological community through professional publications and presentations at meetings.

In coordination with professional archaeologists, the Programme for Belize should establish standardized site recording procedures to be used within the Rio Bravo Conservation Area and should promote the use of these procedures in other areas, such as the privately held lands around Gallon Jug to the south, which participate in the Programme. These procedures should, minimally, collect data required by the Department of Archaeology, but also should include additional information relevant to resource management and research. As part of this recording procedure, a computerized site file system should be established, preferably in association with a computerized mapping and analysis program such as GIS (Geographic Information System; see Gray 1989; Kvanne 1989). An ARC/INFO type GIS system is currently in use by the researchers working on the land resources of Belize and is under consideration for support by USAID. The Department of Anthropology of the University of California at Riverside is

in the process of setting up an ARC/INFO GIS center for Maya regional research, including Belize and the Rio Bravo Conservation Area.

In addition to these general matters, we recognize specific archaeological preservation and conservation priorities. The highest priorities concern the major center of La Milpa. The next level priorities concern the amplification of the settlement surveys to collect an adequate sample addressing the settlement diversity in the area. Finally, a number of supplemental recommendations are outlined.

The major center of La Milpa is in urgent need of attention. The current vigilance afforded by the workmen is an important first step towards protecting this site. Visits to the site should continue to be relatively frequent on a year-round basis. Plaza clearing should be maintained, but additional clearing should be monitored by archaeologists. Before any building stabilization and conservation measures can be taken, an accurate contour site map and permanent benchmark monuments need to be established with a transit. With an accurate map and permanent reference points, all subsequent work will be able to tie into the original base map and may be referenced and recorded properly.
It is very important to stabilize the buildings which have been damaged by the extensive looting. Before stabilization, the research potential of the trench exposures should be realized. Each trench should be documented by drawing the trench wall profile and extracting an excavated column by construction levels for chronological information. Once the trenches are documented they should be backfilled. This technique was employed for the centers of the upper Belize River area (El Pilar, Alta Vista, Yaxox and Bacab Na), and, with a minimal amount of effort, we were successful in gleaning important data on ancient Maya construction activities from the trench exposures.

In addition to taking measures to protect the monumental architecture at La Milpa, it is important to document and shelter carved stela and altars. It would be worthwhile to bring in a skilled epigrapher to examine the carved stela for historic and calendric hieroglyphs. This should be undertaken with extreme caution and with the consultation of the available records on Thompson's survey data (on file at the British Museum). Bearing in mind that this preliminary survey located only 7 stela and Thompson recognized 12, nine of which were clearly carved, there needs to be some effort to relocate the monuments. Minor excavation will be necessary to locate monuments that may be buried at the foot of temples by structure collapse or looter's backdirt piles. Recovery of stela through this technique was effective at Caracol (Arlen and Diane Chase, personal communication May 1987). Once located, all stela should be accurately plotted and examined by professionals to determine the presence and extent of carving.

Another important area in the Rio Bravo Conservation Area is the Irish Creek raised fields site, identified from the air in this survey. The area should be investigated more rigorously. The possible agricultural features within the swamp should be mapped through the use of aerial photography. This would provide a basis for surface investigations in the swamps. The low escarpment adjacent to the swamp should be checked for ancient Maya settlement and the possibility of a center. Archaeological study of this area will provide an important comparison to data from Northern Belize.

In addition to the prominent management issues pertaining to specific areas discussed above, there are the general management concerns that will require additional archaeological study. There should be further air reconnaissance during the dry season over eastern swamp areas to examine the extent of desiccation and to investigate the upland patches. Infra-red photography of wet and dry periods would be an asset in identifying the upland areas within the Lowlands Subregion. Upland areas would appear in foliage during both periods while the seasonal swamps would have decreased foliage in the dry season. Selected sample patches within the Lowlands Subregion deemed of sufficient size to support an ancient Maya settlement should be surveyed on the ground for evidence of architecture. The western upland section should be more thoroughly investigated by selective systematic settlement survey in sample land resource zones. Such systematic archaeological survey would refine the grossly identified land resource and ancient Maya settlement relationships outlined here. Target surveys should be initiated in order to locate other centers equal to or secondary to La Milpa in order to put this center in its hierarchical context within the area. This can be accomplished by using the available land resource data (see Appendix II) to predict locations, as well as by interviewing local workers and consulting earlier archaeological reports.

An important potential of the Rio Bravo Conservation Area is its historical cultural resources documenting an important facet of Belizean history. Belize Estate operated a number of enterprises over the last century within the Gallon Jug Region. On our flights over the eastern Lowlands, we identified a canal connecting the interior reaches of the area with the New River Lagoon that was likely used in lumbering operations. The links between the historical documents and the remains on the ground should be investigated by a historical archaeologist.

Another revealing activity that could bring researchers in agronomy and archaeology together would involve the establishment of experimental agricultural sites. Such experiments should be a cooperative exercise among archaeologists, botanists, and agronomists in the study of potential productive capacity of various cultivation techniques that may have been practiced by the prehistoric Maya. These should be set up in the various land resource zones and may be integrated with plans to reduce the area of extensive (slash-and-burn) cultivation currently used by

farming residents of the Rio Bravo Conservation Area. The Programme for Belize is currently involved in setting up a research station and an archaeological advisory board so that some of these ideas may soon be implemented.

Appendix I

Available and Forthcoming Land Resource Data

Currently, the only available land resource data pertaining to the Programme for Belize property is included the 1959 report of the British Honduras Land Use Survey Team (Wright et al. 1959). The report included a soil map of Belize compiled at a 1:250,000 scale. While this map provides valuable information for the entire country, as discussed in the text, the level of resolution of a 1:250,000 scale map will only distinguish soil-type areas in excess of 252 ha extent. This is a fairly gross scale and is not comparable to the detail attained with the 1:50,000 scale maps available for the Belize River area, as produced by the Land Resources Development Centre of the United Kingdom (Birchall and Jenkin 1979). These 1:50,000 scale maps distinguish areas equal to or greater than 10.1 ha in extent (Davidson 1980:15). This scale provides a much more accurate basis for site density prediction.

The Belize Environmental Center is currently involved in preparing and making available the original, unpublished 1:40,000 soil maps produced by the British Honduras Land Use Survey Team that were used to compile the published 1:250,000 scale maps (Lou Nicolait, personal communication, August 1988). These unpublished soil maps promise to show a considerable amount of detail (Wright et al. 1959:9) and, when available, will be a valuable tool for resource management.

Another future source of land resource data for the Programme for Belize is the research currently underway by the Overseas Development Natural Resources Institute (ODNRI) of the United Kingdom Government Overseas Development Administration. The ODNRI was formed in 1987 by the amalgamation of the Tropical Development and Research Institute, and the Land Resources Development Centre (the organization responsible for the Belize Valley study by Jenkin et al. 1976 and Birchall and Jenkin 1979). The current ODNRI research in Belize is being conducted under the team leadership of Dr. R. B. King. The ODNRI has recently published land resources studies of the Toledo and Stann Creek Districts (King et al. 1986, 1989) and comparable studies of all other districts of Belize are either underway or will be carried out in the near future (J.R. Dunsmore, personal communication, August 1988; R.B. King, personal communication, September 1988 and July 1989). The ODNRI land resource data for Belize is being developed on an ARC/INFO type GIS (Geographic Information System) at the Edinburgh University Department of Geography (see Gray 1989). The digitized land resources data is being shared with Scott Fedick at the Department of Anthropology, University of California at Riverside, where archaeological data coverage will be added in cooperation with the Belize Department of Archaeology.

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Table 2
Soils Included in Each General Land Resource Type1

WELL-DRAINED UPLANDS
Yaxa gravelly clay (9a)
Ramgoat gravelly clay (10a)
Chacluum gravelly clay (11a)
Jolja clay (13)
Jolja gravelly clay (13a)
Jolja dark grey-brown clay (13b)
Jolja clay over chalk (13d)
Jolja gravelly clay loam, hill soil (13H)
SLOW-DRAINED LOWLANDS
Yaxa clay (9)
Yaxa dark grey clay (9c)
Yaxa mottled clay (9d)
Ramgoat clay (10)
Ramgoat dark brown-grey clay (10b)
Ramgoat mottled clay (10c)
Chacluum clay (11)
Chacluum dark grey-brown clay (11b)
Chacluum mottled clay (11c)
Lazaro sandy clay (12)
Lazaro mottled sandy clay (12b)
Jolja mottled clay (13c)
Pixoy sandy loam (20)
Pixoy dark brown sandy loam (20a)

(Table 2, continued)
Pixoy mottled sandy loam (20b)
RIVERINE-ASSOCIATED SWAMPS
Pucte clay (55)
Sibal peaty clay (58b)
Sibal peaty loam (58c)
CLOSED-DEPRESSION SEASONAL SWAMPS
Chucum clay (56)
SAVANNAS
Jobo sand over sandy clay (21f)
Felipe loamy sand (23)
Sennis silt loam (41)
Haciapina sandy loam (50)
Puletan loamy sand (53)
Puletan shallow loamy sand and gravelly sand (53a)
Puletan sandy loam (53c)
Puletan grey silty sandy loam (53e)
Sibal peaty sandy silt and loamy sand (58)

ESCARPMENTS
Xunantunich rocky clay loam (60)

1Soil set names and set numbers (in parentheses) follow Wright et al. 1959.

Table 3: Lands Resources of the Gallon Jug Region
and the Hill and Lowland Subregions

	Well-Drained Uplands	Slow-Drained Lowlands	Riverine Swamps	Closed Swamps	Savanna	Escarp-ments
Gallon Jug Region	42%	36%	8%	6%	4%	4%
Hill Subregion	72%	13%	4%	4%	0%	7%
Lowland Subregion	7%	63%	12%	8%	8%	0%

Table 4: Settlement Composition in the Core Area

	Tikal	Yaxha	Uaxactun
Structures per Square km	190	110	137
Structures per Residential Unit	2.8	2.4	2.4

Figure 1: The Maya area.
Figure 2: The Gallon Jug Region and the Rio Bravo Conservation Area.
Figure 3: Land Resource proportions in Central Lowland Maya Areas Surrounding the Rio Bravo Conservation Area.
Figure 4: Sketch Map of La Milpa.
Figure 5: Sketch Map of Settlement adjacent to La Milpa.
Figure 6: Sketch Map of Settlement in the Hills Area.