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# CHAPTER ONE

# EXECUTIVE SUMMARY

There are a number of ways to produce this chapter. Generally it is written after the following chapters have been produced. It is, after all, a summary of our project and its' best findings. The chapter tends to be written for a busy executive who may not have the time to read the remainder of the report. The chapter will be translated into Spanish and appear as CAPITULO UNO immediately after this chapter in the report. We tend not to assign the Spanish translation a new chapter number, but I am open to suggestions. I would approach this chapter as something that would serve as a handout when Bill and others make presentations about the project. It could be the most important feedback product deriving from the pilot research.

Let me suggest an outline and some style guidance. In past reports our Executive Summaries have had these divisions:

A. **Introductory Essay**: (length 1-2 pages) (author: Stoffle)

*Global Context*. This should be very clearly written but without jargon. My first thought is that we say something about fragile ecosystems being under stress on a world-wide basis. This establishes the global change connection.

*Research*. Then I suggest we move to the problems of researching these global change issues, suggesting satellites as having the potential for collecting the basic data. A limitation of satellite data, however, is that we cannot fully interpret what is observed or what caused what is observed. Otherwise we would not need anthropologists, climatologists, marine biologists, or ethnohistorians. So we make the connection between the discipline scientists and the scientists who produce those wonderful images from space. I would further make the point that because the problems are complex, being produced by a variety of factors, the research teams should be complex reflecting the range of major variables that seem to be influencing the global problem under study. Make the point that there have been very few global change issues studied by complex interdisciplinary research teams using both satellite images and traditional research techniques. So, pilot projects are required in order to ascertain whether or not certain types of global change issues can be studied by certain types of research teams. These questions begin to be answered by a single-location pilot project. This permits the detailed and organizationally complex research that is needed to take the first step. The second step is to move from the successful study of one locale, to the analyst of two or more locales that are similar, in most respects, to the first pilot area, but contrast in ways that permit hypotheses emerging from the first study to be explored. The third step probably would be a regional study where smaller samples taken from a much larger area to see if the methods or findings have scale limitations. Perhaps the ultimate goal would be to be able to monitor the entire planet from space with limited ground-truthing in widely separate locales.

*Application*. Once the problem is studied and the research demonstrates that it can be studied in one location, then it is important to begin to experiment with procedures for distributing the findings so they will be incorporated into policy decisions that can reduce or eliminate the problem. It is important to emphasize that this knowledge transfer process is as complex as the initial research itself. For this reason the knowledge transfer should be perceived as experimental, probably beginning with the pilots as the basis for the experimentation. This suggests using multiple means of knowledge transfer tested at one pilot site. This permits controlled comparisons in a known environment. Perhaps we should bring the people into the experiment, letting them suggest alternative means of providing policy relevant knowledge. Like the pilot research efforts, once it has been found to have utility in one locale, then move the knowledge transfer experiements to multiple locale experiments. Logically, the knowledge transfer experiments would follow the research steps taken by the pilots. There would be a natural increase in both knowlege transfer wisdom and generalizability as the experiements proceed.

B. **CIESIN AND ITS' PILOTS**: (length 1-2 pages) (author: Wagner, Kuhn, Stoffle)

*CIESIN*. When CIESIN administrators reads this they should see a concise picture of themselves in exactly the way they wish themselves pictured. This is a real problem inasmuch as CIESIN is an organization that is still defining itself. For this reason I suggest that Bill help Tom or me craft a clear essay on this topic.

*PILOT PROJECTS*. The pilot projects have a clearer purpose than the mother organization. This is an easy essay, but it should reflect how the pilots are perceived today as well as how they were perceived when this project began last year.

This section is very important because it defines what the contractor expected from the research. The following sections of the Executive Summary will demonstrate whether on not the research achieved the overall CIESIN and the specific pilot project goals.

C. **THE DOMINICAN REPUBLIC PILOT PROJECT**: (length 2 pages of text, 1-2 pages of illustrations) (authors Stoffle, Halmo)

This is a short description of the population-environment issues associated with our pilot project. It should be framed in exactly the same way as the above essays. It should be immediately clear to a reader why this pilot fits the various issues and goals that have been introduced.

*THE SITE*: I believe one or two maps would be good here. An alternative would be to have ERIM provide one or two page-size remote sensing images of the island and the study area. I would not repeat these illustrations in the Spanish translation chapter, although that chapter can be stripped out and distributed with illustrations to various agencies who can then request a copy of the whole document if they desire.

*THE RESEARCH TEAM*: I believe that an important goal of the pilot project is whether or not complex research teams can merge their analysis into one integrated study of a global change problem. For this reason, I would like to highlight the team. I believe it to be the most complex of any pilot project.

*THE FINDINGS*: This should be a very brief summary of the findings. I suggest that each team provide a list of key findings. No more than essential and focussed on the primary purposes of the project. We could add one or two special disciplinary findings, but this must be secondary to the primary reason that CIESIN provided us with funds. Remember this is not NSF.

D. **ORGANIZATION OF THIS REPORT**: (pages 2) (author Stoffle)

This is an easy section. It briefly gives the reader a chapter-by-chapter summary of what follows.

With these sections I believe we could produce a clearly integrated essay that would provide the reader with an overview of the whole effort from the contractor to final report. As conceptualized it would be produced in 10 or so pages. Your comments are welcomed.

# CHAPTER TWO

## TECHNICAL SUMMARY OF THE USE OF SATELLITE IMAGERY

(FORTHCOMING)

# CHAPTER THREE

# CLIMATE HISTORY OF BUEN HOMBRE

This chapter presents an analysis of the climatic history, in terms of annual precipitation, of the north coast of the Dominican Republic. The purpose of the chapter is to reconstruct as accurately as possible the history of and variations in climate using available historic precipitation records.

Climate change has been the focus of much of the research on global change (Clark 1987). Some concerns focus on global warming and its potentially disastrous effects on world ecosystems and production activities. Crises in global agriculture, evidence of rises in temperature and sea levels, drought, famine, and atmospheric pollution have driven national and international research funding initiatives directed at investigating causes of climate change, formulating new policies to solve emerging problems and reverse current trends. Analyzing the role of human "forcings," or activities that contribute to environmental change and degradation is one area of concentration among researchers.

The present analysis is driven by an interest in the extent to which climatic patterns and fluctuations have influenced (1) the biological condition of coastal marine ecozones and their resources, and (2) changes in human patterns of use of certain ecozones and resources. In other words, this chapter examines potential causative phenomena in terms of natural, or climatic, processes, that have resulted in changes in Buen Hombre's ecosystem and the patterns of adaptation in human natural resource use in the community.

The analysis of climate history was also stimulated by oral testimony of elders in the community of Buen Hombre concerning the early cultivation, and later abandonment, of rice and bananas, two significant subsistence crops. According to elders, Buen Hombre was settled at a time when rainfall was abundant. During this period, rice and bananas were cultivated. The two crops were abandoned in the 1940s, according to elders, because precipitation had decreased. Coconuts also were once plentiful on the beaches east of the village, but they, too, have disappeared.

### Methods and Assumptions

Villager recollections of agricultural change attributed to a change in the climate prompted researchers to examine whether or not there had been a significant shift in local climate between 1897 and the 1940s. Based on discussions with research team meteorologists and the crop and soil scientist, a conclusion was reached that precipitation was the key variable, rather than temperature and solar radiation. Meteorologists at the University of Michigan conducted a search for available historic weather records and reports for Hispaniola, the Dominican Republic, and Haiti, with a focus on data reported for stations on the north coast of the Dominican Republic.

In addition, the crop and soil scientist collected information on the "climate space," or minimum requirements in terms of precipitation, temperature, solar radiation, and the interaction among these variables, for the survival of crop plants and animals. The objective is to determine, as closely as possible, whether climatic change had contributed to the abandonment of rice and banana crops, or whether the change was due to social, political, and economic factors (policies, incentives, practices such as deforestation), or other environmental factors such as crop disease episodes. The roles of climate and political economy in historic agricultural change in the village of Buen Hombre are discussed more fully in Chapter Four. Inferences regarding climatic change on the north coast of the Dominican Republic and Buen Hombre in particular, drawn from analysis of weather data, are presented below.

## Climatic Patterns in the Dominican Republic

Climatic patterns and their fluctuations in the Dominican Republic are influenced by geography and topographic characteristics. Climatic zones range from humid tropical in the central upland valleys to semi-arid/subtropical along the coasts as one moves from east to west.

As an example, the Samana peninsula, located in the eastern part of the country, receives nearly 80 inches of rain annually. In stark contrast, the northwest coast receives a mere 25 inches of annual precipitation (Lang 1988:11).

### Comparative Station Analysis

Four stations were selected for analysis of climatic data based on geography and proximity. The stations are (1) Cap Haitien, (2) Monte Cristi, (3) Puerto Plata, and (4) Santiago. The first three stations are located on the north coast of Hispaniola. Cap Haitien is on the north coast of Haiti; Monte Cristi and Puerto Plata are on the north coast of the Dominican Republic. For comparative purposes, the inland station of Santiago was selected to illustrate differences between coastal and inland climatic patterns. In addition, an 18-year record of annual average rainfall for Villa Vasquez (formerly Villa Isabel) was obtained.

The four stations show a typical tropical pattern of rainfall. Three of the stations are on the north coast of Hispaniola (Cap Haitien, Monte Cristi, and Puerto Plata) and one is inland, achieving a geographical spread that allow for some meaningful analysis and inferences about rainfall and temperature in Buen Hombre.

The community of Buen Hombre is located between Monte Cristi to the west and Puerto Plata to the east. Cap Haitien is located to the west of Monte Cristi. Santiago is located southeast of Buen Hombre in the fertile upland valley area south of the Cordillera Septentrional range. The assumption that the climate history of Monte Cristi would best represent the climate of Buen Hombre derives from the fact that it is the closest station to the village. In addition, both locations are similar in topography.

Comparisons of the four stations show that Puerto Plata has more precipitation than the other stations. Possible reasons are: orographic effects (Puerto Plata is located on the windward side of a large mountain), and changes in the seasonal prevailing wind patterns. The wide variability of rainfall from year to year and month to month would be characteristic of the type of precipitation received from the convective storms produced by orographic effects, rather than the mid-latitude frontal systems that we are used to seeing in our part of the world. A tropical cyclone usually passes within 600 nautical miles of Hispaniola every year, but only in September of 1955, 1960, and 1963, and October 1963, was there rainfall much above the average for the month that may be attributable to a hurricane or tropical storm.

Further comparisons between stations shows that the 1960s were slightly wetter than the 1950s for 3 of the stations (Monte Cristi, Cap Haitien, and Santiago), Puerto Plata being the exception. What is significant to note is the noticeable drop in rainfall in Monte Cristi from the period 1905-1926 (approximately 1,200 mm) to the 1950s and 60s (approximately 600 mm), which does not occur at any of the other stations.

What could have caused this local phenomenon is not known. It is possible that measurement errors or a major change in the location of the rain gauge could have occurred, but there is no way of determining this from the records currently available. Consequently, we have assumed that the existing data are accurate for the stations. The following is a station-by-station presentation of weather data.

## Historic Weather Station Records

Monthly precipitation data from Cap Haitien, Monte Cristi, Puerto Plata, and Santiago have been gathered for the years 1951-1970. In some cases, missing data are scattered throughout the months for some of the stations. These data have been gathered from World Weather Records, a publication of the U.S. National Oceanic and Atmospheric Administration (NOAA). Other data that covers 1905-1926 for Puerto Plata and a certain number of years for the other stations, believed to be taken at about that time, come from Average Climatic Water Balance Data of the Continents, Part VI: North America, Excluding United States (Thornthwaite Associates 1961). Attempts to track down the original data from that publication and the dates those data were taken from the other stations have not been successful.

## Cap Haitien

Seasonal Characteristics. Cap Haitien has a rainy season, and a dry season comparable to Puerto Plata, but the dry season runs only from June to August and has two moderate rainy seasons, in the spring (March-May), and the fall (September-October), but the year-to-year variability during a month is much greater than Puerto Plata, with some pronounced dry months during the rainy seasons.

Annual Variation. Since Cap Haitien has occasional months with a great deal of precipitation, the annual total have a great deal of variability. For example, 1952 and 1956 were extremely dry years, and would have been even more so had there not been a month (April 1952 and March 1956) when it received a great deal of rain for the month. Overall, there has been little change from the 26 year average (Thornthwaite 1961:366) and the 1950s and 60s.

**Santiago**

Seasonal Characteristics. Santiago has two moderate rainy seasons, in the spring, and the fall, though the amounts that fall during the rainy season are not as large as in Puerto Plata and Cap Haitien.

Annual Variation. There were a few drier years in the late 1950s and late 1960s and in most years there was one month that had a great deal of precipitation in the spring. The 1950s were slightly drier than the 1960s and both the 1950s and 1960s were drier than the 11 year average for the period 1905-1926 (Thornthwaite Associates 1961:359).

**Puerto Plata**

Seasonal Characteristics. The Puerto Plata station receives a good amount of rainfall throughout the year, though with a pronounced rainy season during the winter (November-February) and a moderate rainy season during the spring (March-May). The dry season runs from June through October. With a few exceptions, at least 50 mm of precipitation falls each month on this station. Monthly average temperatures run about 22.5 degrees C in January and 27 degrees C in July.

Annual Variation. The 1950's were wetter than the 1960's, and both decades were wetter than 1905-26.

**Monte Cristi**

Seasonal Characteristics. Compared with both Puerto Plata and Cap Haitien, Monte Cristi receives much less precipitation. The rainy season runs from November through January and is relatively dry throughout the rest of the year. Except for the very occasional wet month (November 1951, December 1957, December 1959, March 1960, November 1966, November 1968), there is not much rainfall.

Annual Variation. Over this 20 year period, the annual average precipitation is relatively constant, if low compared to the previous 2 stations. The 1950s were slightly drier than the 1960s, but both decades were much drier than the 7 year average from the period 1905-1926 (Thornthwaite Associates 1961:359).

## Inferring Climate Change on the North Coast of the Dominican Republic

Rainfall at Buen Hombre was not recorded before a gauge was established by our research team there in 1991. There are no local data, therefore, to verify the perception that rainfall has significantly decreased for the last two or three decades. The nearest location for which there are records is Villa Isabel, now known as Villa Vasquez (19 degrees, 44 minutes North latitude, 71 degrees, 27 minutes West longitude), about 15 kilometers south-southwest of Buen Hombre. At a reported elevation of 79 meters, it had an average annual rainfall of 638 millimeters (mm) for an 18-year period according to Wernstedt (1961). The specific years of the record were not given.

Monte Cristi (19 degrees, 51 minutes North latitude, 71 degrees, 39 minutes West longitude, elevation 49 meters) is a station with a more complete record. It is about 25 kilometers west of Buen Hombre and near the coast. According to Wernstedt (1961) it had an average annual rainfall of 639 mm for an unspecified 23-year period, nearly identical to that of Villa Isabel. Average annual rainfall in Monte Cristi for the period 1951 to 1960 is given in World Weather Records (                ) as 746 mm.

Two other sources, however, give a 7-year average for Monte Cristi of 1,181 and 1,176 mm, respectively (Alpert 1941; Thornthwaite Associates 1961). Neither source gives the specific years of record. If the 23-year record listed by Wernstedt did not include the unspecified 7-year record, presumably made before 1941, and if it represents a 23-year period immediately preceding, say 1960, then one may conclude that Monte Cristi's rainfall did decrease significantly (40 to 50%) from some time before 1940 to 1970. This, of course, is in comparison to an unspecified 7 year period prior to 1940.

To estimate the rainfall at Buen Hombre and how it may have changed over the last few decades from nearby records requires careful judgement. It is well known that tropical rainfall, particularly in mountainous regions having less than 1,000 mm a year, is highly variable in both space and time. What follows is a brief summary of relevant atmospheric and topographic characteristics to help obtain a meaningful estimate.

### Geographical and Seasonal Patterns

The average annual rainfall pattern for Hispaniola as presented by Portig (1976) in "World Survey of Climatology" is reproduced in Figure 3.1. A description of the data from which it was derived was not given. Some, apparently, were from Wernstedt (1961). It is a complex pattern but in the northern part of the country there is a good correlation with topographic contours in that area (Figure 3.2). The pattern is such that the annual rainfall decreases from east to west along the coastal area from Puerto Plata to Monte Cristi.

In order to estimate how precipitation varies along the coast between these two locations both coastal and highland configurations have to be examined in relation to wind direction at times when atmospheric conditions are appropriate for significant precipitation. Neither local wind data nor data for other relevant atmospheric conditions are available; one must look to overall circulation patterns in the Caribbean and North Atlantic. In particular, their seasonal changes should be examined in relation to seasonal rainfall patterns. Figure 3.3 shows the average monthly rainfall for the north coast of the Dominican Republic in terms of percent of average annual amounts. It was constructed from data given by Portig for all but the easternmost part of the island's north coast. He divided this region into two rainfall regimes, both having very similar bimodal distributions, with the region east of 71 degrees West longitude having a somewhat smaller percentage in the fall months than that of the region west of 71 degrees West longitude.

Many regions in the tropics have bimodal rainfall patterns. In many cases, they can be associated with the twice-yearly passage of the intertropical convergence zone (ITCZ), a band of low pressure discontinuously and variably encircling the earth in the tropical regions. It separates the northern and southern hemisphere semi-permanent sub-tropical anticyclones, (i.e., high pressure cells), occupying the low latitude oceanic areas most of the time. Because circulation around an anticyclone in the northern hemisphere is clockwise, and counterclockwise in the southern hemisphere, the flow tends to converge in equatorial regions. Convergence results in upward motion, condensation, cloudiness and precipitation.

These large-scale circulation features are the result primarily of the rotation of the earth and the gradation in solar heating from tropical to polar latitudes. In the annual swing of the earth around the sun, of course, the north pole tilts toward the sun in June and away in December. This causes the sub-tropical anticyclones to shift latitudinally and, at the same time, the ITCZ to "follow the sun." That is, it shifts into the summer hemisphere.

If a station is near the equator, therefore, it may experience two visits a year of the ITCZ. Stations at the limits of the tropics, however, can expect only one, somewhat, longer period of lower pressure, cloudiness, and precipitation. This relatively simple picture would seem to a provide an equally simple pattern of precipitation in the tropics. The size, shape and distribution of continents, however, create a major distortion in both the flow and precipitation patterns. In the region of the Dominican Republic, for example, the average seasonal swing of the ITCZ is only from the equator to about 5 degrees north latitude. In fact, from about the Dominican Republic westward to 160 degrees west latitude, Riehl (1979) shows the average position to remain north of the equator all year.

The seasonal north and south movement of the ITCZ, furthermore, lags that of the zenith sun. If its influence were felt as far north as the northern coast of the Dominican

Republic it would be felt in August or September, a period, in fact, that shows a minimum in precipitation. It is clear that the low pressure associated with the inter-tropical convergence zone, in its simplest form, cannot be responsible for the observed seasonal rainfall pattern that has a marked summer dry period.

The pronounced November maximum in precipitation observed along the northern coast is equally difficult to account for. Caribbean tropical storms are highly concentrated in September. Alaka (1968) gives statistics for tropical cyclone occurrences for the period 1901-1963 for this region. In 42 of the 63 years no tropical cyclones were reported in November, in 20 of the years there was one reported in each November and in one year there were 2. In September, on the other hand, only one year had no tropical cyclone reports while one year had as many as 7. Altogether, total occurrences for the 1901-1963 period were as follows:

| | |
|---|---|
| June | 33 |
| July | 34 |
| August | 100 |
| September | 173 |
| October | 110 |
| November | 21 |

Tropical cyclones in this context are low pressure areas with cyclonic circulation (counter-clockwise in the northern hemisphere) that develop in the easterly flow (wind from the least) between the high pressure areas of the semi-permanent sub-tropical anticyclones and the equator. They vary in size from 100 to 1,500 km in diameter and generally move slowly westward. If they develop into hurricanes (i.e., having winds greater than 73 mph) they often ultimately move poleward and then eastward in the mid-latitudes. Rainfall may be abundant and extensive regardless of whether or not such a storm reaches hurricane stage.

Antecedent flow patterns for tropical cyclones are often "easterly waves." They appear as low pressure troughs on the equatorward sides of the semi-permanent subtropical anticyclones in well-developed easterly flow. They travel westward at about 8 degrees longitude a day (Riehl 1979). Showery precipitation is associated with the cyclonic flow region in the eastern section of such a trough. They may develop in Africa, move across the Atlantic to the Caribbean over a period of many days and may or may not develop full cyclonic circulation. The associated rainfall as well as their overall development depend strongly on the nature of flow aloft.

Neither the ITCZ nor the occurrence of tropical cyclones and easterly waves appear to account directly for the the seasonal distribution of precipitation along the north coast of the Dominican Republic. A careful consideration of seasonal shifts in both surface and upper-air wind patterns may be fruitful. These may be associated with the above-described large-scale phenomena and may include a variety of flow characteristics throughout the atmosphere.

Included are regions of wind shear, changes in vorticity, and shifting patterns of low-level divergence associated with the anticyclones. Their influence on precipitation is felt through their enhancement or inhibition of the upward motion necessary for precipitation.

Divergence associated with the sub-tropical anticyclones produces a significant characteristic of the middle troposphere in the tropics. It is the temperature inversion associated with the easterly, or "trade" winds that occupy the region between the subtropical high centers and the ITCZs. Diverging air in all quadrants of an anticyclone create a large area of subsiding, or sinking, air which warms at the higher pressures of lower elevations. The resulting increase of temperature with height, or inversion, at the base of the subsiding layer inhibits the localized upward motion required for the development of showers characteristic of tropical precipitation. Variations in the position and intensity of the subtropical anticyclones can, therefore, be a major controller of precipitation patterns.

Shifting flow patterns at all levels in the atmosphere that may enhance or inhibit the upward motion required for precipitation have to be examined along with associated lower atmosphere wind direction in relation to the orientation of orographic features. Lahey (1973) has carefully examined seasonal changes in wind patterns up to 30,000 feet in the southern Caribbean in order to account for the arid climate along the north coast of South America. He maintains that easterly winds parallel to such an east-west coast are significantly divergent because of the increased resistance offered by the land area as compared to that of the sea. This causes the wind over land to turn away from the sea, creating a band along the coast in which the air subsides, thus counteracting the upward motion required for precipitation. In other words, the change in wind direction resulting from such a cross-wind change in friction can be considered the result of a decrease in coriolis force (relative to the horizontal pressure gradient force) due to the friction-induced decrease in wind speed.

Unfortunately his wind patterns for various levels in the atmosphere due not extend to the region of the Dominican Republic in detail sufficient to delineate significant seasonal changes. His surface wind patterns, however, suggest a wind direction nearly parallel to the Buen Hombre coastal area in July. The patterns for the other three months he shows (January, April and October) appear to have east-northeast winds in this area. The coastal resistance-divergence hypothesis appears to be well-founded and, indeed, responsible for the aridity along the north coast of South America. It has been applied to other regions, also, (Bryson and Kuhn 1961) and may reasonably account or the late spring and summer rainfall minima along the north coast of the Dominican Republic.

When the wind is from the northeast or east-northeast the rainfall pattern in the Dominican northern coastal regions is likely to be dominated more by orographic lifting than by coastal divergence patterns. The foothill and mountain ranges running generally west-northwest to east-southeast are then approached by a more nearly perpendicular flow. The rainfall pattern should show, as it does, a characteristic increase in amount with increase in elevation (at least up to about 10,000 feet) on the windward side of the range and a decrease on the leeward side. The picture is further complicated in the region between Puerto Plata and Monte Cristi, however, by the west-northwestward decrease in elevation of the mountain range nearest the coast.

Figure is a reduced reproduction of a section of a topographical map (Army Map Service ) modified in order to highlight elevation countours and the coastline in the region of Buen Hombre. Average annual rainfall amounts from Wernstedt (1961) have been entered. From the foregoing summary of atmospheric conditions controlling rainfall in the region, it is clear that a reasonable pattern of rainfall distribution cannot be made without knowledge of, at least, the wind direction pattern. If data were available a map might be drawn for each month of the year and the annual pattern of rainfall for Buen Hombre thereby reconstructed from regional information.

**Interannual Variability**

Hastenrath (1954) has examined the interannual variability of climate and circulation in the tropical Atlantic Ocean area. He concludes that

> For the most part of these regions, rainfall anomalies tend to be associated with departures in the large-scale atmospheric and oceanic fields that correspond to the pattern changes in the annual alternation of dry and rainy seasons. The inter-annual variability of climate and circulation thus appears largely as enhancement and reduction of the annual cycle. (Hastenrath 1954:1097)

As he points out, however, there is little utility in this conclusion for anticipating future rainfall regimes because of the lack of understanding of the relevant general circulation mechanisms.

An example of the interannual precipitation variability in the Caribbean is given in Figure . The figure charts the average annual rainfall record for Port-au-Prince, Haiti from 1888 to 1950. The average for this period was 1,346 mm and, as can be seen the greatest annual amount, 1,938 mm, occurred within 3 years of the smallest, 859 mm, a range of 80% of the average. There appears to be no systematic trend and, in fact, a 26-year average for the period 1761-1786 for the coastal station of Leogane, about 20 km west-southwest of Port-au-Prince, was also 1,346 mm (Reed 1926). This record supports the commonly-held view that interannual variations in tropical precipitation are large and that long-term trends, if any, are relatively insignificant.

In an earlier study of interannual variability in the Caribbean area, Hastenrath (1976) made an extensive analysis of rainfall records at 48 stations "spanning the entire area from southern Mexico through Central America and the Caribbean to northern South America" for the period 1921-1974 (Hastenrath 1976: ). Figure is a reproduction of part of his Figure 3. It shows the march of yearly values of the standard deviation, that is, "the all-station average of normalized departure of calendar-year annual rainfall totals" (Hastenrath 1976: ). The positive values indicate above average and the negative values below average values for the entire period.

As Hastenrath (1976: ) points out, the "extreme" amounts appear to occur in sequences of several years. For example, the years 1931 to 1938, inclusive, all had above normal rainfall while the years 1944 to 1949, inclusive, had below normal amounts. These data, furthermore, tend to support the perception that Buen Hombre precipitation in the last 2 or 3 decades was less than that received in the immediately preceding decades, particularly if one compares it to the above average data for the 1930's.

Taken all together, the considerations of local topography, nearby rainfall records, local and large-scale atmospheric flow patterns, and their seasonal variations, are not adequate for a useful estimate of either the average annual amount of rainfall for Buen Hombre or its interannual variability. It is likely, however, that its seasonal distribution is much like that for most of the north coastal area as shown in Figure . Its annual average for the past half century may have been 10 to 20% greater than that of, say, Monte Cristi. If the unspecified 7-year average of nearly 1,200 mm for Monte Cristi, furthermore, is an accurate measure, it is quite possible that Buen Hombre experienced a similar decrease in precipitation, as indicated by the last 2 or 3 decades of Monte Cristi's record in comparison to the earlier 7-year period.

Our assumption that the record reflects true rainfall in Monte Cristi, and by extention Buen Hombre, therefore, seems to be a logical one. The assumption is strengthened by ethnographic data, especially given the oral testimonies gathered from village elders that corroborate the record (see Chapter Four).

# CHAPTER FOUR

# ETHNOHISTORY OF BUEN HOMBRE

This chapter summarizes the history of population-environment interactions on the north coast of the island of Hispaniola in general, and in the community of Buen Hombre in particular. The purpose of this chapter is to highlight historical patterns of natural resource utilization and significant human ecological trends from the founding of Buen Hombre to the present.

Researchers sought to reconstruct the history of Buen Hombre to the extent possible using the scientific method known as ethnohistory. In our view, as has been argued elsewhere (Dobyns 1978), an ethnohistorical perspective of populations affected by development and change is a crucial component in informing policymakers and government administrators as to the long-term temporal adaptations employed by local peoples in response to historic alterations in their environmental conditions. Such a perspective can significantly contribute to enhancing the potential of developing human resources, in contrast to perpetuating wasteful conditions which frequently result from uninformed transfer of technological hardware so characteristic of development interventions (Dobyns 1978:104).

## Methods

### Ethnohistory

The first part of the chapter is based on data gathered from the ethnohistorical literature, other secondary sources, and oral history interviews. Ethnohistory combines the analysis of historical documents, traveler's reports and archeological data with interpretations deriving from ethnographic research. These data sets are combined in order to "triangulate," or verify from three independent data sources, the research findings. Ethnohistory of a study area sets a cultural and historical frame for understanding contemporary conditions.

### Oral History

The reconstruction of the ecological history of Buen Hombre from 1897 to the present is almost entirely dependent upon verbal testimonies from key community leaders and elders. Both individual key expert interviews and focus group interviews were conducted to elicit information. Formal, in-depth oral history interviews were conducted in 1990. Five community elders were selected by fisherman, farmer and women's association members during focus group meetings. These individuals were identified as being knowledgeable about the long-term social, economic and environmental history of the community of Buen Hombre from the earliest days of settlement to the present day.

**Native American Occupation of Hispaniola**

The dynamics of population-environment interaction on the north coast of the Dominican Republic are not recent in origin. Further, many current patterns of natural resource utilization have been significantly influenced by indigenous patterns. It is thus necessary to devote some space to briefly summarize the patterns of population-environment interaction characteristic of the indigenous Taino culture. Besides placing contemporary trends in their historical context, such a summary will also provide an invaluable comparative data base.

The island of Hispaniola has been occupied by humans for thousands of years. Native Americans arrived on the island by at least 5,000 BC, and its pristine environment would never be the same. As Indian people settled the island, they expanded in numbers and modified the natural environment. The Taino, speakers of an Arawakan language, had arrived on the island which they called Hayti or Quisqueya by at least 5,000 BC (Black 1986:13; Wilson 1990:1). The Taino were descendants of indigenous South Americans who had migrated into the Caribbean throughout the final centuries BC. In a span of fifteen hundred years they expanded to inhabit nearly all of the Caribbean from Trinidad to the northern Bahamas. In the process they replaced or incorporated smaller groups of indigenous island inhabitants (Wilson 1990:2).

The Indian population probably rose steadily from 5,000 BC until about 800 AD. During this time they increasingly modified the environment as they became increasingly sophisticated at hunting and gathering. With the adoption of corn, beans, and squash as well as other tropical cultigens, horticulture became the economic base upon which the population expanded until it was among the densest and socially most complex in the Caribbean. Extensive environmental use by dense native populations probably reached the apex in terms of environmental alteration well before 1492. Based on analogy with other American Indian populations in the New World, it can be assumed that American Indian people in Hispaniola had recognized the limits of the natural environment to support their people and had developed a wide range of conservation measures long before 1492.

On the north coast of Hispaniola, Indian people combined horticulture with the intensive use of marine resources. In the Buen Hombre area, for example, numerous sherds of stylized, decorated ceramics and heavy concentrations of conch shells in middens and mounds observed in the hillslope fields surrounding the village attest to the presence of a permanent American Indian community. The thick layers of black soil are likely anthropogenic black soils (terra preta) like those described for the Amazon basin (Smith 1980) and elsewhere.

Long before the arrival of Europeans, indigenous Caribbean societies evolved elaborate and complex sociopolitical institutions. The Taino were organized politically into several provinces, composed of numerous villages, led by a cacique or chief as the ultimate authority within each. Caciques were elite politico-religious officials, separated from lower status, commoners. While land tenure and use was communal in nature, the cacique directed both the production and distribution of food and goods in his chiefdom, or cacicazgo (Wilson 1990:4).

The Taino practiced a mode of intensified agricultural production called conuco. The predominant feature of Taino agriculture throughout the Caribbean was the intensive cultivation of such crops as manioc, sweet potatoes, peppers, peanuts, and maize. Aboriginal agriculture was practiced using the slash and burn method of clearing and firing vegetation to create fields and plant crops. Native farmers also used sharpened sticks and polished stone axes (Black 1986:13; Wilson 1990:93).

The Taino also engaged in intensive utilization of marine resources such as a variety of fish, shellfish, turtles and manatee. Fishing technology consisted of wooden spears which were thrown from dugout canoes.

**"Discovery" and Colonization by Europeans: The North Coast**

The island of Hispaniola was the first Caribbean island to be colonized, the north coast being the location of the first Spanish colonial settlements. It was from here that the Spanish empire was governed. It remained the most important base of operations for thirty years.

During Cristopher Columbus' first voyage, he sailed along the north coast of Hispaniola. His journal entries document a dense Taino population that combined horticulture with the intensive use of marine resources:

> This big island appeared to be very high, not encircled by mountains but level like beautiful fields. It appears to be all cultivated, or at least a large part of it, and the crops look like wheat in the month of May in the vicinity of Cordoba… (Fuson 1987:127).

> There must be a lot of people in this region, since I have seen so many canoes. Some of them are as large as a rowboat with fifteen benches for the rowers (Fuson 1987:129).

By January 4, 1493 Columbus began to explore what is the modern-day northwest coast of the Dominican Republic. His journal entries contain a rich description of the Monte Cristi area near Buen Hombre in the late 15th century:

> All this country near the mountain is low, forming a lovely plain…Beyond the mountain, 18 miles to the east I saw a cape which I named Cabo del Bezerro. Between Monte Cristi and

> the cape the reef extends seaward for six miles, although it seems to me that there are channels by which one could enter…To the east of Monte Cristi, toward Cabo de Bezerro, the twelve miles is all beach, the land is very low and beautiful. The rest of the land is very high, with beautiful and well cultivated mountains…as well as very large valleys that are green and possess many rivers (Fuson 1987:165-166).

La Villa de la Navidad, founded on Christmas day in 1492 or January 3, 1493 by the Gregorian calendar (Fuson 1987:231; Woodbury 1959:104), was the first European settlement in the western hemisphere. The settlement was established as a result of the wrecking of the Santa Maria near this area. The site of Navidad was a viable Indian village under the leadership of Guacanagari, a Taino cacique. After the decision to establish a settlement at the site, Columbus left nearly four dozen men behind to build fortified structures and remain there until he returned (Fuson 1987:231). When he returned to the site in 1494 during his second voyage, Columbus found that the settlement had been destroyed and abandoned.

Exactly what caused the demise of this colony is unknown. Ewen (1988:41) suggests that the Taino massacred the settlers and destroyed the buildings. Indian leaders who did not tolerate the capture of village women by Spanish colonizers occasionally succeeded in mobilizing enough force to rebel against the captors (Black 1986:14). The desire for gold also may have led the European settlers to explore further inland.

Columbus made no effort to re-establish La Navidad. He and his crew established a second settlement in 1494, which they named Isabela in honor of the Spanish queen. The settlers established farms planted with melons, wheat, and sugarcane. For the most part, however, the search for gold, which Indians indicated had been present in the Cibao valley became the focus of their time (Black 1986:15). The settlement of Isabela was also short-lived. Conflict among the colonists escalated such that, by 1496, Columbus' brother in charge of the colony, migrated to the south coast and established a new colony on the Ozama river, accompanied by most of Isabela's population. With a population of nearly 300 in 1498, the settlement was named Santo Domingo (Black 1986:16).

Other Spanish settlers continued to colonize the Navidad region in the early 1500's. Their goals were to establish settlements and subjugate the native population (Ewen 1988:41). One of these settlements was Puerto Real, which grew to be a sizable town that was a center for cattle ranching, hide production, and the illegal smuggling system known as the rescate operated by French, English, and Portuguese traders. The mountain topography prevented easy access to other major settlements and the acquisition of necessities and luxury items from the established colonial market on the south coast (Ewen 1988:42).

Mining and sugar cane cultivation and processing were the primary economic activities of the colony. During the next twenty years following the establishment of the first settlement, colonists had built seaports, towns, fortifications, and opened up new gold mines while engaging in agriculture and stock raising. Native woods, cotton, sugar and gold were exported. This rapid development stimulated a wave of new colonists migrating to the settlement. There was a total of 17 towns on the island by 1513 (Woodbury 1959:104).

The cattle that Columbus imported on his second voyage rapidly increased in population on the vast open ranges and provided settlers with abundant meat and hides (Ewen 1988:44). The populations of pigs and dogs also increased such that, by 1506, settlers hunted them as game animals (Woodbury 1959:106).

Despite the importation of a wide variety of Old World plants, trees, cereals, and seeds by Columbus on his second voyage, and the development of large scale cotton and sugar cane enterprises, the focus on gold mining resulted in the colonies having to import food from Spain to feed the rapidly growing population of settlers (Woodbury 1959:108).

**Demographic Impact of Colonization: Population Collapse**

The Indians of Hispaniola were the first in the New World to experience the overwhelming military superiority of the Spanish colonizers and the devastating array of diseases they carried. Thus the Taino represent one of the first New World populations to be quickly and completely eradicated as a consequence of the European discovery (Wilson 1990:2).

Pre-conquest population estimates for the island of Hispaniola vary. Angel Rosenblat (1976) made a conservative estimate of over 100,000. Eyewitness accounts led Bartolome de las Casas to estimate the population at 3,000,000 (Thornton 1987:16). Based on a detailed examination of documentary sources, two distinguished historical demographers (Cook and Borah 1971:I:379-410) estimated the indigenous Native American population to be as high as 8,000,000 in 1492.

The Columbian discovery drastically altered the population density and land use practices on the island. Indian populations suffered heavy mortality from warfare and slavery, but it was Old World pathogens such as smallpox that decimated Native American inhabitants (Crosby 1972; Dobyns 1983; McNeill 1976; Purdy 1988). Aboriginal American populations had no immunity to this and other Old World diseases.

Cook and Borah calculated that the native population collapsed from an estimated 8,000,000 in 1492 to 3,770,000 in 1496 (cf. Dobyns 1983:257). The first recorded outbreak of smallpox originated on Hispaniola in December of 1518 (Dobyns 1983:259), and from there began the first hemisphere-wide pandemic. Between 1496 and 1518, a span of just 22 years, the population of Hispaniola fell from an estimated 3,770,000 to only 15,600 (Cook and Borah 1971:I:401). Only 3,500 remained in 1538 (Cripps 1979:47). Vazquez de Espinosa (1942:39) noted that all American Indian people were gone from the island before he arrived in 1612.

Because of American Indian population collapse and Spanish failure to repopulate the island, environmental recovery probably began in 1492 and lasted until at least 1612. After this time, hispanic people slowly began to reestablish a population that would be as dense and as extensive as that of the American Indians before 1492.

American Indian inhabitants of the area surrounding present day Buen Hombre surely must have suffered heavy mortality. Indeed, Buen Hombre lies 45 kilometers to the west of Columbus' first New World settlement of La Isabela and about 75 kilometers east of the settlement established at La Navidad (in contemporary Haiti). These settlements contained small hispanic populations. On the north coast of Hispaniola, the hispanic population did not begin to establish itself until the late l800s. Consequently, the Buen Hombre area the natural environment may have undergone as much as 250 years of recovery before being redisturbed by humans.

In summary, the Spaniards did not conquer a "virgin land" comprised of pristine ecosystems. Rather, in the words of two eminent ethnohistorians (Jennings 1975:15; Dobyns 1976; 1983:8), they "widowed" an already occupied and extensively altered natural environment. Because of aboriginal depopulation by the early 17th century and slow hispanic repopulation, the natural landscapes and seascapes underwent hundred of years of regeneration before being extensively disrupted again in the late 19th and early 20th centuries.

## Ethnohistory of Buen Hombre

The village of Buen Hombre is situated along the arid northwest coast of the Dominican Republic. The people of Buen Hombre look north to the sea and south to the mountains. The community is located in a cove between an extensive coral reef zone and the flanks of the Cordillera Septentrional mountain range. A deep break in the coral reef and a shallow lagoon are two more of the community's natural resource assets.

As mentioned, archeological evidence suggests that the region was not always uninhabited. Great numbers of sherds of stylized, decorated ceramics and heavy concentrations of conch shells in middens and mounds in the hillslope fields surrounding the village clearly attest to the presence of a significant and sedentary Taino community in the Buen Hombre area. The journal entries of Columbus, as noted above, also document a heavily populated region.

According to elders interviewed in 1990, the community of Buen Hombre was founded around 1897 by a family of thirteen Cuban refugees fleeing their homeland during the second War of Independence (1895-1899). These early settlers found an uninhabited ecosystem characterized by fertile soils, regular rainfall, and dense secondary forest.

While data are scarce, it can be argued based on the comments of elders that the coastal area was at most very sparsely populated in 1897. Taino populations in this region would have likely suffered heavy mortality. The contemporary village of Buen Hombre is only 45 kilometers from the first permanent New World settlement of La Isabela. This area would have been in close proximity to the more significant settlements like Puerto Real. Disease, exploitation and massive exodus into the interior were significant reasons behind depopulation. The north coast area likely continued to experience outmigration of Spanish colonists, who shifted their colonization efforts southward to the more fertile and mineral rich interior. Consequently, the north coast was gradually but steadily abandoned.

This historical pattern of colonization, in combination with the decimation of the aboriginal population, meant that the entire north coast of the Dominican Republic remained sparsely populated. It is not clear whether there were any short-lived settlements in the immediate vicinity of Buen Hombre during the colonial period. It would seem unlikely, as a coastal community would have had difficulties in evading Spanish authority. Consequently, the ecosystem of Buen Hombre may very well have experienced as much as a 250 year "fallow" period before being rediscovered by a group of Cuban refugees.

Early Haitian Settlements on the North Coast. During the Haitian occupation of 1822-1844, there was a Haitian fishing community about three kilometers to the west of the current site of Buen Hombre. They relied predominantly on cage or corral fishing. Buen Hombre elders suggested that there was another Haitian community on the east side of Buen Hombre on the Playa de Coco. The beach received this name because of the large number of coconut trees in the area. The Haitian communities were forced to flee the country when Dominicans liberated their country from Haitian domination.

## Early Agriculture

The founding settlers of Buen Hombre cleared tracts of land near the lagoon and established a diversified agricultural system that included the cultivation of such crops as plantains, cassava, maize, beans, potatoes, peas, tomatoes, bananas, and rice. The cultivation of both rice and bananas on the leeward side of the mountains suggests that precipitation was more regular and reliable during this period. Families also raised a variety of animals including donkeys, horses, pigs, goats, sheep, chickens, and cattle for transportation, traction, and food. Their initial stock of animals was probably acquired from the town of Villa Vasquez and other villages over the mountain slopes.

Climate and Crop Changes. Oral history indicates that prior to 1950 agricultural production in Buen Hombre was abundant. There was sufficient rain to produce many crops, including bananas and upland rice. However, villagers say that since the 1940s rainfall has decreased, and agricultural production has changed both in types of species planted and in decreased overall production. Neither rice nor bananas has been cultivated in the village since the

1940s. Precipitation data from this geographical region in the Dominican Republic have been analyzed to evaluate the accuracy of villagers' retrospective perceptions of rainfall amounts (see Chapter Three). A key question is that if decreases in rainfall actually occurred, were the decreases enough to cause cultivation of rice and bananas to cease, as villagers have stated, or is it possible that factors other than precipitaion might have caused changes in the agricultural activities of the village?

Part of the answer lies in the climatic requirements of these two crops. Rice is a semi-aquatic plant. It grows in standing water, though standing water is not required. Rice grown in flooded paddies or basins is usually called paddy, wetland or lowland rice, while rice grown in well-drained, unflooded, rainfed soils is termed upland or dryland rice. Upland rice, therefore, is cultivated at the ecological limits for the species in terms of water requirements. Climate, especially precipitation, is a key variable in the productivity of upland rice. Yet rainfall is the most variable and least predictable agroclimatic factor (Gupta and O'Toole 1986). Because rice is so sensitive to stress due to lack of water, daily rainfall distribution is more critical than monthly or seasonal distribution. In areas of low rainfall, drought stress at critical growth stages is the main factor limiting yields. Chandhary and Rao (1982) report that adequate total annual rainfall for rice production ranges from 1,100 to 2,000 mm per year, but low to moderate yields can be obtained with annual precipitaion amounts between 700 and 1,100 mm.

In Latin America, where dryland rice requires 1,000 mm of rain per year and 200 mm per month during the growing season, it has been shown that 100 mm per month distributed evenly is better for the rice crop than 200 mm a month falling within a two to three day period (Da Mota 1980). Upland rice cannot be supported in areas with annual rainfall amounts under 700 mm, as occurred in Monte Cristi, just west of Buen Hombre, between 1951 and 1970. If total precipitation in Buen Hombre was similar to that reported for Monte Cristi during those two decades, statements by villagers that rice production was not possible during those years would be supported by rainfall data alone. Annual precipitation data for Monte Cristi in the early 1900's is unknown, but a 7-year average for a seven-year period sometime between 1905 and 1926 was reported at approximately 1200 mm annually. This was enough to produce greater than moderate rice yields during those years and is strong evidence of support for villagers' statements of greater rainfall amounts prior to 1950, as compared to after 1950. The relationship between precipitaion and upland rice production is direct (Stansel 1980). As precipitation decreases, yields decrease.

Bananas require even greater quantities of precipitation than rice. For maximum productivity bananas need 2,000 to 2,500 mm of rain annually (Daniells 1986). In areas where maximum precipitation is only 500 to 1,300 mm per year, irrigation is necessary (Soto, 1985). On a monthly basis bananas are seriously short of water with less than 100 mm of rain per month. 200 mm per month is an adequate amount on all but the most porous soils (Simmonds 1966). Therefore, 100 to 180 mm of monthly rain meets the precipitation requirement for bananas (Soto 1985). This indicates that although precipitation records are patchy for Monte Cristi prior to 1950, 1,200 mm of mean annual precipitation could have supported bananas in the region. It also indicates that either the data for the 7-year average annual precipitation of 1,200 mm was lower than most years prior to 1950 or that in areas where bananas were grown, they were grown on fine-textured soils with high water-holding capacity. The majority of the agronomic soils in Buen Hombre are in fact fine-textured and currently have moderate levels of organic matter, which enhance water-holding capacity and the soil's ability to store water.

Temperatures in Monte Cristi and Puerto Plata, to the west and east of Buen Hombre, respectively, fall within the optimum range for growth and development of both rice and bananas. Bananas are usually cultivated in areas where temperatures vary between 21 and 29.5  C (70 to 85 F) with average annual temperatures at 27 C (80.6 F). The minimum acceptable temperature is 16 C (60 F), the maximum is 38 C (100 F) (Simmonds 1966; Soto 1985). Average annual temperatures for Puerto Plata range from about 24 to 26.5 C, which is within the optimum range.

Rice is rarely produced in areas where average annual temperatures drop below 20 C or where daily temperatures fall below 15 C or go above 30 to 35 C (Da Moto 1980). The first domesticated rice plants originated in a region where mean monthly temperatures ranged from 23 to 28 C (Huke 1976). Buen Hombre temperatures fall within the optimum range for rice.

According to Huke (1976) the period between 1890 and 1945 contained the most benign world climate of the last thousand years. This period encouraged man to extend cultivation of rice into areas that had not previously produced rice crops. Rice, which is grown under more diverse environmental conditions than any other food crop, was expanded from transitional climatic zones for rice production to climates previously beyond the outer limits for rice production. A strong possibility exists that Buen Hombre received unusually high amounts of precipitation during this benign period. Though rice and bananas were produced during these years, after 1950 world weather patterns changed for the worse (Huke 1976). If there were accompanying decreases in precipitation in Monte Cristi, as our data indicate, the decreases would have been disastrous for rice and banana production in the region. As precipitation went from marginal to unacceptable levels for these two cultivars, villagers were forced to cultivate species requiring less water, such as the tobacco, pigeon peas and cotton now farmed.

In summary, the analysis of precipitation data for Monte Cristi and other north coast stations seems to support statements made by villagers that annual precipitation has decreased since the 1940s. Furthermore, precipitation decreases alone are in fact enough to explain why rice and bananas are no longer produced in the village. Other factors also may have contributed in some degree to the change in crop regimes, but historical meteorological data support village oral historical accounts.

**Marine Resource Use**

Historic data on the early use of marine resources is still somewhat sketchy. It seems likely that these early settlers would have utilized the beach and mangrove ecozones in gathering shellfish and conch. Community elders recalled that by 1937 there was a large fish market on the beach front. By the mid 1940s they indicated there was a substantial increase in the use of marine resources.

Salt Ponds, Policy, and Mangrove Expansion. According to community elders, there was intensive mangrove growth between 1910 and 1944. Through time the mangrove has grown from Buen Hombre to La Pasa de la Posa. Behind the mangroves were a series of salt water lagoons or pools. These pools often dried up in the summer months of July, August and September and were utilized as a source of salt for domestic consumption. Both the utilization of this natural supply of salt and the rapid growth of the mangrove came to an end during the early stages of the Trujillo dictatorship. In 1944 he opened up the mangrove forest and the surrounding hills to large-scale timbering and prohibited Buen Hombre residents from utilizing their natural salt supply. In 1950, however, the timber company involved ended its contract and large-scale cutting ceased. Community members up until very recently had used mangrove wood in the construction of their homes. This is now prohibited. By 1958 the salt lagoons had disappeared as a result of the mangroves expanding into these areas.

The early economy of Buen Hombre eventually expanded to consist of two interdependent economic systems, one centered on fishing and the other on agriculture. Such a relationship fits a common pattern of coastal fishing communities supplying interior agricultural communities and towns with marine products.

Village elders stated that there was a substantial increase in the use of marine resources by the mid 1940s. They recalled the period as being one in which the coral reef and tidal shore provided an abundance of fish, large lobster, conch, octopus, and manatee. Fishing in these earlier periods was characterized by the use of lines, nets, and harpoons. Women were also important contributors to the fishing economy at this time. Increasing reliance on marine resources may have been due to the change in amount of precipitation, which led to an abandonment of rice and bananas as locally produced subsistence crops. Between 1890 and 1940, then, the economy of Buen Hombre could be characterized as a subsistence economy based on a mixture of agriculture and fishing that supported an expanding population of approximately 120 persons.

The Problem of Water. The acquisition of water has historically been a central challenge for the inhabitants of Buen Hombre. Initially drinking water was obtained through a combination of household water catchment systems and earthen cisterns that captured runoff rainwater from hillside crevices and small gorges. During the dry season and times of drought, community members were forced to travel over the mountains by foot, mule and horse to collect water from the Rio Yaque del Norte. Thirsty individuals also traveled to the surrounding communities of Villa Vasquez, Las Aguitas, and Las Canas to obtain water. Domestic animals were able to take advantage of standing lagoons or water holes in the village which, during times of drought, were also used as sources of water for agricultural production.

Prolonged periods of drought, however, do not seem to have been a significant problem for the early inhabitants of Buen Hombre. Village elders recall this period as a time of abundance in terms of agriculture, animal production, and fishing. The productivity of this coastal ecosystem seems to have encouraged immigration into the region. The population of Buen Hombre steadily increased until 1957 (see Table 2). During the late 1930s, President Rafael Trujillo had initiated a large-scale road building program in order to increase mechanized transportation to the central-northern frontier (Georges 1990:61, 63-64). Thus immigration was further facilitated by the clearing of a small road from Villa Vasquez to Buen Hombre in 1952 as part of the national program. Although the road was rugged and became impassable after any substantial rainfall, it provided access for the first motorized vehicles to enter Buen Hombre and thus facilitated the importation of food and water into the community. The road probably also stimulated exportation of marine and terrestrial surpluses.

The road proved to be an invaluable asset when a three-year drought struck the region in 1957. The drought was catastrophic for the community. Village elders recalled that there was widespread crop failure, loss of animals, and hunger. What precipitation did occur could not be taken advantage of because the condition of the earthen catchment cisterns and canals on the mountain slopes had deteriorated due to deforestation and resulting erosion. Village elders mentioned that without the government's daily shipments of food and water, which were made possible by the road, everyone in the community would have died or been forced to migrate. Despite government assistance, village elders estimate that the village population declined to approximately 200 people.

During the early 1960s, the drought subsided. The road into the community was improved once again. As a result, the area experienced a resurgence in population growth. Whereas early muleteers served to establish connections between nodes of production on either side of the mountains, the improved road opened up the community to buyers, intermediaries and merchants to an unprecedented extent. The village economy expanded beyond subsistence production to include commercial production. Development of new infrastructure in terms of transportation networks and expansion of port towns seems to have been a significant development in the human ecology of the region. Growth led not only to a significant increase in the population on the north coast, but also to increased exploitation of marine and terrestrial resources. Key consultants who assisted in conducting a census of the community for the Dominican government estimated that the population of Buen Hombre had reached 721 in 1960.

While local population data are scant, ebbs and flows of population continued between 1960 and the present. Georges (1990:176) notes that the Central Valley and Sierra region of the Dominican Republic, just south over the mountains from the Buen Hombre coast, suffered severe droughts in 1966-67 and 1975-76, with dire consequences for small-scale farmers. Buen Hombre farmers must also have experienced the effects of these drought episodes.

## Contemporary Buen Hombre

The village of Buen Hombre consists of a series of farmsteads organized in a line settlement pattern, extending inland from the small lagoon that serves as the boat launching location for community fishermen. As the village grew, new homes were built along the road and now stretch from the lagoon to the foot of the mountains. By 1985, the village population had grown to approximately 855 people (Stoffle 1986:81). The majority of homes contain nuclear families, although it is common for these homes to be arranged in extended family clusters. Social networks between relatives and neighbors are horizontal and multistranded (Wolf 1966).

Today Buen Hombre still lacks potable water. The community remains relatively isolated because its only transportation link with interior communities is the poorly maintained road over the mountain range. Although the road was improved in 1985, it often remains impassable to larger motorized vehicles, so water and other essential commodities are usually transported by horse, mule, motorbike, pickup trucks and small cars.

The people of Buen Hombre typically rely on more than one economic activity, an adaptive strategy, termed "occupational multiplicity" (Comitas 1973), that is common throughout the Caribbean. Adult males engage in fishing and farming enterprises for household subsistence and cash income. Women play a significant role in agricultural production at certain critical times in the farming cycle. Occasionally, a few women accompany their spouses on fishing trips. When rainfall is adequate, women also cultivate mixed kitchen gardens, planting staple tuber and vegetable crops as well as medicinal plants and fruit trees. Women manage most aspects of domestic life. In many respects, the people of Buen Hombre use their natural resources much like the American Indian people who occupied this site before Columbus.

## Terrestrial Ecozones and Resource Use

The people of Buen Hombre utilize two terrestial ecozones: (1) the hillslopes for agriculture, and (2) the upland mountain forests for collecting a variety of useful wild plant resources. The numerous resources found in the hillslope and upland mountain forest ecozones are used for subsistence, medicine, shelter, and cash income. Food crops are planted on the hillslopes and in the valleys. Plants and animals are harvested for food, medicine and construction. Timber harvested from the forested uplands is used for shelter, household fuel and charcoal for use and sale.

### Soils

The topography of agricultural lands in the village ranges from 0 degree slopes at sea level to hills, valleys and mountainsides. Buen Hombre farmers describe three main soil types: (1) black, (2) yellow, and (3) mixed, a combination of black and yellow soil types. All soils are considered by farmers to be very productive in years when there is adequate rainfall. Black soil is described as the most productive.

Soil samples were taken from the top 30 centimeters for the three major soil types. In most locations the topsoil layer (A horizon) is unusually thick, commonly 100 centimeters deep. Soil physical properties were not specifically measured. Based on observations, however, Buen Hombre soils appear to have excellent physical properties. The topsoil depth of 100 centimeters allows ample room for root development and root exploration for nutrients. Soil structure in the topsoil appears excellent with good aggregation and a good mix of micropores and macropores that would allow for ample air exchange with the surface, good drainage, water retention, and infiltration.

Table 4.2 illustrates the results of soil testing. The pH is high in all three soils, ranging from 7.6 to 8.1. The cation exchange capacity, or the soil's ability to retain critical nutrients against leaching by water for use by plants, is well above the critical minimum of 4 milliequivalents (meq) per 100 grams of soil. This cation exchange capacity of between 32 and 41 meq/100g is probably due to the presence of organic matter in the soil.

In the higher elevation black soils, phosphorous, potassium, and magnesium levels are adequate for producing medium crop yields. Nitrate-nitrogen levels are higher than usual for non-fertilized soils. Zinc levels appear low, but copper levels are high and may negatively affect crop growth. The dark color of the soil is probably due to the presence of substantial amounts of organic matter.

The fertility of the yellow soils is very similar to that of the black soil, with the exception of lower levels of copper and nitrate-nitrogen. This is probably due to the lower amounts of organic matter.

The fertility of the mixed soils is also similar to the black soil, except for lower levels of plant-available phosphorous. These levels are high enough, however, to permit adequate crop yields without the use of fertilizers.

It appears, then, that despite 100 years of cultivation, soil quality has been maintained at sufficient levels. Soil fertility may be related to cropping practices of Buen Hombre farmers.

**Agriculture**

Agriculture on the north coast of the Dominican Republic is rainfed. Because of Buen Hombre's location in the rainshadow on the leeward side of the Cordillera Septentrional mountain range, precipitation is seasonal and unpredictable. In stark contrast to the Samana peninsula in the eastern part of the country, which receives nearly 80 inches of rain annually, the northwest coast receives a mere 25 inches of annual precipitation (Lang 1988:11). Brief rainy seasons occur during the summer months of August and September, and between December and January in the winter.

*Fields and Gardens*. Fields are typically comprised of two plots--one adjacent to the homestead and another located on the forested flanks of the mountains. Dual location of fields may be related to local perceptions of crop growth and soil fertility. Root and tuber crops such as yuca are said to yield better in the black and mixed soils on the hillsides. Small game birds such as the guinea hen are hunted with rifles in fallow fields. Some farmers also retain access and use rights to plots that belong to relatives who live in interior villages. Kitchen gardens may be a separate small plot adjacent to the homestead or simply a small area in the dooryard around the house.

*Agricultural Cycle*. The local method of farming is most accurately described as slash and burn. Secondary vegetation is cleared any time from September through December. Crops are planted in November and December, and are timed accordingly prior to the advent of winter rains. Weeding occurs in intervals as necessary. Most crops are harvested in March and April. Cassava and tobacco are harvested over longer periods of time throughout the year.

*Crops*. Farming families in Buen Hombre cultivate yuca (cassava), maize, yams, sweet potato, several varieties of beans, squash, fruit trees such as lechosa (papaya) and lime. Tobacco is the major cash crop. Varieties of beans, pigeon pea and maize crops are planted in hillside plots. Fields adjacent to homesteads are largely reserved for the planting of tobacco crops. The yellow soils of these plots as well as of kitchen gardens are also planted with maize, beans, cassava, squashes, cotton, fruit trees, varieties of medicinal plants, herbs and spices, and other species of trees such as mesquite (locally known as cambron) which are used for shade and construction purposes. Wooden fences around field and garden boundaries support climbing vines which are used for fiber, medicinal plants, and spontaneously growing crop and non-crop plants. Living fencerows of cacti are also planted and serve as hedges around fields and gardens. Mesquite bean pods and crop residues are used as fodder for domestic chickens, pigs, goats, guinea hens, cattle, horses and mules.

*Intercropping*. The farmers of Buen Hombre practice mixed crop agriculture by intercropping. Beans and squash are interplanted with maize, tobacco and cassava. Beans and pigeon peas serve a nitrogen-fixing function for maize plants, thus replenishing soil nutrients. Fruit trees are grown in fields as well as in kitchen gardens. Edible greens, medicinal herbs and grasses which thrive in the disturbed soils between crop rows are spared and harvested from fields.

Buen Hombre farmers create, manage and maintain complex agroecosystems and field microclimates typical of rural small-scale, limited resource farmers (Altieri 1987; Gliessman 1984; Wilken 1972, 1987) by interplanting a variety of agricultural crops, selectively weeding and sparing useful plants that grow spontaneously between rows, and by incorporating tree crops into agricultural fields. Sufficient levels of soil fertility are maintained for longer periods of time by virtue of controlled burning of crop residues not used for animal fodder and by interplanting nitrogen-fixing bean plants with maize and tobacco. Differential heights of crop stories serve to preserve what little moisture is retained in crop plant material and soils. Multiple stories also modify shade patterns within fields. All other factors being equal, then, the farmers of Buen Hombre appear to be practitioners of sustainable agriculture.

**Upland Forest Resource Collecting**

The foothill woodlands are dominated by desert scrub vegetation, mainly varieties of cacti and Acacia. At higher mountain elevations, forests are comprised of pine, several types of hardwood tree species and numerous wild plants. Positive botanical identification of these species has not yet been completed. However, it is clear that these resources provide local people with many necessities of everyday life.

*Wild Plant Harvesting*. The people of Buen Hombre collect a wide variety of wild resources for fuel, medicine and construction. An inventory of over 90 distinct types of plants was obtained from respondents. These plants include herbs, fruits, grasses, cacti, flowers, and trees. Several of these plants are transplanted from the upland forests and slopes to kitchen gardens for easier access.

The majority of collected plants are used for medicinal purposes. Leaves, stems and roots are mixed with water and prepared as medicinal teas for treating a variety of ailments and illnesses. Trees and flowers are used primarily for shade and ornamentation. Several species of wood are used to make fish pots, traps, fences, palisades, and for the construction of houses and ramadas. Palm fronds are obtained from villages on the other side of the mountains and used as thatch for roofing. As with agricultural crops, seeds and cuttings of these useful plants are exchanged between relatives and neighbors.

*Fuelwood Collection and Charcoal Production*. The foothill woodlands and mountain forests are also utilized by the residents of Buen Hombre for collecting fuelwood. Based on observations, it appears that only deadfall timber and branches of several varieties of trees are collected as fuelwood.

Charcoal production is a supplemental economic activity in the community. Over half of the farmers interviewed (54%) are engaged in charcoal production, while thirty-seven percent of fishermen interviewed make charcoal. Most charcoal is produced for cash income.

**Local Factors Affecting Agriculture and Forest Resources**

The most significant limiting factor in agriculture for Buen Hombre is water, in the form of both precipitation and stream flow for irrigation. Like the northwestern region in general, the bimodal annual rainfall schedule is subject to considerable fluctuation within and between specific years (Georges 1990:15, 176). Needed rainfall may not occur during crucial months of the agricultural year, a condition that has been defined as "agricultural drought" (Glantz 1987:45). Between 1989 and 1990, the people of Buen Hombre had experienced extended drought conditions.

Subsistence goods and cash derived from agricultural produce declined according to those interviewed. Respondents commented that 1989 had been the driest year of the previous four, which were also very dry. The drought situation was confirmed dramatically during the 1990 study. Comments made by community members and government officials, as well as national newspapers, emphasized the impacts of the severe drought that affected the entire nation. Millions of dollars in crop and livestock losses stimulated government relief programs, including crop seedling distribution, to the hardest hit areas. By January 1991, the drought seemed to have subsided somewhat.

Lack of adequate rainfall led women temporarily to abandon full-scale kitchen gardening. Small amounts of purchased water are used to pot irrigate medicinal and other plants in dooryards. The crisis in village agriculture is related not to exhausted soil fertility, but to the prolonged lack of adequate rainfall--in short, drought conditions.

It is not clear whether the drought can be characterized as "meteorological" (defined as a 25% decrease in long-term average rainfall) or as agricultural drought (Glantz 1987:45-46). Whatever the case, drastic conditions stimulated emigration from Buen Hombre. Compounding the effects of vagaries in climate are a number of social processes and policies that have adverse consequences for terrestrial ecozones, resources, and village economy.

## External Factors Affecting Agriculture and Forest Resources

Social and economic processes have also played important roles in the agricultural and forest sectors of the Dominican economy. In the mid-1980s, the Dominican government initiated a subsidized tobacco-growing program. Loans were provided to farmers to begin cultivation of tobacco as an export crop. Many if not most Buen Hombre farmers participated in the program. By 1987, however, the tobacco market had crashed. Since the collapse of the market, large portions of the Buen Hombre tobacco harvest remains stacked inside houses and outbuildings because there is no longer a decent price received for it, according to agricultural association members.

Historically, government programs have affected population-environment dynamics on the north coast in general. At the turn of the century, the development and expansion of the lumbering and cattle industries resulted in deforestation and land concentration dominated by large holders. Opening up of the northwestern frontier region stimulated both spontaneous and directed colonization, thus increasing population and exacerbating destructive land use practices (Georges 1990). Colonists, seeking new lands to cultivate because of land concentration and population pressure in the interior, have begun to slash and burn their way up the southern slopes of the Cordillera Septentrional range to the crest of the mountains. Deforestation has adversely affected the already arid environment's capacity to maintain and generate moisture, thus leading to desertification.

## Marine Ecozones and Resource Use

Buen Hombre fishermen-farmers utilize two marine ecozones and the resources found within them. These are (1) the tidal shore ecozone, and (2) the coral reef ecozone. Each of these ecozones is described below, followed by a discussion of the environmental and human factors and their impacts on each ecozone. These sections are meant to characterize the marine ecozones in a broad way. The marine ecology and resources of the coastal zone is described more fully in Chapter Five.

### Tidal Shore Ecozone

The tidal shore or littoral ecozone used by the people of Buen Hombre is composed of three microzones. These are (1) the beach, (2) the mangrove swamp, and (3) the lagoon.

The beach area is used as the cleaning and weighing station for fishermen returning with their catches. It is here that the various fish captured are weighed for sale and cleaned for home consumption. Intermediaries from interior towns as far away as Santiago and the capital city of Santo Domingo, as well as buyers from nearby villages, congregate at the beach on a daily basis and wait for Buen Hombre fishermen to return with their catch. While they wait, spouses of Buen Hombre fishermen prepare dishes of fish, rice and plaintains from a stand adjacent to the weigh station for sale to waiting buyers. Intermediaries buy portions of the first class species for sale to retail dealers in urban centers. Buyers from neighboring villages purchase seafood to take back to their homes for food.

The Buen Hombre shoreline consists of white sandy beaches interspersed with extensive mangrove swamps. This microzone constitutes the junction of sea and land. Water and heavy vegetation result in an environment rich in plant and animal life. In contrast to the arid conditions further inshore, the mangrove is characterized by high humidity.

Currently, the mangroves continue to expand seaward. The mangrove provides a natural nursery for numerous species of aquatic life that are harvested by Buen Hombre fishermen. Crabs, turtles, and shellfish are found in the mangroves and the shallows just offshore. These warm waters support healthy beds of seagrasses and algae which are consumed by a range of marine species.

The Buen Hombre lagoon serves primarily as the boat launch for village fishing crews. The majority of these are typical wooden yolas, the local term for small fishing vessels. Other, more modern boats of aluminum and fiberglass, powered by 15 horsepower Johnson, Yamaha and Evinrude outboard motors, also comprise part of the local fishing fleet.

The lagoon shallows also support thick beds of seagrass which are used by marine species such as crabs, lobsters and other shellfish as nesting and feeding grounds. During low tide, these seagrass beds are exposed just offshore in shallow waters. Frequently, fishing families walk along the shoreline in shallow waters to collect clams and other shellfish. Crabs are a highly valued resource harvested from nearshore waters.

**Local Factors Affecting Beach, Mangrove, and Lagoon Microzones**

Field observations and interview responses indicate that the residents of Buen Hombre recognize the value of the beach, lagoon and mangrove microzones, and so are conservative in their use of these microzones and resources. Mangroves are only occasionally used to collect wood poles from the dominant tree species for use as roof beams.

Over and above the wise and careful utilization of the mangrove by local people is the presence of the coral reef, which serves the function of preventing beach erosion and mangrove destruction by buffering the Buen Hombre shoreline (cf. DuBois and Towle 1985:233). Both environmental features and sustainable human practices on the local village level combine to protect the beach and mangrove microzones from large-scale degradation.

**External Factors Affecting Beach, Mangrove, and Lagoon Microzones**

The Buen Hombre tidal shore ecozone is beginning to undergo changes as a result of exogenous developments. In the beach and mangrove microzones, the number of national and foreign tourists has increased. A small 28-room hotel has recently been constructed in the neighboring village of Punta Rucia. As a result of road improvement, the number of tourists visiting and residing in Buen Hombre has also increased. Beach front property and plots along the new road have been sold and six new single and multi-family vacation homes have been constructed. There is a direct connection between the new road and these homes because the tourists who drive for hours to spend a few days at these homes need to leave the village regardless of weather. Day tourists come more often because of the new road, but their numbers and impacts are unknown.

Despite its small scale, the effects of tourism in terms of increased motorized boating for snorkeling excursions and water skiing may have detrimental effects. Nearshore waters may potentially become convenient disposal areas for non-biodegradable trash such as glass, plastic and metal. Pollutants such as battery acid, spilled or leaking gasoline and oil from boats, could adversely affect marine species, seagrass beds, and water conditions.

In the mangrove microzone, government interventions in the form of legislation have been initiated to protect mangroves. This legislation prohibits the use of mangroves for any unlawful purpose, including tree cutting. Prohibition of mangrove use and tree cutting has resulted in a significant decline in wood harvesting by Buen Hombre residents. Recreational tours for tourists, however, have increasingly subjected the mangrove microzone to disturbance and pollution. As the population of small-scale fishermen increases in the surrounding area, exploitation of mangroves would likely increase, leading to degradation.

## The Coral Reef Ecozone

The coral reef ecozone located off the north coast of the Dominican Republic consists of an inner reef about a quarter-mile off shore, and an outer reef which is located a quarter mile beyond the inner reef. For most of its length, the coral reef serves as a barrier between the deep ocean and the shore. The only major break in the reef is at the entrance to the Buen Hombre lagoon. Because it is a double reef ecozone, changes in weather, water temperature, and wave action affecting the outer reef potentially affect the inner reef. Smithsonian marine scientists have described the Buen Hombre reef as one of the best in the Caribbean in terms of both size and condition.

### *Fishing*

Fishing is one of the two major economic activities in Buen Hombre. As is the case among most small-scale coastal fishermen, the task of fishing is constrained by fluctuations in weather conditions and a general lack of mechanized technology. Buen Hombre fishermen adapt to these constraints by forming social and economic relationships that help ensure access to resources for fishing as well as subsistence.

The next chapter provides a detailed description of the marine biology and ecology of the coastal marine ecozone of Buen Hombre. This data was collected during February, 1991. Aquatic plant communities and fish species are described for each of the ecozones and microzones discussed above.

Chapter Six then describes in detail the human ecology of fishing and marine resource use in Buen Hombre. These data were collected by ethnographers in January and February of 1991. Sociocultural and economic aspects of fishing, and the influences of environmental factors such as weather, are discussed.

# CHAPTER FIVE

# MARINE ECOLOGY OF THE BUEN HOMBRE COAST

The marine coastal region along the North Coast of the Dominican Republic near Buen Hombre is a very diverse, ecologically complex ecosystem. The region can be subdivided into general zones along a depth and distance-from-shore gradient: (1) intertidal mangrove swamp; (2) the first lagoon with extensive seagrass meadows and macroalgae; (3) the first barrier coral reef; (4) the second lagoon, with patch reefs among the macroalgae, seagrass, and unvegetated sand or sediment; and (5) the second barrier coral and sponge reef; and (6) the "fore reef" region beyond the second reef. A third reef system can be seen in the satelliteimages in deeper water, but we were unable to visit this reef.

One of the most striking features of the coastal region is the amount of the sea bottom area that is covered with seagrass, mangrove, macroalgae, or corals, all of which provide physical structure to the ecosystem. For example, 46 of the 49 sites we visited during the February 1991 "sea-truthing" field trip were classified as one of four bottom types (seagrass, coral reef, mangrove, or macroalgae). On the other 4 sites there is little structure present (i.e., sand, silt, or sediment lacking in vegetation). Consequently, the marine environment near the coast is shelters many organisms including many juvenile invertebrates and fishes. The presence of abundant small fishes indicates that these zones, especially the mangrove and seagrass zones, function as nursery areas (areas that provide abundant food and shelter for the youngest stages of fishes) of the larger species harvested in the fisheries of the area. The coral reef zone serves nursery function for some fishes as well, but most importantly is where most of the adult fishes are harvested by local fishermen. For example, of 106 species of fishes in a field guide (Goodson, 1976), 66 were associated with (i.e., caught or observed by fishermen) coral reefs, 46 with seagrasses and algae, 13 with mangroves, 1 with the beach zone, and 3 way offshore. These fishermen recognized that some species occurred in more than one zone, but did not distinguish between seagrasses and macroalgae (both are considered "yerba del mar" or "grass of the sea"). Thus, the offshore, coral reef, seagrass, and mangrove ecosystems are connected via a complex food web and all these zones should be considered as a single ecosystem for management purposes.

We will briefly characterize each of the natural ecozones and natural groups of stations in our sample, describing their physical appearance, the species observed in each zone, some of the ecological relationships observed within and between zones. In addition, a statistical classification of the sites visited will be made in order to further subdivide the region by species composition of the plant, invertebrate, and fish communities. These descriptions and lists should be regarded as preliminary, because we visited the region during a two-week period in February 1991 and may have missed species that grow in or use these habitats at other times. This general description will be further enhanced in a later chapter (Chapter 7) detailing the site-by-site patterns of distribution of the species listed in this chapter.

## Methods

In order to characterize the extensive region defined by the LANDSAT Thematic Mapper satellite image brought by ERIM personnel to the field, we visited as many single-pixel sites as possible during the field visit (13 Feb 1991 through 5 March 1991), often relying on the guidance of the local fishermen of Buen Hombre and Punta Rusia for locating areas of ecological and ethnographic interest. At each of 49 haphazardly selected sites (ecological sampling units, or ESU's; Table 1), a SCUBA or snorkeling dive of approximately 20 minutes was conducted, and an ecological inventory was compiled (species list) within a 28.5 m X 28.5 m area near the boat. Frequently, multiple sites that were more than 28.5 m apart (and hence in a separate pixel) were visited in a general location where the boat was anchored, and each new site was designated as an ESU and given a distinct identifier (example Station K1, K2, K3 are all mangrove stations that were visited during a single boat visit, but were more than 28.5 meters away from one another). In this way, each ESU was associated with a single 28.5 X 28.5 m LANDSAT Thematic Mapper pixel on the image. At each ESU, a precise position (measured to the nearest 0.0001 minute longitude and latitude) was obtained using a Magellan NAV 1000 Pro GPS (Global Positioning System) receiver. Water depth was measured to the nearest 0.1 feet at each ESU with a ScubaPro PDS, a battery-powered sonar device. Due to limited availability of satellites at certain times of the day, 5 sites (M4, V2, Y1, AA4, and AA5) were not precisely positioned by GPS; these stations had geomorphological features that could be visually located on the image during the field visit. At an additional 6 sites (E6, N1, P1, X2, AA1, and AB1), no ecological data were collected because of water depth and SCUBA limitations, or limited time. However, satellite data or ethnographic data alone collected at these sites as well as others (see Chapters 2, 6, and 7). Qualitative rather than quantitative data were gathered on relative abundances of species at each site. Species were divided into 3 categories during collection of field notes on underwater slates: plants, invertebrates, and fishes. While diving, one team member noted species present and collected unidentified species for later laboratory identification, while the other took underwater photographs. Identification of seagrasses, corals, and many invertebrates were made in the field in order to leave each site as undisturbed as possible using current field guides (Kaplan, 1982; Goodson, 1985; Littler et al. 1989; Morris, 1975; Robbins and Ray, 1986; Stokes, 1984). Algae and sponges were removed and preserved for later identification. Fishes were observed and recorded *in situ*.

A species-by-sampling unit (ESU) matrix of presence-and-absence data was constructed for all stations with ecological data; this type of matrix is recommended for studies in which broad scale patterns are required and the time and effort outlay is limited, as in the present case, without the loss of useful information (Pielou, 1984). Matrices were created for plants, invertebrates, fishes, and all species observed and similarity matrices calculated with Jaccard's index, an index specifically for presence-and-absence data (Pielou, 1984). Natural groupings of sites were made using the centroid-linkage method hierarchical clustering strategy (Wilkinson, 1988). Stations were classified based on these statistical methods into groupings with similar suites of species. These groupings were then compared to our field observations on zonation patterns and bottom-type descriptions recorded during our field visit.

## Results

Overall, we collected or observed 59 species of plants, 78 species of fishes, and 103 species of invertebrates, giving a total species richness for the region of 240 species. This is certainly an underestimate for at least some groups of organisms. We were limited by the time and money available for detailed sampling, so many organisms went undescribed due to sampling methodology. For example, the fishes and mobile invertebrates may have been more readily sampled using nets and traps, and none were used. Additionally, invertebrates that associated with epifaunal or infaunal habitats were incompletely sampled. We are certain that this species inventory will increase over repeated samples on subsequent visits.

### Sample Adequacy

The adequacy of the sampling was assessed by examining species accumulation plots (Figures 1A, 1B). A plot of the cumulative number of species versus the ESU number was created for plants, invertebrates, and fishes. The type of curve resulting can give insight into the degree of sampling adequacy we achieved: curves that approach an asymptote are thought to be indicators of good sampling, for few or no species are added at each successive station. If the plot continues to rise as successive samples are taken, then many more species remain to be surveyed. In our data, we have sampled the plants and fishes fairly well, for they appear to rise to a level of 59 and 78 species asymptotically (Figure 1A). The number of fish species showed a large jump at the end of the sampling, because we sampled the offshore reef system last and discovered several new species; plants were less affected because they were light-limited at the offshore stations, and few species were tolerant of the conditions on the deep reefs. The invertebrates were less well sampled as a group, however. We broke this group into subgroups (hard corals, soft corals, and sponges) and noted that the subgroups approached asymptotes at 22, 15, 19 species, respectively (Figure 1B). These three subgroups, representing 54 % of the invertebrate sample, appeared to be well sampled. The remaining invertebrate groups (anenomes, crustaceans, echinoderms, molluscs, tunicates, and polychaetes) must be regarded as under-sampled and require a return visit to adequately determine their patterns of association.

**Classification of the ESUs**

There are ten natural groups of the stations based on the cluster analysis of all species of plants, invertebrates, and fishes using an arbitrary cut-off point of 0.0 dissimilarity (stations that have similar suites of species have negative dissimilarity values in Jaccard's index). Natural groups of stations are linked at joining distances of $<$ 0.0 dissimilarity and are more similar than stations joined at $>$ 0.0 dissimilarity)(Figure 2).

The most obvious group (Group 1) is due to the inadequate sampling done at stations U1, H1, and K1, where little time was allotted for ecological surveying. It is interesting that seagrass (*Thalassia testudinum)* was the dominant bottom cover in all three cases.

The second large cluster of coral reef stations is composed of 3 natural groups of stations (Groups 2, 3, and 4; Figure 2). Group 2 is comprised of stations that are deep, with sponges and corals as bottom cover (Q1, V2, AA4, AA5). AA4 and AA5 were both located on the fore-reef of Sand Key, a deep and diverse coral and sponge reef. Group 3 is comprised of shallow coral reef stations (U2, D1, X3, AA3, E5, R1, W1, Y1, M4) located in the high-surge zones along the first and second barrier reefs. The stations in Group 4 (O1, H2, AND J2) were all patch reefs isolated from other reefs and surrounded by seagrass meadows.

A large cluster of non-coral stations can be subdivided into the last six natural groups. Stations E2 and E3 comprise a single group. They were very shallow sandy seagrass and coralline red algae stations. Additional shallow seagrass and coralline red algae stations (Groups 6, 7, 8 and 9) are also in this large cluster. Group 6 stations seem to have shallow (mean depth = 3.66 feet), sandy seagrass as a defining characteristic. Group 7 stations (F1, B3, J1, K3, I1, and M2), while slightly deeper (mean depth = 12.58 feet), seem to be just low diversity seagrass stations. Group 8 stations (N2, L1, G1, X1, E4, M3, and Z1) are of intermediate depth (mean depth = 7.46 feet) and contain a good deal of macroalgae in addition to seagrass. In particular, coralline algae (*Neogoniolithon*, *Amphiroa*) was very abundant at these stations. The calcareous nature of these algae will make them very good reflectors of light, and these stations should show up in satellite imagery as brightish areas.
Group 9 stations (A2, B1, T1, Z2, B2, F2, and V1) are all dominated by seagrass *Thalassia testudinum*, and green rhizoidal macroalgae (*Halimeda, Penicillus, Avrainvillea, Udotea, Rhipocephalis*) and occurred at the greatest depth (mean depth = 14.49 feet).

Group 10 was judged to be very different in that it contained stations that lacked species diversity. Station S1, for example, was totally depauperate in terms of plants and fishes. The only life at S1 was evident from the many infaunal polychaete tubes observed. It is interesting to note that stations K2 (in the mangroves) and AB2 (offshore samples brought to us by fishermen from between the second and third reef) were in the same group, suggesting that there is some degree of similarity between the stations closest to shore and offshore communities. Indeed, mojarras and gray snappers caused this linking of inshore and offshore stations, because these fishes occur in both areas, the juveniles in the mangroves

FIGURE 1 HERE

FIGURE 2 HERE

and the adults on the reefs, where they are harvested by the fishermen of Buen Hombre.

## Ecozone Characterizations

### Mangrove Forests

This coastal ecosystem is dominated by large trees that grow in the intertidal region and along the beach. They extend from just west of Punta Rucia to Buen Hombre and westward. They are bounded by upland forests to the south and seagrass meadows to the north. Small natural channels of open water wind among the mangrove islands near the seagrass meadows, but the density of the vegetation increases towards shore as the water gets shallower. The mangroves at the seaward edge of the forest, adjacent to the seagrass meadows, are the red mangrove (*Rhizophora mangle*), whereas along the upland forests, black mangroves (*Avicennia germinans*) are dominant.

Red mangroves grow in a monoculture to a height of 50 feet (15 m) along the coast. The prop roots of these trees provide abundant habitat for fishes, invertebrates, and birds (Table 2). Although no manatees were observed, these endangered marine mammals are known to frequent mangrove habitats, especially if there is freshwater input into the swamp. Mangroves in the area we visited apparently had little or no freshwater input, so manatees were absent. Fishermen told us of other mangrove areas that have manatees present; perhaps they have a greater input of freshwater. Many species of invertebrates were observed attached to these roots underwater, notably sponges, tunicates, and hydroids, shrimps, and amphipods, polychaetes, and macroalgae (Table 1). Fishes (mojarras, damselfishes, mullets, snappers) were observed feeding on this microbiota and hiding among the roots, in water depths of less than 3 feet (1 m). The Yellowfin Mojarra was observed both in the mangrove and on the coral reef; this species was harvested by local fishermen during our trips. Above the water, birds (Ospreys, Great Blue Herons, Great Egrets, Snowy Egrets, Green Herons, Kingfishers, Brown Pelicans) were observed perching on the prop roots and branches of red mangrove trees, and wading or diving into the water for fishes. The Magnificent Frigatebirds were observed soaring high overhead as we traveled through the mangroves each day, but were also observed over the seagrass meadows of the lagoons, and the reefs.

Table 1. Species list for the mangrove ecozone in the vicinity of Punta Rusia and Buen Hombre, Domincan Republic.

| **Taxon Name** | **Common Name** |
|---|---|
| **Vascular Plants** | |
| *Rhizophora mangle* | Red Mangrove |
| *Avicennia germinans* | Black Mangrove |
| *Thalassia testudinum* | Turtle Grass |
| **Algae** | |
| *Sargassum fluitans* | Sargassum weed |
| *Halimeda monile* | Halimeda |
| *Ceramium* sp. | Red Filamentous Algae |
| *Dictyota* sp. | Dictyota |
| Unidentified Green Algae | |
| **Sponges** | |
| *Tedania ignis* | Fire Sponge |
| Unidentified sponge | |
| **Echinoderms** | |
| *Holothuria mexicana* | Donkey Dung Sea Cucumber |
| *Holothuria arenicola* | Burrowing Sea Cucumber |
| **Tunicates** | |
| Unidentified tunicates | |
| **Fishes** | |
| *Gerres cinereus* | Yellowfin Mojarra |
| *Eucinostomus* sp. | Mojarra (unidentified) |
| *Lutjanus griseus* | Gray Snapper |
| *Microspathodon chrysurus* | Yellowtail Damselfish |
| *Abudefduf saxatilis* | Sergeant Major |
| *Mugil* sp. | Mullet (unidentified) |
| *Aetobatus narinari* | Spotted Eagle Ray |
| **Birds** | |
| *Pandion haliaetus* | Osprey |
| *Ardea herodias* | Great Blue Heron |
| *Casmerodius albus* | Great Egret |
| *Egretta thula* | Snowy Egret |
| *Butorides striatus* | Green Heron |
| *Megaceryle alcyon* | Belted Kingfisher |
| *Eudocimus albus* | White Ibis |
| *Pelecanus occidentalis* | Brown Pelican |
| *Fregata magnificens* | Magnificent Frigatebird |

## First Lagoon

The first lagoon was a shallow (mean depth = 10 ft, 3 m) basin in which extensive seagrass meadows composed of vascular seagrasses and sessile macroalgae are present (Table 3). The dominant seagrass is turtle grass (*Thalassia testudinum*), which covers the bottom in dense (> 1000 shoots/$m^2$) meadows. The turtle grass grows to a canopy height of 0.3 m, and is the single most common plant observable in the first lagoon. It grows both in shallow areas (adjacent to red mangrove islands and inside the mangrove channels) and deeper water. In shallow water, two other seagrasses, manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*) also occur among the turtle grass shoots, but are relatively rare compared with other seagrass meadows. For example, turtle grass occurred in 32 of the 49 sites (pixels) visited along the Dominican Republic North coast during February 1991, whereas manatee grass occurred in 12 pixels and shoal grass in 3 pixels. In pixels where they co-occurred, turtle grass was always the dominant species of seagrass (greatest percentage cover), with manatee grass second and shoal grass third.

The seagrass meadows were not exclusively comprised of seagrass, however. Interspersed among the *Thalassia* shoots at every seagrass station was a diverse assemblage of macroalgae (Table 3). These were mostly green algae that grew in densities of 10 - 50 plants per $m^2$, some reaching heights of 0.3 m, but most were small (< 0.1 m) and cryptic. The dominant species were *Penicillus capitatus* (16 pixels), *Halimeda monile* (15 pixels), *H. incrassata* (15 pixels), *H. opuntia* (15 pixels), *Rhipocephalus phoenix* (13 pixels), *Penicillus dumetosus* (11 pixels), and *Avrainvillea longicaulis* (10 pixels). Many other species occurred in fewer than 10 pixels, and these species are listed in Table 2 along with the number of pixels in which they occurred. In general, no one species of macroalgae was dominant in the lagoon, unlike the seagrasses.

Some interesting features visible in the satellite image are the shallow areas comprised of calcareous red algae, *Amphiroa fragilissima* and *Neogoniolithon strictum*. These tended to be the dominant algal species at stations E2, M3, and X3 forming large patches that excluded the otherwise dominant *Thalassia*. Such areas show up as lighter areas on the image and are more like small coral patch reefs due to the large amount of calcareous structures secreted by these algae. Indeed, these patches of calcareous red algae co-occurred with small finger corals, *Porites furcata*, and fire corals *Millepora* sp. The calcareous algae and corals gradually decline in abundance as the water deepens onto the *Thalassia* meadows that surround them.

The dominant fishes in the seagrass meadows of the first lagoon are the striped parrotfish (*Scarus croiensis*) juveniles. They dart into the seagrass for cover when approached. Other species observed were gobies (*Gobiosoma* sp.), blue tang (*Acanthurus coeruleus*), slippery dicks *(Halichoeres bivittatus*), and anchovies (*Anchoa* sp.).

**First Barrier Reef**

The first lagoon gradually became shallower away from the coast and became the first barrier reef. These were high-energy habitats with a good deal of wave surge. They were characterized by high diversity coral communities with encrusting algae, sponges, anenomes and tunicates. Stations that clustered together in Group 3 (U2, D1, X3, AA3, E5, R1, W1, Y1, and M4) (Figure 2) are characteristic of this zone.

The dominant species of plants on the first barrier reef stations are brown macroalgae (*Dictyota, Turbinaria, Sargassum, Stypopodium*, and *Lobophora*). These species grow profusely on the surfaces if toppled coral heads. They are well adapted to the high energy environments at these stations, for they are strongly attached to dead corals with holdfasts. Green macroalgae (*Halimeda opuntia, Caulerpa racemosa*) occur attached to rocks and dead coral here as well. Open spaces are often colonized by encrusting coralline red algae as well.

The dominant invertebrates at these sites are the hard coral species. Boulder coral, *Montastrea annularis*, staghorn coral, *Acropora cervicornis*, elkhorn coral, *A. palmata*, leaf lettuce corals, *Agaricia* sp., brain corals, *Diploria strigosa, D. labyrinthiformis, D. clivosa*, fire corals, *Millepora* sp., finger coral, *Porites porites*, and mustard hill coral, *Porites asteroides*, are all dominant at various sites.

The dominant fishes at these sites are members of the family Labridae, the wrasses. Various parrotfishes (*Scarus*, *Sparisoma viridens*) are large adults, unlike the seagrass parrotfish. In addition, bluehead wrasse (*Thalassoma bifasciatum*), and blue tang (*Acanthurus coeruleus*) are very abundant in places. The outer reefs were where all the larger groupers (*Epinephelus striatus, E. guttatus, and E. fulvus*) and snappers (*Lutjanus griseus, Lutjanus apodus*, *Lutjanus synagris*) were observed. It is interesting to note that these large fishes were rarely observed by divers. We knew of their presence at a site by the catches of the fishermen being interviewed. The groupers and snappers were hiding in the presence of a diver, as became obvious later when we went on a dive while the fishermen were spearing these fishes.

# CHAPTER SIX

## ETHNOGRAPHY OF FISHING IN BUEN HOMBRE

This chapter presents ethnographic data on the human ecology of fishing in Buen Hombre. General ethnographic interviews were conducted to better understand relationships between marine ecology, community economy, and patterns of fishing. Data discussed in the chapter are drawn in part from research initiated in 1985 (Stoffle 1986; Stoffle et al. 1990; Stoffle, Halmo and Stoffle 1991). Data generated from these previous studies contribute baseline information from which new iterations of questions were tailored for the CIESIN/N-ASA pilot project. The general ethnographic interviews, conducted in January and February 1991 enhanced the quality of earlier data, thereby extending the long-term ethnographic research program in the community of Buen Hombre. These longitudinal data provide a comprehensive view of fishing as an economic activity.

Ethnographic research was combined with the analysis and interpretation of TM satellite imagery (see Chapter Two). While satellite imagery can provide timely and accurate information on spatial and environmental parameters of a study area, ethnography serves to add the rich detail concerning local perceptions, practices, and values concerning these parameters. That is, ethnography verifies and validates the spatial and environmental information contained in the satellite image. The TM imagery also allows local people, who have limited if any access to photographs and maps of their communities, to see first hand their lands and resources in enlarged photo form. Using the TM image as a reference, local people are able to point out sites of significant social and economic activities. Ethnographic interviews with local people generate data about the cultural meanings and paterns of use associated with these sites. Through this interactive procedure, satellite imagery and ethnography are combined to produce a unique study of the human ecology of fishing.

This chapter has five divisions. The first is about the methods used to collect the data and the national and local consultation that made the research possible and hopefully will make the findings useful to people in the Dominican Republic. The second section is a description of what fishing is like in Buen Hombre. The third section is about local factors that influence patterns of fishing in Buen Hombre. The fourth section is about the external factors that influence how Buen Hombre fishermen fish. The fifth section discussed the uses of satellite imagery for studying the impact of fishing and other changes in the coral reef and marine coastal ecosystems.

## Methods

As used in this study, the term "ethnography" refers to the standard fieldwork methods of anthropologists. One aspect of our ethnographic research involved participant observation--that is, immersing oneself into the daily activities of the local people and recording both what the ethnographer observes and the interpretations of local people about what they are doing. Data were also collected through formal interviews. These occurred as part of surveys administered to a stratified random sample of the local population and to key experts who know about some aspect of local culture. Focus group discussions were conducted with members of community organizations to collect new information and to check past interpretations. Interviews were conducted with government officials having national responsibilities for studying and administering the Dominican Republic fishery and associated natural resources. Documents were available for describing community and national patterns of fishing.

### Permission To Conduct Research

The research was conducted with the permission of government officials of the Dominican Republic. They reviewed the initial proposal which was submitted to CIESIN/N-ASA and were consulted in person in February of 1991. During this consultation the project was described in detail and copies of past materials were left with Lic. Ivonne Garcia, Sub-Secretaria de Recursos Naturales, Secretaria De Estado De Agricultura; Narciso Almonte C., Director de recurson Pesqueros; and Jose Martinez, Director of DIRENA, Departamento Inventario De Recursos Naturales. These consultations recognize the national sovereignty of the Dominican Republic and responsibilities of individual officials to be aware of and responsive to research on topics within their authority. The consultations were to draw upon the expertise of knowledgable local offficals and to focus the research so it produces knowledge that has practical application in resource policy decisions.

Consultation with other persons from national groups occurred during the fieldwork. The study team was visited by Rafeal Castillo who is a technician in Estadistica y Limite Geografico in the Instituteo Cartografico Militar; Lic. Venecia Alvarez who is Director of Centro de Investigacion de Biologia Marina (CIBIMA); Dr. Carlos Cano Corcuera who is a biology specialist in the Agencia de Cooperacion Espanola; and Dr. Jose Serulle Ramia who is the president of Fundacion Ciencia y Arte, Inc. Accompaning these people during the field visit was Ivonne Garcia and Jose Martinez. This in-field consultation involved a trip to the mangrove and coral reef system, a presentation of satellite images and demonstration of the Global Positioning Device, and a review of ethnographic findings. Satellite images were provided to the Department of Agriculture, Department of Fisheries, and the Department of Natural Resources. These officials also met formally with members of the Buen Hombre fishermen's association.

Senor Tomas Montilla is staff person from the Department of Natural Resources who worked with the CIESIN/NASA study team. The Department of Natural Resources provided black and white aerial photographs of the study area and maps for geocorrecting the TM satellite images. He participated in the agricultural interviews and provided insights thought participant observation. At the end of the field session he wrote a summary of his research and observations which was submitted with the Department of Natural Resources and the study team (Montilla 1991).

The people of Buen Hombre were given the right to learn about the study and accept or reject it. Group meetings, locally called *reunions*, were held in Februrary 1991 with members of the Buen Hombre agricultural association, fishermen's association, and women's association. Each group was shown satellite images, told about the proposed research procedures, and made aware of possible study outcomes. All groups took a voice vote which affirmed their interest in and support for the study. When local community members were selected for formal survey interviews, they were orally informed of the study's purpose, assured informant confidentiality, and asked if they wanted to proceed. The interview only proceed after oral permission was received from the respondent.

The CIESIN/NASA study team agreed to provide copies of the report to the Dominican Republics' Departments of Agriculture, Fisheries, and Natural Resources. Copies of the report are to be provided to the Buen Hombre associations for fishermen, farmers, and women. The study team also agreed to provide geocorrected satellite images to each of the government departments and to the fishermen's association.

## The General Fishing Study

Much of this chapter is based upon interviews with expert senior fishermen. The purpose of these interviews was to address general questions about patterns of fishing, the forces that cause changes in these patterns, and the impacts of these patterns on the marine ecosystem. The instrument was developed in the fall of 1990, based on previous studies. The instrument was pretested in February of 1991 during the consultation visit with the Dominican government officials.

General fishing interviews were conducted with six fishermen. Past research indicated that these fishermen were recognized experts who could speak with authority about many aspects of fishing. The fishermen were interviewed separately with the formal general fishing instrument that was pretested in February. They also were interviewed as a group using a 1:50,000 satellite image of the coastal area.

The key expert senior fishermen were chosen as respondents based on standard criteria for selecting key informants most recently described by van Willigen and DeWalt (1985). That is, each of the expert senior fishermen was (1) thoroughly enculturated in terms of having long experience in a culture, (2) each was currently involved with the aspect of culture being studied, and (3) due to the long-term cooperative research relationship with ethnographers, it was assumed that they would be capable of conveying an understanding of the culture without bias or selectivity (van Willigen and DeWalt 1985:69).

The number of fishermen interviewed and the procedure by which they were selected were interpreted as more than sufficient based upon the work of Romney et al. (1986), who suggest a model for predicting the minimal number of informants needed to describe a relatively homogeneous cultural domain. They found three critical factors: (1) the cultural competence of the informants, (2) the required confidence level of the study, and (3) the proportion of questions to be classified correctly. Based on these criteria, a sample of four highly competent (at the 90% level) informants could provide correct answers 85% of the time at a 99% confidence level. The Romney et al. model was grounded using a dimensional sample of Lake Michigan sport fishermen and found to be accurate (Stoffle, Jensen, Rasch 1987). These studies argue for the validity of our study sample because it contains six highly competent individuals, two more than would have been required. The homogeneity of the cultural domain under analysis is attested to by the commonality of fishermen responses to our questions.

Formal reunions were held with the membership of the fisherman's association and officials from the Dominican government's Department of Natural Resources on February 21 and 24, 1991. Less formal group discussions, termed here "focus group interviews" (Morgan 1988), were also conducted. The focus group discussions with senior fishermen occurred on February 28, 1991 and March 3, 1991.

Ethnographic interviews and focus group discussions included questions on the values associated with being a fishermen, the productive careers and developmental cycle of fishermen, the role of the fisherman's association in establishing market prices, providing fishing equipment and other services, the types of fishing equipment used by local and other fishermen, and the economic and ecological constraints and incentives on fishing as an economic activity.

The ethnographic interviews elicited data regarding local knowledge of the marine environment and its resources by the people of Buen Hombre. In addition, the interviews and focus group discussions generated data on the impacts of ecological factors such as climatic seasonality, and human factors, including the use of various fishing technologies, on the biological condition of the marine system, patterns of fishing, and the health and well-being of the local fishermen and their families.

The verbatim responses of the fishermen are presented in the following text. This style of data presentation was chosen because these fishermen represent all fishermen. So the responses represent the extent to which issues being discussed are homogeneous.

## Fishing in Buen Hombre

This section of the chapter discusses general patterns of fishing in Buen Hombre. The section provides a general overview of what it means to be fishermen in Buen Hombre. The discussion begins with a  culture and social organization of fishing, with special emphasis on the rights and obligations associated with belonging the the fishermen's association and the developmental cycle of fisherman careers. Methods and technology used in fishing are then discussed. Patterns of fishing are discussed, with special emphasis on the amount of time invested in fishing and the targeting of marine species.

A wide variety of typical reef fish species are harvested by Buen Hombre fishermen. Large groupers and red snappers are first class fish high in market demand. Coral-eating parrotfish of several sizes and varieties are either sold or consumed in the household. The size and variety of parrotfish determines whether it is classified as first or second class. Delicacies such as octopus are also captured. Larger shellfish such as lambi (conch), lobster, and bulgao are captured by spearfishermen diving inside the inner reef. Third class fish species are kept primarily as subsistence fish. They bring the lowest price in the market, if and when they are sold. Occasionally, barracudas and sharks are taken. Shark is captured for sale and barracuda is generally kept for home consumption. A more detailed discussion of the marine system was presented in Chapter 5.

### Culture and Social Organization of Fishing

Fishermen in Buen Hombre rarely fish alone, preferring instead to go to the sea each day with a team of fellow fishermen, called a fishing crew. Together there is strength and security, a sharing of personal equipment and the costs of renting equipment like boats and motors that are not owned by most fishermen. Fishing in groups also reduces the risk of returning with a catch too small for family subsistence because the crew can be relied upon to share when needed. Fishing in groups results in social leveling, because it assures that no fisherman will become wealthier than another.

The fishing crew is the primary unit of production, but the fishermens' association is the primary marketing unit. Fishermen have organized themselves into a voluntary fishermen's association to increase the market price of their catch and reduce spoilage. The fisherman's association is composed of men who have risen through the ranks of the developmental cycle of fishing, which involves four distinct stages: (1) apprentice, (2) journeyman, (3) craftsman, and (4) beached (Stoffle 1986:95-100). The questions in this section focus on moving through this developmental cycle and belonging to the association.

The expert fishermen were asked, "Why did you choose to become a fisherman?" Their individual responses are listed below:

Simon:Father liked fishing, went out with him and liked it.

Dionicio:It is a good way to earn money and maintain family.

Narciso:From the time I was little I wanted to be one. I was born with a feel.

Bacilio:One of the best ways to make money in the community is by fishing. It is a better way than being only an agriculturalist.

Eugenio:I always wanted to be a fisherman. My father taught me how to fish.

Tuba:My father taught me to be a fisherman as a way of life.

It is clear from the responses that the occupation of fishing is valued positively as a way of making a living. The response of Bacilio illustrates also the advantage of being involved in more than one occupation to spread risk. This is the system known as "occupational multiplicity" (Comitas 1973). The local adaptive strategy of engaging in multiple occupations (fishing and farming), based on mixed production of diverse commodities (varieties of seafood and crops), serves to reduce the risk of economic failure. Perhaps an under-recognized adaptive function of occupational multiplicity is that such a system potentially serves to reduce the risk of environmental degradation in terms of overuse of terrestrial and marine ecozone components of coastal ecosystems.

As the responses above indicate, males are oriented and trained to be fishermen early on, in a context of parent to offspring transmission of knowledge and skill. Prior to becoming formally integrated into the structure of fishing life--that is, moving up in the hierarchy of fisherman classifications, the novice is expected to demonstrate certain levels of knowledge and skill (Stoffle 1986:95-96). Fishermen were asked, "How many years should a man have in order to begin fishing with a crew?"

Simon:11 years of age.

Dionicio:14 years.

Narciso:11 or 12 years.

Bacilio:14-15 years.

Eugenio:11- 12 years.

Tuba:10--11 years.

Responses to this question indicate that there is a good deal of experential learning required before one is formally identified as a "fisherman." Apprentice fishermen typically are fairly young boys and generally are not members of the fisherman's association. Entrance into the association normally occurs when novice fishermen have achieved the status of journeyman.

Once a member of the association, fishermen become members of a corporate group that provides services and access to resources. In turn, fishermen take on social obligations and responsibilities for educating new members, maintaining the fishing equipment (boats, motors), looking out for the safety and welfare of others while fishing, and promoting the unity and law-abiding informal rules of proper fisherman behavior. Senior fishermen were asked a series of questions about the role of the fisherman's association in fishermens' lives.

Each of the expert fishermen were asked, "For you, what is the importance of the Fisherman's association?"

Simon:The association is good, we can work together if we are organized.

Dionicio:In unity there is strength. Alone a human cannot make much. It is easier to get equipment.

Narciso:The associaktion is like a school. We teach fishermen to protect environment, and teach the laws of fishing and agriculture. It is easier to obtain help.

Bacilio:The association provides access to resources and equipment for all different types of fishing.

Eugenio:The association promotes unity. We have more strength when unified.

Tuba:The importance of the association is that we always work together, we are a group of fishermen who are united, and promote the protection of the fauna marina (marine animals). We don't cut coral, and we protect the turtle.

Fishermen were next asked, "What are the obligations of membership in the association?"

Simon:Follow rules of association.

Dionicio:Follow the articles of the association.

Narciso:Maintain the order of law, keep up equipment. Report exploitation of other fishermen.

Bacilio:Sign things out take care of equipment, and when get back from fishing we have to sell fish to the association. We do this to pay for the usage of the boats and motors.

Eugenio:Responsibility to take care of equipment and look out for one another.

Tuba:The obligations are to try to attend meetings.

Fishermen were then asked, "What types of services does the fisherman's association provide?"

Simon:Buy fish.

Dionicio:The association provides education, information, source of work.

Narciso:Do not have the resources to do this.

Bacilio:The president of the association has the obligation to go and look at the price of fish. Also we can sell fish, and get ice from Juanito who works at the place where the fish is weighed.

Eugenio:Helps the progress in future equipment. Get loans if have no money.

Tuba:Provide meetings, reports to government.

Knowing the market prices for certain types and classes of fish is important to association members. Senior fishermen were asked, "Does the fisherman's association announce the price of fish each day?"

Simon:More or less.

Dionicio:Yes, I look at the price before leaving to fish.

Bacilio:Yes.

Narciso:Yes.

Eugenio:NR

Tuba:Yes, every day they announce the price, but it does not matter for us because we do not have any control over the price. No one really cares about the price because this is the only way to make money so we just go out and fish.

Membership in the association has both social and economic advantages. Expert fishermen were asked, "If you were not a member of the association, would the manner in which you fish change?"

Simon:Yes, I would have to sell to intermediaries.

Dionicio:Yes, I would then have to sell fish to intermediaries.

Narciso:(see tape)

Bacilio:Yes, the association here gives us access to equipment. We also earn more money because we work in the association.

Eugenio:Yes, I would have more responsibility, sell at higher price.

Tuba:No, but being a member of the association is much better.

As fishermen move through the hierarchical stages of their fishing careers, they tend to become more influential in the association. Individuals can aspire to the presidency (Narciso is current president) or secretary (Dionicio is current secretary) of the association. Eventually, fishermen pass into the stage of their careers known as "beached association member." While occasionally able to fish, they do not venture out as often, but instead impart their wisdom, gained from many years of experience, to younger fishermen. In order to understand the productive life cycle of fishermen, senior experts were asked, "For how many years can a man fish?"

Simon:Approximately 50 years.

Dionicio:With a speargun, up to 45 years of age.

Narciso:40 or 50 years of age.

Bacilio:Almost 50 years.

Eugenio:About 45 years

Tuba:50 years.

All of the senior fishermen were in agreement that the productive life of a fisherman lasts until the individual is between 40 and 50 years of age. Fishing over this time is a physically taxing and potentially harmful occupation. Ear problems are common among fishermen who spend many years and long hours making repeated deep dives in order to catch fish. As lung capacity decreases (many fishermen also smoke), the amount of time they can remain submerged also decreases. These conditions are indicated in the fishermens' responses to the question, "Does the method of fishing change for fishermen as they grow older?

Simon:A little-- cannot go as deep.

Dionicio:Loses physical equilibrium, gets colder, problem with ears. Can not go as deep, and cannot hold breath as long.

Narciso:After 45, start to lose strength in lungs.

Bacilio:Do not catch as much, often older folks will row boats while others fish for them. Cannot dive as much or as deep. 60-70 feet at 40 years of age for Bacilio, Eugenio can go 30-40 feet.

Eugenio:One loses his capacity to dive very deep.

Tuba:We have less strength as we get older.

**Methods of Fishing**

Buen Hombre fishermen use a variety of methods for catching fish. The most common method is the use of snorkel and speargun for diving in the coral reef ecozone. This method involves the ability to remain submerged for substantial periods of time in order to locate, stalk, wait for and shoot one's target. Accuracy is crucial because spears must be retrieved and refastened to the gun should a fisherman miss his target.

A 1989 inventory of fishing equipment illustrates that the 34 fisherman's association members employ multiple methods in fishing. Forty-one percent of association members use handlines (cordeles), which are used mainly during night fishing. Fifty percent use snorkeling gear and spearguns. Thirty-five percent of association members own and deploy nasas, or fish traps in deeper waters. Access to and use of traditional yolas and motors is controlled by 26% of association members, but it must be remembered that fishing crew members cooperate in boat travel to fishing locations. Twelve percent of association members use atarrayas or beach cast nets. Only two association fishermen use boat nets (trasmallos); no fishermen use beach set nets (chinchorros) as a fishing strategy. Night fishermen also use flashlights and makeshift lamps. These are submerged into the sea in order to attract fish. Social relationships, both kin and non-kin based, facilitate sharing or loaning of equipment among and between fishermen.

The CIESIN project team asked senior fishermen a series of questions regarding the cost of using association equipment and how personal fishing gear is obtained. Fishermen were asked, "How much does it cost to rent a boat for a day?

Simon:20-25% of fish.

Dionicio:25-30% of catch.

Narciso:25% of fish.

Bacilio:25%.

Eugenio:25--30%.

Tuba:NR

Fishermen were then asked, "How much does it cost to rent a motor for a boat?"

Simon:20%.

Dionicio:25-30% of catch.

Narciso:25% of fish.

Bacilio:25%.

Eugenio:25--30%.

Tuba:NR

From the foregoing responses, it can be surmised that renting boat and motor rental can cost a fisherman and his crew over one-half (between 50-60%) of his catch. If rental fees for snorkeling gear and spearguns are added, the total cost of equipment rental could total as high as three-quarters of an individual's catch.

Most association fishermen have their own diving and fishing equipment. Senior fishermen were asked how they obtained that equipment. "How did you obtain your fishing equipment?"

Simon:Worked for and bought it.

Dionicio:From owner of boat.

Narciso:Gift from Santiago. Rifle (local term for a speargun) cost about $1,000 pesos.

Bacilio:I bought it.

Eugenio:Santo Domingo.

Tuba:NR

Fishermen were asked, "Are you able to fish without a spear gun?"

Simon:Yes, with a gancho (hook), cordel (line), and net.

Dionicio:Yes, you can fish for octopus, lobster, conch, and bulgao with a hook (gancho) and spear (harpoon).

Narciso:Yes, you can fish at night with line.

Bacilio:No.

Eugenio:Likes rifle, but can fish with hand line.

Tuba:I can fish with cordel, nasa, and a gancho (line, trap and hook) but very seldom.

The responses indicate that, while the speargun is the most preferred method of fishing, there are other methods and technology available to and used by fishermen.

Fishermen were asked, "What is the worst problem with fishing equipment?"

Simon:The lack of motors and boats.

Dionicio:Lack of motors and boats.

Narciso:Lack of money to buy or rent equipment.

Bacilio:The lack of good equipment, and the need to constantly repair and fix it.

Eugenio:Lack of motors and equipment.

Tuba:We don't have motors or sufficient boats.

**Schedule of Fishing**

Fishing occurs three times a day, in what researchers term shifts. Fishing crews usually operate in three shifts because of frequent equipment failure, access to boats, or other economic commitments in the system of occupational multiplicity. The first shift is usually worked by the majority of fishermen, who begin about 8:00 AM and return around noon, depending on weather conditions. In the early morning hours, the sea is at its calmest, allowing easier boat travel to the reefs and beyond. Returning is also easy because fishermen have the prevailing northeast wind at their backs.

The second shift begins after 12 noon. Rowing or motoring out to the reefs can be difficult against the strong afternoon winds and rough waters. After four or five hours of fishing, the return trip home is facilitated by the same winds.

Several individuals and some crews fish at night. Their shift begins around 8:00 PM and lasts throughout the night. Equipped with containers of coffee and rum, a flashlight hooked up to an automobile battery, hand lines and hooks, night fishermen have the advantage of calm waters. Fish are attracted to the light and thus some of the largest catches occur at night. Night fishing is, however, the most dangerous because of the risks of running into coral heads, damaging boats and motors, and the possibility of being attacked by barracudas or sharks, should the fisherman decide to snorkel dive. The night shift is the longest because fishermen must wait until morning to bring their catch to the market, when someone is there to weigh the fish and put them on ice.

Each of the shifts, then, has advantages and disadvantages. Some fishermen will occasionally fish more than one shift, going out in the morning and then making another all-night trip (Stoffle 1986:101-102). Ethnographers hypothesized that the greater distance to the site, the more potential risk in fishing at the site. Consequently, fishermen were asked, "Do you do anything for good luck before leaving with the crew?"

Simon:No.

Dionicio:No.

Narciso:Prayer.

Bacilio:I ask for God's help and the help of the virgin of Carmen.

Eugenio:I ask God to help.

Tuba:Not really.

Three of the six fishermen indicated that they pray prior to leaving on a fishing trip, indicating the potentially precarious nature of fishing in the sea. Fishermen were then asked, "Where are the most dangerous spots for fishing?"

Simon:Outside the third reef. El Veril.

Dionicio:El veril, because of shark, barracuda and congle.

Narciso:El veril. It is far away and if you have a problem with your motor then you would not be able to get back to Buen Hombre.

Bacilio:On top of reef, there is a lot of movement. El Veril is dangerous because there are many sharks.

Eugenio:El Veril, because it is very deep and many sharks are found there.

Tuba:Banco de Lalu. there is also a place in close where the wind is very strong and that makes it very dangerous. In El veril you will find a large number of sharks. There are also sharks in other distinctive sites. And in part of a bank called Banquera de la Mata.

It is clear that the El Veril site, outside the third reef, is perceived by the majority of fishermen as the most dangerous site to fish at. A couple of other sites in addition are seen as dangerous because of the number of sharks. Interestingly, one fishermen stated that tops of reef were dangerous and related the danger to the movement of aquatic animals over the reefs. This is probably due to the wave action near the surface of the reefs.

Ethnographers sought to understand a typical fishing trip in terms of hours fished and the number of sites visited. Fishermen were asked, "In general, how many hours do you fish in one day?"

Simon:6:00am to 12:00pm.

Dionicio:5-7 hours.

Narciso:6 hours.

Bacilio:4-5 hours.

Eugenio:6 hours.

Tuba:8 hours.

The range of responses indicates that typical fishing trips last between four and six hours. These responses most likely refer to first shift outings, as night trips usually last 10 to 12 hours.

In response to the question, "How many site do you visit in one day of fishing?" the fishermen said:

Simon:3 sites.

Dionicio:2-3 sites.

Narciso:4 to 5 sites.

Bacilio:3-4 sites.

Eugenio:2-3 sites.

Tuba:3-4 sites.

In order to understand more fully longer term patterns, fishermen were then asked, "How many locations did you fish last week?" They responded:

Simon:18 sites.

Dionicio:12-18 sites.

Narciso:NR

Bacilio:4, 5, 6 sites.

Eugenio:4 sites.

Tuba:NR

Fishermen were then asked, "How many different locations did you fish in the last 30 days?"

Simon:18 sites.

Dionicio:(12-18) 4 sites.

Narciso:NR

Bacilio:4-5 sites per day x 6 x 30.

Eugenio:NR

Tuba:NR

Ethnographers were also interested in the frequency of fishing site visits on a daily basis. Fishermen were asked, "Are there places that you fish everyday?" Their answers were:

Simon:Yes, lobster spots on the way out.

Dionicio:No.

Narciso:No.

Bacilio:Yes, the Cordillera de Callito (near the Tuba's Rock site).

Eugenio:Yes, the Playa de los Cocos, Cordillera de Afuera, and Silla de Caballo.

Tuba:If one does not have a motor, it is more possible to visit the same sites.

Three of the fishermen visit certain sites on a daily basis. Two fishermen do not repeat visits to the same sites each day. One fishermen stated that sites visited are based on the contingency of access to technology (i.e., a motor).

Fishermen were asked, "Do you look at the prices of fish before going out?" They responded:

Simon:Yes.

Dionicio:Yes.

Narciso:Yes, the price is usually established.

Bacilio:Yes.

Eugenio:Yes.

Tuba:Yes.

The next step for ethnographers was to gain an understanding of the species composition as related to certain sites. Senior fishermen were asked, "When you go to a particular spot to fish, are you looking for a specific type of fish?"

Simon:Yes.

Dionicio:Yes.

Narciso:Yes. There are some places which we know will have a lot of certain types of fish. Sometimes we will go to a place where we think there is mero (grouper) or lobster.

Bacilio:No.

Eugenio:No.

Tuba:Yes, there are places where there are more of one specific type of fish or lobster which we like to catch.

Four of the six fishermen stated that certain sites are known to contain a certain type or types of fish, particularly lobster. Grouper, a first class fish, is also found in higher densities in certain locations.

Fishermen were asked, "How do you decide the members of the crew?"

Simon:Three at a time, does not seem to change much. I will find people on the beach and say, "I am leaving now, do you want to go?" But for the most part I fish with the same three people.

Dionicio:I go out with friends.

Narciso:It depends on who can get the equipment. I ask friends and members of the association if they can get a boat and want to go out.

Bacilio:We decide the day before who we are going to fish with.

Eugenio:I go with experienced fishermen, and whoever is around when I want to go.

Tuba:We have meetings to see who are the people that they want but there is no preference because everybody is equal. I fish with different people.

Ethnographers asked about the degree to which fishermen act communally in terms of fishing information: "Do you share information on sites where the fishing is good?"

Simon:Yes.

Dionicio:Yes.

Narciso:Yes.

Bacilio:Yes.

Eugenio:Yes.

Tuba:Yes.

All fishermen share information and knowledge about locations where the fishing is good. Ethnographers then asked whether certain locations existed where fishing is preferred and the catch is typically plentiful. In other words, ethnographers wanted to understand something of the productivity of certain sites. Fishermen were asked, "Where are the best places to fish?"

Simon:Piedra de Buen Hombre, Pasita de lo Coco.

Dionicio:Los Lomo, El Veril, Chayes.

Narciso:NR

Bacilio:NR

Eugenio:NR

Tuba:NR

Ethnographers then asked fishermen about the seasonality of fishing. "Are there certain times of the year when you fish more than others?" "Why?"

Simon:Yes, during the summer, because the water is warmer.

Dionicio:Yes, during the summer, because the water is much warmer.

Narciso:Did not use question.

Bacilio:Did not use question.

Eugenio:Did not use question.

Tuba:Did not use question.

The least understood fishing shift is the night shift. Fishermen were asked, "Why do you fish at night sometimes?"

Simon:Because we can catch a lot of lobster.

Dionicio:When fishing is bad during day, we fish at night.

Narciso:If day fishing is not so good, then I will fish at night with lines.

Bacilio:I don't like to fish at night.

Eugenio:Yes, when the water is cold during the day, you can go out at night and fish. It is a good way to fish.

Tuba:If the ocean is bad during the day, I will go out and fish during the night.

Fishermen were then asked, "How many sites do you visit when fishing at night?"

Simon:Two--La Piedra de Buen Hombre, and the Cordillera de la Posa.

Dionicio:1 to 2 sites.

Narciso:2 sites.

Bacilio:NR

Eugenio:NR

Tuba:3 to 4 sites.

The next question sought more detail on the typical length of night fishing trips: "How long do you fish at night?"

Simon:All night. From 8:00pm to 6:00am.

Dionicio:8 to 10 hours.

Narciso:All night long.

Bacilio:NR

Eugenio:All night.

Tuba:12 hours.

Buen Hombre fishermen traditionally have employed sustainable methods of fishing that appear to derive from a conservation ethic. Interviews with key experts indicate that fishermen recognize the potential adverse effects of indiscriminate fishing practices on reef fish populations. Small fish of all classes are not targeted by fishermen; only rarely are they captured in fish pots. Expert fishermen explain that small fish are avoided in order to allow them to grow to an appropriate size. Economically, small fish are not ideal for consumption or sale because of the low proportion of meat. Larger fish provide higher returns in terms of the amount of protein-rich food compared to the amount of energy expended to catch them. Avoidance of small fish and other seafood species implies that fishermen are cognizant of the effects of overfishing on population reproduction.

The enterprise of fishing entails the dual goals of providing food and income. Consequently, fishermen harvest a diversified supply of seafood. Daily individual catches usually include an array of parrotfish, grouper, snapper, crab, lobster, conch, and other reef fish. The diversity of catch clearly indicates that multiple species are deliberately and commonly sought. Buen Hombre fishermen thus employ deliberate fishing strategies for both subsistence and cash. While fishermen prefer certain species for home consumption, these species are usually part of a diversified catch. It can be argued that diversifying the catch reduces the risk of overfishing certain species.

Data suggest that these strategies can and do change, based on such factors as weather conditions and stress in other sectors of the local economy (Stoffle et al. 1990). These changes can be either short-term (day, week, month) or longer-term (seasonal). Under the current conditions of environmental (drought) and economic (crop failure) stress, Buen Hombre fishermen appear to be intensifying their fishing efforts in terms of (1) length of fishing trip, (2) more intensive exploitation of certain locations along the coral reef, and (3) a concentrated effort to capture species that are in high demand in the market economy.

## Local Factors Affecting Fishing Patterns

This section of the chapter describes local factors, both environmental and sociocultural, that influence access to resources and patterns of fishing behavior among the fishermen of Buen Hombre. While factors such as climate are clearly exogenous and beyond local control, its effect, and those of other factors, are discussed here in terms of their impact on the bounded community of Buen Hombre, its residents and their economic pursuits. A subsequent section will deal with the kinds of external social, political and economic factors operating beyond the boundaries of Buen Hombre and how they impinge upon the practice of fishing in the community.

Key expert interviews and focus group discussions with senior fishermen documented a direct relationship between patterns of fishing, the weather, and availability of fishing equipment, especially motors for fishing boats.

**Effects of Climate, Seasonality, and Technology**

One major factor affecting fishing is weather. Wind and rain play significant roles in decisions regarding whether or not one goes out to fish. If the weather is favorable, the pressure of having to fish long hours and exert great amounts of effort is reduced. On the other hand, when weather conditions are adverse, the lack of larger boats and outboard motors mitigate against going out to the reefs to fish. Boats and motors are too small to be safely handled in strong winds and rough waters. Consequently, fishermen may be more likely to walk along the shore to the point of the lagoon and swim out to fishing spots well inside the inner reef. To compensate for lost subsistence and income on those days when weather conditions are not favorable, fishermen may exert more effort while fishing or target specific species of seafood on those days when the weather is favorable.

Field observations reinforce this hypothesis. Following two successive days in which strong morning winds prevented crews from going out, fishermen fished much longer than on previous trips. One of the authors had participated in fishing with a crew of Buen Hombre fishermen many times during 1989 and 1990, thus providing an accurate sense of the amount of time the fishermen normally spend fishing during a morning outing. These observations correspond with observed and recorded patterns of fishing from 1985 (Stoffle 1986). In the past, first shift fishing trips normally lasted about four hours, from 8:00am to 12 noon. On the day following adverse wind conditions, however, the first shift fished from 8:00 am until around 1:30 pm, an increase of one and a half hours over typical outings. Observations and fishermen's responses indicate that the reason for this change in fishing patterns was due to adverse wind conditions during the morning hours of the two previous days.

Other changes in fishing patterns were observed during the 1990 fieldwork. Usually, fishermen go out to a particular location along the inner reef and attempt to capture a variety of species. The following day, fishermen choose a different location along the reef. During fishing trips in 1990, participant observers noted that the crew went to a particular location during the early morning. After spending a period of time there, the crew moved to another location with the goal of capturing lobster. After spending nearly an hour searching for lobster, the crew then moved to a third location to resume spearfishing.

Fishermen were not observed going to a spot deliberately for lobster during 1989 fishing trips. Usually, lobster were taken spontaneously when encountered to supplement fish caught with spearguns. Likewise, fishermen were not observed fishing exclusively for one type of fish or seafood. During some of the 1990 fishing trips, however, fishermen stayed out longer in order to ensure that adequate amounts of specific fish were captured for sale and consumption.

A biological factor that affects fishing in the coral reef ecozone is a seasonal disease known as ciguatera. The disease is apparently contracted by fish that consume algae and other ocean nutrients contaminated with a highly toxic substance. Like PCBs, the levels of toxin accumulated in fish is correlated with the size and type of fish. Buen Hombre fishermen commented that the poisoning is seasonal. The toxin first begins to appear in May, June and July. The condition begins to peak between November and December; by January, February and March it is prevalent. Susceptible fish species are recognized by a blackening that occurs in the skin. It is not clear how many types of fish are affected by this poisoning, but the condition may affect the kinds and amounts of fish caught in a given period.

As is common in the tropics and subtropics, there are pronounced seasonal variations in climate. Dry and wet seasons are characterized by different weather and precipitation patterns, as well as variations in the availability and abundance of specific natural resources. Seasonal variations affect the economic, health, and nutritional status of local rural populations (Chambers 1982; 1983). Most researchers and officials only visit the most isolated rural communities during the dry season, when conditions are most favorable (Chambers 1983).

**Seasonal Food Shortage and Fishing Change**. During the CIESIN project, ethnographers conducted fieldwork during the rainy season and asked a series of questions aimed at gaining understanding the effects of climatic seasonality and health on fishing patterns and other activities. Senior fishermen were asked, "During what time of the year is it most difficult to obtain food?

Simon:December.

Dionicio:Autumn and winter.

Narciso:Winter. January and February are the months when we begin work on our farms.

Bacilio:December and January.

Eugenio:November, December, and January.

Tuba:October, November, and December.

Late autumn and winter are the times in which fields are prepared and planted. These are also the time of the onset of the rainy season precipitation. While crops are ripening in the fields, people must rely more heavily on purchased goods and marine resources obtained from fishing. Fishermen were asked, "When there are food shortages, how does your manner of fishing change?"

Simon:We help others raise cages, and work on agriculture. We also sell labor to intermediaries, work on farms.

Dionicio:We fish more frequently.

Narciso:I am always changing my manner of fishing. If I need to fish during the night, then I will do that, and if I can get enough during the day, then I don't need to go out and fish at night.

Bacilio:We fish less, because when there is not much food, we don't have a lot of strength to fish.

Eugenio:We fish at night.

Tuba:Yes, I have to change my way of fishing. I will stay closer to shore when fishing. This is because the water is much clearer and not as deep. Like Bacilio, when one is hungry, one cannot go far out to fish because of a lack of energy.

The responses indicate that fishermen are engaged in agricultural labor during the late fall and winter. This labor is both on their own fields as well as wage labor on other farms. Fishing patterns change depending on the fishermen. Some fish more and in more than one shift, while others indicate that hunger and lower levels of energy hamper their ability to expend a lot of effort on fishing. One fisherman suggests that sites closer to shore are used more frequently under these conditions. Fishermen were then asked, "When there is a food shortage does it change where you fish?"

Simon:Yes, I fish at La Pasita.

Dionicio:No.

Narciso:Yes, I change my sites when I am looking for the best spot to find fish.

Bacilio:Yes, we stay in much closer.

Eugenio:Yes, we go to more consistent sites where fish are commonly available.

Tuba:We stay in closer.

Only one fisherman said that he did not change the type of sites he visits. The other five fishermen either maintain their standard pattern of visiting a series of sites. Two of these five clearly stated that they stay much closer to shore during rainy season food shortages.

Previous studies suggest that seasonality affects the type of seafood sought during fishing. This is based on analysis of two years of fish sales records from the summer of 1989 and the spring of 1990 (Stoffle et al. 1990:28-36). Senior fishermen were asked, "When there is a food shortage, do you look for different types of fish?"

Simon:Yes, octopus and arrigua.

Dionicio:No.

Narciso:NR

Bacilio:We can only catch smaller fish because have to stay in close. I do not have the strength to fish farther out.

Eugenio:No.

Tuba:Yes, there are certain fish farther out, but we can't fish for them because we stay in close. But we look for the same types of fish.

Three of the six fishermen stated that they look for specific types of fish under consitions of seasonal food shortages. This illustrates that fishermen target certain species during times of economic hardship (Stoffle et al. 1990).

**Cash Shortages**

Changes in fishing patterns are also linked to seasonal shortages of cash. Ethnographers asked fishermen, "During what time of the year do you have the least money?"

Simon:December.

Dionicio:Winter.  December, January, and February.

Narciso:December, January, and February.

Bacilio:August, September, and October.

Eugenio:Winter.

Tuba:October, November, and December. August is a bad time for fishing because it is very dangerous; there are a lot of cyclones and strong storms.

Fishermen were then asked, "When you have only a little money, does the manner in which you fish change?"

Simon:I fish more to make more money.

Dionicio:Yes.

Narciso:NR

Bacilio:Yes, I will leave early to go fish and stay out later because I need food for the family. I also need money.

Eugenio:I will work harder on my farm.

Tuba:No, I don't change the way I fish. I fish the same all the time.

The next question asked was, "When you only have a little money, does it change where you fish?"

Simon:Yes.

Dionicio:Yes.

Narciso:No.

Bacilio:I have to stay in close. It is likely that I will not have food, because of a lack of strength for fishing.

Eugenio:Yes, I go to best sites.

Tuba:Yes, I will go to different sites which have not been exploited as much, so that I can find more fish.

Fishermen were then asked, "When you only have a little money, do you look for different sorts of fish?"

Simon:No, I look for the same kinds of fish.

Dionicio:No.

Narciso:NR

Bacilio:No, I look for the same types of fish.

Eugenio:No.

Tuba:Yes, I will go to an area where I can find bigger fish.

**Farm Labor**

Previous data indicates that changes in fishing patterns are partially linked to peak periods during the agricultural cycle that require a high degree of labor. All fishermen also own farms of varing sizes. Older fishermen tend to prepare themselves for retirement by investing in land. Fishermen were asked, "When you work a great deal on your farm, does it change the manner in which you fish?"

Simon:Yes, I fish less.

Dionicio:Yes, I do not fish.

Narciso:NR

Bacilio:Yes, I work to fish every other day, so that I can work on my farm.

Eugenio:Yes, we fish in different sites. We have knowledge of the good sites and where we can find good seafood. We will fish a little more quickly, so that we can get back to the fields and continue working.

Tuba:I will hire a couple of people to work on my farm.

Fishermen were then asked, "When you work a great deal on your farm, does it change where you fish?"

Simon:Yes, sometimes.

Dionicio:NR

Narciso:Yes, because I fish less often.

Bacilio:I will stay in close to get a few fish and then come in to work on the farm.

Eugenio:No, I fish in the same places. I fish in close.

Tuba:Yes, sometimes I do, but not much.

Ethnographers then asked, "When you are working a great deal on your farm, do you look for different sorts of fish?"

Simon:No.

Dionicio:NR

Narciso:NR

Bacilio:No, I look for the same types of fish every time that I go out.

Eugenio:No.

Tuba:Yes, I do not need to catch as many fish.

**Climate and Seasonality**

Previous studies documented, as mentioned above, that climatic conditions affect fishing for Buen Hombre fishermen. Ethnographers asked a series of questions designed to more completely understand the effects of climate on patterns of fishing. Senior fishermen were asked, "During the cold season, does the manner in which you fish change?"

Simon:I work in my field, and use lines and cages more often when fishing.

Dionicio:Yes, I fish with a line.

Narciso:I fish less underwater and do more night fishing.

Bacilio:Yes, the water is colder, so I cannot stay in as long.

Eugenio:We fish with hand lines in the winter, and with the spear gun in the summer. I use the hand line in the winter because it is cold. We catch many fish in the winter with the hand lines.

Tuba:I cannot work as many hours because water is cold.

Fishermen were then asked, "During the cold season, do you change where you fish?"

Simon:Not much.

Dionicio:Yes, I stay within the limits of Buen Hombre.

Narciso:Yes.

Bacilio:Yes, I will go to fish at a certain spot and then tomorrow I will go somewhere else.

Eugenio:In the winter, we change our spots for fishing. One night we will go to a spot over there in the Silla de Caballo, and the next night we might go over to Sand Key. But we also fish these sites during the summer.

Tuba:Sometimes, because when I go to a place where the water is very dirty, I will look for another place where the water is not as dirty.

Ethnographers then asked fishermen, "During the cold season do you look for different fish?"

Simon:No.

Dionicio:Yes, I look especially for cariti and colirubia.

Narciso:No.

Bacilio:No.

Eugenio:No.

Tuba:Yes, because sometimes the water is very cold, so I will go to a place more shallow where the water is warmer. Then I will fish for mero pequeno (small grouper) and pulpo (octopus).

**Personal and Family Illness**

There is a negative synergy between the rainy (cold) season, human health and nutritional status, and increased poverty (Chambers 1982, 1983). The rainy season is a time when crops are maturing in the fields. Ill health hampers the ability of villagers to work in the fields as well as fishing. Since both agricultural and marine products are sold as commodities to generate income, inability to work mens that incomes are often stretched if not exhausted during this period. Consequently, there are frequent shortages of food and cash for buying food and medicine during the rainy season.

The summer dry season can also have adverse effects on humans in terms of drought, and famine, which can lead to shortages of food and cash, and thus higher levels of morbidity. Senior fishermen were asked, "During what time of the year is there the most sickness?"

Simon:During times of drought.

Dionicio:During spring and summer. There is less water and more contamination. There is also less food in winter, but people are in better health.

Narciso:As summer leaves, it gets cold and that is when people get sick.

Bacilio:In the winter.

Eugenio:In August, September, and October. Entering the winter season it is hard to defend against the cold.

Tuba:Between the middle of October and January, there is little food.

Ethnographers then asked, "What types of sickness does the community experience?"

Simon:Cold and fever.

Dionicio:Cold, diarrhea, headaches, and refriado (heat exhaustion?).

Narciso:Cold, fever, and conjunctivitis--a sickness people get in the winter.

Bacilio:Cold, fever, and headaches.

Eugenio:Diarrhea, colds, and fever.

Tuba:Diarrhea, fever, and colds.

Fishermen were then asked, "Who suffers the most from sickness: women, children or men?"

Simon:Everybody.

Dionicio:Children suffer the most.

Narciso:Children frequently get diarrhea.

Bacilio:The children suffer more.

Eugenio:Children.

Tuba:Everyone suffers a lot from sickness.

These responses suggest that children are most susceptible to disease, particularly during times of seasonal stress, when food and cash are in short supply. Ethnographers then asked a series of questions regarding the impact of illness on patterns of fishing. Senior fishermen were asked, "When someone in your family is sick, does the manner in which you fish change?"

Simon:I fish more to earn additional money.

Dionicio:I have to fish for money to buy medicine.

Narciso:No.

Bacilio:I fish quickly to get some money, and then go to the doctor to buy medicine.

Eugenio:We have to fish more.

Tuba:I have to fish more.

The amount of time spent fishing is increased, according to five of the six fishermen. Clearly, the objective is to sell the fish caught and use the cash to buy medicine. Fishermen were then asked, "When someone is sick, do you change where you fish?"

Simon:No.

Dionicio:No.

Narciso:No.

Bacilio:I stay closer in to shore.

Eugenio:I go to more dependable sites.

Tuba:I change the location many times and fish more rapidly.

Ethnographers then asked, "When someone in your family is sick, do you look for different sorts of fish?"

Simon:No.

Dionicio:No.

Narciso:No.

Bacilio:No.

Eugenio:No, because we always fish for the same fish.

Tuba:We catch whatever we can find.

In the case of illness, the responses suggest that fishermen will fish more often and at a closer distance to shore but, by and large, the same sites are fished and there is no targeting of specific species.

Local resource use and management practices of Buen Hombre fishermen-farmers are currently being threatened by the destructive practices of outsiders. The potential effects of these external factors is discussed below.

**External Factors Affecting the Coral Reef Ecozone**

The burgeoning tourism industry affects the coral reef ecozone. Even in small-scale resorts near Buen Hombre, there already appears to have been an increase in coral harvesting, collected by tourists as souvenirs. As the industry continues to grow and expand beyond the boundaries of port towns, increasing numbers of tourists will intensify their search for "wilderness" areas, thus subjecting the Buen Hombre coral reef microzone to extreme levels of disruption. Together, tourists, commercial fishing fleets and growing numbers of small-scale fishermen using increasingly destructive technologies have the capability to destroy one of the largest living reef zones in the world.

Like most small-scale fishermen (Cordell 1989a, 1989b, 1989c), the people of Buen Hombre perceive the coastal waters as part of their community territory. Interior village and port city commercial fishermen compete for access to reef and sea resources with fishermen of Buen Hombre. In addition, foreign fishing fleets from Puerto Rico have exploited Dominican waters. In the words of a Smithsonian marine scientist who has observed the practices, large-scale competitors are "reef rapers" (Walter Adey, personal communication 1985) because they use destructive and illegal net fishing techniques. These illegal nets have a small mesh (in some cases, less than one inch), and are known as chinchorro nets. Other fishermen dive using compressors, which are hooked up to an air line from boats, and allow them to remain submerged for long periods of time and catch larger numbers of fish.

The Caribbean Fishery Management Council has adopted a fishery management plan for reef fish fisheries of Puerto Rico and the U.S. Virgin Islands that includes regulations on net size. While the Dominican Republic government also has national regulations on fishery practices, the north coast is relatively isolated. Moreover, manpower for enforcement is generally lacking.

Senior fishermen were asked a series of questions regarding their perceptions of the marine environment and the primary threats to its continued survival. Fishermen were asked, "What do you think are threats to the ocean's environment?"

Simon:Chinchorros and compressors.

Dionicio:Chinchorros, compressors, hurricanes, storms, and earthquakes.

Narciso:Chinchorro fishermen using two types of nets--de arrastre (drag nets) and trasmallo (boat cast nets), and compressors.

Bacilio:Chinchorros and compressors. These are the worst things for the sea. They take all different types of fish in their nets.

Eugenio:Chinchorros and compressors.

Tuba:Overfishing, too many fishermen, chinchorro nets, and compressors. These things affect a great deal the marine environment.

Fishermen were then asked, "Do you think it is important to protect the marine ecosystem?"

Simon:Yes.

Dionicio:Yes.

Narciso:For sure, this is our struggle.

Bacilio:Yes, it is very important.

Eugenio:Yes.

Tuba:Yes.

Ethnographers then asked, "Do fishermen (of Buen Hombre) do things to protect the environment?"

Simon:Yes, we fight against net fishing. We do not kill small fish.

Dionicio:Yes, we do not cut coral, we prevent the use of compressors and chinchorros. We do not cut mangle (mangrove), and we do not let many other fishermen in from other communities.

Narciso:Yes, we fight against chinchorro fishing and against cutting of mangrove and coral. We do not take small fish or lobster. We also teach our children.

Bacilio:We do not take small fish, lobster, and avoid killing pregnant lobster. We also teach our children.

Eugenio:We help those who are doing fishing by being teachers.

Tuba:Yes, we do things like not use compressors and chinchorros. We protect the fish by not killing pregnant species and small fish.

Fishermen were then asked, "Do you think that fishermen from other communities are a threat to the ocean environment?"

Simon:Yes, fishermen from Monte Cristi and La Varea.

Dionicio:Yes.

Narciso:Yes, those from Monte Cristi and Castilla, who use chinchorros.

Bacilio:Yes, fishermen from Monte Cristi, La Vereda, and Loma Atravesada. There are also two compressor fishermen in Buen Hombre.

Eugenio:Yes, fishermen from Monte Cristi.

Tuba:Yes, because many fishermen from Monte Cristi and Loma Atravesada come in and are using compressors.

Ethnographers followed that question up with, "How do fishermen limit people from other viliages from fishing in the territory of Buen Hombre?"

Simon:Talked with authorities. Talked with fishermen.

Dionicio:We try to work with outsiders.

Narciso:NR

Bacilio:We try and speak with government officials.

Eugenio:We try to do our part and work with government.

Tuba:We prohibit people from other places from coming into Buen Hombre territory. We work with authorities to help control the problem. We accept people coming in and fishing in our territory, but we do not want people who will come in and hurt the marine environment. They need to fish in the same way as the fishermen of Buen Hombre.

Ethnographers then asked a series of questions concerning the impact of destructive technologies such as chinchorros and compressors on marine resources in the coral reef system. Senior fishermen were asked, "Do you think there has been a change in the number of fish along the coral reef?"

Simon:Yes, there are less fish.

Dionicio:Yes, there are less fish because of chinchorros and compressors.

Narciso:There is a change because people are using new equipment and overfishing the reefs.

Bacilio:Yes, because of the lack of motors, people can't go out as far and for this reason they are overfishing the inner reef.

Eugenio:Yes, there were a lot more fish in the past. There are less fish now because of the chinchorros and the compressors.

Tuba:Yes, there has been a big change, because there are too many fishermen that fish every day.

Fishermen were then asked, "Do you think there has been a change in the plant life of the coral reef?"

Simon:No.

Dionicio:No.

Narciso:I have seen some changes, but not big ones.

Bacilio:No.

Eugenio:No.

Tuba:No.

Ethnographers then asked, "Do you think there has been a change in the condition of the reef?"

Simon:Yes, it is darker now.

Dionicio:No.

Narciso:The number of fish has changed greatly. 15 to 20 years ago, the sea was very rich with fish, but now, no.

Bacilio:There is more reef growing.

Eugenio:No, I haven't seen a change. The reef is in good health and seems to be growing.

Tuba:It does not seem sick.

These responses show that, while the coral reef itself remains in relatively good condition, biologically, and in fact seems to be expanding, the aquatic lifeforms inhabiting the reef are perceived to be declining as a result of destructive fishing practices.

Finally, each of the senior fishermen was asked, "What do you think is the future of the coral reef system?"

Simon:If we do not stop fishermen with chinchorros, we will not have resources. If we can stop the chinchorros, production will continue.

Dionicio:If we do not control chinchorros and compressor fishing, then the system will fail.

Narciso:If fishermen continue to use compressors and chinchorros, they will destroy the environment. If they kill the largest and smallest fish, they will kill whole generations of fish.

Bacilio: With conservation projects the reef will be protected, as well as the mangrove. Everything will be good with the reef if we continue to protect it. The reef will get sick if chinchorro fishermen continue their practice.

Eugenio: We will have to protect the reef. We think that we will have to care for the reef. We cannot do bad things to it. There will be little future if people continue to use chichorros and compressors.

Tuba: If we do not guard and protect the reef, it will disappear. If we protect it, the reef will sustain our community.

The responses of these knowledgeable fishermen, derived from years of experience and observation, speak for themselves. The third section of the chapter describes and analyzes the results of using Landsat TM images to illustrate the effects of seasonality and changing access to technology on fishing patterns.

## Satellite Imagery Mapping of Fishing Sites and Patterns

The 1991 fieldwork reinforced previous data and hypotheses concerning changing patterns of fishing as a result of fluctuations in environmental and economic conditions described above. During the focus group discussions with key senior fishermen, a 1:50,000 scale Landsat TM satellite image was used as a visual aid. The senior fishermen identified the physical boundaries of the community and its territory (land and sea), as well as the numerous named fishing locations visited during typical outings.

On plastic overlays placed on the image, senior fishermen mapped the various fishing sites visited under two hypothetical situations. On one overlay, the senior fishermen were asked to plot the sites normally visited when weather conditions were favorable and access to boat motors and fuel were possible. Figure 6.1 shows where individual fishermen and crews fish when there is good weather and a motor is available for the boat. Note that fishing sites are widely distributed. This causes fishing pressure to be spread over a wide range of coral reef locations and a variety of fish species being targeted.

On a second overlay, the senior fishermen were asked to plot the sites visited when weather conditions were adverse and boat motors or fuel could not be obtained. Figure 6.2 shows where individuals and crews fish when the weather is poor and a motor is not available. Note sites concentrated on the inner coral reef. This results in a few locations receiving all the fishing pressure for the entire village and a limited set of fish species being targeted.

The second overlay correlates with data obtained concerning seasonality, particularly the rainy season. Because fishermen-farmers are busy planting their crops, they must buy food until the harvest can be carried out. Because crops have not yet ripened, they cannot be sold nor consumed. The nutritional value of processed foods is not as adequate as agricultural produce.

Colder temperatures and frequent rains lead to increased incidence of colds and other illnesses, especially among the young. What cash is available must go for provisioning the household and investing in medication for sick family members. Consequently, access to fishing technology such as boats and motors (and also gasoline to fuel the motors), may be at its lowest point during the rainy winter season. Given that adverse weather (temperature, precipitation, cold water) and economic conditions are likely to be most intense during this time of year, we can expect that the inner reef is more intensively fished, as shown in Figure 6.x (the second overlay), during the rainy season winter months.

Conversely, we would hypothesize that during the spring and summer months, when crops have been harvested and sold, and when ready cash is available, access to boats, motors, and fuel is easier. Therefore, the number and range of fishing locations would be more dispersed.

The utility of Landsat TM satellite imagery in visually demonstrating changing patterns of fishing behavior and distribution of site use was demonstrated to Dominican government officials in the Departments of Natural Resources and Fishery Resources. Such use of satellite imagery can be used to monitor changing conditions (see Chapter Seven). In response officials and local people can collaboratively design and implement programs of development, in terms of the small-scale fishery, and conservation, in terms of protecting natural resources potentially threatened by human activities using data derived from satellite imagery and ethnographic ground truthing fieldwork. It is clear that local fishermen, with long experience in and knowledge of their marine environment, can serve as effective managers of the sustainable development and conservation of their coral reef system.

# CHAPTER SEVEN

# SEA TRUTHING SATELLITE IMAGERY

This chapter reports the results of *sea truthing* a sample of sites selected in order to better understand the interpretative strength of Landsat TM satellite images. To accomplish this goal it was necessary to select sites of a known location for detailed biological and ethnographic study. The exact location of each site was identified through a Global Positioning System receiver. A marine biologist SCUBA-dived at each site to describe the plant and animal life there. The history of human-environment interactions at the site was identified through ethnographic interviews with local fishermen.

Satellite images are composed of information units called *pixels*. The range of light spectrums collected for a pixel is constitute the *pixel signature*. The purpose of sea truthing is to collect information that helps interpret the range of pixel signatures in a satellite image. To accomplish this it is necessary to know the depth of water at that location, the type of plants and geological materials present on the ocean floor. With these data it is possible to train the computer to interpret any particular pixel as to water depth or bottom type. Through this procedure both satellite images can be used to make bathymetric and marine ecology maps. When satellite images are available for different time periods they can be compared and changes in either water depth or bottom type can be visually demonstrated in what is called a *change image*. Because this project is concerned with understanding why ecological changes are occurring, ethnographic interviews were conducted with knowledgeable local people about how humans use the natural resources.

## Methods

This analysis defines a sea truthing site as composed of three data components (1) pixel stations, (2) ecological sampling units, and (3) ethnographic interview areas. Each of these site components has a different geographic boundary, although the ecological and ethnographic units tended to correspond to one another. A sea truthing site usually has a number of pixel stations, each of which is 812 meters (28.5 X 28.5) square. . Ecological Sampling Units (ESUs) were pixel-sized as well; a new ESU was designated when samples were taken in an area more than 28.5 m from a previous sample. Similarly, ethnographic interviews were conducted at one pixel station within a site, but usually discussed the more extensive ecological sampling area rather than be confined to small the pixel station. The term sea truthing site is used to describe the largest analytical unit for which any ecological or ethnographic data are available.

Each sea truthing site was located by at least one pixel station. At least one ethnographic on-site interview was conducted with local fishermen at the first pixel station within the site area. At three sites, two ethnographic interviews were conducted. When the pixel stations were taken within a ecologically homogeneous zone, the ethnographic information collected at the first pixel station could be extrapolated to the other pixel stations in the site. . When the pixel stations appeared to be ecologically dissimilar based on in situ observation, they were treated as representing separate sea-truthing sites. In all, ethnographic and ecological studies were conducted at 23 sea truthing sites which were located by 50 pixel stations. Seven expert fishermen from Buen Hombre and one fishermen from a village 20 miles to the east, contributed to a total of 25 ethnographic interviews. A group interview involving 6 Buen Hombre fishermen was conducted regarding the deep reef located farthest from the shore. This interview was facilitated by a 1:50K Landsat image that was specially processed by ERIM to show subsurface features in the ocean. This special image made it possible to talk about specific segments of the reeaweven though the whole reef is under water.

The sea truthing occurred between February 13, 1991 and March 5, 1991. The work was conducted using a hand-held Global Positioning System receiver called the Magellan NAV 1000 Pro. The device was field tested using 100 meter tape which was used to measure a distance on the beach. The Magellan was found to be accurate to within one meter. Ocean depths were measured using a Scubapro PDS, a battery-powered sonar device that was shown to be quite accurate. Biological data were collected though observation, sample, and photography. Many samples were identified using scientific field guides; however, samples that could not be positively identified were preserved in alcohol and identified at East Carolina University. Ethnographic data were collected with an instrument that was pretested in January 1991 and revised before returning to the field in February 1991.

## Site-By-Site Analysis

This section describes each of the sea truthed sites studied in 1991. The following information is provided for each site: (1) its location and description, (3) its biological and ecological characteristics, and (4) its cultural characteristics and patterns of use by local fishermen. The list of all species of plants, invertebrates and fishes observed at each site is listed in Appendix 1.

(NOTE: This draft of the chapter has the sea truthed sites listed by the number on the ethnographic interview. This is obviously a convience for creating a first draft. The clustering of the sites into natural groups is discussed in Chapter 5.

**La Pasita del Coco** (Interview #01, Station D-1 )

Location and Description. This site was visited on February 18, 1991. It is located outside of the first barrier reef. Site coordinates are 19 degrees, 51.0923 minutes North latitude, 71 degrees, 18.5654 minutes West longitude. Local fishermen rely on three physical and visual markers to locate the site. There is a small gap or pass (pasita) in the reef where there is a high point of coral that protrudes above other corals. The beach known as the playa del coco (coconut beach) is directly to the south.

Site Ecology. The bottom type at this site is coral reef. The depth of the water at this site is between 20-30 feet. This was a pass or cut through the first barrier reef from the first lagoon to the second lagoon. The ecological sampling was conducted on the east side of the pass, along a reef wall that started at 25 feet and continued to the surface. Nine species of brown and green algae (*Halimedia opuntia, Caulerpa languginosa, Dictyota mertensii, Lobophora variegata, Sargassum fluitans, S. platycarpum, S. polyceratium, Stypopodium zonale, Turbinaria turbinata*), seven species of hard corals (*Acropora, Montastrea, Diploria, Agaricia, Porites*), four species of soft corals (*Gorgonia sp., Briarium asbestinum, Plexaurella grisea, Plexaura sp.*), and sea anenomes (*Condylactis gigantea*) were observed along this wall. Seventeen species of fishes were observed here, of which the bluehead wrasse (*Thalassoma bifasciatum*) was the dominant. Few large fishes were observed here, but fishermen were spearing gray and yellowtail snapper (*Lutjanus griseus* and *Ocyurus chrysurus*) here on the days we visited. At the base of the wall, the bottom type changed to sparse sand and seagrass (*Thalassia testudinum*) and macroalgae complex.

Site Ethnography. The fisherman interviewed at the site has fished the location for twenty years. The location is used by fishermen from Buen Hombre, fishermen from other coastal villages such as Punta Rucia, fishermen from larger coastal cities such as Monti Cristi, and tourists who visit the area. The location is consistently fished about ten times per month throughout the year. The local fishermen know when fish spawn at this location and in order to protect the reproducing fish, fishermen report that they visit the site less often during the late spring and early summer months. According to the fisherman interviewed at the site, the water is normally clear except for the winter months when turbidity is more of a problem. These water clarity fluctuations are due to currents that are weak much of the year. During the winter months, however, higher winds cause the more turbid water inside the reef to move through the gap.

A number of different species of fish are harvested from this location. Table 7.1 lists the varieties of fish. In addition, donkey dung known as gusano del mar (worm of the sea) is consumed. Over time, fish stocks at this location have generally declined due to the increasing number of fishermen using the site, both local and outsiders. Most recently, weather patterns and equipment breakdowns have resulted in fewer trips to this site. Most significantly, however, outside fishermen using nets have caused a reduction in the fish population at the site. According to the fisherman interviewed, both losses in terms of capture and migration of fish to other similar habitats have occurred as a result of destructive net fishing. Despite net fishing contributing to a reduction in the fish population at the site, there is little degradation of the marine vegetative habitat at the site.

Table 7.1. FISH SPECIES PRESENT/CAPTURED
AT LA PASITA DEL COCO SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| Pargo prieto | Gray Snapper | *Lutjanus gresius* |
| cohinua | ? | ? |
| bocallate | Grunt | *Haemulon* sp. |
| Pargo colorado | Dog or red snapper | *Lutjanus* sp. |
| Pargo tao tao | ? | ? |
| cotorra | Stoplight parrotfish | *Sparisoma viridens* |
| mojarra | Yellowfin mojarra | *Gerres cinereus* |
| cabrilla | ? | ? |
| cabrilla negra | ? | ? |
| mero | Nassau grouper | *Epinephalis striatus* |
| colirubia | ? | ? |
| gurrera | ? | ? |
| pargo pluma | Porgy | *Calamus* sp. |
| langosta | Spiny lobster | *Panulirus argus* |
| centolla | Green reef crab | *Mithrax sculptus* |
| langostino | ? | ? |

**Cayito de Arena** (Interview #02, Stations E-1)

Location and Description. This site was visited on February 18, 1991. It is a small, largely submerged sand caye or key located in front of the gap of the reef off the la playa de coco, slightly northeast of the Buen Hombre beach. Site coordinates are 19 degrees, 52.0847 minutes North latitude, 71 degrees, 22.8572 minutes West longitude. Local fishermen find the site by orienting themselves to a road to Los Conucos, an extensive large mangrove and a large rock formation.

Site Ecology. This site is a partially submerged sandbar immediately behind the first barrier reef with waters ranging in depth from two to five feet . The site is a sandy bottom dominated by two species of seagrasses (*Thalassia* and *Syringodium*) and eight species of green, brown and red macroalgae (*Caulerpa languinosa*, *Derbesia* sp., *Dictyota mertensii*, *Halimeda incrassata*, *Penicillus capitatus*, *P. dumetosus*, and *Neogoniolithon strictum*). Seven species of invertebrates (sea anenomes, *Calliactis tricolor*, crabs *Portunus* sp., donkey dung and burrowing sea cucumbers (*Holothuria mexicana* and *H. arenicola*, and sea urchins, *Tripnuestes ventricosus* and *Lytechinus variegatus*) and empty conch shells (*Strombus gigas*) were observed in this shallow water habitat. No live conch were observed here. Four species of fishes were observed here (Ocean surgeon, *Acanthurus bahianus*, slippery dick, *Halichoeres bivittatus*, striped parrotfish, *Scarus croicensis*, and Beaugregory, *Pomacentrus leucosticus*), all very small juveniles.

Site Ethnography. The fisherman interviewed at the site has fished the location for 12 years. This site is intensively used throughout the year by Buen Hombre fishermen, fishermen from the villages of Punta Rucia and La Varea. Depending on how calm the waters are, the site is visited on a daily basis. In a 30 day day period for example, the fisherman interviewed visited the site 27 times. The location is also frequented during night fishing trips. Fishing activity at the site is highest during the months of June, July, and August when the waters are calmest. Fishing visits decline during the colder winter months of November and December. The cool air and water temperatures keep the fish away, according to the respondent. Marine species harvested at the site consist primarily of pulpo (octopus), lambi (conch), langosta (lobster), and mero (grouper ). Currents at this site are weak and the water is generally clear throughout the year. Turbidity levels rise in December when surface runoff from mountain rains washes out into the shallow waters. The site contains good habitat for octopus, conch, lobster and grouper .

Tourists also visit the site in relatively large numbers during high season. The shallow waters and sand make the site ideal for tours involving swimming and bathing. Local fishermen attribute a general decline in the abundance of marine species at the site to increasing numbers of tourists and fishermen using the site for recreational and economic purposes. The intensity of activity at the site, according to the fisherman interviewed, has played a role in lowering the rate of reproduction of marine species populations.

**Bajio de Cayito** (Interview #07, Stations E-2 through E-6)

Location and Description. This site was visited on February 22, 1991. It is referred to as a sandbank or shallows (bajio) near the Cayito de Arena (Little Sand Key) site. The site is located in front of the sand bar just out from the first beach east of Buen Hombre. Six pixel station measurements were taken at different points of the site. Site coordinates at stations E-2 through E-6 are listed below:

*E-2: 19 degrees, 52.1059 min. N. latitude, 71 degrees, 22.8453 min. W. longitude
*E-3: 19 degrees, 52.1366 min. N. latitude, 71 degrees, 22.8273 min. W. longitude
*E-4: 19 degrees, 52.1692 min. N. latitude, 71 degrees, 22.8208 min. W. longitude
*E-5: 19 degrees, 52.2168 min. N. latitude, 71 degrees, 22.7940 min. W. longitude
*E-6: 19 degrees, 52.1110 min. N. latitude, 71 degrees, 22.8779 min. W. longitude

Site Ecology. The water depth at these stations ranged from two to five feet. The bottom type gradually changed from sandy bottom with seagrasses to corraline red algae flat to coral reef habitat along an inshore-to-offshore transect. At the calmest station (E-2, 2.0 feet deep), *Thalassia testudinum* and *Syringodium filiforme* were mixed with ten algal species (dominated by *Halimeda incrassata* and *Penicillus dumetosus*). In 2.5 feet of water, Station E-3 had a mixture of seven seagrass and algal species (*Thalassia testudinum*, *Halimeda incrassata* and *Penicillus dumetosus* were dominant) along with seven invertebrate species (rose coral, *Mancina aureolata*, and donkey dung sea cucumbers, *Holothuria mexicana*, were the dominant invertebrates). At station E-4 in very shallow water (1.0 foot deep), large areas of the corraline red algae *Neogoniolithon strictum*, *Amphiroa fragilissima* and *A. rigida* were present. In deeper water at station E-5 (2.0 feet deep), the bottom was a shallow barrier coral reef, with 8 species of algae (*Sargassum fluitans* and *Dictyota mertensii* dominant). Surge and breaking waves characterized this station, and many coral colonies had been toppled here by storm surges. No biological observations were made at E-6. . is .

Site Ethnography. At depths of two to eight feet, these relatively calm waters are generally clear, with the highest degree of clarity occurring during the late spring and summer months (May through August). The bottom type is almost exclusively coral reef, interpsersed with species of aquatic vegetation such as seagrass and sand The most turbid period occurs in the winter (November through January). Despite this general pattern, the fisherman interviewed at the site indicated that water clarity varies throughout the year. The factors contributing to such variation include runoff from mountain precipitation. Another cause of water turbidity is attributed to sediment deposition from the "River of Monte Cristi" (Rio Yaque del Norte).

(NOTE: This is unlikely, however, due to the fact that the prevailing current pattern would send sediment loads in a westerly direction. It may be that smaller sediment-carrying streams to the east of the area contribute somewhat to the turbidity. CHECK with climate people)

The fisherman interviewed at this site has fished the location for 13 years. The site is visited three to four times per week and fishing at the spot is more frequent during the summer months. Cold, rain and turbid water reduce the number of times the site is visited during the winter months. In addition, this location is known for its function as a nursery for juvenile fish, octopus and lobster. Eggs are laid in December; larval and juvenile fishes grow inside the inlet within the reef, and adults move out to the outer reef. When nearly full grown the offspring will repeat the cycle.

Besides local fishermen, fishermen from other villages along the coast also engage in fishing at the site. There are numerous species of fish harvested from this location. Table 7.2 list the species commonly captured by fishermen at the site. The 2-3 feet deep reef portion of the inlet is only fished when breezes are too strong to allow fishing in the deeper waters around the site.

Fishermen perceive that the fish stocks at this site have declined. The fisherman interviewed at the site indicated that the reduction was due to the increase in the number of fishermen using the site.

Table 7.2. FISH SPECIES PRESENT/CAPTURED
AT THE BAJIO DE CAYITO SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| mero | Nassau grouper | *Epinephilus striatus* |
| pargo riso | Spanish hogfish | *Bodianus rufus* |
| pargo prieto | Gray snapper | *Lutjanus gresius* |
| pargo tao tao | ? | ? |
| pargo mantequilla | ? | ? |
| pargo | Mutton snapper | *Lutjanus analis* |
| chena | ? | ? |
| mojarra | Yellowfin mojarra | *Gerres cinereus* |
| cotorra | parrotfish | *Scarus* sp. |
| varraco | ? | |
| bocallate | Grunt | *Haemulon sp*. |
| medico/merico | ? | |
| jira | | |
| rubia | | |
| picua | Great barracuda | *Sphyraena barracuda* |
| cohinua | | |
| tiburon | shark | *Carcharodon* sp. |

**Los Tocones/El Canon de Sansie** (Interview #03, Stations K-1, K-2, K-3)

Location and Description. Three pixel stations of this site were visited on February 20, 1991. The site is located at the entrance of and within a mangrove channel 30 meters from the shore with reef another 30 meters to the north, respectively. The coordinates for Los Tocones are 19 degrees, 50.7926 minutes North latitude, 71 degrees, 17.5376 minutes West longitude. The coordinates for El Canon de Sansie are 19 degrees, 50.8806 minutes North latitude, 71 degrees, 18.1117 West longitude. This latter location is named after the community of Sansie. The site is located to the east of Buen Hombre.

Site Ecology. This mangrove channel site is characterized by waters of two feet at the entrance to 10 feet in depth within the channel itself, with mud and seagrass (*Thalassia testudinum* ) bottom types. Station K-1 was entirely within a seagrass meadow, outside of the entrance to the mangrove channels. Only *Thalassia* was observed at this site, although most certainly other species were present. No snorkling or SCUBA dives were made at K-1, so a poor sample of the plants was obtained at this site. Cast-net throws yielded no fish. At site K-2, the 10-foot-deep mangrove channel, a snorkling dive was made, but few species were observed. The red mangrove, *Rhizophora mangle*, lined one edge of the channel, and two species of brown algae (*Dictyota* sp. and *Sargassum fluitans*) were growing on prop roots of the mangroves, along with fire sponge (*Tedania ignis*) and other sponges and tunicates. On the bottom of the channel, a thin coating of an unidentified green alga occurred, with scattered litter and detritus from *Thalassia* and *Rhizophora* plants. No fishes were caught in cast nets at this site, but five species were observed hiding and feeding in among the prop roots (sergeant major, *Abudefduf saxatilis*, small unidentified mojarras, *Eucinostomus* sp., yellowfin mojarras, *Gerres cinereus*, gray snapper, *Lutjanus griseus*, and Yellowtail damselfish, *Microspathodon chrysurus*). Mojarras were dominant, although most were juveniles. Site K-3 was in a small cove off the main mangrove channel, with muddy/sandy bottom and sparse vegetation (*Thalassia*, *Halimeda monile*), and many burrowing (*Holothuria arenicola*) and donky dung sea cucumbers (*H. mexicana*).

Site Ethnography. Turbid water and fluctuating strength of currents depending on the tides. Highest degrees of turbidity occur in the winter months December through March, when there are frequent rains and brisk winds. Turbidity also is a result of runoff from mountain precipitation. Wind and rain are minimal during the months of April, May and June.

The fisherman interviewed at this site is from Punta Rucia. He has fished the location for many years. He and his crew, as well as fishermen from other coastal villages such as Estero Hondo and Punta Rucia, visit the spot most frequently during April, May and June when wind and rain are infrequent. Trips to the site are reduced during August and September and winter as the frequency of winds and rain increases. The site is frequently visited during night fishing trips. Four species of fish were mentioned as being harvested from the location. These are listed in Table 7.3.

Fish stocks were said to be lower than before. He said that this was due to the use of more and more varied types of equipment such as chinchorro nets by an increased number of fishermen using the site.

Table 7.3. FISH SPECIES PRESENT/CAPTURED
AT THE LOS TOCONES/CANON DE SANSIE SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| Sabalo | Tarpon | *Megalops atlanticus* |
| robalo | Snook | *Centropomus undecimalis* |
| pargo prieto | Gray snapper | *Lutjanus griseus* |
| pargo sama | Mutton snapper | *Lutjanus analis* |

**Higuerito/Bajio de Sansie** (Interviews #4, #23, Station L-1)

Location and Description. This site was visited on February 20, 1991 and on March 2, 1991. It is located at the entrance to the Canon de Sansie site, from which the site derives its name, at the opening of the mangrove channel. Site coordinates are 19 degrees, 51. 0210 minutes North latitude, 71 degrees, 18.6393 minutes West longitude.

Site Ecology. The water depth at the site is three to six feet deep with bottom types of sand and seagrass (*Thalassia*). The bottom is very silty, due to the bioturbation of burrowing sea cucumbers, *Holothuria arenicola*, which create large mounds (40 cm diameter) of fecal pellets and reworked sediments around the mouth of the burrow. Ten species of plants were observed at this site, including several notable new species of algae (*Acetabularia calyculus*, *Avrainvillea longicaulis*, *Dictyosphaeria cavernosa*, *Laurencia intricata*, *Rhipocephalus phoenix*) as well as three species of *Halimeda* (*incrassata*, *monile*, and *opuntia*) and *Penicillus capitatus*. Four queen stromb (also called conch or lambi) adults, *Strombus gigas*, were collected here alive, the only station where they were observed living. Four species of fishes, Anchovy, *Anchoa* sp., slippery dick, *Halichoeres bivittatus*, an undidentified goby, *Gobiosoma* sp., and conchfish, *Astrapogon stellatus*, were observed here. Four conchfish were collected living symbiotically inside the mantle of the queen strombs. In general, fishes here were small and not very abundant. .

Site Ethnography. The waters are calm, characterized by weak currents and generally clear. Periods of high turbidity occur in August, September and October, due to breezes which move turbid water from well inside the channel out to the opening. The waters are clearest from December to March. Two fisherman were interviewed at the site. One fisherman is from Buen Hombre and the other from Punta Rucia. Both have fished the location for over 20 years. According to the fisherman from Buen Hombre, the site is most frequently visited during the winter months when the waters are clearest. Visits number about eight to ten per month. It is at this time that octopus are most abundant. In summer the site is visited less often due to turbid waters.

According to the fisherman from Punta Rucia, the primary method of fishing at the site is with chinchorro nets. Normally, the site is visited two times per week, or eight times per month, by the respondent and his crew. During February and March, May and June, and November through December, fishing conditions are generally optimal due to the lack of wind. These winds pick up during July, August, and September, which results in fishermen experiencing increased difficulty in casting their nets. Consequently, the site is visited less often during these months.

Buen Hombre fishermen use the site as well as fishermen from the villages of Cope, Sabana Cruz, Punta Rucia, Estero Hondo and Rancho Manuel. Urban fishermen from Monte Cristi using chinchorros (set nets) also use the site.

A large number of marine species are harvested at this location. Table 7.4 lists the varieties of seafood captured. The large numbers of fishermen using the site, however--especially the urban chinchorro fishermen out of Monte Cristi--have contributed to a reduction in the abundance of seafood species at the site, according to both of the fishermen interviewed.

Table 7.4. FISH SPECIES PRESENT/CAPTURED
AT THE HIGUERITO/BAJIO DE SANSIE SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| lambi | Queen stromb (conch) | *Strombus gigas* |
| pulpo | octopus | *Octopus* sp. |
| picua | Great barracuda | *Sphyraena barracuda* |
| bocallate | Grunt | *Haemulon* sp. |
| candil | Squirrelfish | *Holocentrus* sp. |
| langosta | Spiny lobster | *Panulirus argus* |
| raya | Stingray, | *Dasyatis* sp. |
| chucho | Spotted eagle ray ? | *Myliobatus goodei* |
| ballombe | ? | ? |
| sardina | Redear sardine | *Harengula humeralis* |
| robalo | snook | *Centropomus undecimalis* |
| mojarra | yellowfin mojarra | *Gerres cinereus* |
| mojarra blanca | white mojarra | *Eucinostomus* sp.? |
| pargo prieto | Gray snapper | *Lutjanus griseus* |
| lisa | mullet | *Mugil* sp. |
| boqueron | small sardine? | ? |
| mejua | | |
| mero de yerba | "Grouper of the grass" | *Mycteroperca* sp.? |
| memejuelo | ? | |
| chichote | conch | |

**La Piedra de Buen Hombre** (Interview #05, Station A-1, A-2)

Location and Description. This site was visited on February 15 and 20, 1991. Site coordinates are 19 degrees, 52. 6033 minutes North latitude, 71 degrees, 24.9774 minutes West longitude about 25 meters off the northeast point of the westernmost part of the rockIt is easily identified by a large formation of rock La Piedra de Buen Hombre (rock of the good man) situated near shore and extending about 30 feet above the surface of the water. The site derives its name from the legend that a shipwrecked sailor was rescued and provisioned by one of the area residents prior to the founding of the village. The sailor proclaimed the area La Costa de Buen Hombre (the coast of the good man). The site is located to the west-northwest of the Buen Hombre beach.

Site Ecology. The site is characterized by water five to twenty feet in depth, and bottom types that range from seagrass to coral barrier reefs. Station A-1 was a transect that crossed several pixels extending out from Buen Hombre Rocks to the barrier reefs approximately 200 m offshore. There were 18 species of plants observed along this transect, including all three species of seagrasses (*Thalassia testudinum*, *Syrinogium filiforme*, and *Halodule wrightii*). *Halodule* occurred closest to shore, but *Thalassia* was dominant throughout the transect. Fifteen species of green, red and brown macroalgae were observed at this site, seven in the seagrass meadows (*Amphiroa fragilissima*, *Caulerpa languinosa*, *C. paspaloides*, *Avrainvillea rawsonii*, *Halemeda monile*, *Penicillus capitatus*), the remaider on the coral reef (*Dictyota mertensii*, *Stypopodium zonale*, *Lobophora variegata*, *Turbinaria turbinaria*, *Padina gymnospora*, *and Sargassum polyceratium*, *Derbesia sp.*, *Ventricaria ventricosa*). In this area, large (20-30 m diameter) "blowouts" occurred in the seagrass substratum. In these blowouts, the depth of the bottom would drop abruptly from 2-5 feet to 15-20 feet. These are probably due to storm surges that ripped away the rhizomes of the stabilizing seagrasses. Seagrass (*Thalassia*) had recolonized these blowout zones, indicating that the storm damage had occurred some time ago. The invertebrates in this area where also very diverse with 19 species observed. Staghorn coral, *Acropora cervicornis*, elkhorn coral, *Acropora palmata*, two species of brain coral, *Diploria* sp., boulder coral, *Montastrea annularis*, and rose coral, *Manicina aureolata*, were the dominant hard coral species on the barrier reef, which was fairly shallow (5 feet) and experienced a good deal of wave energy. Toppled colonies of elkhorn and staghorn corals were observed on the barrier reef. This is again likely to be due to the storm damage. All coral species seemed to be growing rapidly to rebuild the reef. Very little evidence of coral bleaching was observed. It was mainly confined to a few colonies of *A. palmata* in very shallow water. This bleaching condition has been shown to occur on in this species in shallow water due to abnormal warming of the surface water or nutrient loading stress. Five species of soft corals (Knobby candelabrum, *Eunicea mammosa*, sea fans, *Gorgonia* sp., porous false plexura, *Pseudoplexura porosa*, and sea feathers, *Pseudopterogorgia bipinnata* and *Pseudopterogorgia acerosa*) were observed growing on the walls leading down from Buen Hombre rocks into deep water and on the barrier reef. There were also some patchy outcrops of hard and soft corals just offshore from the Buen Hombre rocks, but inside the barrier reef. Twelve species of fishes were observed at this site, including blue tang, *Acanthurus coeruleus*, bar and yellow jacks, *Caranx ruber* and *C. bartholomaei*, Porcupine fish, *Diodon hystrix*, bluestriped grunt, *Haemulon scirus*, squirrelfish, *Holocentru*s sp., Cocoa damselfish, *Pomacentrus variabilis*, spotted goatfish, *Psuedupeneus maculatus*, parrotfish, *Scarus* sp., and Bluehead wrasse, *Thalassoma bifacsiatum*. An unidentified shark was observed roughly ten meters from the boat during the on-site visit.

Site Ethnography. The fisherman interviewed at this site has fished the location for 20 years. In addition to his crew, other fishing crews from Buen Hombre and crews from the communities of Los Uveros, La Cana, Las Aguitas, and La Loma Atravesada also fish at the location. Urban fishermen from Monte Cristi also fish at the site. Most fishing trips to the site are made during the month of April, when the water is said to be clearest. The site is visited less frequently during the period from November through February because of high water turbidity. Currents around the site fluctuate between weak and strong. Stronger currents are more common during rains. Turbidity of water is highest during late fall and winter (November through February). The rainy season brings runoff from mountain precipitation during these months

Numerous species of seafood are harvested at this site. Table 7.5 lists the variety of species captured. Abundance of these varieties has decreased, mostly due to the increased number of fishermen. According to the fisherman interviewed, the biggest threat to fishing at this site is fishing by crews using small sweep nets (chinchorros de arrastre) who come from Monte Cristi.

Table 7.5. FISH SPECIES PRESENT/CAPTURED
AT THE PIEDRA DE BUEN HOMBRE SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| bocallate | Grunt | *Haemulon* sp. |
| mero | Grouper | *Epinephilis striatus* |
| pargo prieto | Gray snapper | *Lutjanus griseus* |
| pargo amarillo | Schoolmaster | *Lutjanus analis* |
| madama | ? | *?* |
| mojarra | Yellowfin mojarra | *Gerres cinereus* |
| cariti sierra | mako shark | *Isurus oxyrinchus* |
| langosta | spiny lobster | *Panulirus argus* |
| langostino | ? | ? |
| centolla | Green reef crab | *Mithrax sculptus* |
| bayombe | ? | ? |
| raya | stingray | *Dasyatis americana* |

**Piedra de Tuba** (Interview #06, Station O-1)

Location and Description. This site was visited on February 22, 1991. It is named after the fisherman who was interviewed at the site, owing to the fact that as a young fisherman he "discovered" and frequented the spot, where he encountered abundant lobster and fish. It is located on the point of the reef with two large coral heads at a spot aligned with the mountain peak located south of Buen Hombre at 19 degrees, 52.4948 minutes North latitude, 71 degrees, 23.5239 minutes West longitude.

Site Ecology. This site is characterized by water thirty-four feet deep and bottom types consisting of healthy, diverse patch reef with six species of hard coral (Leaf lettuce coral, *Agaricia agaricites*, brain corals, *Colpophyllia natans* and *Diploria labyrinthiformis*, cactus coral, *Isophyllia sinuosa*, fire coral, *Millepora* sp., and boulder coral, *Montastrea annularis*) surrounded by sand. Varieties of algae (*Dictyota* sp., corraline red algae, *Halimeda opuntia*, *Penicillus* sp.) are also present at the site. Eight species of fishes were observed here (including blue tang, *Acanthurus coerulis*, gulf surgeonfish, *A. randalli*, sharpnose puffer, *Canthigaster rostrata*, Red hind, *Epinephelus guttatus*, cleaner goby, *Gobiosoma genie*, Threespot damselfish, *Pomacentrus planifrons*, striped parrotfish, *Scarus croiensis*, princess parrotfish, *S. taenopterus*, stoplight parrotfish, *Sparisoma viride*, bluehead wrasse, *Thalassoma bifasciatum*.

Site Ethnography. The fisherman interviewed at this site has fished the location for 22 years. As mentioned, he first found the spot as a young fishermen and encountered numerous lobster and fish species. Currently, he, his crew, other crews both from Buen Hombre and nearby communities of Punta Rucia and La Loma Atravesada fish at the site. The respondent and his crew stop at the site to fish about five times per month, most frequently during the spring and summer months (April through August). The reason given is that the water is clearer at this time of the year. The number of visits is reduced during November, December and January because of cold temperatures and turbidity. The currents are generally weak at the site, but during the months of December through January, the rains increase the currents and thus the turbidity of the water. Water turbidity is said to vary a good deal throughout the year.

A wide variety of fish and other seafood is harvested from this site, including lobster and crab. Table 7.6 provides a full list of species captured as told to ethnographers during the interview.

The abundance of fish was said to have declined at the site. This was due to the increased number of fishermen using the site.

Table 7.6. FISH SPECIES PRESENT/CAPTURED
AT THE PIEDRA DE TUBA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| pargo riso | Spanish hogfish | Bodianus rufus |
| bocallate | Grunt | *Haemulon* sp. |
| pargo colorado | Dog snapper | *Lutjanus jocu* |
| guinea | ? | ? |
| mero | Nassau grouper, | *Epinephelis striatus* |
| cabrilla | ? | ? |
| langosta | spiny lobster | *Panuliris argus* |
| centolla | Green reef crab | *Mithrax sculptus* |
| langostino | | ? |
| pulpo | octopus | *Octopus vulgaris* |

**La Pasa de la Poza/Boca de la Pasa de la Poza** (Interviews #8, #15, #18, Station Q-1)

Location and Description. This site was visited on February 23, 1991 and February 26, 1991. Site coordinates are 19 degrees, 53.2400 minutes North latitude, 71 degrees, 25.6017 minutes West longitude. It derives its name from the depth of the water (poza, pool) in a small cove or inlet (ensenada). The site is located where the beach ends, aligned with a stone outcrop on the mountain known as El Peregon, which is used as a reference point.

Site Ecology. This site is characterized by a deep channel through the barrier reef reaching 45 to 55 feet in depth with bottom types consisting mainly of sponge reef and muddy, silty sediments. No plants were observed on this site, probably because it is beyond the depth at which light penetrates. The water clarity was murky at this site on the day we visited. Six species of sponge were identified, and these dominated the bottom cover on the reef (tube sponge, *Aplysina fistularis*, *Erylus* sp., *Haliclona viridis*, gray cornucopia sponge, *Niphates digitalis*, *Ptilocaulis spiculifer*, and Basket or tub sponge, *Xestospongia muta*). Leaf lettuce coral, *Agaricia* sp., was the only species of hard coral at this station. Sea rods, *Plexaurella grisea*, were the only type of soft coral and were rare. A shell from a mollusc, Lima scabra tenera was also collected. Fishes observed were the clown wrasse, *Halichoeres maculipinna*, sharpnose puffer, *Canthigaster rostrata*, and nassau grouper, *Epinephelis striatus*.

Site Ethnography. Two fishermen were interviewed at this site. Both have fished the location for 20 years. They and their fishing crews currently use the site, along with fishermen from other villages and cities such as La Vereda, El Manantial, Loma Atravesada, and Monte Cristi. Because of the depth of water and variable weather, the number of fishing trips to the site varies. The site is most frequently visited in spring and summer (April through September), during which time there is less rain and the water is said to be clearer. During the colder, wetter months of October through December, the number of trips is reduced. High degrees of water turbidity and strong currents also contribute to the reduction in fishing trips to the site. Water clarity fluctuates throughout the winter, but is generally always clear in the summer months. Turbidity due to runoff precipitation from the mountains and currents increase beginning in September and persisting through December, January and February. Currents are strong to the east and west. The site provides habitat for numerous species of fish and other seafood species

Numerous species of fish and other seafood are harvested from this location. Table 7.7 provides a list of these species derived from interviews with both fishermen. Harvests reach their high point during the late spring and summer because of the warmer water temperatures during this period.

Both fishermen noted that the abundance of fish at the location has declined due to increased numbers of fishermen using the site. These include urban chinchorro fishermen. In addition, because of the relatively deep waters, the site is also exploited by fishermen using compressor technology.

Table 7.7. FISH SPECIES PRESENT/CAPTURED
AT LA PASA DE LA POZA/BOCA DE LA PASA DE LA POZA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| pargo prieto | gray snapper | *Lutjanus gresius* |
| pargo tao tao | ? | ? |
| pargo sama | mutton snapper | *Lutjanus analis* |
| pargo riso | spanish hogfish | *Bodianus rufus* |
| chivica | ? | ? |
| bocallate | grunt | *Haemulon* sp. |
| cotorra | parrotfish | *Sparisoma* sp. |
| mojarra | yellowfin mojarra | *Gerres cinereus* |
| vallobez | ? | ? |
| madama | ? | ? |
| varraco | ? | ? |
| merico | ? | ? |
| pejesol | ? | ? |
| langosta cucaracha | slipper lobster | *Scyllarides* sp. |
| jaiba marina | crab | ? |
| centolla | green reef crab | *Mithrax sculptus* |
| langostino | | |
| arrigua | red hind | |
| mero | grouper, sea bass | |
| jurel | | |
| cariti | | |
| candil | | |
| merico | | |
| colirubia | | |
| bemejuelo | | |

**La Poza** (Interview #9, Station R-1)

Location and Description. This site was visited on February 23, 1991. It is a shallow reef located in what was termed an estuary (ria) of the mangrove, between two channels and near the deep mangrove channel. It is adjacent to the La Pasa de la Poza site, where the beach and mangrove merge. The site coordinates are 19 degrees, 53.2312 minutes North latitude, 71 degrees, 25.6981 minutes West longitude.

Site Ecology. Ecologically, this site is very similar to La Pasa de la Poza. It is characterized by shallower waters of three to five feet in depth with bottom types consisting mainly of coral interspersed with sponges and aquatic plants such as sargazo (gulfweed). Water clarity flucuates throughout the winter, but is generally clear in the summer months. Currents are strong, flowing east to west. The site provides habitat for numerous species of fish and other seafood species.

Site Ethnography. The fisherman interviewed at this site has fished the location for 28 years. Fishermen from the communities of La Vereda, Los Uveros, and Las Aguitas also fish in this location, as well as other crews from Buen Hombre. Because of variable weather, the number of fishing trips to the site varies. The site is most frequently visited in spring and summer (May through August), during which time there is less rain and the water is said to be clearer. During the colder, wetter months of November through February, the number of trips is reduced. High degrees of water turbidity and variable currents also contribute to the reduction in fishing trips to the site.

Numerous species of fish and other seafood are harvested from this location. Table 7.8 provides a list of these species derived from interviews with both fishermen. Harvests are highest during the late spring and summer.

The fisherman noted that the fish populations have declined at this site. He attributed the decline to net fishing as a primary cause of fish depletion at the site.

Table 7.8. FISH SPECIES PRESENT/CAPTURED
AT LA POZA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| bocallate | | |
| pargo tao tao | | |
| pargo prieto | | |
| pargo colorado | | |
| pargo pluma | | |
| pargo blanco | | |
| pargo riso | Spanish hogfish | |
| vallombez | | |
| mojarra | mojarra | |
| mero | grouper, sea bass | |
| langosta | lobster | |
| jaiba centolla | crab | |
| candil/candi | | |
| pulpo | octopus | |

**El Canal de la Poza** (Interview #10, Station S-1)

Location and Description. This site was visited on February 23, 1991. It is located to the south of La Poza at the front of the mangrove where the deep channel terminates and the mangrove and sandy beach merge. The site coordinates are 19 degrees, 53.0595 minutes North latitude, 71 degrees, 25.7861 minutes West longitude.

Site Ecology. This site is characterized by turbid waters reaching a depth of 24 feet. The turbidity is a result of the silt and mud that make up the dominant bottom types. Consequently, turbidity is fairly constant throughout the year, although minor fluctuations occur. The water is somewhat clearer in the spring and summer (May through August), mainly due to weak currents.

Site Ethnography. The fisherman interviewed at the site has fished the location for 11 years. In addition to crews from Buen Hombre, fishermen from several other coastal communities use the spot for fishing. These communities include Las Aguitas, La Vereda, Los Uveros, Las Canas and El Manantial. The site is most often used during the spring and summer, when the water is relatively clearer and there is less breeze. In December, however, the water is very cloudy because of stronger breezes accompanying fronts bringing rain.

Table 7.9 lists the varieties of fish species that are harvested at this location. The depletion of fish stocks in this location were attributed to the larger numbers of fishermen using the site. The increased use of small nets for fishing was also given as a cause leading to decline in the fish populations at the site.

Table 7.9. FISH SPECIES PRESENT/CAPTURED
AT THE CANAL DE LA POZA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| vallombe | | |
| bocallate | | |
| colirubia | | |
| merito/mero | grouper, sea bass | |
| pargo prieto | | |
| cotorra | parrotfish | |
| cofre | boxfish, trunkfish | |
| memejuelo | | |
| chivica | | |
| pulpo | octopus | |

**La Cordillera Afuera** (Interview #11, Stations X-1, X-2, X-3)

Location and Description. Three pixel stations of this site were visited on February 25, 1991. It is located inside the second reef on a crescent formation. Its name derives from the site's location (cordillera referring to the chain of reef, afuera to its location "outside" the first reef). The site coordinates are 19 degrees, 53.6801 minutes North latitude, 71 degrees, 21.4943 minutes West longitude.

Site Ecology. The waters at this site range in depth from three feet to twenty feet, with bottom types composed of sand, coral and green algae. The site once supported large stands of aquatic vegetation. The water is generally clear, but because of seasonal variation in the strength of the currents, clarity also fluctuates. Turbidity is higher in winter, because of runoff from mountain rains and deposition by rivers flowing out into the coastal waters from Puerto Plata to the east and Monte Cristi to the west. Turbidity is lower in late spring and summer. The site provides habitat for numerous seafood species.

Site Ethnography. The fisherman interviewed at this site has fished the location for 20 years. Besides fishing crews from Buen Hombre, fishermen from Punta Rucia, La Vereda, Loma Atravesada, and Monte Cristi also fish at the site. The site is most intensively used in the spring and summer months when currents, water clarity, and wind conditions are more favorable to sailing without a motor. The number of trips are limited in the winter because of adverse weather. Frequent lack of motors prevents fishermen from visiting the site.

Many fish species and other types of seafood are harvested from this site. Table 7.10 lists the varieties of marine life captured at the site. The abundance of seafood harvested has decreased because of increased exploitation by larger numbers of fishermen. Significantly, the aquatic plants and coral that provide habitat for fish has been degraded as well. According to the fisherman interviewed at the site, the location once supported relatively dense aquatic plant life. He noted that fishermen have extracted the vegetation and coral to sell to intermediaries based in Santo Domingo. So in addition to the loss of animal species, this site represents one of the few examples of a marine location exploited for its aquatic plant resources, resulting in a deteriorated habitat for marine animals.

Table 7.10. FISH SPECIES PRESENT/CAPTURED
AT LA CORDILLERA DE AFUERA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| cotorra | parrotfish | |
| mojarra | mojarra | |
| cabrilla | cabrilla | |
| bocallate | | |
| langosta | lobster | |
| centolla | spider crab | |
| lambi | queen conch | |
| madama | | |
| pargo tao tao | | |
| pargo pluma | | |
| merico | | |
| chivito | goatfish | |
| jira | | |
| mero | grouper, sea bass | |

**La Punta de la Cordillera de Afuera** (Interview #14, Station W-1)

Location and Description. This site was visited on February 25, 1991. It is located at the point (punta) of the second, outside reef. The site coordinates are 19 degrees, 53.7680 min. North latitude, 71 degrees, 21.7255 minutes West longitude.

Site Ecology. This site is characterized by waters 20 feet in depth with bottom type dominated by coral with small amounts of sand. The waters are generally clear and calm except for the winter months (December through February). Currents during this time are varied. The site provides habitat for numerous species of marine animals.

Site Ethnography. The fisherman interviewed at this site has fished the location for nearly 25 years. The site is primarily fished by people of Buen Hombre. Other fishermen also fish at the site, however, the respondent mentioned that use by others was infrequent. The site is most commonly fished when the water is clearer, calmer and warmer during the months April through August. The spot is less frequently visited during the period December through March, when the water is colder and more turbid.

As with most locations on the outer reef, numerous types of fish are harvested. Table 7.11 lists the types captured. This site can be a risky place to fish, since barracuda and shark are encountered around the outer reef.

The fisherman interviewed at the site noted that there has been a decrease in the number of fish harvested from the location. The decrease was attributed to more intensive use by more fishermen.

Table 7.11. FISH SPECIES PRESENT/CAPTURED
AT LA PUNTA DE LA CORDILLERA AFUERA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| pargo | | |
| cotorra | parrotfish | |
| varraco | hogfish | |
| colirubia | | |
| bocallate | | |
| mero | grouper, sea bass | |
| candil | | |
| tortuga | sea turtle | |
| centolla | spider crab | |
| cofre | boxfish, trunkfish | |
| arrigua | | |
| langosta | lobster | |
| carel | | |
| chivo | goatfish | |
| cariti | | |
| picua | barracuda | |
| tiburon | shark | |

**Los Morrales** (Interviews #12, 13, Stations V-1, V-2)

Location and Description. This site was visited on February 25, 1991. The coordinates are 19 degrees, 52.7884 minutes North latitude, 71 degrees, 22.8628 minutes West longitude. It is located about 6 kilometers east of the Buen Hombre beach, 2.5 kilometers offshore, on the second reef. The site is recognized by aligning a gap in the mountains near Punta Rucia with a grouping of blackish rock surrounded by white sand and gulfweed (sargazo) seagrass.

Site Ecology. This site is characterized by waters between 44 to 48 feet in depth with a mixed bottom type of patch coral reef at the eastern end of the site, sand, seagrass and a diverse array of algaes. The waters are seasonally warm, calm and clear in the late spring and summer, cold, rougher and more turbid in the winter, due to ocean current patterns. The site provides habitat for numerous species of fish and other types of seafood.

Site Ethnography. Two fishermen were interviewed at this site. Both have fished the location for 20 years. Fishermen from nearby villages also use the spot in addition to those from Buen Hombre. The site is fished most frequently during late spring and summer when the waters are clearer and warmer. It is visited less often during the winter months (December through March) because of higher turbidity and colder water temperatures. One fisherman said that he fished at the location an average of seven times per month.

Fishermen harvest numerous types of seafood at this location. These are listed in Table 7.12. One fisherman noted that sea turtle (tortuga) is encountered at this site. The size of fish and other marine populations are seen as having diminished in size, noticable even in the last year. This was attributed to more fishermen using the site, particularly those using compressors that increase the amount of time a fisherman can remain submerged, thereby increasing the amount of seafood captured. One fisherman added that increased exploitation by net fishermen prevent fish from returning. This is likely due to the habitat destruction, notably tearing up of seagrass beds, caused by the nets.

Table 7.12. FISH SPECIES PRESENT/CAPTURED
AT LOS MORRALES

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| pargo pluma | | |
| pargo riso | Spanish hogfish | |
| pargo amarillo | | |
| varraco | hogfish | |
| bocallate | | |
| arrigua | | |
| candil | | |
| mero | grouper, sea bass | |
| chivo | goatfish | |
| centolla | spider crab | |
| cariti | | |
| cohinua | | |
| colirubia | | |
| picua | barracuda | |
| carel | | |
| delfin | dolphin (fish) | |
| tortuga | sea turtle | |
| jurel | yellow jack, mackerel | |
| colirubia | | |
| guinea | | |
| pargo riso | spanish hogfish | |

**La Pasa de la Silla de Caballo/Silla de Caballo** (Interviews #16, 17, Station Y-1)

Location and Description. This site was visited on February 26 and 27, 1991. It is located offshore of the coastal community of La Vereda. The formation of the mountain in front of the community resembles the saddle of a horse (silla de caballo), from which the site gets its name. The site is a small passage or channel. No site coordinates could be taken for this site due to the satellites not working.

Site Ecology. This site is characterized by waters six to thirty feet in depth with bottom types consisting of mixed sand, algae, coral and seagrasses known as pino and sargazo. Water temperature and turbidity are influenced by strong currents from the south. This results in a seasonal pattern in which the waters are clearer and calmer in the late spring and summer (May through July), and more cloudy and colder during December through February. The site provides habitat for many varieties of fish and other seafood.

Site Ethnography. Two fisherman were interviewed at this site. Both have fished the location for 20 years. In addition to Buen Hombre fishing crews, fishermen from the communities of La Vereda, Monte Cristi, and interior villages on the other side of the mountains fish at the site. The site is visited on an average of four to five times per month by the respondent and his crew. Fishing is more common at the location during late spring and summer when the waters are clearer and warmer. Conversely, colder and more turbid waters reduces the number of trips made to the site during the winter.

The fishermen of Buen Hombre harvest many varieties of fish and other seafood species from the site. A list of the kinds of species captured at the site is presented in Table 7.13. The decline in fish stocks at the location, according to the fisherman interviewed, is due to the growth in the number of fishermen using the site with more and varied kinds of technology, including nets and compressors.

Table 7.13. FISH SPECIES PRESENT/CAPTURED
AT LA PASA DE LA SILLA DE CABALLO/SILLA DE CABALLO SITE

| Spanish Name | English Name | Scientific Name |
| --- | --- | --- |
| bocallate | | |
| pargo pluma | | |
| pargo prieto | | |
| pargo colorado | | |
| cotorra | | |
| mero | grouper, sea bass | |
| cariti | | |
| colirubia | | |
| candi | | |
| bocallate | | |
| arrigua | | |
| pulpo | octopus | |
| bulgao | stocky cerith snail? | |
| varraco | hogfish | |
| picua | barracuda | |
| lambi | conch | |
| centolla | spider crab | |
| langosta | lobster | |

**Bajio de lo Jengibre** (Interview #19, Station Z-1)

Location and Description. This site was visited on February 27, 1991. It is located near the end of the Buen Hombre beach in the first lagoon. Its coordinates are 19 degrees, 53.1107 minutes North latitude, 71 degrees, 25.9789 minutes West longitude.

Site Ecology. This is a unique, ecologically heterogeneous round patch reef site approximately 45 meters in width. Its uniqueness is evidenced both in the name by which it is referred (bajio means shallows or sandbank, jengibre means ginger), and its ecological makeup. The site gets its name from an abundance of crustious red, rose or coraline algae, known locally as jengibre. The waters range from a very shallow two feet to three feet in depth with bottom types consisting of the red coral, Thalassia seagrass and sand. The waters are calm and clear throughout the major part of the year. During the winter months of December through February, turbid water washes in from a nearby channel. Consequently, the deeper waters of the site area are turbid much of the year. The site provides habitat for several species of fish and other marine animals.

Site Ethnography. The fisherman interviewed at the site has known of the location for 20 years. Interestingly, the fishermen of Buen Hombre do not fish at the spot, according to both fishermen interviewed. Fishermen using chinchorro nets from Monte Cristi, however, exploit the site. One fisherman mentioned that he has observed the ecological condition of the site for 20 years.

Several species of marine life either inhabit the site or pass through during migrations. Table 7.14 lists the species present at the site. In the deeper portions of the site, the most significant animals passing through is the manatee and sea turtle. It seems likely that the shallows of the site serve as a nursery and feeding ground for several species of marine animals, and it is apparent that Buen Hombre fishermen avoid fishing the location for this reason. Nevertheless, one fisherman noted that the abundance of marine life has declined at the site, and he attributed these losses to exploitation by chinchorro fishermen.

Table 7.14. FISH SPECIES PRESENT/CAPTURED
AT THE BAJIO DE JENGIBRE SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| cofre | boxfish, trunkfish | |
| pulpo | octopus | |
| candi | | |
| langosta | lobster | |
| mojarra | mojarra | |
| merito/mero | grouper, sea bass | |

**Canal de lo Mangle** (Interview #20, Station Z-2)

Site Location and Description. This site was visited on February 27, 1991. It is known locally as simply a mangrove channel (canal de lo mangle). It is located out from a cano or narrow channel known as cano de mongo. Site coordinates are 19 degrees, 53.1409 minutes North latitude, 71 degrees, 26.1378 minutes West longitude.

Site Ecology. The waters at this site are 13 feet in depth with bottom types consisting of extensive Thalassia seagrass, green algae, mud and sand. The waters are calm but turbid throughout the major part of the year. During the winter months of December through February, turbid water washes in from the mangrove. Consequently, the waters of the site area are turbid much of the year. The site provides habitat for several species of fish and other marine animals.

Site Ethnography. The fisherman interviewed at the site has known of the location for 20 years. Fishermen from Monte Cristi, however, exploit the site with trasmallo and chinchorro de arrastre nets. The fishermen of Buen Hombre do not fish at the spot because they do not use these types of nets.

Several species of marine life either inhabit the site or pass through during migrations. Table 7.15 lists the species present at the site. The most significant animals passing through is the manatee and sea turtle. It seems likely that the shallows of the site serve as a nursery and feeding ground for several species of marine animals, and it is apparent that Buen Hombre fishermen avoid fishing the location for this reason. Nevertheless, the fisherman noted that the abundance of marine life has declined at the site, and he attributed these losses to exploitation by chinchorro fishermen.

Table 7.15. FISH SPECIES PRESENT/CAPTURED
AT THE CANAL DE LO MANGLE SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| jurel | yellow jack, mackerel | |
| picua | barracuda | |
| cariti | | |
| bemejuela | | |
| pargo prieto | | |
| pargo sama | | |
| ballumve | | |
| mojarra | mojarra | |
| cohinua | | |
| bocallate | | |
| colirubia | | |
| mero | grouper, sea bass | |
| cofre | boxfish, trunkfish | |
| tortuga | sea turtle | |
| manati | manatee | |

**Cayo Arena** (Interview #21, Stations AA-1, AA-2, AA-3)

Location and Description. This site was visited on March 1, 1991. It is a small raised sandy island or key east-northeast of the Buen Hombre beach, off the coast of the community of Sansie. Coordinates for three pixel stations were taken. These are listed below:

*AA-1: 19 degrees, 52.2221 min. N. latitude, 71 degrees, 18.3523 min. W. longitude (land)
*AA-2: 19 degrees, 52.2363 min. N. latitude, 71 degrees, 18.4145 min. W. longitude
*AA-3: 19 degrees, 52.2528 min. N. latitude, 71 degrees, 18.3165 min. W. longitude

Site Ecology. The island and immediate environs are characterized by waters ranging in depth from five to eighty feet in depth with bottom types of mixed sand, coral and seagrass. Currents are weak around the island, but water turbidity is highly variable throughout the year, particularly during the rainy season (November through February). The site provides habitat for many species of fish and other seafood species.

Site Ethnography. The fisherman interviewed at this site has fished the location for 20 years. The site is used by fishermen from nearby coastal communities of Punta Rucia, Loma Atrevesada and La Vereda. The site is more frequently visited during late spring and summer (May through August), when the ocean waters are calm. Because of calm waters during this time, the fairly distant site can be reached by fishermen without a motor. The number of visits to the site is reduced during the period November through March for two reasons. First, rougher waters necessitate the use of a motor, which is not always possible, to reach the site. Secondly, the waters are said to be colder and more turbid during this time of the year because it is the rainy season. The fisherman interviewed at the site attributed the higher turbidity to runoff of precipitation and deposition of sediments flowing out to the area from the rivers near Puerto Plata, Catillo--a community near Punta Rucia, Luperon, and the Rio Yaque del Norte near Monte Cristi.

Many types of fish and seafood species are harvested from the site. These are listed in Table 7.16. Varieties of shellfish such as crabs, lobster, and conch are found at the site. In addition, a conch-type shellfish known locally as bulgao is seasonally present in May when the waters are calm.

The abundance of seafood resources at this site were said to have declined for two reasons. First, a growing number of fishermen use the site. More significantly, many of these fishermen employ chinchorro nets and compressors, destructive technologies in a fragile microenvironment. Second, there has been a rapid increase in the number of tourists who visit the site to engage in recreational activities such as swimming, boating and snorkeling. Consequently, it was explained by the fishermen that the intensification of both kinds of activities, conducted by growing numbers of people, will eventually put the site and the resources it supports at a greater risk of degradation and eventual destruction.

Table 7.16. FISH SPECIES PRESENT/CAPTURED AT THE CAYO ARENA SITE

| Spanish Name | English Name | Scientific Name |
| --- | --- | --- |
| bocallate | | |
| cabrilla | cabrilla | |
| pargo colorado | | |
| pargo tao tao | | |
| cotorra | parrotfish | |
| lambi | conch | |
| centolla | spider crab | |
| langosta | lobster | |
| jaiba marina | crab | |
| madama | | |
| bulgao | | |

**Palo de la Garza** (Interview #22, Station P-1)

Location and Description. This site was visited on March 2, 1991. It is located near a mangrove channel in proximity to the entrance to the canon, or deep water portion of the channel. The site coordinates are 19 degrees, 50.9434 minutes North latitude, 71 degrees, 18.8561 minutes West longitude. The name derives from the fact that the location is frequented by a population of herons.

Site Ecology. This site is characterized by waters ranging from a shallow four to five feet to twelve feet deep with typical mangrove bottom types composed of seagrass and mud. Currents are generally weak, but water turbidity is variable. High degrees of turbidity are more common during the rainy winter months (November through February) when the muddy bottom is stirred up as the mangrove waters rise. Water is clearer during late spring and summer. The site provides habitat for many varieties of fish.

Site Ethnography. The fisherman interviewed at the site has fished the location for 20 years. In addition to his crew and others from Buen Hombre, the site is also used by fishermen from the communities of El Cope, Punta Rucia, Estero Hondo, and Sancho Manuel. Tourists also visit the location as a recreational activity.

Fishing trips to the site are more frequently carried out in late spring and summer, when the waters are said to be clearer. During the rainy winter months (November thorugh February), the turbidity of the water limits the amount of visits to the site by fishermen.

Many varieties of seafood are taken from the site. Table 7.17 provides a list of the fish and other seafood species. According to the fisherman interviewed, the abundance of seafood at this location has decreased. He attributed the decline to increased use of the site by a larger number of fishermen.

Table 7.17. FISH SPECIES PRESENT/CAPTURED
AT THE PALO DE LA GARZA SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| pargo prieto | | |
| picua | barracuda | |
| sabalo | shad | |
| robalo | bass | |
| mojarra | mojarra | |
| ballombe | | |
| lisa | striped mullet | |
| boqueron | small sardine | |
| mejua | | |
| bocallate | | |
| chucho | herring-like fish | |
| raya | ray, skate | |
| langosta | lobster | |
| centolla | spider crab | |

**Pasa de lo Grullone** (Interview #24, Stations N-1, N-2)

Location and Description. Two pixel stations of this site were visited on on February 21, 1991 and again on March 2, 1991. The site is located to the west of a nearby channel of the same name that extends to the shore. The site coordinates are 19 degrees, 51.6751 minutes North latitude, 71 degrees, 22.1171 minutes West longitude. Another pixel station had coordinates of 19 degrees, 51.6900 minutes North latitude, 71 degrees, 22.2518 minutes West longitude.

Site Ecology. The two pixel stations of this site are characterized by water ranging from four to 13 feet in depth with a bottom type of seagrass interspersed with patch reef, coral and algae. Currents are weak at the site, but turbidity of water varies with the season, being clearer during late spring and summer, and becoming increasingly turbid in the fall and winter (November through February) due to rainfall runoff from the mountains. The site provides habitat for numerous species of fish and other marine animals.

Site Ethnography. The fisherman interviewed at the site has fished the location for 20 years. Fishermen from other coastal villages, including La Vereda, Sabana Cruz, and Punta Rucia, as well as urban fishermen from Monte Cristi, use the spot for fishing in addition to Buen Hombre fishermen. Tourists also visit the site as a form of recreational activity.

Fishing at the site is carried out more frequently during the months of May through July. The water is said to be clearer during this time. Turbid waters during the rainy witner season reduces the number of trips fishermen make to the spot.

Numerous species of fish and shellfish are harvested from the location by fishermen. Table 7.18 provides a list of these species. The abundance of fish numbers has decreased due to increasing numbers of fishermen using the site. Chinchorro fishermen's nets make a large contribution to destroying habitat for seafood populations. In fact, the fisherman interviewed at the site noted that a species of fish known as macabi (banana fish) has disappeared from the location entirely. This is the only instance where the fishermen mentioned that a type of fish has become "extinct" or fished out completely at a site.

During the first site visit on February 21, ethnographers had the opportunity to observe a crew of chinchorro fishermen engaging in fishing. Divers obtained a satellite fix of coordinates at each end of the chinchorro net and then went down to observe mesh size and contents.

The net approached 125 to 175 meters in size, spread out in a circular formation much like a beach seine net, in waters ranging from four to eleven feet deep. From the margins of the net the mesh size decreased from three inches to less than one inch at the narrow or "caught" end, where there was a bag attached into which captured fish eventually swam.

Table 7.17. FISH SPECIES PRESENT/CAPTURED
AT THE PASA DE LO GRULLONE SITE

| Spanish Name | English Name | Scientific Name |
| --- | --- | --- |
| pargo pluma | | |
| pargo sama | | |
| cohinua | | |
| jurel | yellow jack, mackerel | |
| mojarra | mojarra | |
| guaguancho | | |
| lambi | conch | |
| langosta | lobster | |
| centolla | spider crab | |
| bocallate | | |
| candil | | |
| memejuelo | | |
| mero | grouper, sea bass | |
| ballombe | | |
| agujon | | |
| balaju | | |
| colirubia | | |
| chivo | goatfish | |
| chivica | | |
| palometa | palometa | |
| macabi* | bonefish | |

*extinct at site

That chinchorro net usage results in indiscriminate and destructive catches was evident from the contents of the net, observed by divers. The net had snared a six-inch porcupine fish, a six-inch spiny lobster, and numerous juvenile bicolored damselfish, parrotfish, and spotted goatfish. Virtually all of these fish were less than 50 millimeters to two inches in length.

**La Punta del Muerto** (Interview #25, Stations M-1, M-2, M-3, M-4)

Location and Description. Four pixel stations comprising this site were visited on February 20, 1991. An ethnographic interview was conducted on March 2, 1991. It is located at the end of a beach along the Buen Hombre harbor. Site coordinates for station M-2 are 19 degrees, 52.1559 minutes North latitude, 71 degrees, 24.2170 minutes West longitude. The coordinates for the other pixel stations are listed below:

*M-1: 19 degrees, 52.0130 min. N. latitude, 71 degrees, 24.1127 min. W. longitude
*M-3: 19 degrees, 52.1244 min. N. latitude, 71 degrees, 24.0524 min. W. longitude
*M-4: no coordinates taken--satellites down

The site derives its name from an occasion in which a person from another area drowned and the body was found floating at the site.

Site Ecology. This site is characterized by shallow waters about four feet deep with bottom type of mixed coral, seagrass and sand. The water is more or less clear and calm throughout the major part of the year. The only time it is consistently cloudy is in December, due to the rains. The site provides habitat for numerous species of seafood.

Site Ethnography. The fisherman interviewed about the site participated in the ecological assessment and collection of samples. He has fished the location for 11 years. In addition to Buen Hombre fishermen, fishermen from the communities Las Canas, Los Conucos, and Los Uveros also use the spot for fishing. The site is used most frequently from May to August when the waters are warmer and clearer. During the rainy season month of December, the water is consistently cloudy, and therefore less trips are made to the site.

A large number of fish and other seafood species are harvested from the site. These species are listed in Table 7.19. According to the fisherman interviewed at the site, the abundance of fish and shellfish has declined at the site. He attributed the decline of fish populations at the site primarily to the use of chinchorro nets by increasing numbers of fishermen.

Table 7.19. FISH SPECIES PRESENT/CAPTURED
AT THE LA PUNTA DEL MUERTO SITE

| Spanish Name | English Name | Scientific Name |
|---|---|---|
| bocallate | | |
| sabalo | shad | |
| mero | grouper, sea bass | |
| langosta | lobster | |
| pargo sama | | |
| pargo riso | Spanish hogfish | |
| pargo manchila | | |
| pargo mantequilla | | |
| pargo tao tao | | |
| arrigua | | |
| candil | | |
| cotorra | parrotfish | |
| colirubia | | |
| centolla | spider crab | |
| cofre | boxfish, trunkfish | |
| pulpo | octopus | |
| lambi | conch | |

## Other Marine Sites Visited

The section below describes sites that were visited during the course of the fieldwork for the purpose of collecting biological samples and making ecological assessments. No ethnographic interviews were conducted at these sites, because the majority of them are more proximal to Punta Rucia than Buen Hombre. Still, the site descriptions help to characterize a larger coastal marine area along the north coast.

**La Pasa** (Stations B-1, B-2, B-3)

Site Location and Description. Three pixel stations of this site were visited on February 17, 1991. The boat captain from Punta Rucia referred to the site as La Pasa. Site coordinates are listed below:

*B-1: 19 degrees, 50.2986 min. N. latitude, 71 degrees, 14.2956 min. W. longitude
*B-2: 19 degrees, 50.3856 min. N. latitude, 71 degrees, 14.3201 min. W. longtiude
*B-3: 19 degrees, 50.3768 min. N. latitude, 71 degrees, 14.3259 min. W. longitude

Site Ecology. The site is a large seagrass bed near the Discovery Bay hotel. Water depth at the above pixel stations is 13 feet, 11 feet, and 35 feet, respectively.

**El Paso** (Station D-1)

Site Location and Description.

Site Ecology.

The sites described below are listed by station number only. No names for them were elicited from local fishermen.

**Stations F-1 and F-2**

Site Location and Description. The two pixel stations of this site were visited on February 19, 1991. They are near the Discovery Bay hotel in Punta Rucia. Site coordinates are listed below:

*F-1: 19 degrees, 50.3524 min. N. latitude, 71 degrees, 12.9602 min. W. longtiude
*F-2: 19 degrees, 50.3871 min. N. latitude, 71 degrees, 12.9776 min. W. longtiude

Site Ecology. These two stations are located in the first lagoon off the hotel. Water depth ranges from four-and-a-half to eight feet at the two stations, respectively. Bottom types are seagrass and sand.

**Station G-1**

Site Location and Description.

Site Ecology.

**Stations H-1 and H-2**

Site Location and Description.

Site Ecology.

**Station I-1**

Site Location and Description.

Site Ecology.

**Stations J-1 and J-2**

Site Location and Description.

Site Ecology.

The sites described below are all located near the playa del coco, east of Buen Hombre beach.

**Station T-1**

Site Location and Description. This site was visited on February 24, 1991.

Site Ecology.

**Stations U-1 and U-2**

Site Location and Description. The two pixel stations of this site were visited on February 24, 1991.

Site Ecology. A screen from the Smithsonian mithrax crab mariculture pilot project, implemented in Buen Hombre (1985-1987), was found at the station U-2 (see Stoffle 1986; Stoffle, Halmo and Stoffle 1991).

## General Patterns Derived from Site-Specific Ecology and Ethnography

(forthcoming)