PROCEEDINGS OF THE 9th SYMPOSIUM ON THE GEOLOGY OF THE BAHAMAS AND OTHER CARBONATE REGIONS

Edited by
H. Allen Curran and John E. Mylroie

Production Editors:
Matthew A. Reece
Laurel L. Powers

Bahamian Field Station, Ltd.
San Salvador, Bahamas
1999

Front Cover: Lee-side exposure of a fossil parabolic dune viewed from the Grahams Harbour side (west) of North Point, San Salvador, Bahamas. These Holocene carbonate eolianites have been assigned to the North Point Member of the Rice Bay Formation (Carew and Mylroie, 1995). The eolian cross-stratification dips below present sea level, proving that late Holocene sea-level rise is real. Top of the dune is about 7 meters above the sea surface. Photo by Al Curran.

Back Cover: Dr. Noel P. James of Queen's University, Kingston, Ontario, Canada, keynote speaker for this symposium. Noel is holding a carving of a tropical fish created by a local artist and presented to him at the end of the symposium. Photo by Al Curran.

Printed in USA by

ISBN 0-935909-67-2

PRELIMINARY GEOGRAPHICAL INFORMATION SYSTEM ANALYSIS AND MAPS OF PHYSICAL, HYDROLOGICAL, ARCHAEOLOGICAL, AND BIOLOGICAL RESOURCES, SAN SALVADOR ISLAND, BAHAMAS

Matthew C. Robinson and R. Laurence Davis
Department of Biology and Environmental Sciences
University of New Haven
300 Orange Avenue
West Haven, CT 06516

ABSTRACT

The last major map of San Salvador was published in 1972 and was based on aerial photographs taken in 1968. Since then, there has been much development on the island and pressures for more development are currently increasing. Local and national decision makers need additional information about the island's physical, hydrological, biological, archaeological, and human resources in order to manage that development, to conserve the island's rare and unique natural and human systems, to enhance its economy, and to provide protection from natural hazards to its human population.

In 1997, the Bahamian Field Station, a group of researchers at the station, and the Don and Kathy Gerace Foundation agreed to undertake an update of the 1972 map in Geographical Information System format. The new map would incorporate all of the information on the old map and also include additional data on major new developments, historic and pre-historic sites, fresh water wetlands, well locations and water quality, important geologic sites, vegetation, and locations of rare and endangered plants. The map is being assembled by the authors at the University of New Haven Geographical Information System Laboratory using data from our own studies and those of other researchers. One of the beauties of the GIS format is that the product is easily revised. This paper presents the preliminary results of our work, most of it in map form. We hope that it will generate suggestions, constructive comments and criticisms, and additional data, all of which may be incorporated into future "updates" of the data and information base.

INTRODUCTION

The most detailed map currently available for San Salvador Island is the 1:25,000 scale Bahamian Government topographic map, published in 1972 (Lands and Surveys, 1972). This map is based on 1968 aerial photographs of the island and numerous ground surveys. Twenty-seven years ago it offered an up-to-date compilation of San Salvador and its features. It is now outdated and lacks much of the information currently needed for analysis and planning purposes.

In 1992, in "honor" of the 500th anniversary of Columbus' landing on San Salvador, a new Club Med hotel opened near Cockburn Town, the island's governmental seat. Even the casual return visitor to the island can't help but notice the tremendous spurt of development that followed this event. New houses are springing up everywhere. There are new stores and new infrastructure. There are more residents and they are far more prosperous. The air is thick with rumors of additional resort openings and they are passed on to whomever will listen. Given

this tremendous increase in development and the pressures for more, it is obvious that in order to deal with it, planners now need an enhanced and up-to-date collection of maps and data.

The Bahamian Government has shown interest in using a Geographical Information System (GIS) as an aid in this planning process. The presence on San Salvador of a major scientific research facility (the Bahamian Field Station founded in 1972) has resulted in the collection of a huge amount of data about the island. Because there is such a large amount of information available for San Salvador, the government chose it as the site for a pilot project that would illustrate what could be done in the Bahamas with digital information and GIS. In 1997, we began a project with a goal to compile a GIS database of digital information and maps for San Salvador Island that would be useful for planning purposes. The objectives of the project were to 1) update existing map data and put it into digital format, and 2) supply additional digital information on San Salvador's physical, hydrological, biological, archaeological, and human resources. Obviously, this is a large project and it is still in progress. We present our preliminary results and maps here.

WHY USE A GIS?

We chose a Geographical Information System (GIS) as the main platform for this project because a GIS offers an effective means of compiling, storing, and analyzing large amounts of information and data. This system can use a variety of data formats, it allows quick access to that data, it can perform complex analyses on it, and it can produce many types of output. For example, topography can be displayed in 3-Dimensional views from various perspectives (Figure 1). With a GIS, you can focus on one or more aspects within a data set, you can isolate specific characteristics within your data (such as selecting all of the wells with salinities over 500 mg/L), and you can combine your results to produce a number of different outputs for analysis. This will allow you to observe patterns in the data, something which would be particularly useful in land planning. This system can also perform statistics on the data, such as complex metrics calculations or bi-variate and multi-variate analyses (ESRI, 1995, 1996).

METHODS

In compiling our data base we used both published and unpublished information plus data gathered especially for this project. Some of the materials included:

1) Existing published maps of the island such as the 1972 topographic map, the Columbus Landings Company Master Plan map (1974), and the San Salvador nautical charts (NOAA, 1959).

2) Data from transit field surveys carried out since 1988 such as trail and water well locations.

3) Newly collected data from recent Global Position System (GPS) and transit field surveys such as water well locations and archaeological sites.

4) Additional research data that has never been previously available in map form (for example, water chemistry data and soil information).

In order to "capture" the published map data, we first scanned it into the computer at its full scale. Then, we performed the actual digitization on the computer screen at a substantially enlarged scale. Since we also had scanned in the air photographs on which the 1972 topographic map was based, we were able to check our digitized map against these. Finally, we registered our maps against the Universal Transverse Mercator (UTM) grid system and made any corrections necessary.

We treated our field survey data in two dif-

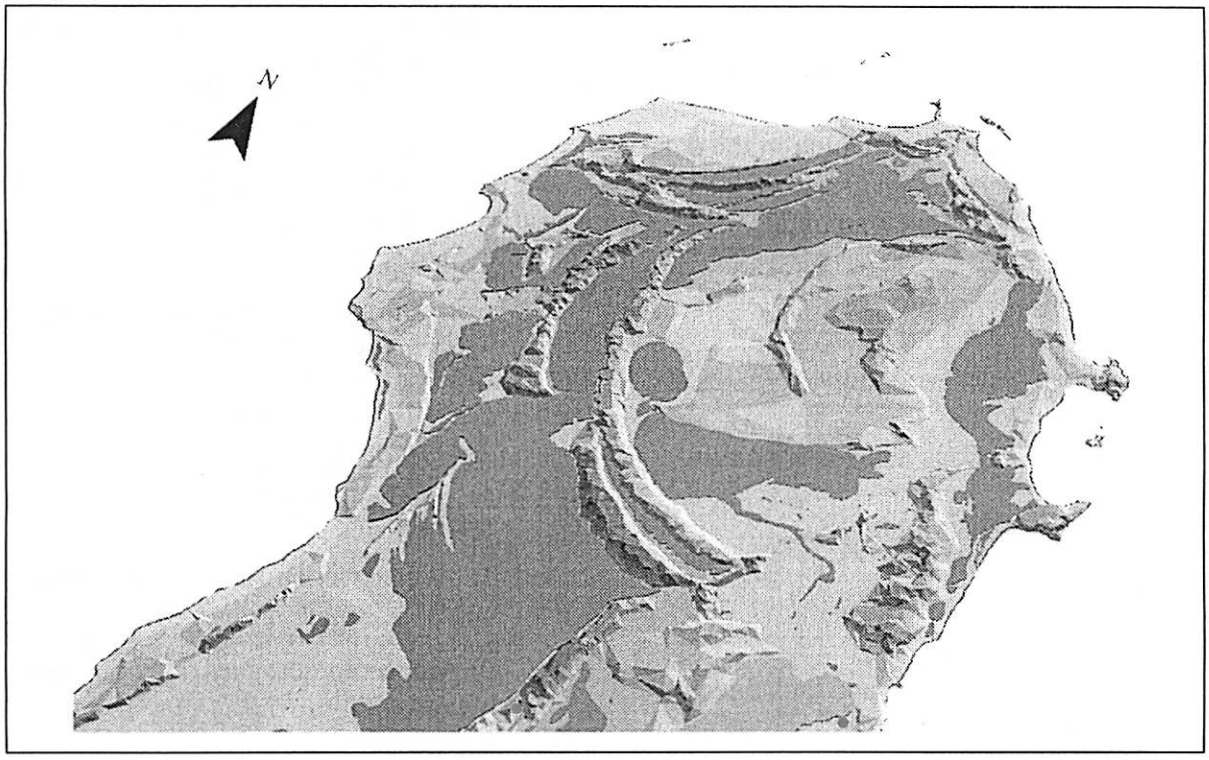

Figure 1: Three-dimensional view of NW part of San Salvador Island (after Lands and Surveys, 1972).

ferent ways. Since Global Positioning System can return information in UTM coordinates, we were able to enter these directly into the GIS system. Before entering sites surveyed with a transit, however, we first had to convert the locations into UTM coordinates based on those of the survey benchmark. Since all transit surveys were done relative to magnetic north, we also had to correct for the declination at the time of the survey (about 8° west) and also for the discrepancy between grid north and true north (about 12 minutes east).

The rest of the data that we put into the system did not come in map form, although they were usually associated with specific locations. Two examples illustrate this. Over the last 12 years, one of the authors (Davis) and his colleagues have taken nearly a thousand water samples and analyzed their chemistry. We wanted to have those results available in the system and have them linked to the sample location. We also wanted to link written descriptions and site maps of archaeological sites to the site locations themselves. In a GIS it is possible to establish these kinds of links directly, which is, of course, one of the system's great strengths.

The Global Positioning System surveys were done in January and April, 1998. The many transit surveys have been conducted over the years since 1987. In carrying out the surveys and in obtaining the data to be included in the GIS, we consulted with long time island residents, government officials and members of the scientific community working on the island. All information was field verified when possible.

Figure 2 (Foldout): Digitized topographic map (after Lands and Surveys, 1972).

RESULTS

In our discussions with the Bahamian Government, we identified the following information that they wanted us to include in the database:

1) Major new developments.

2) Archaeological sites.

3) Fresh water wetlands.

4) Well locations and water quality.

5) Important geologic sites.

6) Vegetation.

7) Locations of rare and endangered plant and animal species.

In this initial phase of the project, we limited ourselves to terrestrial and inland water areas. Coastal areas will have to be added later.

Based on these requests, we have produced a GIS data base of San Salvador Island. The figures that follow illustrate some of its aspects. Obviously, we can only present information in map form here. The actual GIS contains a great deal of additional information and linkages as discussed above. As of this writing (November, 1998) the actual data base is about 90% finished. We anticipate its completion by the end of 1998 at which time we will turn it over to the Bahamian Government. It should be available to the public some time in mid-1999.

So far, we have digitized the following information and entered it into the GIS database:

1) Most of the information on the 1972 Bahamian Government topographic map (Figure 2).

2) The major roads on the 1975 Columbus Landings Master Plan map (Figures 3 and 4).

3) The rock quarries from the 1959 National Ocean Survey chart (Figure 2).

4) The vegetation patterns from Smith's (1992) vegetation map (Figure 5).

5) Bedrock geology from Carew and Mylroie's (1995) map.

6) Land parcel ownership information from unpublished Bahamian Government maps.

We placed the following recently surveyed GPS data into the GIS database:

1) Water wells (modern, test, historic, and abandoned. Figure 6).

2) Archaeological sites (historic and prehistoric. Figure 7).

3) Rare and endangered tree species (Figure 7).

4) Currently accessible fresh water wetlands.

5) Likely fresh water wetlands identified from 1968 and later air photos, the 1972 topographic maps, and informal aerial surveys.

FUTURE WORK

While carrying out our work, we noted many problems with the data, particularly the 1972 Bahamian Government topographic map. Because this map is twenty-six years old, it lacks many of the features presently extant on the island. These include such things as the Columbus Landings roads, Club Med, the newly cleared area near the airstrip, and all major developments that have occurred in the last 25 years. We also noted that many of the classified features on the topographic map, such as wetlands and vegetation, are no longer accurate or are not representative of the current conditions.

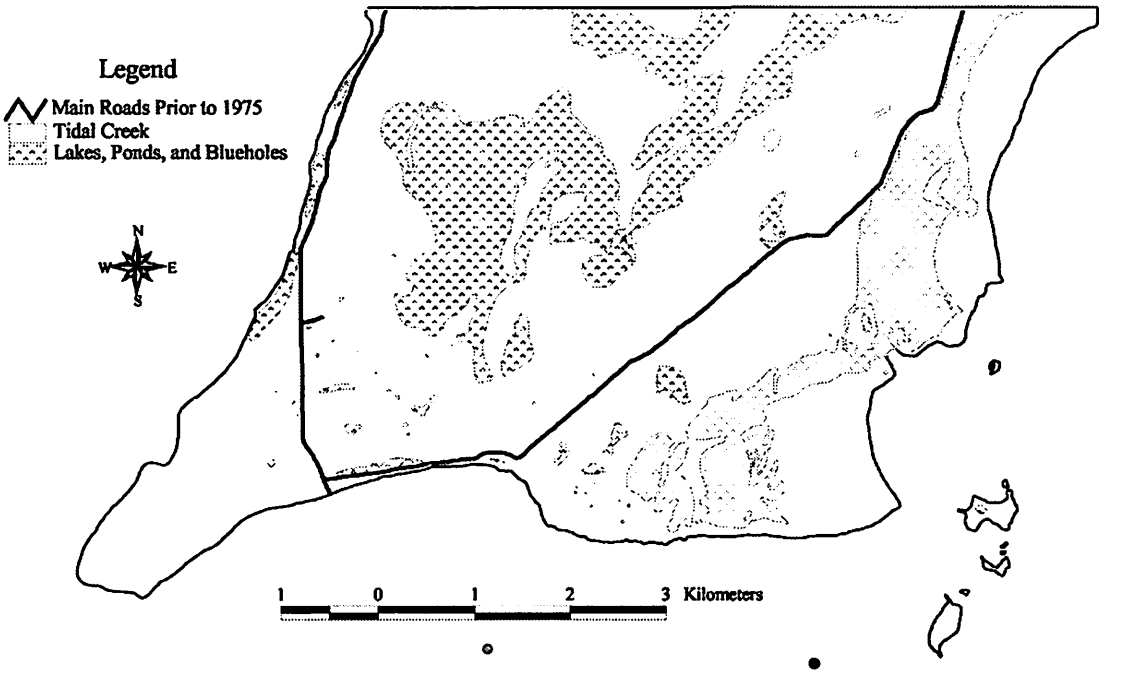

Figure 3: South End of San Salvador Island Showing roads before Columbus Landings development (after Lands and Surveys, 1972).

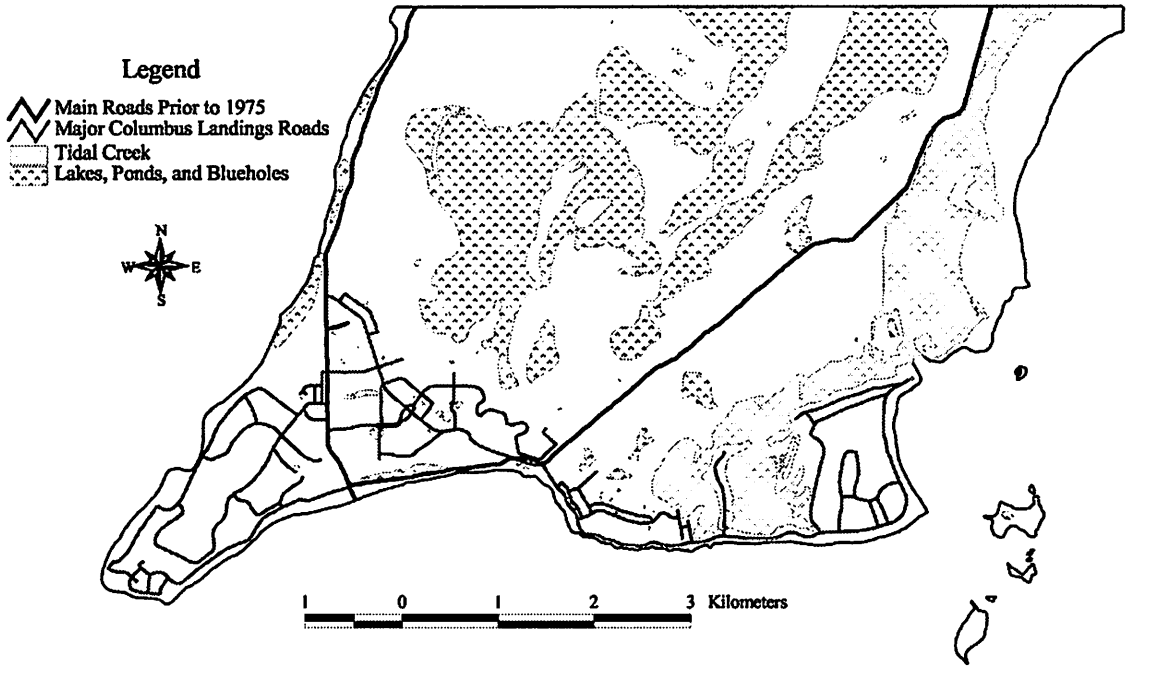

Figure 4: South end of San Salvador Island showing principal roads following Columbus Landings development in 1975 (after Lands and Surveys, 1972 and Columbus Landings, 1975).

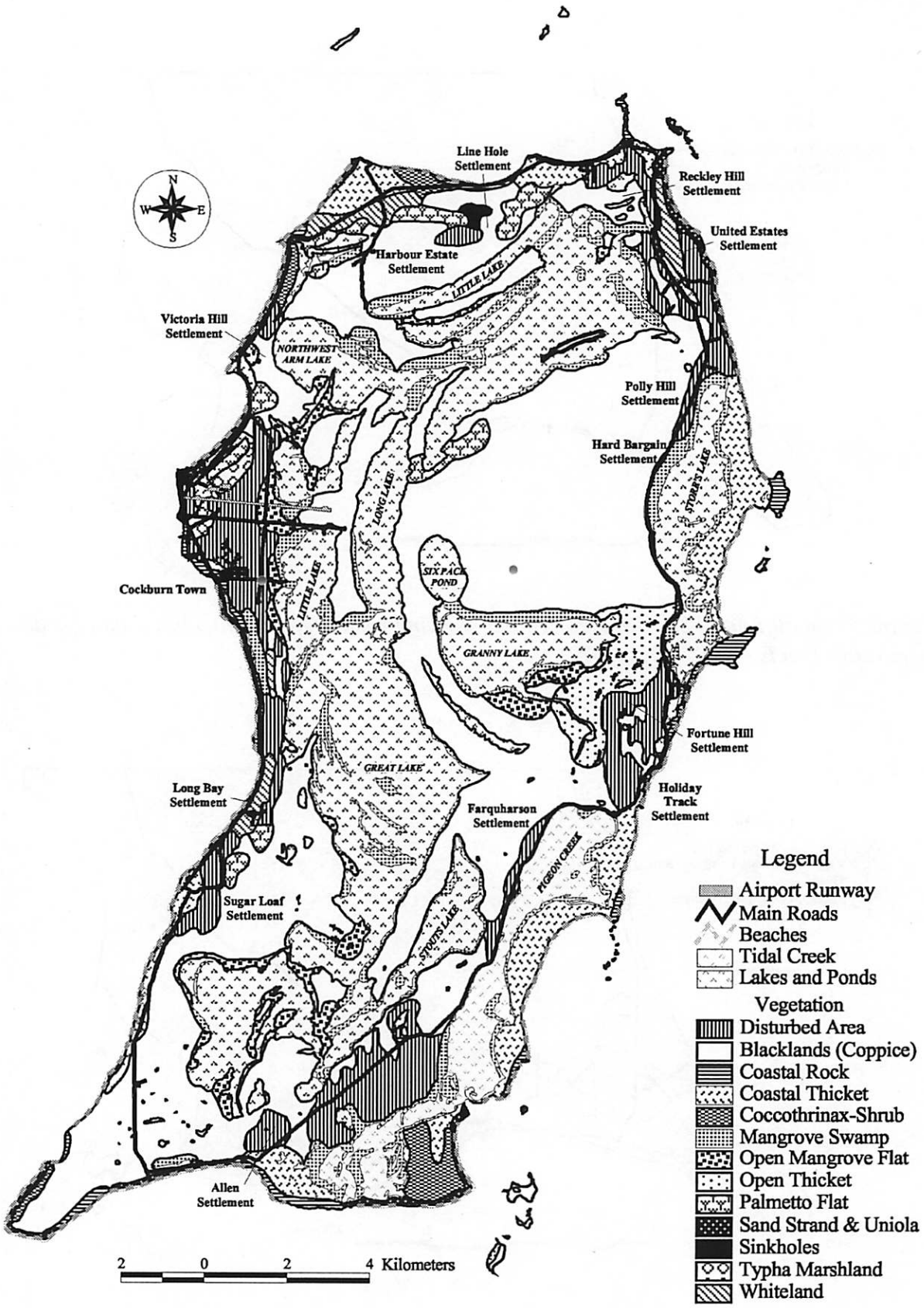

Figure 5: Digitized vegetation map for San Salvador Island (after Smith, 1992).

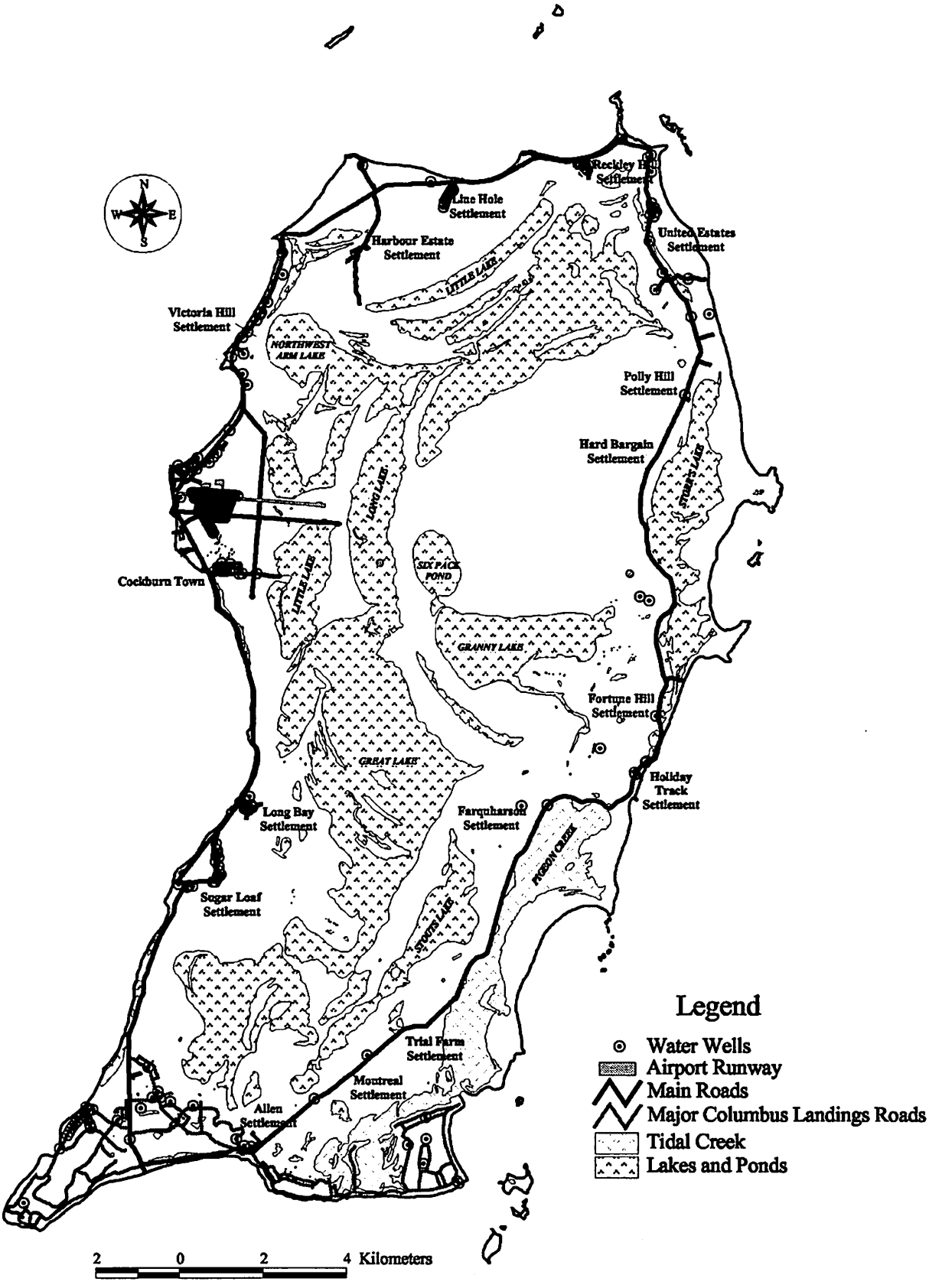

Figure 6: Locations of some major private and government water wells.

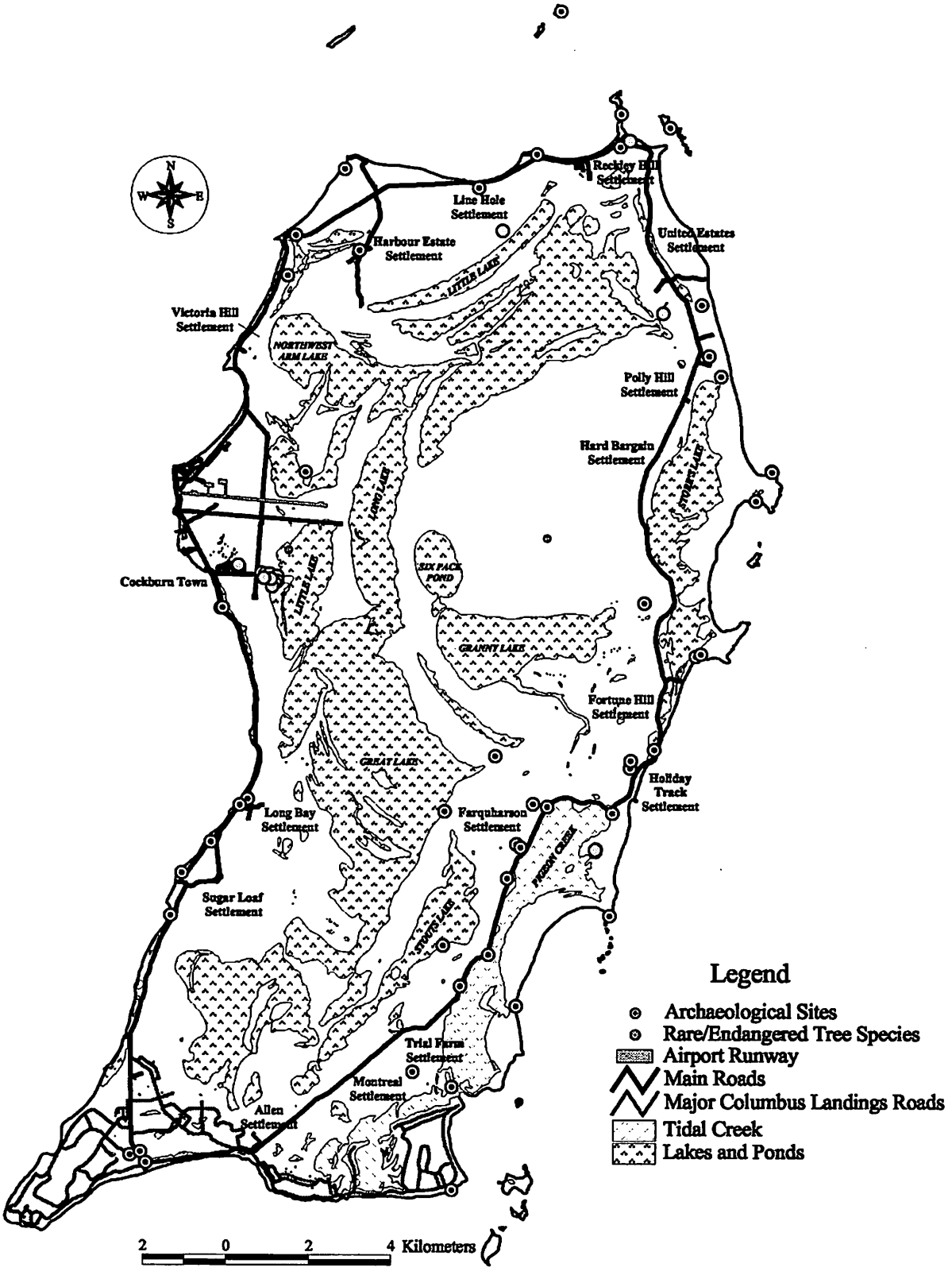

Figure 7: Locations of identified archaeological sites and endangered tree species.

These problems will require additional work in the future. This work might include:

1) Completing and updating the existing data coverages (such as wells, archaeological sites, fresh water wetlands, important geologic sites, vegetation, and rare and endangered species).

2) Adding other important or useful information into the project (such as soil information and locations of caves on the island).

3) Performing analyses on the data to produce new analytical information and data coverages (such as environmentally sensitive areas or a Land Use Capability map for San Salvador).

ACKNOWLEDGMENTS

We gratefully acknowledge the financial and logistical support of the Bahamian Field Station and the University of New Haven. Additional financial support came from the Don and Kathy Gerace Foundation. We would also like to thank the staff of the Bahamian Field Station, the residents of San Salvador, and all of those who contributed to this project by allowing us to use either their data or knowledge or who assisted us with the field work. They include Dr. Don Gerace, Kathy Gerace, Kenneth Buchan, Dr. John Winter, Dr. Nancy Elliot, Dr. Ronald Shaklee, Francois Smith, Craig Parke, Emily Mobley, Michael Warner, Dr. Jeffrey Niemitz, Matthew Niemitz, Thomas Hanna, Kimberly Brecher, and Kimberly Clarke.

REFERENCES

Carew, J. L. and Mylroie, J. E., 1995, Depositional Model and Stratigraphy for the Quaternary Geology of the Bahama Islands, *in* Curran, H. A. and White, B., eds., Terrestrial and Shallow Marine Geology of the Bahamas and Bermuda: Geological Society of America Special Paper 300, p. 5-32.

Columbus Landings Company, 1975, A Property and Road Map, Columbus Landings Master Plan, 1:7,200, unpublished map.

Environmental Systems Research Institute, 1996, Computer Software, ArcView 3.0a: Redlands, California, ESRI, Inc.

Environmental Systems Research Institute, 1995, Computer Software, PC Arc/Info 3.5.1: Redlands, California, ESRI, Inc.

Lands and Surveys Department, Government of the Bahamas, 1972, San Salvador Island, Bahamas, 1:25,000, topographic map.

National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 1959, San Salvador and Approaches: National Ocean Survey Chart No. 26281, 1:50,000.

Smith, R. R., 1992, Field Guide to the Vegetation of San Salvador Island, the Bahamas: San Salvador Island, Bahamas, CCFL Bahamian Field Station.