

Virgin Islands National Park GIS Project
with
Sir Sandford Fleming College

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1.0 Executive Summary

The main purpose of this study is to implement a GIS database for Hassel Island, USVI. This database houses information pertaining to the locations and attributes of archaeological resources on Hassel Island. Data collection was undertaken on the Island during a period of two weeks in early January, 2005. This data, along with extant data about Hassel Island, was processed at Sir Sandford Fleming College in Lindsay, Ontario, Canada during the winter term (January – April 2005).

Peripheral goals of the project were to place 3-Dimensional models of historic structures in geographical context on existing GIS maps of St. John, perform spatial analysis for possible hurricane damage control on archaeological ruins, and to begin development on an archaeological resource protection/monitoring program for Park Law Enforcement. The 3-D models were constructed using existing two-dimensional architectural drawings made for the Park, and GPS points collected at various historic structures.

GPS points were collected in the field at various archaeological structures where available. Archived maps, architectural drawings and data collected from past studies were used for implementation of the project. The main database holds the data collected for the locations as well as attributes for these points. Archived maps and Oxholm maps were rectified in order to plot the locations of the archaeological ruins for both St. John and Hassel Islands.

Once the maps were completed with the proper coordinate locations of archaeological structures, tracings were done for the architectural drawings of these structures. Using Autodesk the 3-D models were developed. Using the GIS maps of St. John and Hassel Island a geographic model is used to locate specific structures on the map. 3-D models were rectified to their geographic coordinates. Integrated with a 3-D model of historical structures these maps provide full multi-dimensional analysis. The database allows users to input further data regarding the archaeological sites and possible changes that have occurred due to erosion, weather, and vandalism. Temporal analysis will allow researchers to determine possible sites that may be of concern to looting and vandalism and this would allow for excavation.

Hurricane data was used to do spatial analysis for St. John Island. Various hurricane strengths may cause considerable damage to historical structures and this is a major cause for concern. Spatial analysis will allow researchers to develop a time table in which a better knowledge for what archaeological sites must be first researched and excavation. Better prevention and preparation would be greatly enhanced with the use of archaeological spatial analysis.

National Park Service Law Enforcement is responsible for the protection and conservation of Hassel Island as well as the park on St. John Island. A database was created for continuous monitoring of the historic sites and to maintain future records of alteration and security.

2.0 Introduction

About the Study Area – Virgin Islands National Park

The study area for this project is Virgin Islands National Park (VINP), US Virgin Islands. The park is administrated by the United States National Park Service, and includes Hassel Island and a large portion of St. John (Figure 1, park area shown in green).

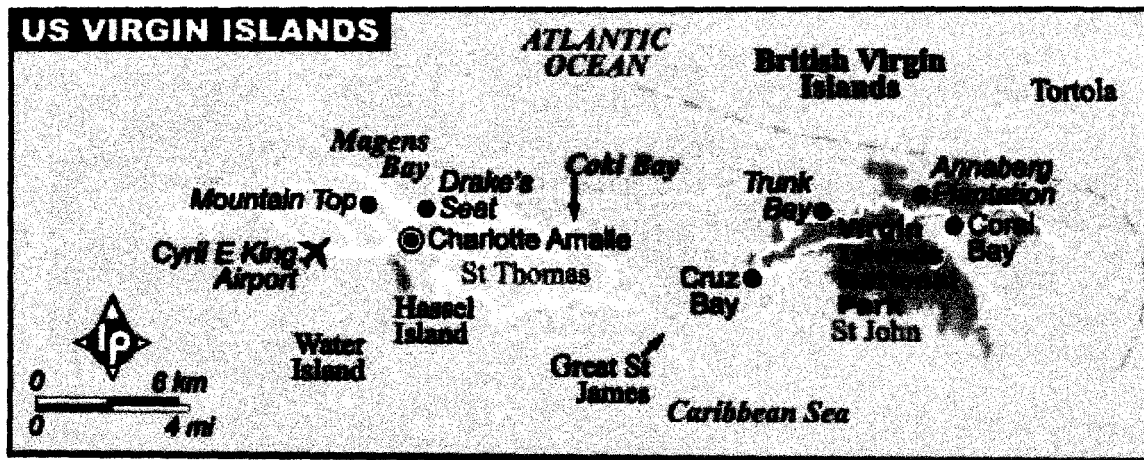


Figure 1. Study Area (Map by Swish - EXSE Inc. 2004)

Within the borders of this national park are relics from the Taino, a Pre-Columbian Amerindian civilization (Figure 2a), remains of the Danish colonial Sugar Plantations (Figure 2b) and reminders of African slave culture that all occurred in the hundreds of years since the islands were first discovered by Christopher Columbus (NPS Interior).

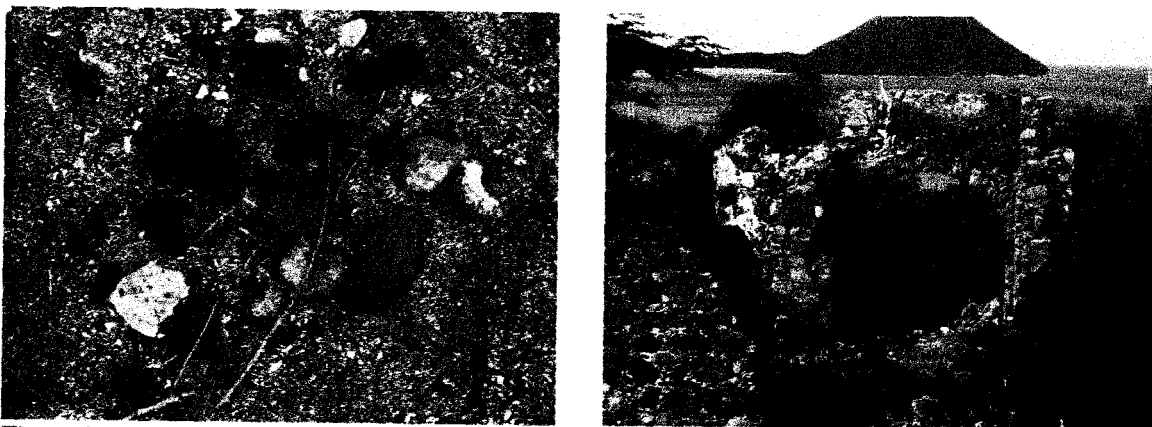


Figure 2. a. Taino ceramics litter the surface of the Palm Grove site on Hassel Island; b. 18th century Guard House overlooking the plantation at Lameshur Bay, St. John. (Photographs by Brain Nickle 2005)

The Danish colonized the island of St. Thomas in 1666 and the islands of St. John and St. Croix soon afterwards. The islands were controlled by the Danish West Indies Company until 1755 when they were purchased by the king of Denmark.

During the 18th and 19th centuries the Virgin Islands flourished as a center for the slave trade and as a producer of sugar (Catered To, No Date). Slaves were imported from Africa in 1673 as the Danes began to depend more and more on slave trade. Eventually Slave trade was prohibited by the Danish government in 1792 and a slave revolt on St. Croix in 1848 led to their emancipation.

The Hassel Island Historic District includes the entire island and contains the ruins of early 19th-century English fortifications (Figure 3a) – some of which could possibly date back to as far as the late 17th-century – and of mid-19th-century shipping and coal stations (Figure 3b) (National Register of Historic Places: 2005). Ruins include Fort Shipley on the highest point of the peninsula, an important remnant from Britain's occupation of St. Thomas Island during the Napoleonic Wars (1801-1802), when Denmark had allied with Napoleonic France. The remains of Creques Marine Railway, found on the northwest side, and were constructed in the 1860s by the Orkanshullet Island Coal and Oil Fuel depot (National Register of Historic Places: 2005).



Figure 3. a. Fort Willoughby, an English fort whose original construction may have been as early as the 1660's; **b.** Historic photograph of the Hamburg-American Company coaling station. (Fort Willoughby photograph by Brian Nickle 2005; Historic photograph from Archives, VINP)

With such a rich history there is a major concern to preserve the artifacts and remains in their original context. With this in mind it is possible for archaeologists and researchers to excavate in a professional manner as well as keep remaining structures intact. With tourism providing a substantial economy for the Virgin Islands, especially on St. John, it

is vital that this rich history remains preserved. Many tourists flock to the island of St. John and in various hikes stop to view and learn of its history. Three-dimensional modeling, geographically coordinated mapping of these ruins, and updated photographs taken sequentially every few months, will allow researchers to monitor the state of archaeological sites.

In 1989, Hurricane Hugo caused at least \$500 million damage in the US Virgin Islands, and 1000 U.S. troops were sent in to suppress looting and unrest. The islands were damaged once again by Hurricane Marilyn in 1995 (Catered To, No Date). With the threat of hurricanes, it is vital to know where damage may occur and to what extent. Hurricanes are measured on a scale of 1 to 5, depending on factors such as wind speed and wave size. With this knowledge, spatial analysis will help the client determine a ranking of sites threatened by erosion and other hurricane-related factors.

3.0 Objectives

About the Client – National Parks Service, U.S. Department of the Interior

The National Parks Service (NPS) prides itself on working with communities to preserve and protect neighborhood treasures. Work with teachers creates valuable opportunities for students to learn about natural and cultural history within the parks where history and nature unfold (NPS Interior). The NPS provides many important services for recreation and education.

Student Responsibilities

To fulfill the client's requests each of the following elements are present in this project or were completed:

- **Data Acquisition** - acquiring field data, directly or indirectly, and/or independent research including: collected attribute data, verified correctness of spatial or attribute data.
- **Pre-processing** - conversion and preparedness of data. For example: spatial layers were converted into UTM coordinate systems, spatial layers were converted into correct software formats, and clipped maps to study area boundaries.
- **Database Design** - formatted and altered design structure of attribute data.
- **Spatial Analysis** - overlay analysis, map algebra, selection by distance.
- **Programming** - involved customization of project to meet client's specific needs, automation, etc.
- **Presentation** - good cartographic output of product.

Client Responsibilities

For the project to be completed the client provided the following:

- **Project Specifications** - clear concise project specifications, with clearly defined progress indicators and goals, were critical for success.
- **Data** - spatial data was provided for analysis. Since data acquisition, ie: digitizing, scanning, registering maps can take a considerable amount of time,

it was mostly done by the client to allow the student to fulfill the requirements. All costs associated with acquiring the data were the responsibility of the client.

- **Hardware/Software** - Specific software was not needed directly from the client.
- **Communication** - The client was available either by telephone or email throughout the duration of the project. The client provided the students with contact information. The client was prepared to answer student inquiries regarding the project and understood that the students had deadlines to meet.

4.0 Proposed Services

Every task originally proposed when the project commenced seemed conceivable.

However, this was not the case.

Difficulties

- After the three-dimensional models were constructed pre-established coordinates were to be added to their designated models. These models with their real world coordinates were to be exported into ArcGIS 8.3 but this was not feasible. Autodesk Map 6 .dwg files are not compatible with ArcGIS 8.3 files. This proposed idea to import a coordinated three-dimensional model was inconceivable. New ideas were proposed and a new approach was designated. The three-dimensional models were to be brought into a paint program and saved as a .gif file. This would allow us to generate a point feature layer and create a hyperlink for various archaeological sites.
- A photo gallery of each site and related field work was to be established as a hyperlink as well. This approach seemed rather simple at first but in turn was far too resourceful and would have taken a large amount of time.
- Hurricane spatial analysis was also conceived using data given to us from the National Park Service. The data in which was originally given to us was incorrect and not the data attended. This was not discovered until further into the project. In a second attempt to acquire the hurricane data some files were missing, including the INFO file for the data. Without this file not of the shapefiles could be read. Time was of the essence and so we decided to develop our own analysis by carefully researching hurricane strengths, related damage to the surrounding environment and storm surges.

5.0 Benefits

The client provided most of the data necessary to complete the project. More data was acquired by group members by going into the field and taking GPS coordinates of archaeological ruins. This was not essential but proved to be extremely beneficial as it was found that the newly acquired data was significantly more accurate than the provided data.

The data pre-processing time took longer than estimated. This was because of the absence and clarity of metadata. The problem carried over into the spatial analysis component of the project. The hurricane data was not complete which caused for some adjustments in the analysis. It is unclear as to how beneficial the analysis will be in the future as initially proposed but a good base has been created for further research.

The initial construction of the 3-D models was unclear but through trial and error a successful methodology was derived. To assist the client a user-manual was created consisting of the processes. Research was done to try and establish a method that would place each model onto a map to give them a geographic perspective. This was unsuccessful and instead a hyperlink was created for the client to view the models. It would have been beneficial to have the models directly on the map however, they can still be useful. The ruins are better represented in 3-D rather than by architectural drawings on a flat surface.

A database was created to organize the existing and new data. A graphic user interface is useful for the client to increase efficiency of research. User-friendly forms allow the client to change, add, or view data in tables within the database at the click of a button. It was made dynamic to make it versatile according to the clients needs.

6.0 Methodology

Objectives

Data Acquisition

- Applied for Research Permit (See Appendix A)
- Collected GPS data at specific sites throughout the Park
- Burned CDs of existing GIS/digital data for St. John and Hassel Island
- Photocopied/scanned existing non-digital reference material (reports, maps, etc.)

Data Preprocessing

- Transferred digital data to our private co-op network drive
- Tested data to make sure it is correct and compatible with available software
- Built 3-D models of historic ruins
 - Digitized architectural drawings in AutoDesk Map 6
 - Assembled plan and elevations of each building to form 3-d models
 - Extruded 3-dimensional walls to complete models
- Assembled mosaics of aerial photos of St. John and Hassel Island and created .tfw file for these
- Digitized island boundaries from various photo mosaics
- Rectified all relevant data
 - Aerial photo mosaics
 - Scans of paper maps
- Updated the St. John GIS
 - Put GPS points we collected on map
 - Calculated mean center of GPS points for each building and add these points to the map
- Created the Hassel Island GIS
 - All components same as those from St. John GIS

Customization of ArcGIS 8.3

- Constructed new buttons for unique processes such as accessing the database and 3D models of sites/structures
 - Created internal database to update data interactively with map
 - Made it completely dynamic for viewing, adding, and changing records

- Created other buttons to automatically add specific layers and create event themes of the GPS points
- Added hyperlinks to the 3D model button so that when the user clicks on a point where a model would be

Data Analysis

- Added hurricane data to maps
- Determine ranking of sites threatened by hurricanes and erosion
 - Reclassify point themes to represent this ranking
- Write “Plan of Action” for site preservation based on rankings

Software Employed

- ArcGIS 8.x
- ArcIMS
- Dreamweaver – webpage creation
- AutoDesk Map 6
- MS Office
 - ACCESS and EXCEL for data manipulation
 - WORD for document processing
- Adobe Photoshop 7.0.1
- MS Visual Basic 6.0

Data Acquisition

All data was gathered while completing field work on St. John and Hassel Island. Field data was initially collected by a Trimble GPS unit for various historical sites on both islands and was gathered on a basis of whether or not the unit was able to collect readings. Previously gathered GPS data was in spreadsheet format on CDs. Maps and other shapefiles for both islands were provided by the client. Scans of architectural drawings of the historic ruins on St. John were also provided. Detailed articles about the islands and their archaeological sites were photocopied at the National Park Service office.

Data was obtained from the following sources:

1. GPS Satellites – data collected by the Trimble GPS unit for Archaeological Site locations on Hassel Island and St. John Island.
2. Ken Wild and Christy Loomis – Shapefiles for St. John., architectural drawings of the archaeological ruins, and previously acquired geographical data.
3. National Park Service – Photocopies of reports and previous research for cultural sites in the Park.
4. Brian Nickle – digital photographs of relevant cultural sites.

GPS Data Collection:

Hassel Island

All GPS data for Hassel Island was collected by Krissy Nickle, Stephanie Allen, and Justin Smith using a Trimble Pathfinder Pro XR Backpack Receiver and a Trimble TCI-21 Handheld Data Collector (Figure 4a). Using the Trimble unit the following data was acquired: Northings, Eastings, Altitude, and Date. The site location and a short note of what point it was with regards to the bearing was also entered into the Trimble. Using architectural drawing printouts each point that was taken was marked for each specific historical site. Further field notes were recorded on drawings as to information such as an offset and bearing if a point was not easily obtained as well as what number the point was. The information was later entered manually into an Excel spreadsheet with site name, point number, northing, easting, altitude, field notes and date. The file was also saved as a .dbf file so that it could be opened in ArcGIS 8.3 as well as ArcView 3.3. Sites on Hassel Island in which field notes were collected were the Garrison House, Fort Willoughby, the Radar tower, Fort Cowell, and locations surrounding the Creque Marine Railway.

St. John

The same collection processes took place as those done on Hassel Island. Note that previously collected data by Maine University and Syracuse University students on St. John Island is of a different set from the data collected by us. Sites on St. John Island include Annaberg, Leinster Bay, Lameshur Bay, Mary Point, Trunk Bay, and Cinnamon Bay.



Figure 4. a. Justin Smith collecting a GPS point for a boiler, once part of the Creque Marine Railway, on Hassel Island. **b.** Stephanie Allen collecting a GPS point on a wall at Annaberg Sugar Plantation, St. John, while Kristine Nickle takes notes. (Photographs by Brian Nickle 2005)

Maps, Shapefiles, and Other Digital Data for St. John and Hassel Island:

Ken Wild and Christy Loomis supplied us with all existing non-digital and digital maps from the National Park Service. This included the shapefiles currently in use in the Park's GIS systems, as scans of paper maps from the archives of St. John and Hassel Island. One of these maps (Figure 5) dates back to 1780.

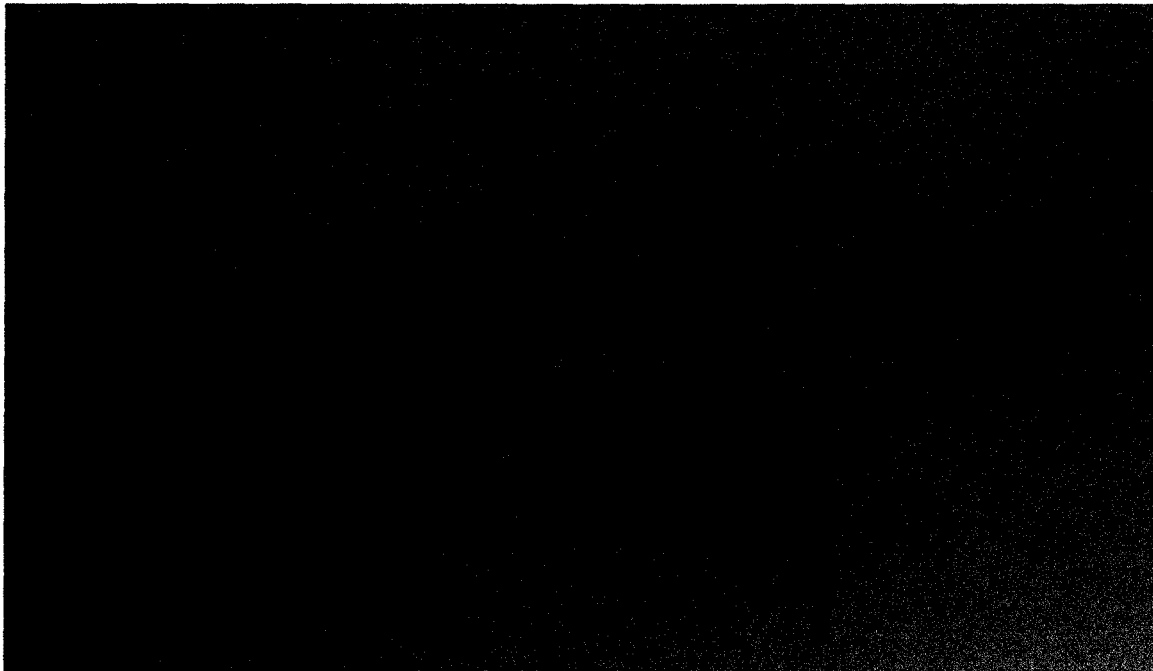


Figure 5. Oxholm map of St. John from 1780.

Black and white aerial photographs from 1994 of St. John and Hassel Island (Figure 6) were also copied over, along with a MrSID image of St. John (Figure 7).



Figure 6. Aerial photographs of Hassel Island (mosaic by S. Allen, 2005)

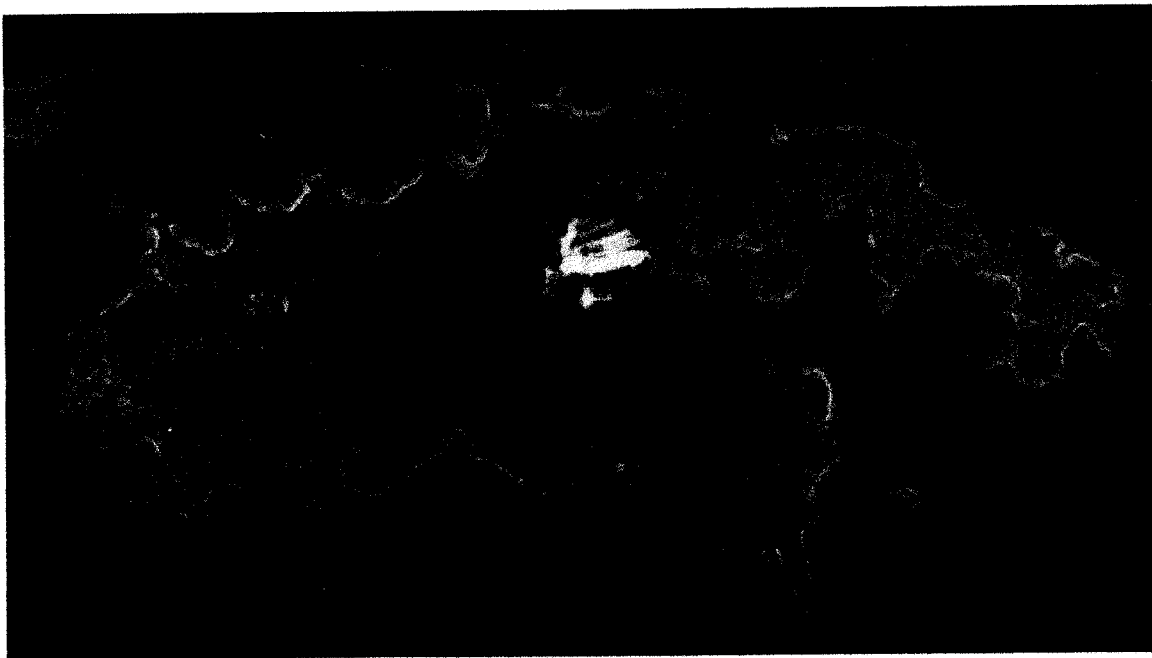


Figure 7. MrSID file of St. John.

Previously acquired data already in Excel Spreadsheet format was also copied onto CD. This data includes fields for the point number, northing, easting, altitude, estate and notes taken regarding the point. This data was acquired for various historical sites in studies done in the past.

Architectural Drawings of Historic Ruins:

All architectural drawings received for structures on St. John Island were scanned and copied from Ken Wild's office at the National Park Service. These drawings included meticulous measurements of all structures that were done by the volunteers of the National Park Service. Each drawing included height and width measurements of structure walls and retaining walls. Piles of rubble from the structures are also found in the drawings as well, which shows the deterioration of the walls. Drawings for the following structures were obtained, digitized and assembled into 3D models (see Appendix D):

Annaberg Slave Housing
Cinnamon Bay
Lameshur
Leinster Bay Fort/Plantation
Trunk Bay Factory

Reports and Previous Research for Cultural Sites:

All documentation, research papers, and historical information that were considered of importance for the progress of the project were photocopied for further reference. Research papers on the Islands, the historical sites and their history are mainly what comprise the material.

Digital Photographs of Relevant Sites:

Brian Nickle was an assistant who was responsible for capturing all field work on film for future reference. All sites including specific location points that were visited were photographed and referenced.

Data Preprocessing

Map Rectification and Digitizing:

Before any analysis could commence, the aerial photos had to be prepared which involved 'stitching' them together to make a complete island photo. Each of the original photos had World Files and after they were joined together a new world file was created for the complete island photo. The stitched photos were opened in Autodesk 6 and the island was digitized on-screen by tracing the shoreline. This layer was exported as an Arc Shapefile to our project drive. The stitched photos and the shapefile were then added as layers in ArcMap to produce a new map of Hassel Island. All maps will be projected in UTM-WGS84, Zone 20N to be consistent with the data given to us. The same procedures were applied to the most recent St. John aerial photographs.

Once the photos and shapefiles are added to ArcMap 8.3 the GPS database files can be added and joined. From here, analysis and customization can be developed for the final product.

Creating Hyperlinks for Three-Dimensional Models

In order to give the user an opportunity to view the archaeological structures as well as view any possible change in the state of the ruins, a hyperlink was created for sites in Cinnamon Bay, Leinster Bay, and Trunk Bay. Three-dimensional models were created in Autodesk Map 6 for all three sites. Each site was built from floor plans and exterior wall drawings done by various members of the Caribbean Volunteer Expedition (see references). The order in which the three-dimensional drawings were resurrected is detailed in the Appendix D: Manual for Construction of 3D Models of Historic Ruins. After the models were created they were cropped in Microsoft Paint and saved as a .gif file. Each individual path to a three-dimensional model is designated in a field of the feature class table for a point shapefile.

Using Microsoft Excel, a spreadsheet with an Easting field, Northing field, and Document field was created and saved as a .dbf file (Table 1).

Table 1. Database file for hyperlinked GPS points.

<u>EASTING</u>	<u>NORTHING</u>	<u>DOCUMENT</u>
314731.07	2029980.56	V:\STJData\STJCAD\CinnamonBay\CinnBayFactory.gif
314724.33	2029970.70	V:\STJData\STJCAD\CinnamonBay\CinnBayKitchen.gif
314731.240	2029973.99	V:\STJData\STJCAD\CinnamonBay\CinnBayOHouse.gif
314752.33	2029975.54	V:\STJData\STJCAD\CinnamonBay\CinnBayWarehouse.gif
318227.14	2031472.08	V:\STJData\STJCAD\LeinsterBay\LeinsterFactory.gif
318222.66	2031442.46	V:\STJData\STJCAD\LeinsterBay\LeinsterFort.gif
313186.92	2029983.84	V:\STJData\STJCAD\TrunkBay\TrunkFactory.gif

In ArcView 3.3 the .dbf table was added and an Add Event Theme was selected. The x-field was designated as the Easting and the y-field was designated as the Northing. This created a point theme in the View window. Each point was selected in the theme table and then Convert to Shapefile was selected from the menu. This created a shapefile for the point theme and this would allow the feature layer to be added to the Cultural Resources GIS ArcMap Project.

Once opened in ArcGIS the feature layers property window was opened by right-clicking on the layer. In the display tab, 'Support Hyperlinks Using Field' check box was selected with the field 'Document' and the Document radio button was selected as well. After this was applied the user is able to click on the 3D Models button and each hyperlink is highlighted blue. By clicking on one of the hyperlinks the path to the three-dimensional model for that site is opened and the user can view the drawing.

Customization of ArcGIS 8.3

Several customizations will be made to the GIS interface that will allow the client to access unique functions. The customizations will be in the form of buttons, linked to forms and code that will allow site selection and displayed 3D models of the structures for each site. A major addition to the existing GIS used by the client will be a link to a database allowing updates to be made directly from the GIS.

To facilitate this segment of the project, the following ESRI courses will be completed by the group members:

Customizing ArcGIS 8.3 (S. Allen, K. Nickle)

Introduction to Visual Basic 6.0 (S. Allen, K. Nickle, J. Smith)

Learning ArcGIS 8 (S. Allen, J. Smith)

Working with CAD Drawings in ArcGIS (K. Nickle)

Data Analysis

Hurricane Threat to Cultural Sites:

Hurricanes of varying strengths can cause insurmountable damage when they make landfall. Tropical storms form just off the west coast of Africa and increase intensity as they travel across the Atlantic Ocean and towards the Caribbean. Most hurricanes follow a path along the 20° N and as they move across the warm ocean constant evaporation and a cycling of winds aid in the increase of a hurricane's strength. The Virgin Islands are found at 18° N and so are in close proximity to most hurricane paths. With this in mind there is cause for concern to the damage that may occur across the islands. Hurricane intensity is measured using the Saffir-Simpson Scale. A 1-5 rating gives an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall (NOAA/ National Weather Service). Wind speeds are a determining factor as storm surge values are highly dependent on the slope of the continental shelf in the landfall region (NOAA/ National Weather Service).

Hurricane landfall may cause considerable destruction to archaeological historical and prehistoric sites. A hurricane of category one cause considerable erosion and eliminate sites that may be close to the shore line whereas hurricanes of category five may cause considerable damage to inland historical sites that are still held in the greatest of context. A spatial analysis measuring possible zones of damage due to each category of hurricane will allow future excavation plans to be initiated earlier on. By knowing to what extent each category of a hurricane causes damage after landfall maps of these possible destruction zones can be produced for both St. John Island and Hassel Island. The National Park Service will be fully aware of what sites must be first researched and excavated in order to completely obtain knowledge of the past.

Hurricane Analysis

In order to perform a spatial analysis to determine the effects hurricanes may have on the Virgin Islands archaeological sites it is important to look at the possible damage that may occur due to their varying categories. As a hurricane strikes land those sites closest to shore are at the most risk to damage from high waves, strong winds, and flying debris. Buffer zones can be established for each separate hurricane category which represents the distance inland which is at greatest risk to structural damage. There are many factors that however would effect what may occur if a hurricane were to pass over the islands. Storm surges are the onshore rush of sea water caused by the high winds associated with the land fall of the storm and the low pressure as well (AOML, no date).

Hurricanes Categories

Saffir-Simpson Category	Maximum Sustained Wind Speeds (km/hr)	Minimum Surface Pressure (mb)	Storm Surge (m)
1	118 – 152	> 980	1.0 – 1.7
2	153 – 176	979 – 965	1.8 – 2.6
3	177 – 208	964 – 945	2.7 – 3.8
4	209 – 249	944 – 920	3.9 – 5.6
5	250 +	< 920	5.7 +

- In category 1 hurricanes there is generally a minimal damage level. Most damage occurs primarily to shrubbery, trees and foliage and there is no real significant damage to other structures. (AMOL; no date)
- In category 2 hurricanes there is considerable damage to vegetation, and some minor damage to the roofing of buildings. The evacuation of some shoreline residences and low-lying areas is sometimes required. (AMOL; no date)
- In category 3 hurricanes there is serious flooding along the coast, structural damage to small buildings, and many smaller structure near coast are destroyed. Larger structures on coast are damaged by battering waves ad floating debris, flat terrain 1.5 meters above sea level or less flood, inland for up to 12.8 km. (AMOL; no date)

- In category 4 hurricanes there is major damage to lower structures near the shore due to flooding and battering of floating debris. Major erosion of beach and evacuation of lower structures within 2 miles of shores occurs as well. Flat terrain 3 meters above sea level or less, flood inland as far as 16 km. (AMOL; no date)
- In category 5 hurricanes vegetation is blown down, there are complete building structure failures, small buildings are overturned, and there is major damage to lower parts of structures in which are less than 4.5 meters above sea level and within 460 meters of shore. Massive evacuation of residential areas within 8 to 12 km of shore. (AMOL; no date)

To analyze the threat from hurricanes faced by archaeological sites throughout the island of St. John a new data sets were required. The data set was a series of three buffers representing the distance from shore which storm surges reach in category 3, 4 and 5 hurricanes (detailed above). The buffers were intersected with the GPS point themes to determine which sites fell within which areas.

The results of this analysis would suggest that several sites on St. John are in direct danger from storm surge caused by category 3-5 hurricanes (Appendix C). Historic ruins at Annaberg, Brown Bay, Cruz Bay, Denis Bay, Lameshur Bay, and Leinster Bay fall within the range of storm surge caused by a category 3 hurricane, and are therefore at the most risk. The ruins at Francis Bay are only threatened by category 4 hurricanes.

7.0 Resources

Student Skills

During the program it was essential to become familiar with the following for this project:

- **Programming Languages:** Visual Basic (6.0), SQL, PL/SQL, HTML, CFML, MapObjects 2.1
- **GIS Software Skills:** ArcGIS, including: ArcMap, ArcCatalog, ArcToolbox, Spatial Analyst, Network Analyst, 3-D Analyst, MapInfo Professional ArcIMS, and Autodesk (6.0)

Other Skills: Relational Database Management using MS Access, external connection of RDBMS to GIS, various methods of data acquisition including: surveying techniques using Total Station, GPS, statistical analysis techniques, customization techniques for GIS software, presentation of tabular data using various software, web development including CFML and HTML in ArcIMS.

8.0 Risk Assessment

There were very few risks involved due to the nature of the project. The accuracy of the GPS points was important mostly for the prehistoric sites. The purpose of acquiring the points was to obtain locations of the historic and prehistoric sites. The client found that it is difficult to keep vegetation growth low and the sites become engulfed over time.

Where there are known prehistoric areas, there are no ruins upon them. GPS accuracy is critical for locating them in the future for further digging or research. It was found that the new data had more accuracy than the previously existing data.

Another risk was the efficiency of the coding behind the database. Assurances were made so that when the user saves new updates or additions, they saved to the correct tables and the location is known. The forms were made user-friendly and a manual was included so that the client has a full understanding of the structure of the database and its method of operation.

9.0 Conclusion

The goal of this project was to improve on a GIS and to facilitate cultural resource management for the Virgin Islands National Park Service. The peripheral goals discussed earlier were achieved to an extent where improvements were made. The contribution this project makes helps in future preservation of historic and prehistoric areas on St. John and Hassel Island.

There are several factors to the final goal which were largely affected during the study and project. Acquiring, managing and cleaning up the data were the initial phases in the process. Two weeks of field work was involved in acquiring the archaeological site data across the Virgin Islands. The next step was to enter the data into a database in which would manage all data for all Pre-Historic and Historic Sites across the National Park Boundaries on St. John Island and Hassel Island. Rectifying and producing a main map of St. John took many hours of work to accomplish. Throughout the project it took a great deal of time to produce three-dimensional models of the archaeological sites using architectural drawings of the floor plans and exterior walls. The goal was to place 3-D models onto the map using the GPS points as a base. ArcGIS 8.3 did not have the capabilities to interpret the 3-D data contained in the .dwg files. An alternate plan was derived using images of the 3-D models. Hyperlinks were created on the designated sites so that when the user clicks on one, it is linked to its corresponding model.

The graphic user interface was built in the final product in order for easy viewing of records and entering of data. There are 3 forms available to the user, one for viewing site records, one for altering or adding new records, and one to alter buoy records. The purpose of the GUI is to keep consistent data from now on. A user-manual was added to assist the client with any discrepancies or further questioning.

Finally, the hurricane analysis showed that only a few sites were in danger of damage from storm surges. Though the analysis could not be executed to the full extent using TIN models or other raster methods, a study was still performed using other means. Buffers were created instead using a shoreline file of St. John at specific intervals determined by the Saffir-Simpson Scale. Any ruins that were found within the buffer zones are in danger. The client is now able to further investigate these sites and create a

plan of action to protect them. It is important that the Virgin Islands cultural resources are preserved for years to come. This project will help ensure that monitoring of vulnerable sites is made easier and more efficient.

10.0 References

Architectural Drawings:

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Appendix A

Research Permit and Waivers

TEAMWORK

You already have
copies of these, so
no point in
sending you more.

Kissy

Appendix B

Virgin Islands National Park GIS Project User-Manual

Getting Started

Installing the Project

1. Insert the CD.
2. Navigate to the CD directory and double-click the VIGIS.zip icon.
3. Click on the **Extract** tool in the “Unzip” program window.
4. Select the directory/folder you wish to extract the files to.

NOTE: You can choose any directory/folder to extract to, as long as the underlying directory structure is not altered.
5. Exit the “Unzip” program.
6. Navigate to the folder containing the files you just extracted.
7. Double-click on the **CulturalResources-GIS** icon to open the project.

Project Startup

When the project opens, the view encompasses both Hassel Island and St. John (Figure 1). The land masses are displayed in light green, and the area of Virgin Islands National Park is displayed in darker green. Two custom toolbars are visible on startup, each with a number of buttons created to facilitate the use of the GIS interface. One of these toolbars is made up of the main controls for displaying the map data, and the other has controls for other useful functions.

The following sections provide descriptions of these toolbars and their buttons.

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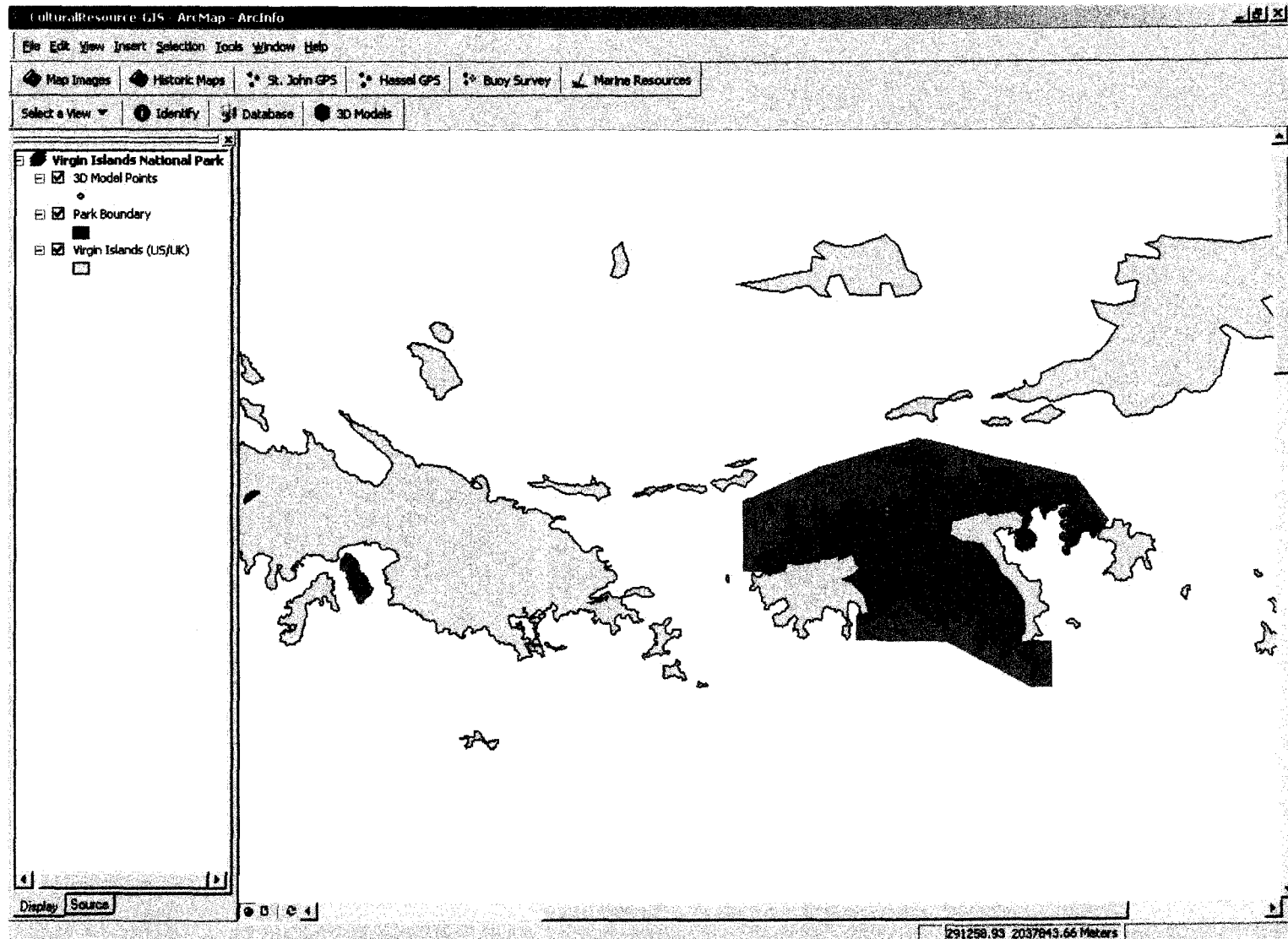
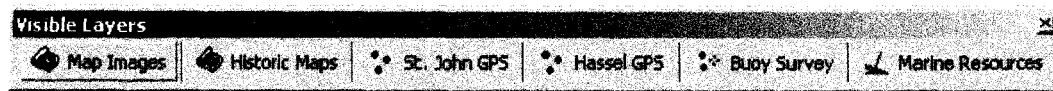


Figure 1. Virgin Islands GIS Project: the view when the project opens shows both Hassel Island and St. John.

Custom Toolbars

Visible Layers Toolbar

The Visible Layers Toolbar contains the buttons to display the various data layers available for both St. John and Hassel Island, including GPS point layers and raster images of historic maps.



- **Map Images** – Click on this button to load the SID file and the 1947 aerial photo mosaic for St. John, and the aerial photo mosaic for Hassel Island (Figure 2).
- **Historic Maps** – Click on this button to display the Oxholm maps of St. John from 1780 and 1800, along with the point themes of the Estates shown on those maps (Figure 3).
- **St. John GPS** – Click on this button to generate point themes of the GPS points taken at historic and prehistoric sites throughout St. John. The point themes are updated each time the button is clicked, to include new entries added to the database (Figure 4).
- **Hassel GPS** – Click on this button to generate point themes of the GPS points taken at historic and prehistoric sites on Hassel Island. The point themes are updated each time the button is clicked, to include new entries that have been added to the database (Figure 5).
- **Buoy Survey** – Click on this button to display the buoys around St. John. The buoys are displayed with symbols to designate whether they have been surveyed (Figure 6).
- **Marine Resources** – Click on this button to display the shapefiles of marine resources such as shipwrecks and historic artifacts found at buoy locations (Figure 7)

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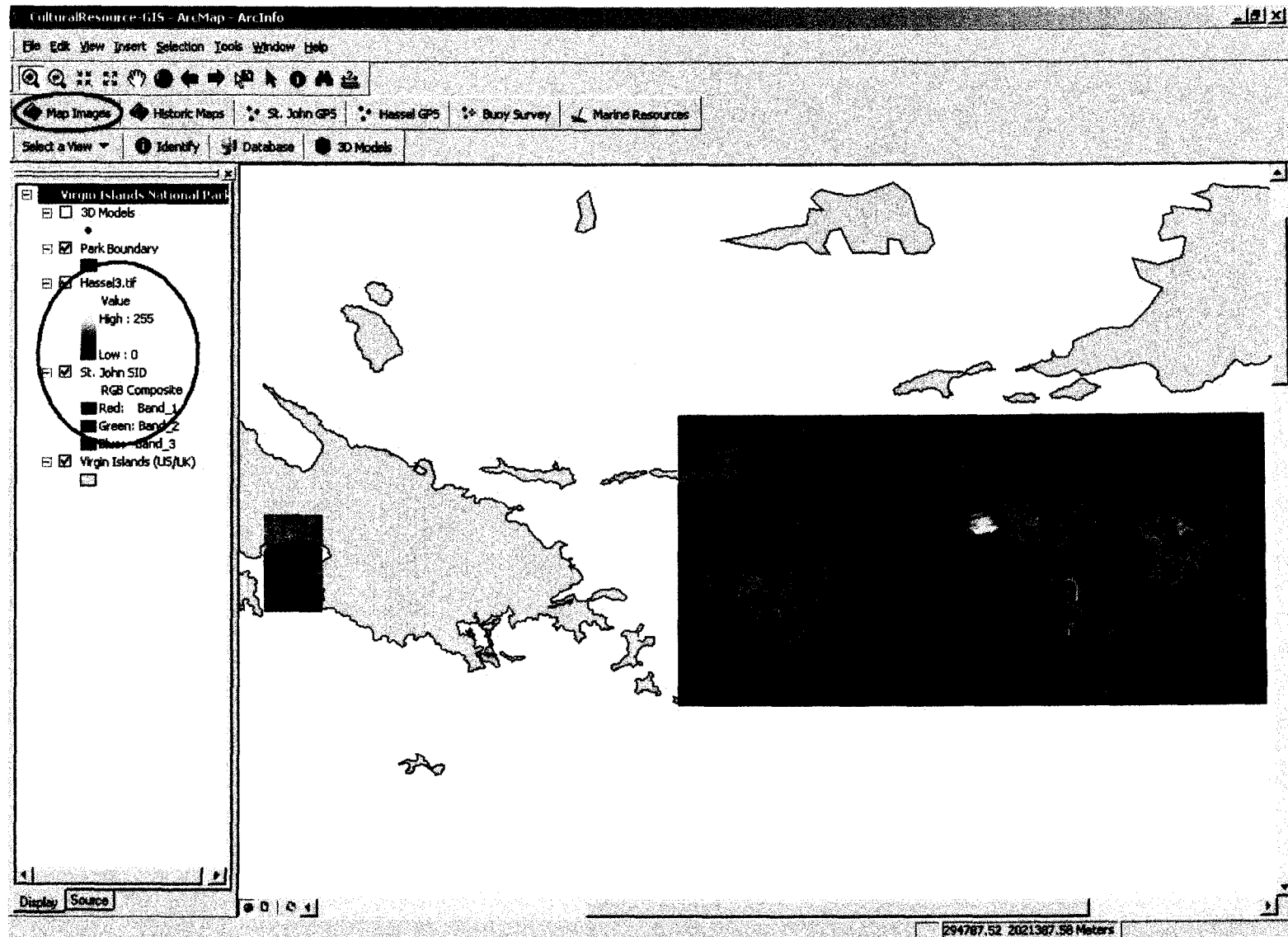


Figure 2. MrSID of St. John, 1994 aerial photo mosaic of Hassel Island, displayed when the **Map Images** button is clicked.

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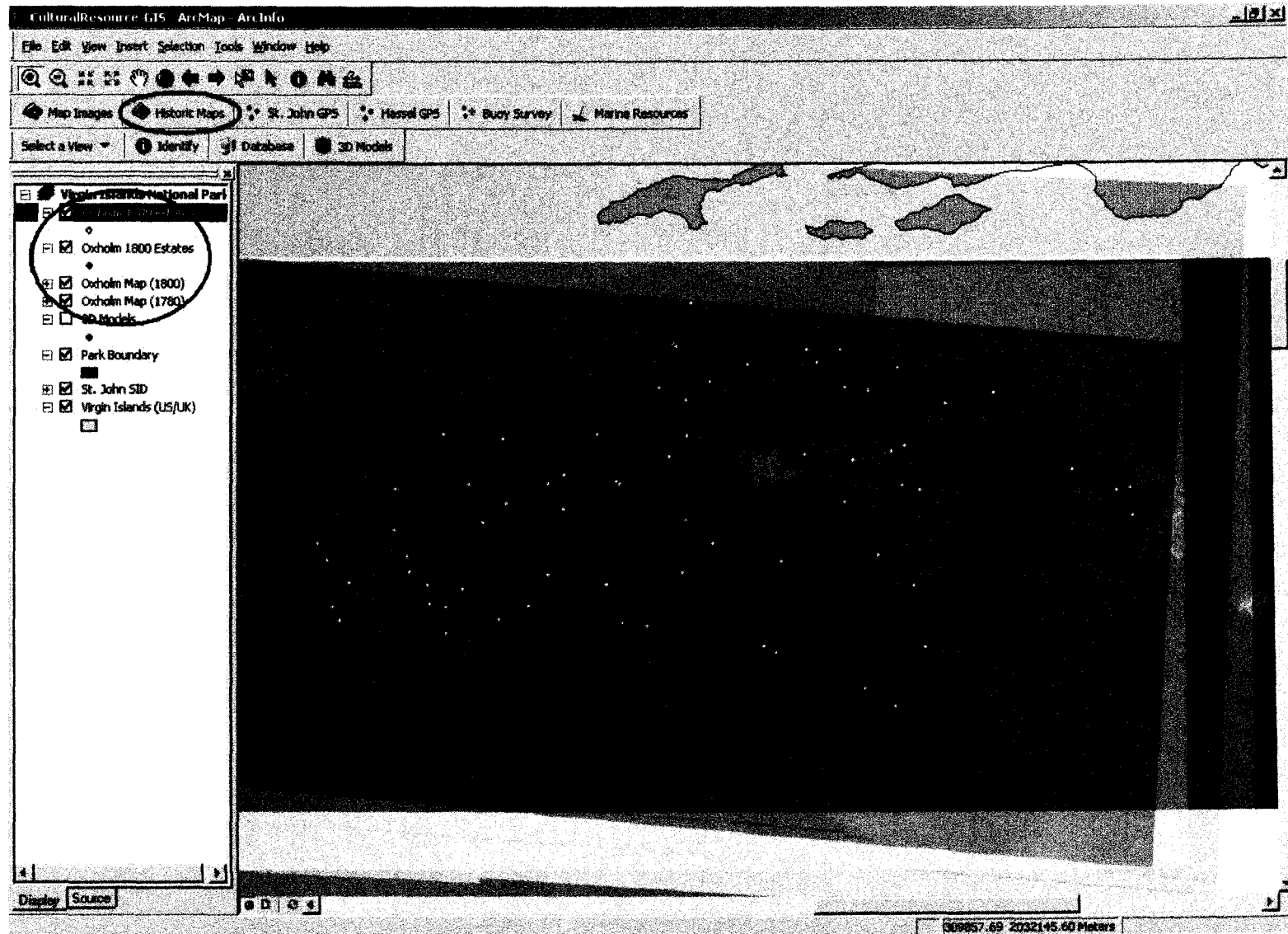


Figure 3. Oxholm maps of St. John from 1780 and 1800, displayed when the **Historic Maps** button is clicked.

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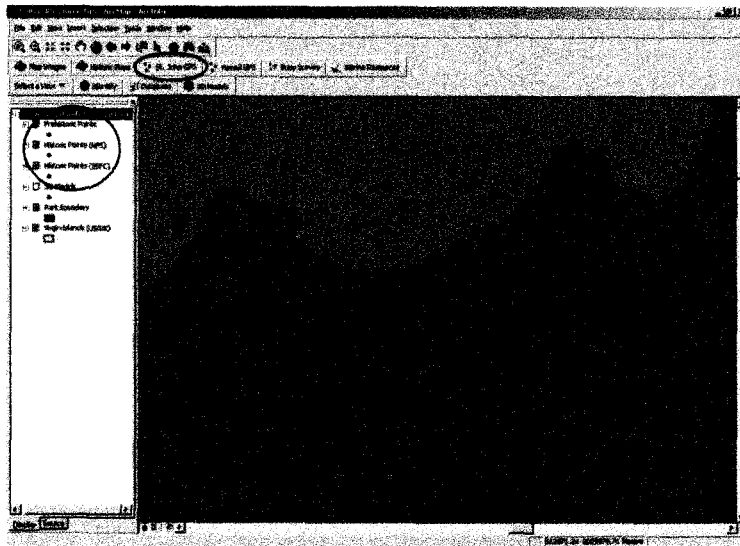


Figure 4. St. John GPS points generated from the CR_GIS Database when the **St. John GPS** button is clicked

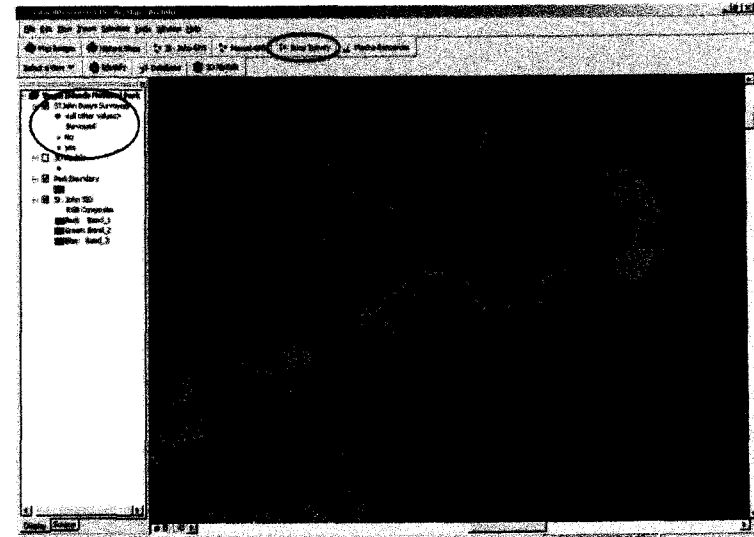


Figure 6. Theme showing which buoys have been surveyed, and which haven't, displayed when the **Buoy Survey** button is clicked

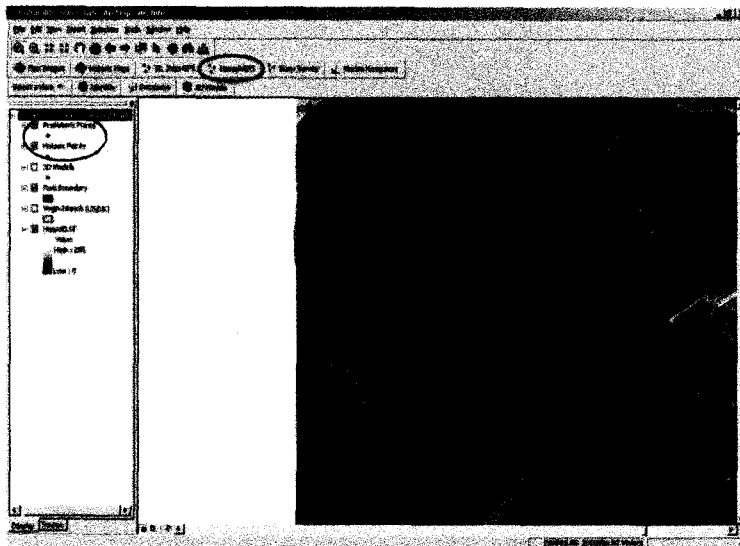


Figure 5. Hassel Island GPS points generated from the CR_GIS Database when the **Hassel GPS** button is clicked.

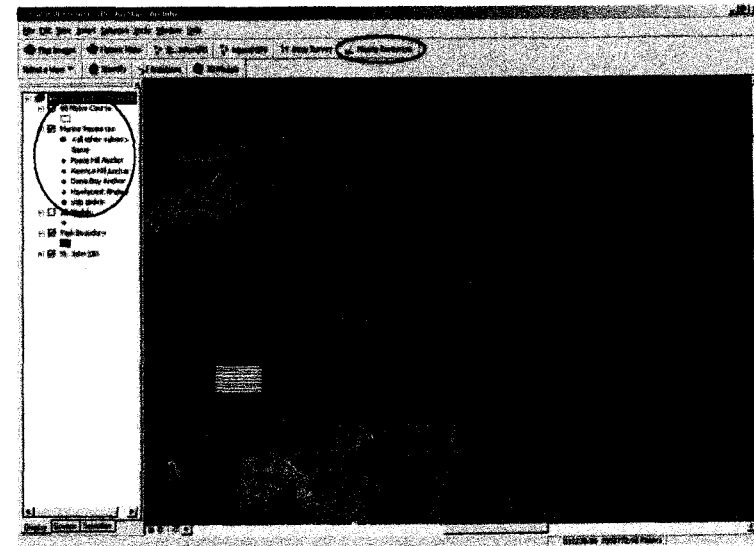
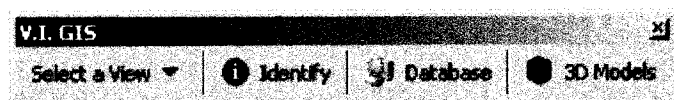


Figure 7. Theme showing the locations of anchors, shipwrecks, etc., displayed when the **Marine Resources** button is clicked.

V.I. GIS Toolbar

The third custom toolbar contains four buttons which provide easy access to useful features built in to the Virgin Islands GIS Project.



- **Select a View** – Select one of three views from this drop-down menu:
 - Entire Park** – Displays both Hassel Island and St. John
 - St. John** – Zooms to St. John (Figure 8)
 - Hassel** – Zooms to Hassel Island (Figure 9)
- **Identify** – Click on this tool and then select any map feature to display the attribute data for that feature (This is the standard ArcMap Tool).
- **Database** – Click on this button to access forms for viewing and updating the GPS points database, and updating the buoy surveys. (See **Data Management** section for a more detailed explanation of the forms and processes).
- **3D Models** – Click on this tool, then select one of the highlighted points to view 3-Dimensional models of historic ruins on St. John (Figure 10).

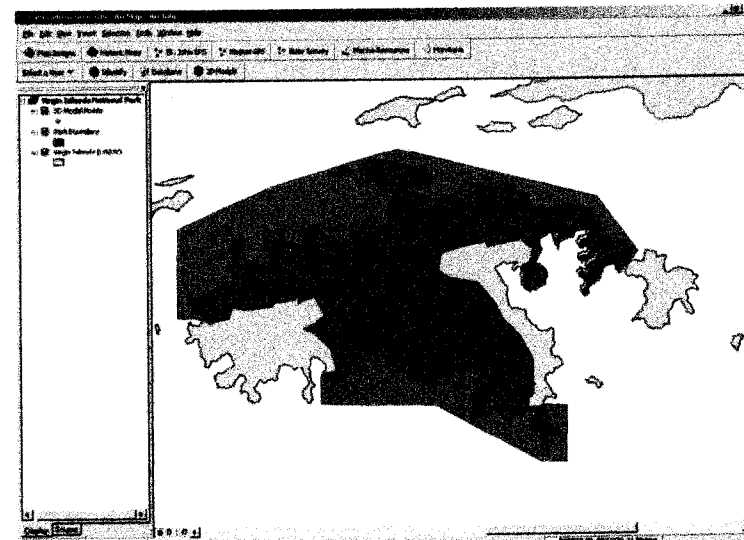


Figure 8. St. John: view after selecting **St. John** from the **Select a View** menu.

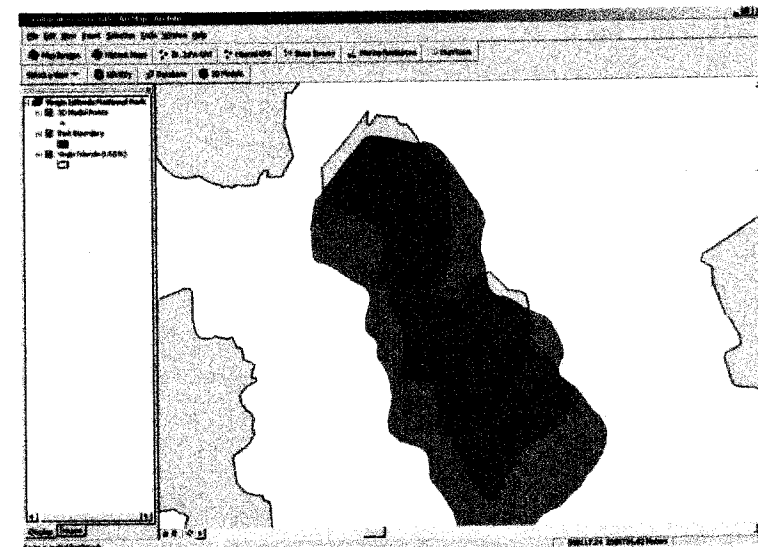


Figure 9. Hassel Island: view after selecting **Hassel** from the **Select a View** menu.

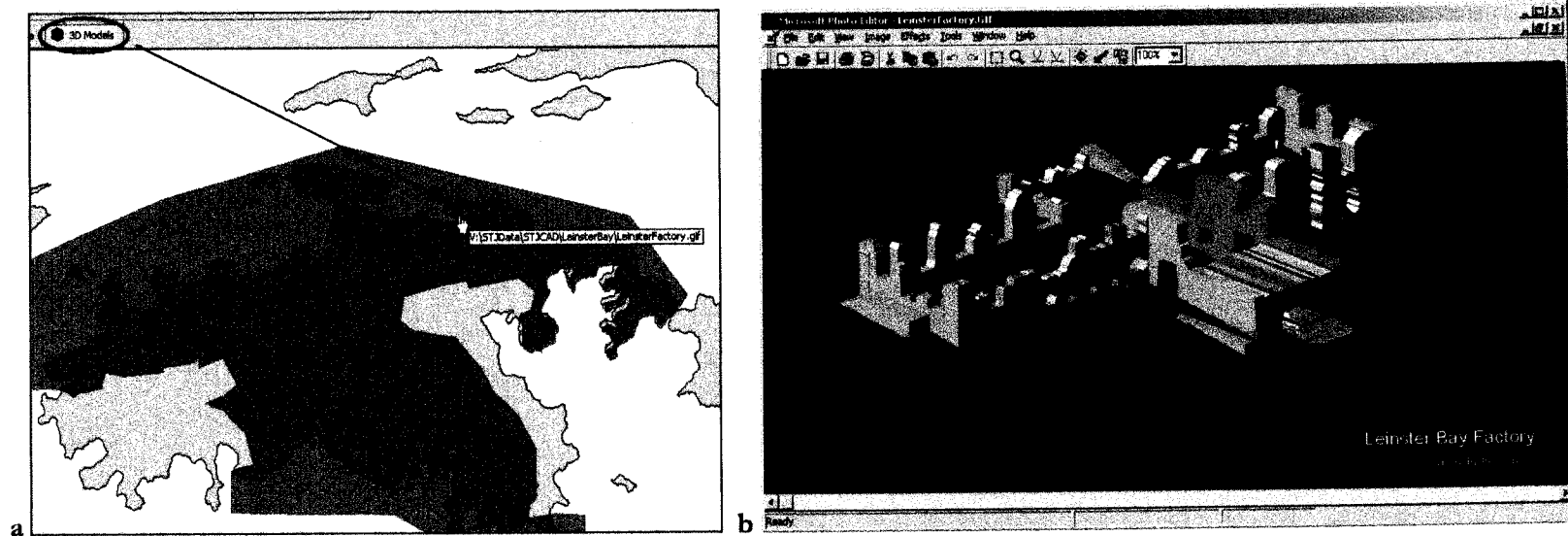


Figure 10. **a)** After clicking on the **3D Models** button, the points linked to 3D models are highlighted. Select a point to **b)** view its model.

Using Custom Features

A number of custom features were created to simplify certain tasks in the Virgin Islands GIS Project. A Microsoft Access database was created to store the tabular data associated with the Cultural Resources GIS. Forms were created to view and automatically update the GPS point tables and the buoy surveys without having to actually open the Access database, thereby cutting down on data entry errors and time.

In the following sections, details of these features are provided, along with instructions on how to use them.

Data Management

To begin viewing or editing GPS point data, click on the **Database** button in the **V.I. GIS** toolbar. The Data Management form opens, allowing you to choose which section of the application you would like to use (Figure 11).

- **View Point Data** – This section allows the user to view the existing GPS point data one record at a time.
- **Enter Point Data** – This section allows the user to enter data for new GPS points collected in the field.
- **Exit** – Click this button to close the Data Management application

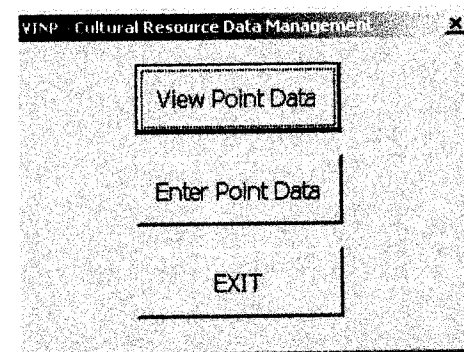


Figure 11. Data Management form, the initial form in the Data Management application.

Viewing Data

1. Click on the **View Data** button. The View Data form opens, displaying several blank text boxes (Figure 12).
2. Click the **Connect** button to open the database connection.
3. Select a table from the choices in the **Tables** dropdown box. Select the table for the appropriate island (St. John / Hassel) and site type (historic / prehistoric) of the GPS data you wish to view.
4. To begin viewing data, select a site/estate location from the dropdown box or select. The data in the first record for the selected location appears in the various text boxes.
5. Use the navigation buttons to move through the records for the selected location.
 - First** – Display the first record in the selected set
 - Previous** – Display the previous record in the selected set
 - Next** – Display the next record in the selected set
 - Last** – Display the last record in the selected set
6. Click the **Back** button to return to the Data Management form.
7. Click the **Exit** button to close the Data Management application.

Figure 12. View Data form, connected to the database and ready for a site location to be selected.

Entering Data

1. Click on the **Enter Data** button. The Enter Data form opens, displaying several disabled text boxes (Figure 13).
2. Click the **Connect** button to open the database connection.
3. Select a table from the choices in the **Tables** dropdown box. Select the table for the appropriate island (St. John / Hassel) and site type (historic / prehistoric) of the GPS data to be entered.

NOTE : To update buoy survey data, choose the STJBuoys table (this is discussed in the next section)

4. To begin editing data, click the **Create New Record** button. The various text boxes are now enabled, allowing you to enter the new GPS point data.
5. Enter the Eastings, Northings, and Altitude (Elevation) obtained from the GPS unit into the appropriate text boxes.
6. Select the site/estate location from the drop-down box or, if the name does not appear in the list, type the new site/estate name.
7. Select the type of site
Prehistoric – Check this option for pre-European era sites.
Historic – Check this option for post-contact sites.

The screenshot shows the 'Enter Point Data...' window with the following components and numbered callouts:

- Database Connection:**
 - Callout 3: A dropdown menu showing 'HasselHistoric_SSFC'.
 - Callout 2: A 'Connect...' button.
- GPS Data:**
 - Callout 5: A group of three text input fields labeled 'Eastings:', 'Northings:', and 'Elevation:'.
 - Callout 4: A 'Create New Record' button.
- Site Information:**
 - Callout 6: A dropdown menu for 'Estate/Site:' showing '--- Select a Location ---'.
 - Callout 7: Radio buttons for 'Site Type:' with options 'Prehistoric' and 'Historic'.
 - Callout 8: A text input field for 'Point #'.
 - Callout 9: A text input field for 'Date:' with the example 'Ex. 1/5/2005'.
 - Callout 10: A large text area for 'Notes:'.
- Navigation Buttons:**
 - Callout 12: A 'Back' button.
 - Callout 11: A 'Save Record' button.
 - Callout 13: An 'Exit' button.

Figure 13. Enter Data form, connected to the database and ready for data entry.

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8. Enter the point number for the selected site in the **Point #** text box. For the previously highest point number for each site, consult the table in the CR_GISData database.

NOTE : The point number **must be unique** for the site location, otherwise there will be an error saving to the database.

9. Enter the date the point was taken, in the format **dd/mm/yy**, in the **Date** text box.
10. Enter any notes or data not covered by the other options on the form in the **Notes** text box.
11. When all the data is entered for the new record, click the **Save** button to save the record to the selected table in the database.
12. Click the **Back** button to return to the Data Management form.
13. Click the **Exit** button to close the Data Management application.

Updating Buoy Data

1. Click on the **Enter Data** button. The Enter Data form opens, displaying several disabled text boxes.
2. Click the **Connect** button to open the database connection.
3. Select the STJBuoys table from the Tables drop-down list.
The Update Buoy Survey form opens, displaying several blank text boxes and option buttons set to their default values (Figure 14).
4. Enter the Buoy ID number in the **Buoy ID#** text box.
5. Select whether the buoy has been surveyed
Yes – Check this option if the buoy has been surveyed
No – (DEFAULT) Check this option if the buoy has not been surveyed
6. Enter the date of data entry in the **Date** text box.
7. Enter any notes on the condition of the buoy and the activities carried out on the buoy in the **Condition** and **Activity** text boxes.
8. Select whether any finds were made at the buoy site
None – (DEFAULT) Check this option if there were no finds at the buoy site
Historic Artifacts – Check this option if historic artifacts were found at the buoy site

The screenshot shows a window titled "Update Buoy Survey" with a standard Windows-style title bar (minimize, maximize, close buttons). The form is divided into two main sections: "Buoy Update" and "Survey Notes".

Buoy Update Section:

- Callout 4 points to the "Buoy ID#" text box.
- Callout 5 points to the "Surveyed?" label, with radio buttons for "Yes" and "No".
- Callout 6 points to the "Date:" text box, with an example "Ex. 5/22/04" below it.

Survey Notes Section:

- Callout 7 points to the "Condition:" text box.
- Callout 8 points to the "Finds:" label, with radio buttons for "None" and "Historic Artifacts".
- Below the "Activity:" text box is an example "Ex. inspected, cleaned, etc.".

Bottom Buttons:

- Callout 10 points to the "Back" button.
- Callout 9 points to the "Save Update" button.
- Callout 11 points to the "EXIT" button.

Figure 14. Update Buoy Survey form, ready for data entry.

9. When all the data is entered for the buoy, click the **Save Update** button to save the changes to the selected record in the STJBuoys table. The text boxes and option buttons are reset to blank values, ready for the next data entry.
10. Click the **Back** button to return to the Enter Data form.
11. Click the **Exit** button to close the Data Management application.

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Useful Hints:

- Certain display symbols (such as Anchors and Shipwrecks) will have to be changed manually
 - Right-click on the layer in the Table of Contents
 - Select “**Properties**” from the menu
 - Change the symbols under the “**Symbology**” tabOR
 - Double-click on the symbol you wish to change in the Table of Contents
 - Change the symbol in the resulting dialog box
- Remove the old GPS points layers before clicking the GPS buttons to generate new ones (this will save a lot of confusion and reduce the clutter in the Table of Contents)
- If the layer “**Virgin Islands (US/UK)**” is not visible in the “Entire Park” view (SEE: Select View, above)
 - Right-click on the layer in the Table of Contents
 - Select “**Visible Scale Range**” from the menu
 - Select “**Set Minimum Scale Range**” from the options
 - Repeat the first two steps, this time selecting “**Set Maximum Scale Range**” from the options

- If you have any further questions or concerns, please contact me using the following contact information:

Kristine Nickle

