

GIS and Land Preservation: Development of a Strategic Plan

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Abstract

The spatial analysis capabilities of GIS allow it to be a powerful tool perfectly suited for land preservation planning. The multi-faceted functionality of GIS allows the Kiawah Conservancy to develop maps displaying a variety of data, including: property information, wildlife data, habitat quality information and even fundraising data.

Developing maps based on these types of data greatly supports the “Enclave Preservation Program” – the Conservancy’s main effort to preserve undeveloped parcels on Kiawah Island, SC. Through analysis based on spatial relationships and relevant attribute data, this information allows enlightened decision making in regards to land preservation.

Model building further supports strategic planning as it allows selection of undeveloped properties based on a variety of desired parameters. These parameters can include (but are not limited to) lot size, habitat quality (forest canopy cover, forest under story, etc.), appraised value and sale date. This tool further strengthens land preservation planning at the Conservancy.

Introduction

Kiawah Island is a coastal barrier island located 22 miles south of Charleston, South Carolina. The island is just over ten miles long and 1.5 miles wide at its widest point. Approximately 10,000 acres in area, the island's habitat includes maritime forest, marsh, dunes, beaches and ponds. The island also contains anthropogenic features including five golf courses, a resort, tennis center and private residences. Kiawah provides habitat for 18 species of mammals, more than 30 species of reptiles and amphibians, and more than 190 species of birds (Kiawah Island Fast Facts 2006).

The Kiawah Island Natural Habitat Conservancy (Kiawah Conservancy) is a chartered non-profit 501(c) 3, grassroots organization established by island residents in 1997 to preserve the natural habitat of Kiawah Island. The Conservancy's mission is to keep the barrier island of Kiawah, SC unique in America through identification, preservation and appropriate management of critical maritime strand habitats needed to maintain a healthy, balanced and diverse population of native flora and fauna on the island and its immediate environs. The Conservancy has the capability to be a holder of land and conservation easements, and as such, it is a land trust. In this regard, the Conservancy is a member of the Land Trust Alliance and has adopted and subscribes to the Land Trust Standards and Practices as a guide for its organization and operations. The Conservancy is committed to maintaining a balance between the local natural environment (flora and fauna) and the residents and visitors of the island through enlightened land management and community education.

In 2003, the Conservancy implemented a Geographic Information Systems (GIS) program to support its land preservation efforts and meet the following objectives:

- 1) to allow the Conservancy to determine where development is occurring the fastest,
- 2) to help locate current land preservation opportunities,
- 3) to help identify the areas most used by wildlife,
- 4) to allow the identification of the areas with the highest habitat ratings,
- 5) and to allow the observation of property in relation to land already preserved.

Through the evolution of the Conservancy's GIS database, three types of data have become distinctly important in their displays of spatial information: property data, wildlife data and habitat quality information. Although these three types of data are independent of each other, together they provide the Conservancy's foundation for decision-making in regards to land conservation. The incorporation of property information, wildlife location data and habitat quality data in the Conservancy's GIS database provides unparalleled support for land management and preservation decision-making.

The Enclave Preservation Program is the Conservancy's main effort to preserve undeveloped parcels on Kiawah. The Conservancy designed the Enclave Preservation Program as a land preservation strategy that is aimed at preserving natural habitat within neighborhoods - areas that provide excellent havens for various forms of wildlife, including migratory birds, deer, bobcats, foxes, and small mammals. The Enclave Preservation Program divides the island into twenty-three sections, referred to as "enclaves." An enclave is a particular neighborhood, or group of neighborhoods, in the

same area of the island that are separated from other groups by anthropogenic or natural boundaries such as roads, rivers, marshes, golf courses and ponds. The Conservancy created these enclaves to make habitat conservation more manageable, and to encourage individual property owners to preserve property within their neighborhoods (Norton 2004). Island-wide property information is maintained in the Conservancy's GIS database in support of the Enclave Preservation Program.

In addition to property information, the Conservancy also uses GIS to display and analyze wildlife data. Through on-island studies, the Conservancy has gained a substantial amount of information regarding island wildlife – especially bobcats, a keystone species on Kiawah. Having this data in the GIS database is extremely important as it allows the Conservancy an additional resource on which to base land preservation decisions. In addition to bobcat data, the Conservancy also utilizes spatial information regarding alligators, raptors, and other species.

Another set of information that is quite valuable to the Conservancy's land preservation efforts and associated decision-making is habitat quality data. The Conservancy has developed a habitat rating system that provides numerical values for several criteria for all of the island's undeveloped properties. Having these values in the Conservancy's GIS database allows the construction of models within ArcToolbox that can select parcels based on a variety of habitat criteria. Using these ratings in conjunction with property and wildlife data allows models to select properties that are ideal for preservation. Along with property data and wildlife data, habitat quality information also lends support to the Enclave Preservation Program.

Through the development of a GIS program, the Conservancy has the ability to make decisions based on the spatial data presented in ArcView 9.1, as well as the associated attribute data. The property information used for the Enclave Preservation Program displays the boundaries for all 23 enclaves, parcel data for the entire island – showing developed lots, undeveloped lots, and undeveloped lots for sale, road data, pond data, and land that is owned by the Conservancy or is placed under conservation easement. GIS is an ideal tool for the Conservancy’s Enclave Preservation Program, as it allows all of these data to be displayed at once – allowing comparisons between enclaves, and undeveloped area versus developed area. The data can also be manipulated and updated, to reflect current information, such as the number of undeveloped lots within a particular enclave. Another reason GIS is a powerful tool for the Conservancy is its ability to be used at presentations and “enclave gatherings,” where local residents learn about the Conservancy and conservation opportunities. With the use of GIS data, particularly enclave maps that display the spatial relationships between undeveloped and developed property, as well as the calculated areas of undeveloped and developed property, local communities can gain a better sense of how much of their particular enclaves are undeveloped, as well as specific trends taking place within their enclaves. The property information database associated with the Enclave Preservation Program is kept current through the constant modification and creation of various shapefiles/feature classes within ArcView.

In addition to property information, the following data is also displayed spatially as feature classes or shapefiles: bobcat telemetry locations, bobcat 24-hour tracks, bobcat “hotspots,” alligator nests, osprey nests and other wildlife nests. GIS can also be used to

support fundraising efforts by displaying property owned by key Conservancy donors. Through the examination of this data along with pertinent property data, the Conservancy is able to make enlightened land preservation and conservation decisions in support of its mission.

Data and Methods

To best support the Enclave Preservation Program, various forms of property information, wildlife information and habitat quality information are needed. The necessary layers used to develop the Kiawah Conservancy's Enclave Preservation Program's GIS database were derived from various sources: some data were purchased, some were created, some were attained from other entities and some shapefiles/feature classes were produced by modifying existing data.

PROPERTY DATA

For every enclave defined by the Conservancy, the following property data layers are necessary: an enclave boundary, parcel boundaries/property lines, undeveloped parcels, developed parcels, parcels deemed priority wildlife habitat, preserved land, and undeveloped properties for sale. Other shapefiles/feature classes used include roads and ponds layers (both obtained from the Town of Kiawah Island in 2002). Occasionally, the base layer, upon which all other layers are placed, is a mosaic of aerial photographs of Kiawah Island. Two sets of these photographs are used: one set downloaded from the South Carolina Department of Natural Resources GIS Clearinghouse website (Fig 1), and one set obtained from the Town of Kiawah Island (Fig 2).

**Figure 1. South Carolina DNR aerial orthophoto mosaic of Kiawah Island (1994).
Scale 1:12,000**

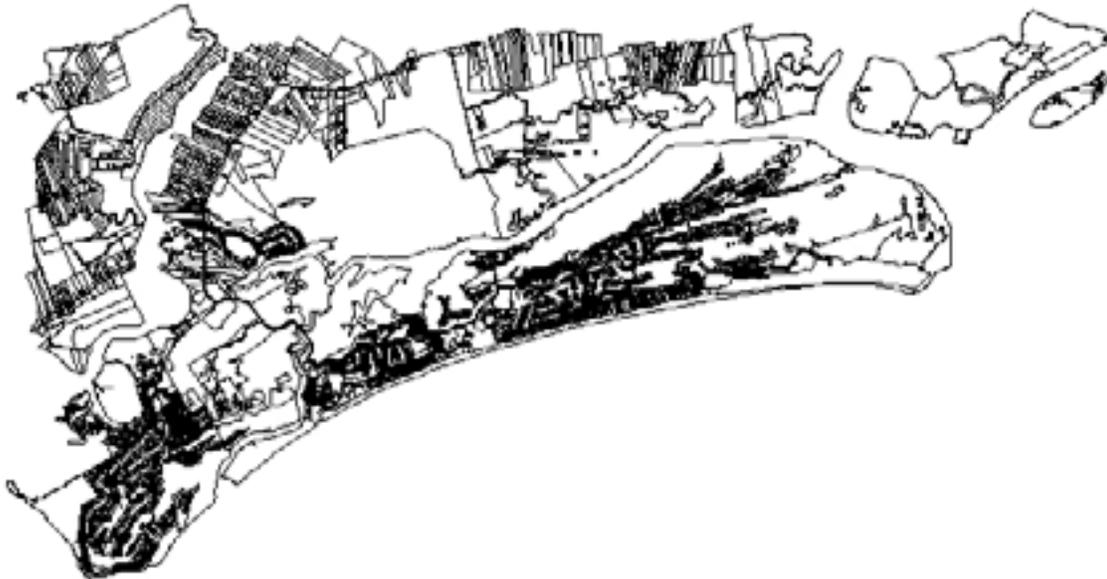


Figure 2. Town of Kiawah Island’s aerial photo mosaic of Kiawah Island (2005).



The DNR aerial photos used are from 1994 and the Town’s photographs were taken in 2005. The parcel data that displays all property lines on Kiawah Island (Fig 3) was purchased from Charleston County’s GIS Department in February, 2003. Along with the spatial representation of the property lines, this layer also contains attribute data associated with ownership and tax information (Owner, Value, Property Identification Number, Address, etc). Although tax data is public information, there is a data license agreement between the Conservancy and the County of Charleston that states how this data is defined and how it can be used.

Figure 3. Charleston County GIS Department's Tax Parcel Map of Kiawah Island.



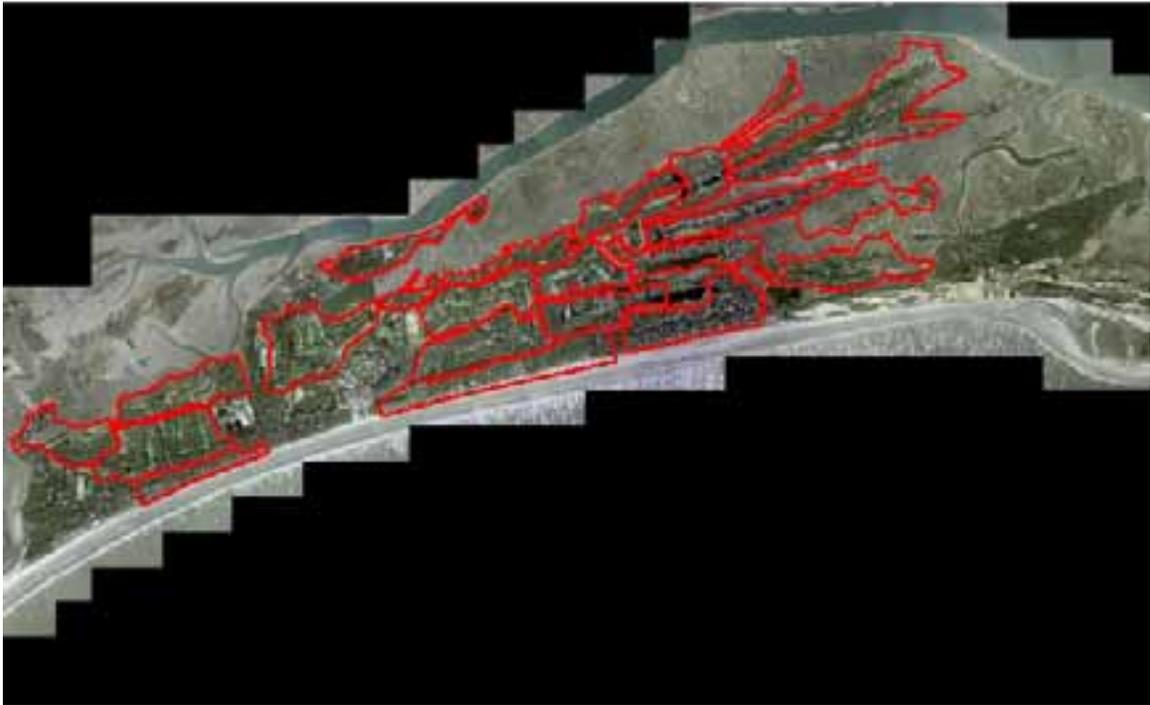
GIS LAYERS

Enclave Boundaries

Enclave boundaries (Figure 4) were developed for the twenty-three enclaves by a staff biologist in ArcView 3.3 when the Enclave Preservation Program began in 2002.

Although most work involving the Enclave Program makes use of these original layers, occasional manipulation of these boundaries is necessary for enclave gatherings or other projects.

Figure 4. Boundaries for all 23 enclaves.

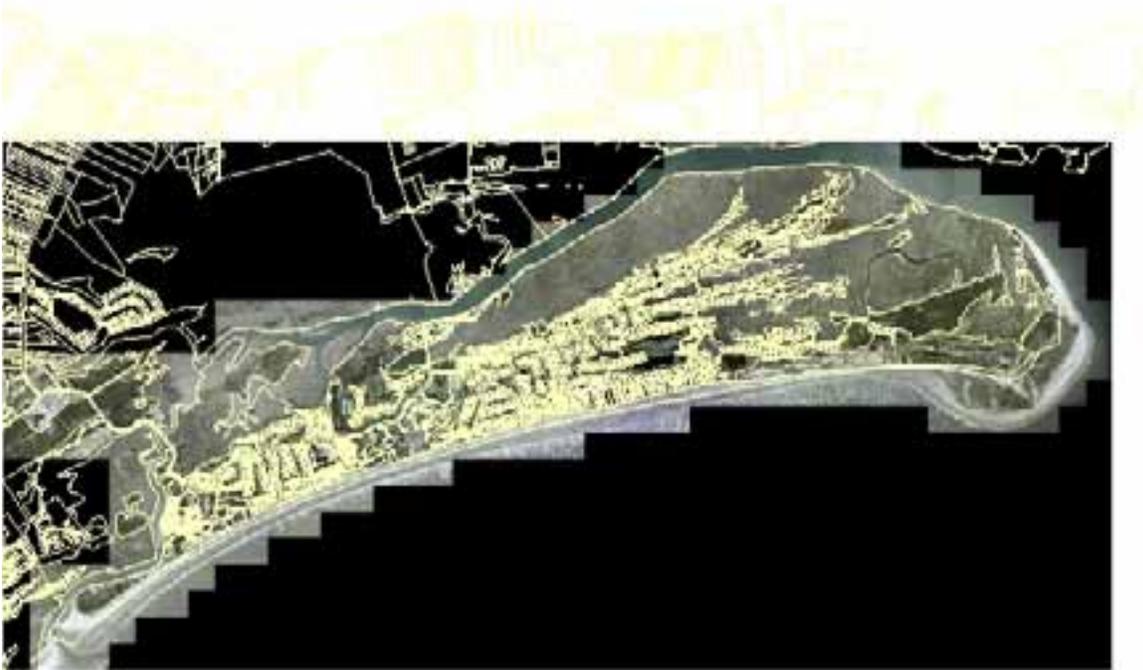


Manipulation or creation of enclave boundaries was performed by using ArcMap and ArcCatalog's on-screen digitizing techniques. For new enclave boundaries, polygon shapefiles were created and the properties of the polygon were modified to represent a border enclosing the enclave. The XTools extension of ArcView was used to calculate the area (in acres) within each enclave boundary.

Parcel Data

The parcel data obtained from the Charleston County GIS office displays all property boundaries on Kiawah Island (Fig 3), and contains tax and ownership information as attribute data. This layer can be placed over aerial photography in ArcView to display property boundaries, and can be viewed with a Kiawah roads data layer for a clearer spatial understanding of the location of parcel boundaries on the island (Fig 5).

Figure 5. Charleston County tax parcel data placed over Town of Kiawah aerial photography mosaic.



Platted Properties

A platted properties layer is created for each enclave based on the parcel data obtained from Charleston County (Fig 6).

Figure 6. The platted properties layer for the Yellowthroat enclave.



To create a platted properties layer, all of the developable parcels that comprise a particular enclave (the parcels within the enclave boundary) are selected in ArcMap. Platted properties are selected either on screen using the Select Features tool, or by

utilizing the parcel data's attribute table and selecting parcels based on Property Identification (PID) Numbers. Then the "Create Layer from Selected Features" function is chosen by right-clicking on the parcel data layer in ArcMap's Table of Contents and selecting the "Selection" submenu. After a new layer is generated in ArcMap, the data is exported as a shapefile or feature class by right-clicking on the newly created layer in the Table of Contents and choosing the "Export Data" command from the "Data" submenu. Figure 7 shows a sequence of how a platted properties layer for a particular enclave is created.

Figure 7. Creation of an enclave's platted properties layer.

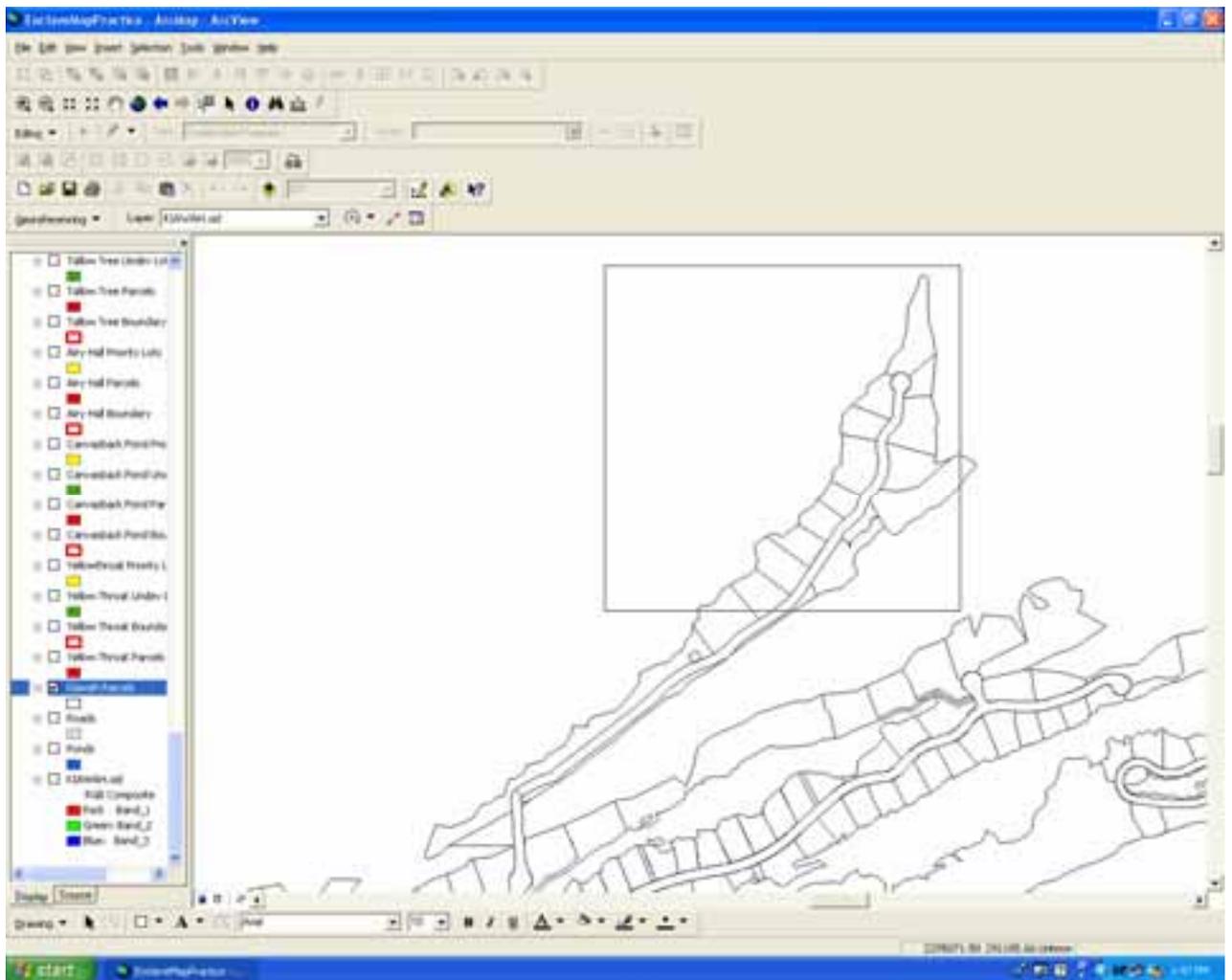
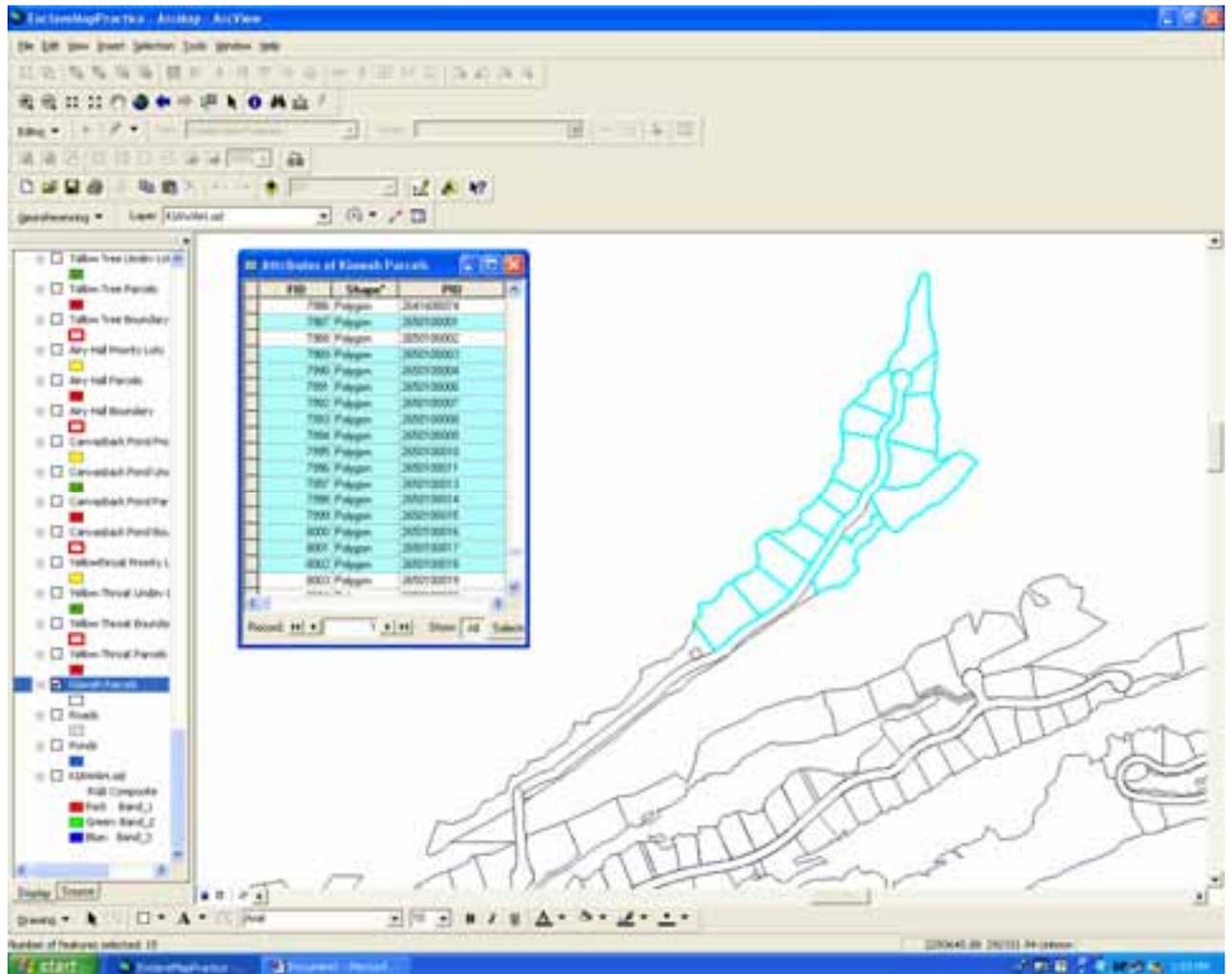


Figure 7 (cont.)



By creating the platted property layer for each enclave in this manner, the attribute data for each lot remains unchanged. Standard attribute data for each County of Charleston parcel contains the following information: shape, PID, Street Number, Street, City (Kiawah Island), Subdivision, Legal Description, Owner, Sale Date, Mailing Street Number, Mailing Street, Mailing City, Mailing State, Mailing Zip Code, Sale Price, Final Value and Area. Once created, this layer does not need to be modified unless the boundaries of the enclave change – resulting in the loss or gain of a particular enclave’s parcels.

Undeveloped Properties

Layers for undeveloped properties within each enclave are created as well. The development of these data layers is dependent on regular ground-truthing and information from the Architectural Review Board (ARB). Ground-truthing is performed by driving through all 23 island enclaves to monitor development, and is followed by updating all of the GIS data to reflect recent changes with regards to developed and undeveloped area on the island. Driving around the island occurs on a quarterly basis. ARB data are also used to keep track of which undeveloped lots are in the process of being developed. The ARB data that the Conservancy receives lists home sites where plans to build new homes have been approved, and those parcels that will no longer remain undeveloped. The Conservancy receives updated information from the ARB roughly two to three times per month. This information supplements the data obtained from ground-truthing quite well – allowing the GIS database to be kept current, through modification on a regular basis.

To create a layer that displays undeveloped platted parcels within an enclave, the following procedure is performed. Parcels within an enclave that have been identified as undeveloped are selected from that enclave's platted properties layer, using the Select Features tool from the ArcMap toolbar or by selection within the platted properties attribute table. Upon selection of the desired parcels, a new layer is created similarly to the creation of the platted properties layer. The selected parcels representing undeveloped lots within an enclave are used to create a new layer by choosing the "Create Layer from Selected Features" function, and then the new layer is exported as a shapefile or feature class. These files are named based on the enclave they represent – an example would be: "yellowthroat_undvp.shp." When a layer representing undeveloped

properties is placed over the platted properties layer in ArcView, an analysis of developed versus undeveloped platted property within an enclave can be performed (Figure 8).

Figure 8. Undeveloped property (green) vs. developed property (red).



Upon driving the island or receiving ARB conceptual review data, modification of the undeveloped parcels layer for a particular enclave may be necessary. If development in an enclave is detected, the undeveloped layer for that enclave must be updated to accurately reflect the change. Modifications are performed using the Editor Toolbar in ArcMap. If a particular parcel within an enclave becomes developed, that parcel is

deleted from the enclave's undeveloped parcels layer. This is done by selecting the "Start Editing" function in ArcMap's Editor Toolbar, defining the layer to be edited (yellowthroat_undvp.shp, for example), selecting the proper parcel with the mouse cursor, and deleting it – thus, eliminating that particular parcel from the rest of the layer. Upon deleting newly developed parcels, the undeveloped parcels layer accurately reflects change within an enclave.

Undeveloped Properties for Sale

Another layer specific to each enclave displays undeveloped lots for sale. This layer is created prior to events such as enclave gatherings, where there is potential for undeveloped land to be purchased. This layer is also created prior to some board meetings and meetings of the Habitat Preservation advisory committee. Kiawah Island Real Estate's website provides up-to-date information on what undeveloped home sites are currently on the market (<http://www.kiawahisland.com>). Before an enclave event or meeting, this website is checked to determine if there are currently any undeveloped parcels for sale within that particular enclave. If there are, a layer is created by selecting the proper parcels in ArcMap and using them to create a new layer (the same process as used to create the undeveloped properties layer discussed earlier).

Donors

Another shapefile that was created to support the Enclave Preservation Program displays the property owned by substantial Conservancy donors. This layer is important for fundraising purposes, and was created by selecting each donor's property using his of

her street address in the Kiawah parcel layer's attribute table. After the properties were selected, a new layer was created and exported as a new shapefile (as discussed earlier).

Land Preserved by the Conservancy

In addition to the data used for the Enclave Preservation Program, shapefiles have been created to represent preserved land on Kiawah Island. Currently, there are nine pieces of land owned by the Conservancy or under conservation easement. The properties owned by the Conservancy include the Maritime Forest Reserve and Nature Trail (133 Conifer Lane), the Wassén Preserve (9 Airy Hall), 77 New Settlement Road, 168 Bluebill Ct, 25 Arrowhead Hall, 141 Red Cedar Lane and Plenty's Island. The properties under conservation easement are Beck Island and Little Bear Island (Ducks Unlimited is the primary easement holder for Little Bear Island; the Kiawah Conservancy is the secondary easement holder).

The Maritime Forest Reserve and Nature Trail at 133 Conifer Lane, the Wassén Preserve at 9 Airy Hall, 77 New Settlement Road, 168 Bluebill Court, 25 Arrowhead Hall and 141 Red Cedar Lane are undeveloped home sites purchased by or donated to the Conservancy. Creating shapefiles for these properties involved selecting these properties on the parcel map, and creating layers for the selected features (as discussed earlier for platted properties and undeveloped parcels). The layers for Plenty's Island, Beck Island and Little Bear Island were created in a similar fashion, as these properties were already defined in the County of Charleston's parcel boundary layer, also. The projection used for these, as well as the other shapefiles/feature classes representing the preserved

properties is the NAD 1983 (North American Datum) UTM (Universal Transverse Mercator) Zone 17 North.

TABULAR DATA AND CALCULATIONS

In addition to creating layers, various calculations were also made using GIS. Area (in acres) was calculated for a number of features, including the area within each of the 23 enclave boundaries, the total area of undeveloped platted property within each enclave, and the total area of developed platted property within each enclave. Area was calculated by utilizing the XTools extension of ArcView, where the area of selected polygon shapefiles can be calculated in a chosen unit (in this case, acres). After XTools calculates the area of each selected shapefile, it adds this calculation to the associated attribute table. This is useful because each layer's attribute table can be viewed as a database file in Microsoft Excel. By putting this data into Excel, total area of undeveloped and total platted property within an enclave can be determined by summing the appropriate column using Excel's Sum (Σ) Tool. Also, the total number of undeveloped parcels within each enclave can be easily viewed.

WILDLIFE DATA

The Conservancy also utilizes a variety of wildlife data (for several species) to support land conservation decision-making and the Enclave Preservation Program. Most of the data related to wildlife is obtained by the Conservancy from other entities.

Although the Conservancy maintains data for alligators, ospreys, red-shouldered hawks

and several other species, the majority of the Conservancy's wildlife data is related to the bobcat.

GIS LAYERS

Alligators

The American Alligator (*Alligator mississippiensis*) is a native species of Kiawah Island. Each year, the Kiawah Island Community Association's Lakes Department conducts alligator nest surveys and records the location of each nest with a handheld GPS. They provide the Conservancy with these lat-long points, and these are added to the Conservancy's GIS database. This is done by listing the coordinates of each nest in a .txt file (using Notepad). Then the "Add XY Data" function is chosen from the Tools dropdown menu in ArcMap. The appropriate file is chosen (for example, "gatornests2006.txt"), the proper map projection is selected (NAD 1983, UTM Zone 17 North), and the coordinates are imported into ArcView as a points layer (see Figure 9).

Figure 9. Kiawah Island Alligator Nests.



Raptors

The Conservancy also keeps GIS data in the form of points for raptor nests. Several species of raptor can be seen on Kiawah. These include ospreys, red-tailed hawks, red-shouldered hawks and bald eagles. There are also species of owl that are residents of the island. Most of the osprey nest locations are reported by residents or located by the Community Association's Lakes Department. Again, the coordinates of these nests are recorded using a hand-held GPS, and the points are added to the

Conservancy's GIS database as points using the same method as for alligators (see Figure 10).

Figure 10. Kiawah Island (East End) Osprey Nests.



Bobcats

The most extensive set of wildlife data maintained by the Conservancy is related to the bobcat (*Lynx rufus*). The bobcat is a keystone species on the island, and there has been much research regarding this native predator – most notably the Predator-Prey Study conducted by University of Georgia doctoral candidate Shane Roberts, which

began in 2002. Roberts placed radio collars on sixteen bobcats and by using radio telemetry locating methods, produced hundreds of point locations for these island bobcats (Figure 11). Roberts also tracked several bobcats for 24 straight hours, producing a series of points illustrating the daily movement habits of each bobcat (Figure 12). Although some data were solely coordinates, and the layers representing these locations were created by the Conservancy (using the methods discussed above), Roberts provided most of the data as GIS layers already in the correct format/projection as points or lines to be immediately imported into the Conservancy's database. With the help of Roberts, bobcat "hotspots" were also located. Circles 100 meters in diameter were created around high density bobcat location areas ("hotspots") using ArcMap's Buffer Wizard (Figure 13).

Figure 11. Bobcat Locations.



Figure 12. Bobcat 24-Hour Tracking Data.



Figure 13. Bobcat “Hotspot” Buffers.



HABITAT QUALITY DATA

The Kiawah Conservancy also uses habitat quality data to support conservation strategies. The Conservancy utilizes a variation of a property rating model originally created by the US Fish and Wildlife Service for use by land trusts. This model rates undeveloped properties based on the following seven attributes:

- Habitat Pressure: The probability of the lot being built on (for example, is the lot in a quickly developing enclave?)
1 = Minimal 2 = Average 3 = Heavy

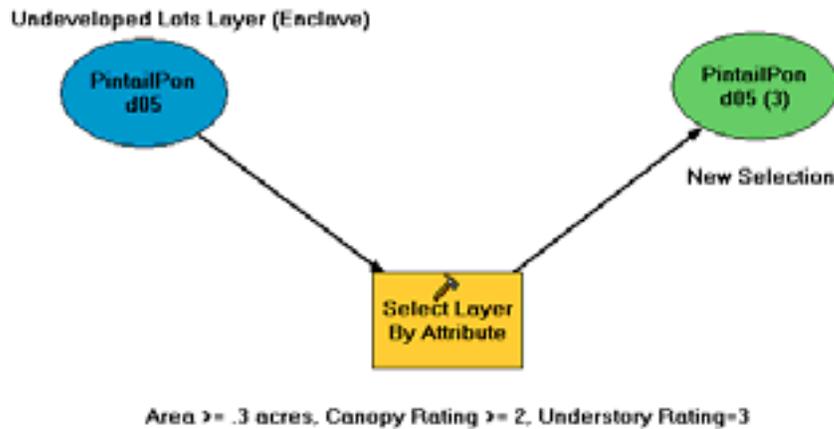
- Scenic Value: How many property owners and/or visitors will enjoy the views the lot will provide if it is preserved?
1 = Minimal 2 = Moderate 3 = Great
- Canopy Cover: The development of the forest's canopy
1 = Minimal 2 = Medium 3 = Dense
- Dead Trees: The value is based on the number of dead trees on the lot – these can provide great habitat for wildlife
1 = Minimal 2 = Moderate 3 = Extensive
- Under Story: The degree of low-lying vegetation including shrubs, vines and small/immature trees
1 = Minimal 2 = Medium 3 = Dense
- Natural Disturbance: The degree to which the lot has been affected by natural disturbance
1 = Heavy 2 = Moderate 3 = Minimal
- Manmade Disturbance: The degree to which the lot has been impacted by human activities (clear cutting, bush hogging, etc)
1 = Severe 2 = Noticeable but not severe 3 = No Disturbance

A staff biologist employed by the Conservancy walked all of the undeveloped lots on Kiawah to determine the values for each of these attributes (rated 1 to 3), and recorded them in a paper file. This data was then appended to the existing GIS data for each undeveloped property on the island. This was done by editing each lot's attribute table: a field was added for each of the seven criteria listed above and the appropriate values were input for each lot.

After this information was appended to the existing GIS data for undeveloped lots on the island, the model builder could be used to select properties that met certain parameters desired by the Conservancy's Habitat Preservation advisory committee. Model builder is the interface used to create, edit and run models based on spatial and attribute data through both ArcCatalog and ArcMap (Kasianchuk and Taggart 2000-

2004). The model builder can be used to select properties based on a number of criteria, thus working as a suitability model (Kasianchuk and Taggart 2000-2004). For example, the model builder could be used to select undeveloped properties within a particular enclave that have areas greater than .3 acres, canopy ratings greater than or equal to two, and under story ratings equal to three. This is performed by creating a new model within ArcToolbox. This is done by right-clicking the ArcToolbox icon (in the ArcToolbox window within ArcMap), and selecting “New Toolbox.” Then right-click on the new Toolbox and select “New,” then “Model.” The model window opens. The appropriate undeveloped lots layer from a particular enclave is dragged from the ArcMap Table of Contents into the model window. Then the “Select Layer by Attribute” tool (in the “Layer and Table Views” toolbox, within the “Data Management” toolbox) is dragged from ArcToolbox into the model window. By double-clicking on the “Select Layer by Attribute” icon, the “Select Layer by Attribute” dialog window opens. Then an expression is built within the tool, using the existing attribute data associated with the parameters desired (Area > .3, etc). Then, by right-clicking on the “Output Layer” symbol in the model window, one can choose to add the selection to the display. After running the model (select “Run” from the “Model” drop down menu), the properties will be selected (default: outlined in light blue) by ArcView in the display. Then, a new layer can be created from this selection and it can be exported as a feature class or shapefile (see Figure 14 for an illustration of the model builder interface window).

Figure 14. Model Builder Interface.



Results

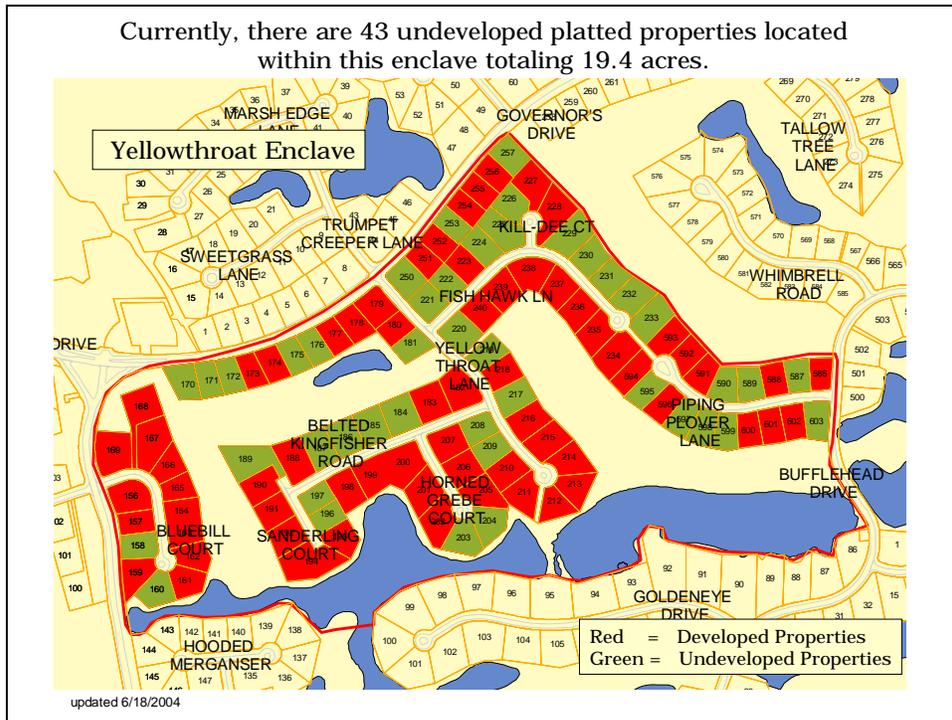
PROPERTY DATA

Upon creating the necessary property data layers, various maps could be created to support the Conservancy's Enclave Preservation Program. A collection of maps showing developed and undeveloped lots was created for each enclave. A preserved land map displaying all property owned by the Conservancy or under conservation easement was also successfully created. The construction of these maps allows spatial and temporal analysis of land use and development trends on Kiawah Island.

The collection of maps showing developed and undeveloped properties for each enclave was created to keep board members and the Habitat Preservation advisory committee updated on the state of development within each enclave on the island. These maps were created by overlaying the undeveloped properties layer over the platted

properties layer for each enclave. The number of undeveloped properties and number of undeveloped acres were added to each map. Lot numbers are labeled, and the roads and ponds layers from the Town of Kiawah Island are also utilized in these maps. An example of this map is shown in Figure 15.

Figure 15. Map showing undeveloped vs. developed properties, with pertinent data added in PowerPoint.



A series of five maps is created prior to enclave gatherings for analysis by the board of trustees and enclave property owners. These maps display the state of development in the enclave and give additional information such as number of lots, percentage of undeveloped plated property within the enclave, and location of properties currently for sale.

Once the necessary shapefiles/feature classes were created, a preserved land map displaying all property owned by the Conservancy or under conservation easement was also created. This map displays the seven properties owned by the Conservancy: the Maritime Forest Reserve and Nature Trail (133 Conifer Lane), the Wassén Preserve (9 Airy Hall), 77 New Settlement Road, 25 Arrowhead Hall, 168 Bluebill Court, 141 Red Cedar Lane and Plenty's Island. This map also displays the two properties under conservation easement: Beck Island and Little Bear Island. This map (Figure 16) also includes the 23 enclaves and the roads layer.

Figure 16. Preserved properties map.



The creation of these maps which utilize various new, previously created, modified and updated shapefiles, as well as other maps such as those showing the property owned by large donors are vital to the Conservancy's Enclave Preservation Program, as they allow analysis by the Conservancy Board and committees, as well as island property owners.

WILDLIFE DATA

Upon inputting all of the existing wildlife data, maps could be created and viewed that show what areas of the island are used by wildlife (namely bobcats, alligators and raptors).

The data collected and created by Shane Roberts' Predator-Prey study displays hundreds of telemetry locations for the sixteen collared bobcats. His data also shows 24-hour movement patterns for each collared bobcat. This data allows the Conservancy to determine which areas of the island have the highest concentration of bobcat locations/activity and to focus preservation efforts on such areas. Also, when collecting data on properties that can potentially be preserved, the bobcat data can be viewed overlaying the undeveloped lots layer(s) to show if the lot in question is being used by bobcats. After analyzing the data with Roberts, "hotspots" were created using the buffer wizard. The Conservancy can also utilize these features to look for land, as the properties within these buffers likely provide excellent habitat for bobcats and other wildlife.

Points for alligator nests and raptor nests also benefit the Conservancy's decision-making process when analyzing potential land preservation opportunities. The Conservancy can try to acquire properties that contain these nests to preserve the nesting

habitat of the species. Having the nest data for ospreys and other raptors is also important because it allows the Conservancy to warn the Architectural Review Board (ARB) about lots with such nests that have been approved for new home construction. By supplying the ARB with this data, it is hoped that the trees that house these nests can remain undisturbed.

HABITAT QUALITY DATA

After the habitat quality data was appended to the attribute table for each undeveloped lot on Kiawah, it provided a great resource for land preservation planning. By having this data as part of the existing GIS database for each undeveloped lot, it allows model building to select lots based on virtually any parameter desired by the Conservancy. Lots can be selected by their rating for habitat pressure, scenic value, canopy cover, dead trees, under story, natural disturbance and man-made disturbance, or any combination of these characteristics. In addition to selecting properties based on these attributes, properties can also be chosen based on the combination of these characteristics as well as property information already existing within the undeveloped property's attribute table (acreage, value, sale price, date purchased, etc.). Being able to perform these functions greatly benefits land preservation planning at the Conservancy, as it allows swift property selection based on a specific set of criteria.

This approach was used to select each enclave's "priority lots" – properties in each enclave that the Conservancy is most interested in preserving. These lots were chosen based on their habitat quality ratings, their locations and the interest shown in their preservation by the community.

Discussion

The use of GIS at the Kiawah Island Natural Habitat Conservancy has greatly benefited the Enclave Preservation Program and strategic planning for land preservation. The GIS database provides critical conservation information upon which to base conservation decisions. In addition to these benefits, it is also used to educate property owners and the public about the Conservancy's mission.

The Conservancy's Board of Trustees and Habitat Preservation advisory committee use the GIS-generated maps to examine potential property purchases. Through the analysis of spatial characteristics such as the number of undeveloped lots within an enclave, percentage of undeveloped land within an enclave, priority lot status, and proximity to other preserved properties, the Conservancy is better informed about which enclaves to focus conservation efforts upon – and furthermore, which individual undeveloped properties within enclaves to consider purchasing. GIS also provides temporal data, and examining the rates of development in the enclaves is also a factor in conservation decisions. The addition of wildlife data and habitat quality rating data further benefits conservation planning. The constant updating of the GIS database benefits the Conservancy greatly, as it allows decision-makers to be kept informed, in regard to development on the island at all times.

GIS data also supports the Enclave Preservation Program through its use at enclave gatherings and other events. At enclave gatherings, the Conservancy distributes a series of maps – allowing property owners to learn about development in their enclaves, as well as which properties in their enclaves are currently on the real estate market. As property owners learn more about development on the island or within their particular

enclaves, it is hoped that they will contribute to the Conservancy, and they will be encouraged to support the Conservancy – be it through monetary funds, gifts of undeveloped land, or placing a conservation easement (to be held by the Conservancy) on undeveloped property. Maps have also been used in presentations by the Conservancy when discussing particular pieces of property or when presenting information on the Enclave Preservation Program to other groups such as funding agencies or other land trusts.

The Conservancy's website (<http://www.kiawahconservancy.org>) also utilizes GIS to deliver the Conservancy's mission to the public. The page regarding the Enclave Preservation Program, under the "What's Happening?" section, displays a GIS-generated map displaying the 23 enclaves on the island. There are other GIS-generated maps displayed throughout the website.

GIS will continue to provide vital information to the Kiawah Conservancy, as the current database has potential to support more data. Additional wildlife data regarding other species can be appended to the database. There is also potential to link property data to digital photography and other information that would support the Enclave Preservation Program. More specifically, GIS can also be used to determine goals for preservation within each enclave, based on the enclave's size, percentage of undeveloped properties/area, location and rate of development.

Conclusion

Using GIS to support the Kiawah Island Natural Habitat Conservancy's Enclave Preservation Program has proven to be a tremendous tool for strategic land preservation

and conservation planning. Through the creation and modification of various shapefiles/feature classes and their incorporation into several different maps, the Conservancy can maximize its spatial and temporal analysis capabilities. GIS allows the Conservancy's Board and Habitat Preservation advisory committee to determine which areas of Kiawah are at the highest risk of being developed as well as which areas (enclaves) to focus their efforts upon. Decision-makers at the Conservancy can view and compare the percentage of undeveloped land within enclaves. GIS also allows the Conservancy to analyze development trends on the island, for example, which areas are growing fastest. In addition to property data, the GIS database can also display wildlife and habitat quality data across the entire island. The development of the GIS database also allows the Conservancy's board to view the location of prime maritime strand habitat, as well as where preserved land on the island is located. Model building further supports strategic planning as it allows selection of undeveloped properties based on a variety of desired parameters. These parameters can include (but are not limited to) lot size, habitat quality (forest canopy cover, forest under story, etc.), appraised value and sale date. This tool further strengthens land preservation planning at the Conservancy.

The development of the GIS database also engages property owners on the island through the distribution of GIS-generated maps at enclave gatherings and the posting of GIS data on the Conservancy's website. These maps have also been converted to posters and put on display at the island's nature center, in an effort to further the Conservancy's mission.

The use of ArcGIS by land trusts around the country exhibits how important the technology can be for land preservation management. From the education of the public

and property owners, to facilitating the decision-making process within the Conservancy, GIS has proven to be a powerful tool for land preservation planning and management at the Kiawah Conservancy.

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