TARGETING POTENTIAL CONSERVATION SITES FOR SWALLOW-TAILED KITES (*Elanoides forficatus*) IN LEVY COUNTY, FLORIDA

by

Julia E. Gruber
Dr. Jennifer Swenson, Advisor
April 24, 2009

Master's project proposal submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University
2009

Abstract

The Swallow-tailed Kite (*Elanoides forficatus*) is facing population declines due to habitat loss and fragmentation across much of its remnant range. Current population estimates suggest that fewer than 5000 of these graceful birds of prey remain, with 60-65% of the population breeding in Florida during the summer months. Levy County, Florida, is a known "hot spot" for kites and serves as the focal area for this project. The goal of this study is to provide an objective, science-based approach for prioritizing areas for kite conservation, as it is critical that conservation resources be used efficiently.

Using a species specific habitat model and county tax mapping data, nine ecological and socio-economic criteria were developed in GIS for inclusion in the prioritization scheme. A multi-criteria compromise analysis was performed to calculate a conservation score for each parcel, effectively ranking the parcels in terms of their value for kite conservation. The mean score of the parcels under consideration was 19.6, with 94 parcels scoring greater than 70. Parcels that have already been conserved scored significantly higher (mean = 44.8), which indicates that the conservation areas in Levy County are protecting habitat suitable for Swallow-tailed Kites.

The criteria ranking and weighting schemes used for this analysis can be easily modified to meet the needs and goals of different end-users. Cooperative management, land acquisitions, conservation easements, and landowner partnerships are a few examples of conservation actions that may benefit this imperiled species. This parcel prioritization scheme, designed specifically for Swallow-tailed Kites, provides an analytical approach for planning such conservation efforts.

Acknowledgements

I would like to thank my advisor, Jennifer Swenson, for providing guidance on this project and for reviewing many drafts of this manuscript. I am grateful to Ken Meyer for the inspiration, data, ecological knowledge, and general support behind this project. I would especially like to thank Nicholas Hollingshead for his enthusiastic assistance with the GIS data analysis, and Grant Firl for his expert mathematical advice. I also appreciate the information shared by S. Beyeler, L. Cienek, G. Galpin, T. Hoctor, S. Lowrimore, L. Maguire, J. Masten, S. Neeley, B. Newsome, D. Salvesen, W. Taylor, and. G. Zimmerman.

Faculty Support

Dr. Jennifer Swenson, project advisor
Assistant Professor of the Practice of Geospatial Analysis
Duke University, Nicholas School of the Environment.

Kenneth D. Meyer, Ph.D.
Executive Director, Avian Research and Conservation Institute
Associate Professor (Adjunct), Wildlife Ecology and Conservation, University of Florida

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

The Swallow-tailed Kite (*Elanoides forficatus*) is facing population declines from habitat loss and fragmentation across much of its remnant range. Once nesting in up to 21 states, kites suffered an abrupt decline around 1900, possibly as a result of shooting and habitat loss due to agricultural development and logging of bottomland forests (Robertson 1988). The disappearance of this species from three-fourths of its breeding range between 1880 and 1910 (Figure 1) was one of the most dramatic range contractions of any bird species before the highly publicized post-WWII Peregrine falcon crash (Cely 2005). The breeding distribution has apparently stabilized since the 1940's (Figure 2), when the population reached its low point (Meyer 2005a). Currently, nesting occurs only in portions of seven southeastern states, with 60-65% of the entire breeding population nesting in Florida (Meyer 1995). Estimates place the breeding population at 800 to 1,200 pairs or about 3,500 to 5,000 individuals at the end of the breeding season, including non-breeding adults and young of the year (Meyer 2005a).

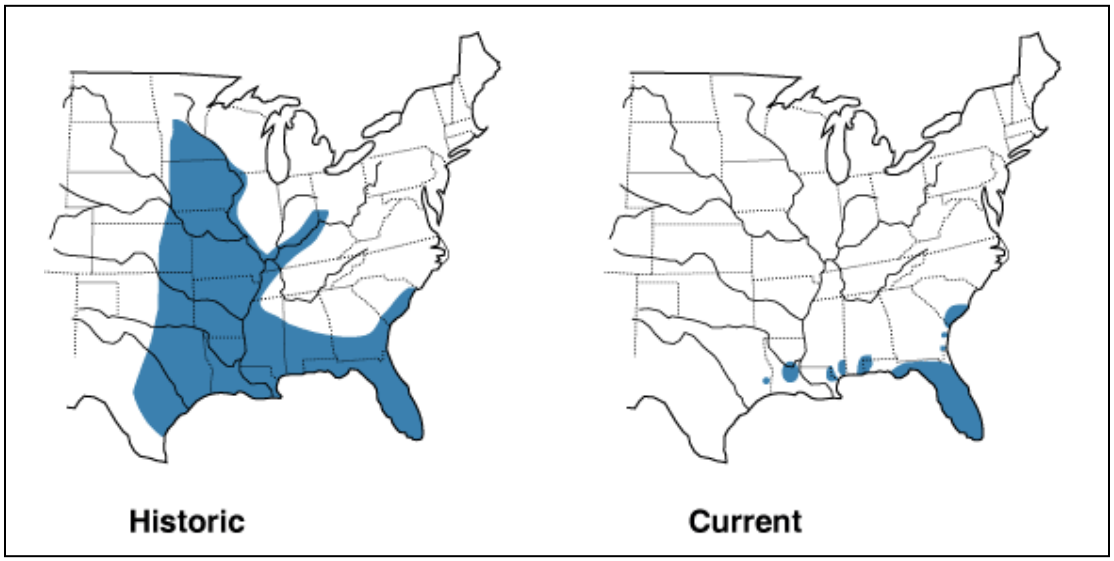

Figure 1. Historic and current breeding range of the Swallow-tailed Kite. (Meyer 1995)

Figure 2. Current year-round range of the Swallow-tailed Kite.

Throughout the southeast, industrial and individually owned timberlands support the majority of the breeding population and, thus, play a critical role in the conservation and persistence of the U.S. population (Meyer 2005a). In 1998, 68% of kite nests monitored in northern Florida were on or within 300 m of stands actively managed for timber (Meyer 2004a). The majority of this timberland is privately owned, mostly by real estate investment trusts and families, and has no official conservation protection. This nesting distribution poses distinct challenges for kite management and conservation since breeding habitat available on publicly owned lands is almost certainly insufficient to ensure persistence of the species (Meyer 1995).

Furthermore, most winter roosting sites in Brazil are on privately owned ranches and are under threat of development (Meyer 2004a). It is equally important to consider management and conservation of kite habitat domestically and on the migration and wintering grounds.

The Swallow-tailed Kite is assigned Partners in Flight's highest priority for immediate management and conservation action, listed on the National Audubon Society's Watchlist as a species of critical concern, and designated by the U. S. Geological Survey's Biological Resources Division as a Species at Risk. The International Union for Conservation of Nature has classified the Swallow-tailed Kite as a species of least concern since it is not believed to reach the threshold for the population decline criterion of the IUCN Red List (i.e. declining more that 30% in ten years or three generations) (IUCN 2008). Still, the Florida Fish and Wildlife Conservation Commission has ranked the Swallow-tailed Kite as one of Florida's most vulnerable and poorly understood species (Millsap et al. 1989).

Biologists, conservationists, and land managers participating in the Swallow-tailed Kite Working Group have reached consensus in recommending that federal threatened or endangered status *not* be pursued at this time (Ken Meyer, Avian Research and Conservation Institute, personal communication, March 2008). Seeking landowner cooperation shows potential for being a more effective means for stabilizing or increasing the breeding population (Meyer 2005a). Indeed, it has been argued the Endangered Species Act – which is based on land-use restrictions – has failed to protect endangered species on private land (Langpap 2006). The traditional regulatory approach of this legislation may generate perverse incentives to compel landowners to manage their land in ways that discourage the presence of endangered species in order to avoid land-use restrictions (Langpap 2006).

Fortunately, conservationists have been encouraged by the interest and cooperation already exhibited by several forest landowners (Meyer 2005a). For example, Plum Creek, a real estate investment trust which owns more than 145,000 acres of timberland in Levy County, has placed approximately 38,000 acres under conservation easement with the Suwannee River Water Management District (Steve Lowrimore, Plum Creek Forester, personal communication, November 2008). In addition, Plum Creek forest managers are very active in kite management on their lands and are trained to identify signs of nesting activity during the breeding season. It is company policy to protect active nests when they are discovered and to monitor productive nesting areas for another year - or until it is determined that the area is no longer being used by kites (Steve Lowrimore, Plum Creek Forester, personal communication, November 2008).

The objective of this study is to address the need for kite habitat protection by developing a method for identifying and prioritizing areas for conservation and management. The need to protect wildlife habitat and set aside land for conservation is far greater than the funds available, therefore, acquisition efforts must focus on protecting the most important parcels of land or those with the highest ecological value (Manomet 2006). A multi-criteria compromise analysis was performed for parcels within Levy County, Florida – a known "hot spot" for Swallow-tailed Kites. This study was developed to provide conservationists with an objective, science-based tool for prioritizing land protection efforts (Manomet 2006). The end result is a prioritization scheme that gives each parcel a conservation score based on nine ecological and socio-economic criteria. The evaluation matrix has been designed to be easily modified to match the priorities of different conservation organizations. The overall objective is to provide conservationists the information they need to select the best parcels for conservation management focus for Swallow-tailed Kites within Levy County, Florida.

Background: Natural History of the Swallow-tailed Kite

The northern subspecies of the Swallow-tailed Kite, *Elanoides forficatus forficatus*, is a neotropical migrant which breeds in the southeastern United States and winters in South America (Meyer 1995). These elegant birds of prey are gregarious in all seasons, and are a conspicuous inhabitant of wetlands in the southeast (Meyer 1995).

Swallow-tailed Kites are found in riparian and bottomland forest habitats and mixed pine habitats, showing a strong preference for nesting in dominant or co-dominant loblolly pine (*Pinus taeda*) stands growing near or within wetlands (Cely 2005). The physical structure of the forest stand is perhaps more important than the specific vegetation communities. Kites prefer tall, easily accessible nest trees near open areas that provide sufficient prey (Meyer 1995). The average dimensions of nest trees from a study in South Carolina were 32 m tall, 49 cm diameter at breast height, and approximately 61 years of age (Cely and Sorrow 1990). Nests are typically built at the top of the tallest trees in the stand; the preferred surrounding stand is usually low density and has an uneven height/age structure (Meyer 1995).

Kites have large home ranges encompassing thousands of acres, and will often commute long distances, up to 24 km, from the nest site to forage. Because of the species' large home range, it could serve as an umbrella species for other wetland wildlife in the U.S. including neotropical migratory songbirds, Red-shouldered hawks, Pileated woodpeckers, River otter, and Black bear (Cely 2005). In other words, protecting habitat suitable for kites will benefit many other species that rely on similar habitat.

The main food source of kites is large insects caught on the wing; a variety of other prey such as snakes, anoles, frogs, nestling birds, and wasps nests, are gleaned from vegetation. In areas of high insect prey abundance, feeding aggregations of more than 50 individuals can form

(Cely 2005). In addition, large communal roosts near nesting areas are common, and pre-migration roosts may draw hundreds of kites from large areas (Meyer 1995).

The Swallow-tailed Kite exhibits social nesting behavior. An average of 2 - 5 pairs, each apparently monogamous and producing a single clutch (typically 2 eggs per clutch), nest in close proximity (Meyer 1995). One or two non-breeding adults are typically present at most nests throughout the breeding season (Meyer 1995). These nesting behaviors result in a more clumped distribution than expected based on available habitat and are referred to as "loose neighborhoods" (Newton 1979). However, this breeding behavior may impede kites' ability to disperse into unused habitat that may otherwise appear suitable (Cely 2005). In addition, Swallow-tailed Kites are known to reuse old nests year after year, regardless of previous nesting fate (Meyer 2004a).

The current challenges to kite conservation include wetland loss and drainage, extensive clear-cutting, short rotation timber harvesting, and significant land use changes along migration routes and wintering habitats in South America (Meyer 2004b). Rapid development throughout its current range and the possible effects of climate change, including prolonged droughts, sea-level rise, and an increase in major hurricanes, pose additional challenges for this highly vulnerable species.

Methods

Using a species-specific habitat model and county tax mapping data, nine ecological and socio-economic criteria were developed in GIS for inclusion in a parcel prioritization scheme. A multi-criteria compromise analysis was performed to calculate a conservation score for each parcel, effectively ranking each parcel in terms of its value for Swallow-tailed Kite conservation.

Study Area

Levy County (pronounced *lee-vee*) is a relatively undeveloped county in the Gulf Hammock region of northern Florida (Figure 3). The county is a known "hotspot" for Swallow-tailed Kites and is home to a large population of nesting birds during the summer months. There are seven municipalities located within the county: Fanning Springs, Chiefland, Bronson, Williston, Otter Creek, Yankeetown/Inglis, and Cedar Key (Figure 4). The U.S. Census Bureau recorded a 13.4% human population increase in Levy County during the years 2000 to 2006.

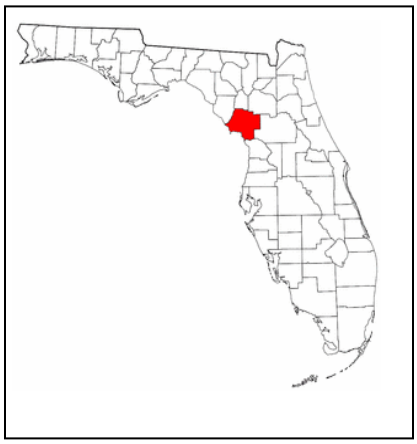

Figure 3. Location of Levy County, Florida. (www.nationmaster.com)

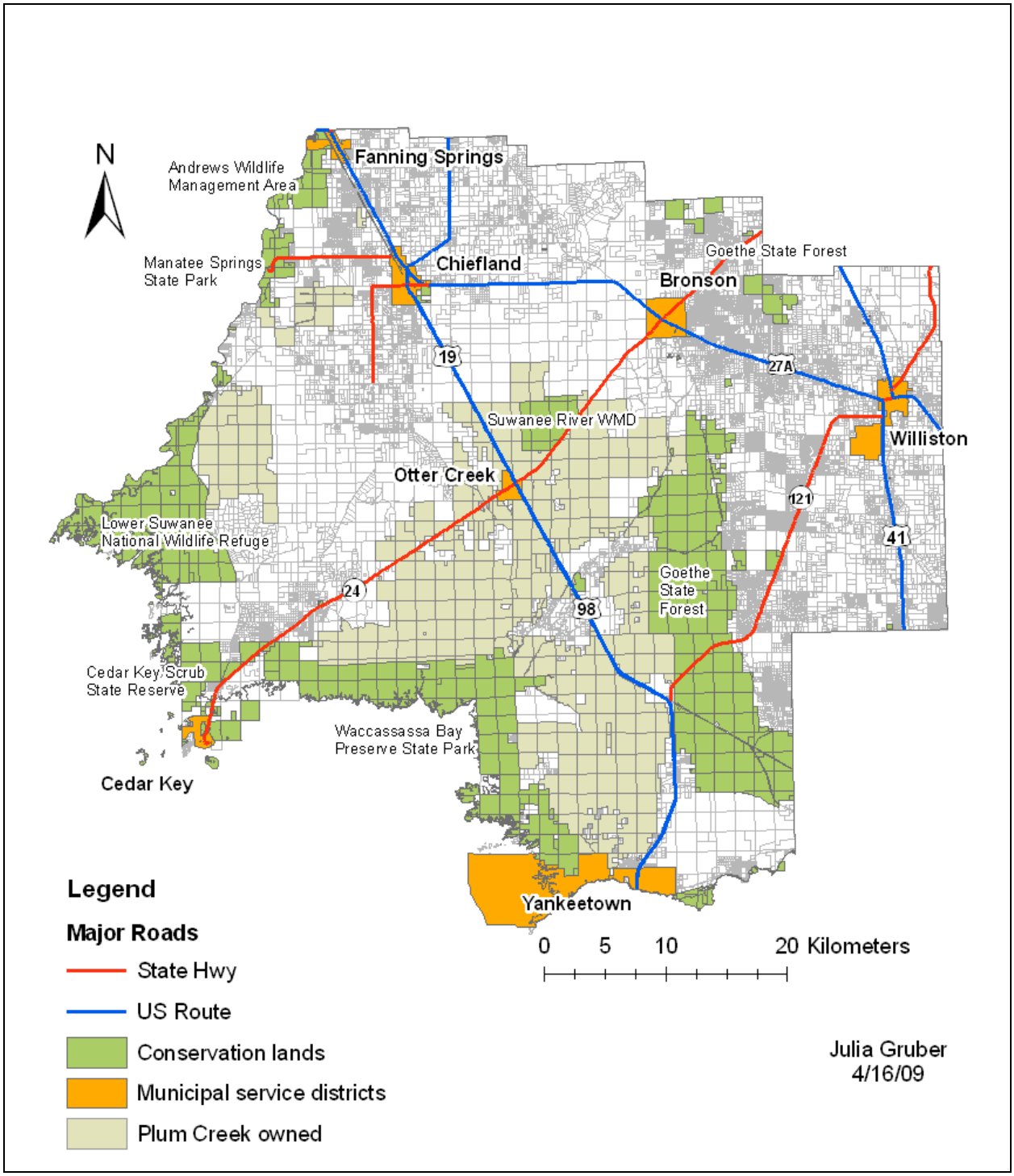

Figure 4. Levy County, Florida

Levy County encompasses 1412 square miles of land area. The largest private landowner in the county is Plum Creek Timberlands; this real estate investment trust owns approximately 145,000 acres of timberland in central Levy County. Many of the central and coastal areas of the county remain in 640-acre sections (1 mi^2 parcels), as established by the Federal Lands Survey and the Land Ordinance of 1785 (Platt 2004). Many of these parcels are permanently conserved, undeveloped timberland, or used for agriculture, and therefore have yet to be further subdivided. Conservation lands include state and federal conservation areas, such as state parks, forests, or reserves, national wildlife refuges, and parcels under conservation easement, such as those held by the Nature Conservancy and the Watershed Management Districts.

Data Development, Part I: The Habitat Model

This study doubles as a trial project to illustrate an analytical approach for the use of a Swallow-tailed Kite habitat model being developed by the Avian Research and Conservation Institute (ARCI) with funding from the U.S. Fish and Wildlife Service (Suzanne Beyeler, ARCI, personal communication, June 2008). A beta version of the habitat model, which represents kite habitat selection and spatially-explicit demography of Swallow-tailed kites in a Geographic Information System (Environmental Systems Research Institute (ESRI) 9.3, 2008) was used for this study. It ultimately identifies patches of the landscape that contain the most suitable kite habitat. The full habitat model encompassing the entire southeastern breeding range of the species is scheduled for completion in June 2009.

The foundation of ARCI's habitat model is based on GPS data of over 900 nests in Florida, Georgia, and South Carolina from 1997-2008, including 263 nest locations in Levy County. All nest point data available since 1997 were used in the habitat model, regardless of

repeated uses of nests or presumed breeding territories by the same (or a succession of) pairs. The nest data show that 28 nests were reused in consecutive years, including three nests that were used in three consecutive years. Nests are also reused in non-consecutive years; the maximum known period of nest vacancy before reuse is four years (ARCI, unpublished data).

Other data used in the development of the habitat model include a land use-land cover raster layer categorized according to the Florida Land Use and Cover Classification System (FLUCCS). The Southwest Florida Water Management District photo-interpreted features at 1:12,000 on 1 m color infrared digital aerial photographs taken in 2004.

The first component of the habitat model was to identify land cover types most likely to be used as nesting sites (Beyeler 2008). Nest points were buffered by 1000 m, and all land use-land cover types found within those 3.14 km^2 buffers were identified as potentially suitable for nesting (Table 1).

Table 1. Land use-land cover identified as potentially suitable habitat.

FLUCCS Code	**Description**
4110	Pine flatwoods
4111	Mesic flatwoods
4130	Sand Pine
4340	Mixed hardwood-pine
4410	Coniferous plantation
6130	Gum swamp
6150	Stream and lake swamps
6172	Mixed wetland hardwoods
6200	Wetland coniferous forest
6210s	Cypress
6300	Wetland forested mixed

The unique ecology of Swallow-tailed Kites is such that the birds require open areas for foraging and, in fact, avoid large areas of dense tree cover (Meyer and Collopy 1995). Therefore,

the second component of the habitat model was to retain only those cover types selected in the first step that are also within 1000 m of an edge with open cover (Beyeler 2008). Open cover types suitable for foraging include pasture lands, fallow agriculture, rangelands, scrub, shrubby wetlands, herbaceous wetlands, and intermittent ponds. The final component of the habitat model was to identify suitable foraging habitat within 1000 m of all cover types selected in steps one and two (Table 2). The final output of the beta habitat model is shown in Figure 5, as well as the nest point locations within Levy County.

Table 2. Land use-land cover identified as foraging habitat (Meyer and Collopy 1995)

FLUCCS Code	**Description**
1900s	Open land
2120	Unimproved pasture
2130	Woodland pasture
2600s	Fallow agriculture
3000s	Rangelands
4000s	All upland forest cover
6100-6399	All wetland forests
6410s	Freshwater marshes
6430s	Wet prairies
6440	Emergent aquatic vegetation
6460	Hydric savannah
6600	Cutover wetlands
6900	Wetlands shrubs
8170	Gas transmission line corridors
8320	Electrical power line corridors

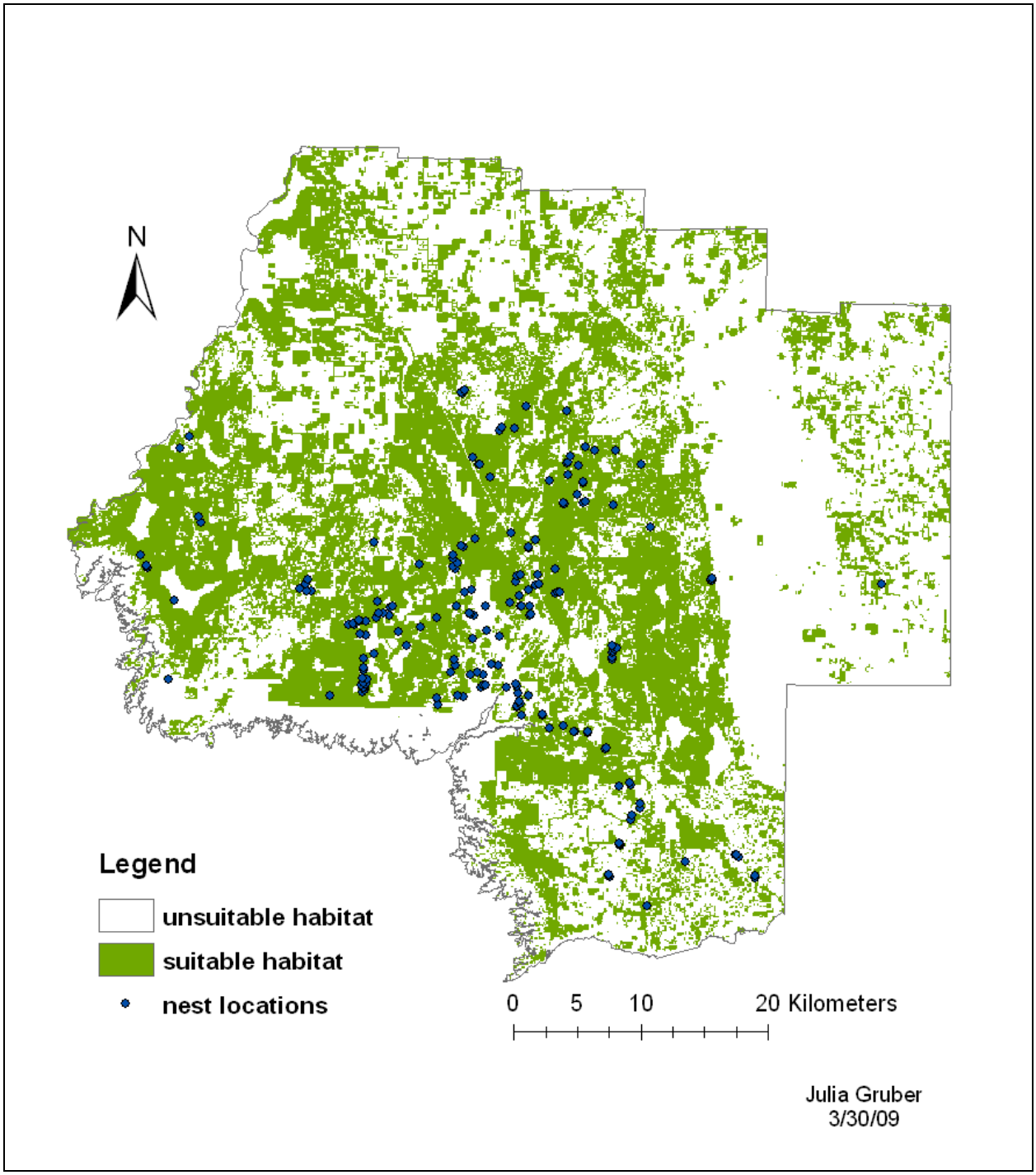

Figure 5. Suitable STKI habitat and nest location in Levy County, FL.

Data Development, Part II: Developing Criteria for Analysis

Parcel level prioritization is essentially a multi-criteria analysis problem (Malczewski 1999). Therefore, a set of conservation criteria was created to provide the basis for the prioritization scheme. Nine criteria were determined to be of importance for the prioritization of parcels for Swallow-tailed Kite habitat protection. The criteria were chosen based on the expert opinions of ecologists at ARCI and on the availability of data. The data generation process and assumptions associated with each criterion are described below.

This analysis was conducted on all undeveloped parcels having more than 0.1 acres of suitable habitat. The assumption was that parcels that are already developed or that contain a negligible amount of suitable habitat will never be considered for conservation action. Parcels defined as "parcels with no values" were removed from the final analysis since price and ownership data were incomplete. Furthermore, subdivided parcels listed under the same PARCELNO identification code were dissolved into a single polygon. These steps reduced the number of parcels to be analyzed from about 49,000 to only 7,500. Acres were used as the unit for analysis throughout this study since it is the most commonly used unit by land managers and the real estate community. Aside from the habitat model, all data used for this analysis were provided by the Florida Department of Revenue's 2006 tax database for Levy County, which includes parcel boundaries and all associated tax information.

1. Suitable habitat within parcel (acres)

The amount of suitable habitat contained within each parcel was determined by overlaying the habitat model on the parcel boundary shapefile. To prepare the habitat model for analysis, the suitable habitat raster layer was converted to a simplified polygon layer. The

original intent was to analyze the habitat model based on contiguous patches of suitable habitat rather than parcel boundaries. However, the output of this process showed that approximately ten "mega-patches" cover most of the county, with several hundred very small patches scattered throughout. The analysis therefore shifted to the parcel level, with additional steps included to account for proximity to other areas of suitable habitat. Parcels that contain a greater amount of suitable habitat will receive a higher conservation score.

2. Suitable habitat within 1 km of the parcel

To incorporate a metric for assessing the quality of the area immediately surrounding each parcel, two concentric buffers were delineated around each parcel of interest. The inner buffer width of 1 km was based on the average nearest distance between nests in a colony in 1989, which was 730 m (Meyer and Collopy 1995), rounded up to 1000 m. It was assumed that the quality of the habitat within this proximate range is most critical for nesting kites and successful colony formation. The amount of suitable habitat contained within the parcel itself was not included in the 1 km buffer since this value has already been accounted for in criterion 1. Parcels that have more suitable habitat within 1 km will be prioritized in the final weighting scheme.

3. Suitable habitat within 1 – 3 km of the parcel

The outer buffer width of 3 km was based on the average minimum daily activity range of nesting kites, which is 30 km^2 (3.09 km radius) (Meyer and Collopy 1995), rounded down to 3 km. Kites travel great distances to forage and readily cross developed areas, so it is important to consider the habitat value of larger areas. The output of the outer buffer analysis will be used to

identify the amount of suitable habitat within a distance of 1 - 3 km of each parcel. The amount of suitable habitat contained within the parcel itself or within 1 km was not included in the 3 km buffer since these variables have already been accounted for in criteria 1 and 2. Parcels that have more suitable habitat within 1 - 3 km distance away will be prioritized in the final weighting scheme.

Both the 1 km and 3 km radii buffers were calculated from the geometric center of each parcel. Calculation of the amount of suitable habitat contained within the buffers was completed using Manifold software (Manifold System 8.0, 2008) and SQL commands.

4. Distance to nearest conservation land

A shapefile representing conservation land, or land that is currently protected from development, was created based on the DESCRIPTION attribute field from the Levy County tax data. Parcels categorized as “forest/park/recreation”, “other federal”, and “other state” were included in the Conservation Lands layer. Parcels within Goethe State Forest, Waccasassa Bay Preserve State Park, Cedar Key Scrub State Preserve, Lower Suwannee National Wildlife Refuge, Manatee Springs State Park, Andrews Wildlife Management area, and lands under conservation easement by the Nature Conservancy or the Suwannee River Water Management District comprise the majority of this layer (Figure 4). It is assumed that a parcel near or adjacent to land that is already protected will provide a greater opportunity to protect large, contiguous patches of habitat. Figure 6 shows the GIS output for this criterion. The patches of white on the map indicate those parcels that were removed from the analysis, as discussed previously.

5. Distance to nearest developed land

A shapefile representing developed lands was created based on the DESCRIPTION attribute field from the Levy County tax data. The 'select by attributes' function in ArcMap was used to select 52 description categories that were most obviously a form of development, such as schools, single family homes, restaurants, etc. Ambiguous land use descriptions, agricultural lands, and vacant land zoned for development were not included in the developed lands layer. See Appendix A for a list of all land use descriptions classified as "Developed Land". It was assumed that areas farther from developed lands will be less likely to suffer negative effects resulting from human disturbance, such as air and noise pollution (Duffy 2000).

6. Distance to nearest municipal service district

Parcels that are within one of Levy County's seven municipal service districts (MSDs) were also incorporated into the analysis to provide a measure of potential or future development. MSD boundaries are created by municipalities to control where development will occur. Parcels within MSD boundaries are most likely zoned for development, demand a high market price, and will be developed in the near future. Therefore, the MSD boundaries provided by the Withlacoochee Regional Planning Council were used to identify which parcels might be developed in the future. No new major roads are planned for construction in Levy County; however there is a new nuclear power plant planned which may influence development in the vicinity (Shenley Neeley, Levy County Planner, personal communication, October 2008). It is assumed that areas farther from developed lands will provide higher quality habitat due to less disturbance from humans, less air pollution, less noise pollution, etc. (Duffy 2000).

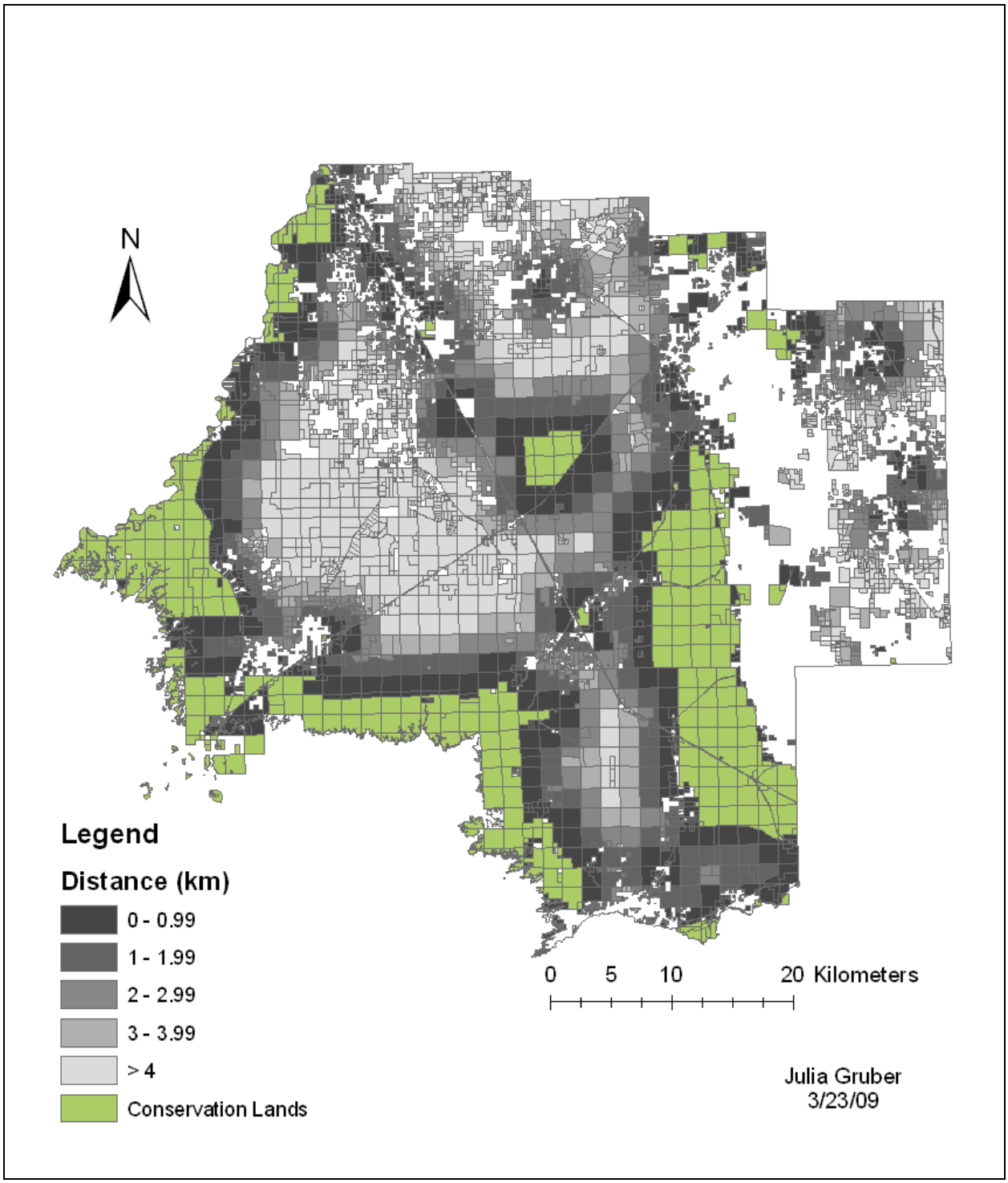

Figure 6. Distance to nearest conservation land.

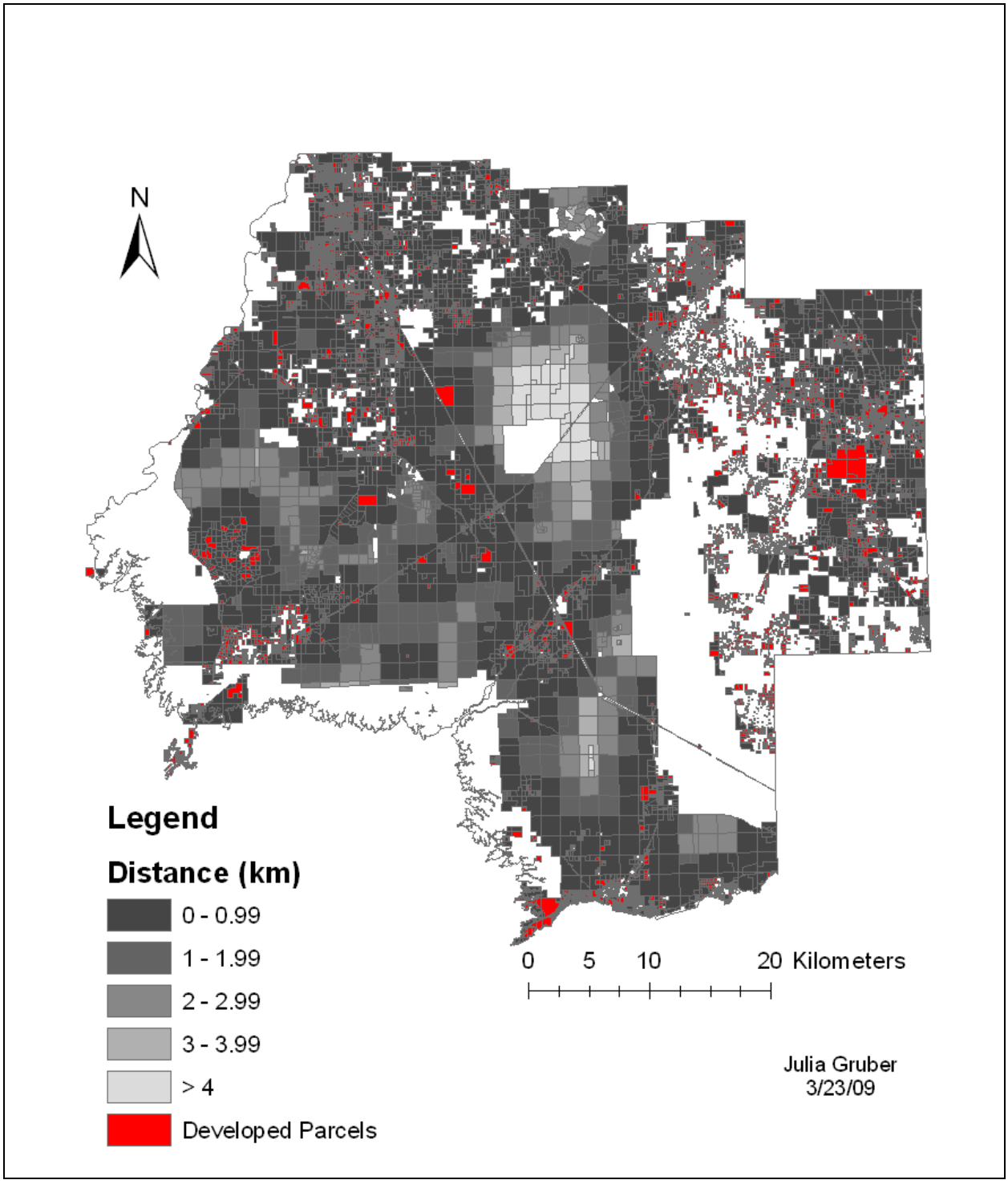

Figure 7. Distance to nearest developed parcel.

While there is some redundancy between the outputs of criteria 5 and 6, the distance to MSD data was retained to provide some measure of the threat of future development. The MSD boundaries are quite extensive when compared to the currently developed parcels; awareness of where the densest human development is (or will be) is important to consider when planning conservation areas. However, use of a more accurate estimate of future development - if one exists - is encouraged if these methods will be applied to other counties or regions.

7. Total area of parcel (acres)

Data for parcel area were provided directly from the 2006 Levy County tax database. Prioritizing larger parcels (and those containing greater amounts of suitable habitat) is supported by the species-area relationship from the ecological theory of island biogeography (MacArthur and Wilson 1967, Simberloff and Wilson, 1969). Species conservation efforts have generally shifted from single-species plans to multi-species or ecosystem protection plans, so it follows that larger parcels or patches of habitat are preferable to smaller patches.

From the perspective of a land trust, it requires nearly as much time and effort to protect a 2-acre parcel as a 200-acre parcel; therefore larger parcels are given priority over smaller parcels. However, it should be noted that larger parcels might also require additional costs for management and monitoring for easement compliance (Strager and Rosenberger 2007).

8. Assessed Value of Parcel

To provide a metric for considering what the purchase price for a particular conservation parcel might be, the assessed value of each parcel was included in the compromise analysis. This method of using appraised land value to estimate land acquisition costs was adopted from a study

by Xiang (1996). Acquisition cost information may be useful for conservation organizations that are looking to maximize the conservation returns on their investment. For example, if a 100-acre parcel can be acquired for a relatively low price, but only contains 1% suitable kite habitat, it may make more sense to use those funds to buy a smaller parcel that contains a greater amount of suitable habitat.

9. Ownership

Data for ownership were collected directly from the 2006 Levy County tax database. The ownership category of interest for kite conservation is primarily commercial forestry, specifically the real estate investment trust Plum Creek Timberlands. Plum Creek owns a large amount of suitable kite habitat in Levy County and has already shown a willingness to work with conservationists in protecting kite habitat. There are likely other landowners who are willing to participate in cooperative conservation efforts, but in the absence of a complete list, lands owned by Plum Creek were the only parcels used for this criterion.

Data Analysis

The methods used for this analysis were adapted from Strager and Rosenberger (2007). One of the many solving algorithms in the multi-criteria literature that can be used to find a prioritization solution is compromise programming (Strager and Rosenberger 2007). Compromise programming identifies non-dominated solutions under the most general conditions, allows specified goals, and provides an excellent base for interactive programming (Tecle et al. 1988). The "best" alternative from the analysis may not contain the most preferred values for all objectives; rather, it is a compromise solution that is overall better than all other

feasible combinations (Strager and Rosenberger 2007). For this analysis, the attributes of each parcel were compared to those of an ideal conservation parcel, with the end result being a single value or conservation score for each parcel evaluated (Manomet 2006).

The final output from Phase II of data development was a single GIS table containing the criteria values for each parcel of interest, which was then exported into an Excel worksheet for the final analysis. A utility value was calculated for each criterion for input into the final weighting scheme. Utility values for all criteria in the evaluation matrix were normalized to a 0 - 1 range, creating a payoff matrix with 1 being the highest or best value.

For variables in which greater values are preferred to lesser values for conservation purposes, the following normalizing calculation was applied to the raw data (Grant Firl, Colorado State University Ph.D. candidate, personal communication, February 2009):

Equation 1a.

$$\text{Utility Value} = \frac{\text{Criterion Value} - \text{MIN}(\text{Criterion Value})}{\text{MAX}(\text{Criterion Value}) - \text{MIN}(\text{Criterion Value})}$$

For example, greater distance from developed land is preferable to a shorter distance for kite conservation. The maximum distance of all parcels from a developed area was 6925 m, and the minimum distance was 0 m. If the parcel of interest is, say, 500 m from the nearest developed area, the following calculation was applied to generate the utility value for that parcel:
Utility Value = (500 – 0) ÷ (6925 – 0) = 0.0722.

For criteria in which lesser values are preferable to greater values for conservation purposes, the inverse of the previous equation was applied to the raw data (Grant Firl, Colorado State University Ph.D. candidate, personal communication, February 2009):

Equation 1b.

$$\text{Utility Value} = 1 - \frac{\text{Criterion Value} - \text{MIN}(\text{Criterion Value})}{\text{MAX}(\text{Criterion Value}) - \text{MIN}(\text{Criterion Value})}$$

For example, a shorter distance to a parcel that is already conserved is preferable for kite conservation. The maximum distance of all parcels from a conserved area was 10,654 m, and the minimum distance was 0 m. If the parcel of interest is 500 m from the nearest developed area, the following calculation was applied to generate the utility value for that parcel:

Utility Value = [1 - (500 – 0) ÷ (10,654 – 0)] = 0.9531.

Lastly, parcels owned by Plum Creek were assigned a utility value of 1 and all others were assigned a utility value of 0.

Next, the relative weight each criterion would carry in the final prioritization scheme was determined. This was done by ranking the importance of each criterion on a scale from 1 to 9, and then distributing the total weight relative to those rankings.

Equation 2.

$$\text{Weight}_{\text{criterion}} = \frac{\#\ \text{of criteria} - \text{rank}_{\text{criterion}} + 1}{\sum_{i=1}^{i=\#\ \text{of criteria}} \text{rank}_{\text{criterion}_i}}$$

For example, for the criterion of suitable habitat area within the parcel, ranked #1 in importance:

$$\text{Weight}_{\text{criterion \#1}} = \frac{9 - 1 + 1}{1 + 2 + 3 + \cdots + 9} = \frac{9}{45} = 0.2$$

Table 3 displays the nine criteria generated in the data development phase, the ranks of importance, and the relative weight assigned to each criterion for use in the prioritization scheme. Measures of habitat suitability (criteria 1 - 3) account for 43.4%, measures of spatial arrangement or connectivity potential (criteria 4 - 7) account for 40%, and the socioeconomic factors (criteria 8 and 9) account for only 6.6% of the total conservation score for each parcel.

While somewhat arbitrary, the weighting scheme can easily be modified based on the particular priorities of the end-user. For example, if a wildlife agency was looking to create connectivity between conserved lands, distance from conservation lands might be assigned the highest relative weight.

Table 3. Multi-criteria prioritization scheme.

Criterion	**Rank**	**Relative Weight**
Suitable habitat within parcel (acres)	1	0.20
Suitable habitat within 1 km	2	0.178
Suitable habitat within 1 - 3 km	3	0.156
Distance to nearest conservation land	4	0.133
Distance to nearest developed land	5	0.111
Distance to nearest municipal service district	6	0.089
Total area of parcel (acres)	7	0.067
Assessed value of parcel	8	0.044
Ownership by Plum Creek	9	0.022

Finally, the utility values for all nine criteria were combined into a final conservation score calculation for each parcel of interest. The following calculation was applied to generate a raw conservation score:

Equation 3.

$$\text{Raw Conservation Score} = \sum_{i=1}^{\#\text{ of criteria}} (\text{utility value})_i * (\text{criterion weight})_i$$

or:

$$\text{Raw Conservation Score} = u_1 w_1 + u_2 w_2 + \cdots + u_9 w_9$$

Each raw conservation score was then normalized and multiplied by 100 to represent the final conservation score as a readily understandable value between 0 and 100.

Equation 4.

$$\text{Final Conservation Score} = 100 * \frac{\text{Raw Conservation Score} - \text{MIN}(\text{Conservation Score})}{\text{MAX}(\text{Conservation Score}) - \text{MIN}(\text{Conservation Score})}$$

An "if-then" statement was applied to the distance to conservation land utility value so that all parcels within or directly abutting conservation land were assigned a value of 1 (the maximum criterion score possible). This made it possible to distinguish which parcels are actually conserved versus those that are simply adjacent to a conserved parcel based on the DESCRIPTION attribute of each parcel. The final output shows that many of the highest ranking parcels are, in fact, already conserved. These parcels were intentionally included in the prioritization scheme to evaluate how well these conserved parcels would score in terms of kite habitat suitability. All parcels that had been classified as "conservation lands" during the data development phase were then removed, and the prioritization scheme was repeated. This final analysis step most accurately identifies which parcels should be prioritized for current conservation action.

Results

By using GIS to examine the parcels within Levy County, those parcels containing the most desirable characteristics for kite conservation were identified. Parcels receiving a conservation score greater than 70 were deemed "priority" (Figure 8). See Appendix B for selected information on parcels scoring greater than 70.

The descriptive statistics of the 7,217 parcels under consideration (not including conserved parcels) are shown in Table 4. In summary, 94 parcels scored 70 or greater, but the mean score was only 19.6. A histogram of the final score distribution illustrates the long positive tail of the data (Figure 9).

As explained previously, the analysis was repeated with parcels classified as "conserved" included. Table 5 displays the descriptive statistics for *only* those 288 parcels that are already conserved. This step facilitates comparison of how well conserved parcels perform in the compromise analysis versus those parcels that are still under consideration for conservation.

The descriptive statistics of the 288 conserved parcels indicate that 41 parcels scored greater than 70. The mean score of the conserved parcels was 44.7; this is much greater and more than one standard deviation away from the mean score of parcels under consideration. The histogram of the conserved parcels' scores indicates a more normal distribution (Figure 10).

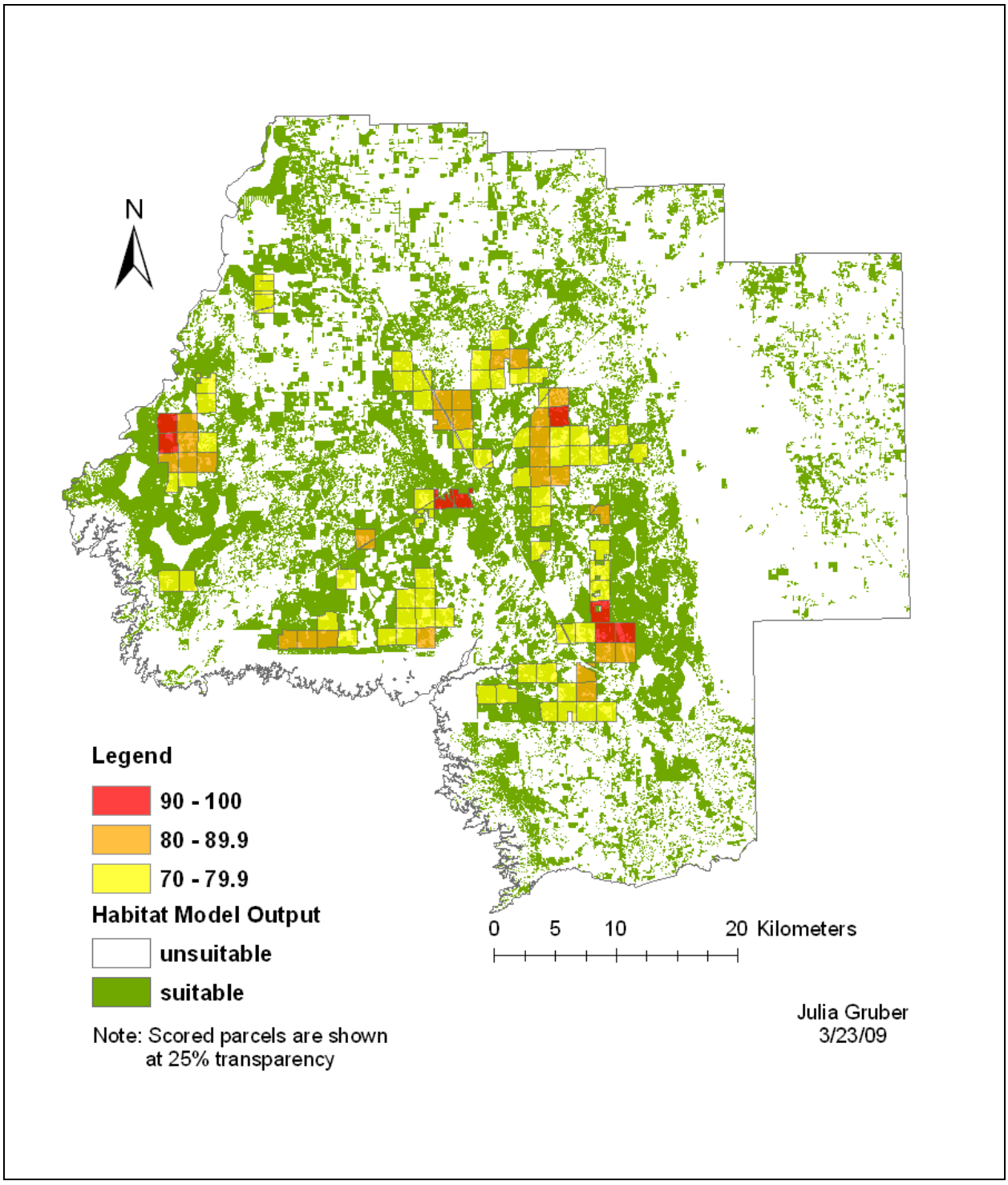

Figure 8. Levy County parcels with conservation scores > 70.

Table 4. Statistics of conservations scores, all parcels

Conservation Scores	
Mean	19.632
Median	16.605
Standard Deviation	12.412
Number scoring 70 - 79.9	62
Number scoring 80 - 89.9	25
Number scoring > 90	7

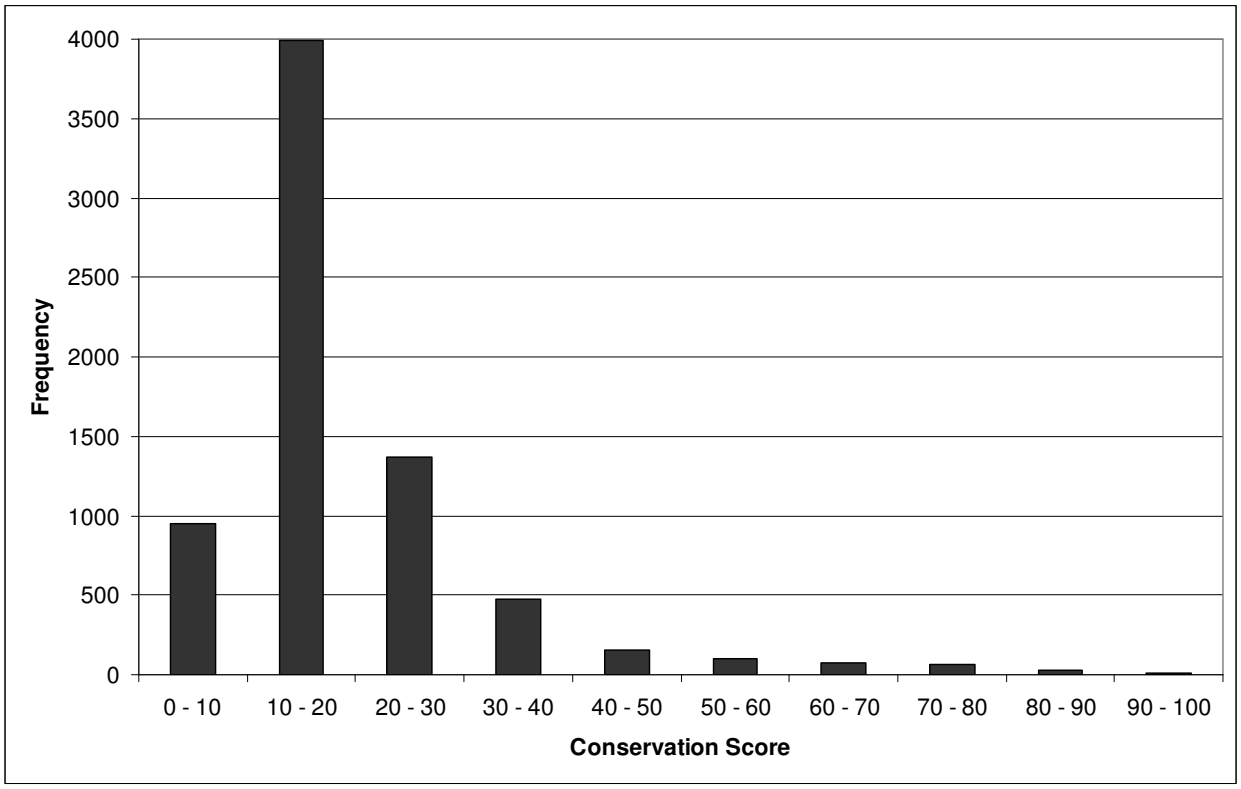

Figure 9. Histogram of conservation scores, all parcels

Table 5. Statistics of conservation scores, conserved parcels only.

Conservation Scores	
Mean	44.771
Median	42.485
Standard Deviation	20.328
Range	85.643
Minimum	14.357
Maximum	100
Number scoring 70 - 79.9	19
Number scoring 80 - 89.9	17
Number scoring > 90	5

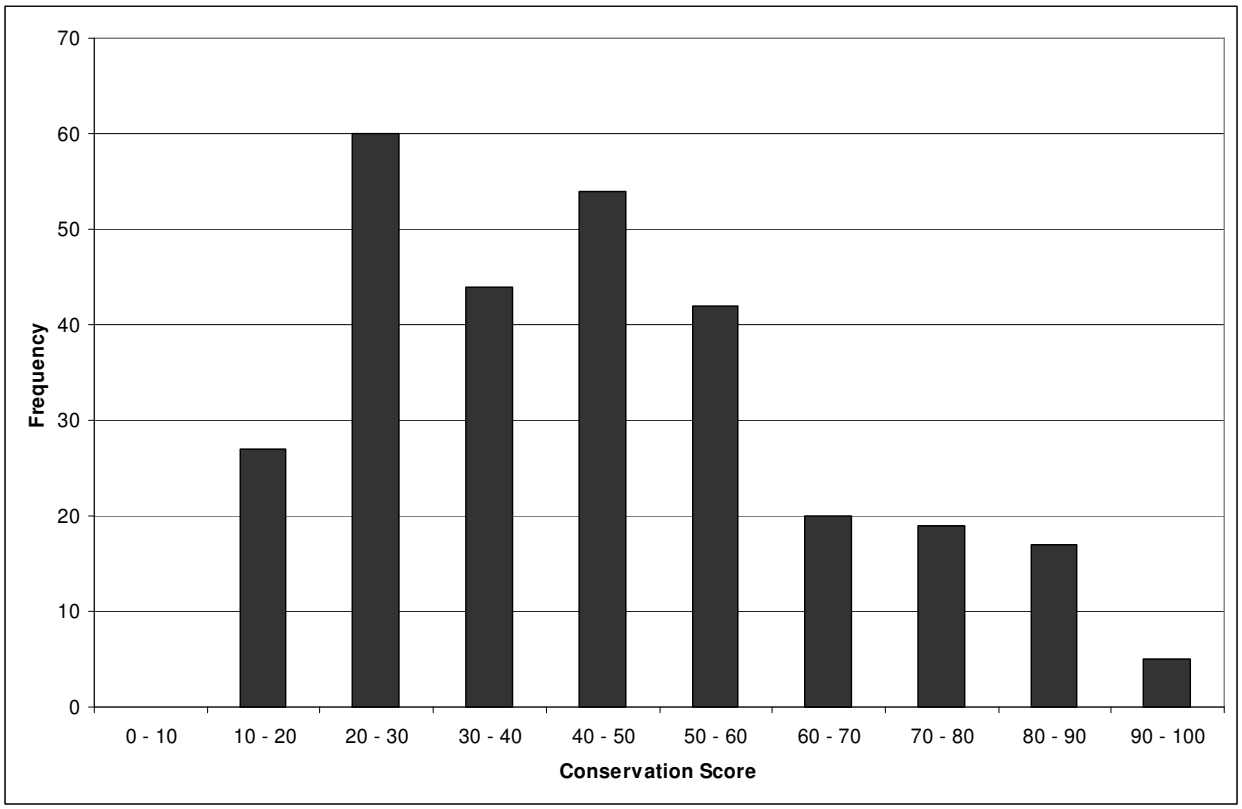

Figure 10. Histogram of conservation scores, conserved parcels only.

Discussion

The output of this multi-criteria analysis provides useful information for conservationists to consider when prioritizing parcels of land for kite habitat protection. It is hoped that when the southeastern regional kite habitat model is completed, the methods used in this study can be applied to other counties or regions.

As discussed previously, the rank of importance assigned to the individual criteria can be easily modified to match the specific goals of the end-user. Adding or removing criteria is also possible, with appropriate revisions of the final score calculation. The proportional weighting scheme can also be adjusted. Assigning equal weights to all criteria is common in multi-criteria analysis studies (Lynn Maguire, Duke University faculty, personal communication, March 2009). If applied to this study, each criterion would carry a weight of 0.11. While somewhat less biased than assigning weights proportional to rank, this method does not seem to adequately measure the suitability of parcels for kite conservation, nor does it incorporate the knowledge and desires of the land managers.

An alternate weighting scheme was applied to the data to provide a basic sensitivity analysis. As shown in Table 6, the criteria ranks remained the same for this test, but the relative weight each carried was slightly different. In this alternate prioritization scheme, measures of habitat suitability (criteria 1 - 3) account for 45%, measures of spatial arrangement and connectivity potential (criteria 4 - 7) account for 50%, and the socioeconomic factors (criteria 8 and 9) account for 5% of the total conservation score for each parcel. Recall that in the primary analysis these values were 43.4%, 40%, and 6.6%, respectively. The descriptive statistics presented in Table 7 indicate that the mean score was slightly higher (20.9 vs. 19.6), and that more parcels scored greater than 70 in the alternate analysis (124 vs. 94).

Table 6. Multi-criteria prioritization, alternate scheme.

Criterion	Rank	Relative Weight
Suitable habitat within parcel (acres)	1	0.2
Suitable habitat within 1km	2	0.13
Suitable habitat within 1-3km	3	0.12
Distance to nearest conservation land	4	0.15
Distance to nearest developed land	5	0.15
Distance to nearest municipal service district	6	0.1
Total area of parcel (acres)	7	0.1
Assessed value of parcel	8	0.025
Ownership by Plum Creek	9	0.025

Table 7. Conservation scores, alternate prioritization scheme

Conservation Score	
Mean	20.993
Median	17.716
Standard Deviation	13.277
Number scoring 70 - 79.9	59
Number scoring 80 - 89.9	46
Number scoring > 90	19

The results of these two analyses were very similar. The alternate scheme generated 31 additional parcels that scored greater than 70, but only one parcel was prioritized in the primary scheme that was not prioritized in the alternate scheme. Because the same parcels scored highest in both prioritization schemes, this indicates that scoring process is relatively insensitive to minor adjustments in criteria weights.

A limitation of this study is the accuracy level of the kite habitat model. For example, examination of the model output (Figure 5) reveals that not all known nest points are located within an area deemed “suitable” by the beta version of the habitat model. All nest points recorded from 1997 to 2008 were used in creation of the habitat model, so the land use-land

cover associated with some older points may be vastly different from the current land use-land cover. Furthermore, it has been hypothesized that the clumped nesting distribution and unique breeding behavior of Swallow-tailed Kites may impede their ability to disperse into unused habitat that may otherwise appear suitable (Cely 2005). If this hypothesis holds merit, it would seem that conservation efforts should be focused on protecting established nesting areas, rather than protecting areas that seem to possess suitable habitat conditions.

Another limitation of this study lies in the accuracy and availability of data. For example, the assessed value of each parcel obtained from the Levy County tax mapping records may or may not accurately reflect the true market or re-sale value of the property. However, the results of this study provide only a starting point for conservationists. Careful examination of the individual parcels being considered for kite conservation will be necessary. Furthermore, the results of this study could be improved with the availability of more data. As discussed in the data development phase, there is certainly redundancy between the 'distance to developed land' and 'distance to municipal service district' criteria. Given the available data, the distance to MSD criterion was used as a proxy for threat of future development.

Upon identification of the highest scoring parcels for Swallow-tailed Kite habitat protection, several conservation options are available. Some possibilities are management agreements such as Candidate Conservation Agreements (CCAs) with the U.S. Fish and Wildlife Service (USFWS), or direct acquisition or conservation easement through a local land trust. CCAs provide assurances from regulatory action in response to specified management cooperation as an incentive to help prevent the necessary listing of a species. If the species does become listed, a landowner is not faced with any stricter land-use restrictions (USFWS). Langpap (2006) suggests that incentive programs aimed at eliciting conservation-oriented

management decisions from landowners can be effective. Survey data indicate that compensation for management actions and assurances against land-use restrictions can be effective incentives, whereas cost-sharing may not be as effective (Langpap 2006).

Plum Creek Timberlands offers protections with no formal agreements or financial compensation; these are perhaps best termed something like "cooperative management" or "contributory management" (Ken Meyer, ARCI, personal communication March 2009). These voluntary actions are based on current relationships with conservation organizations and perhaps stakeholder influence, and are therefore more temporary than other approaches. ARCI and USFWS have formally proposed Candidate Conservation Agreements to Plum Creek, but even though these are non-binding and impose no penalties for abandonment, they have not wanted such a formal agreement. Perhaps they feel they would attract too much negative public response if they ended such a cooperative relationship (Ken Meyer, ARCI, personal communication, March 2009).

Kite management in Levy County will be most effective if multiple approaches are employed, and if ample communication and cooperation occurs between the various stakeholders. There is a need for increased cooperative partnerships between the public, NGOs, timber companies, private landowners, and government agencies to share information and generate support for protection of Swallow-tailed Kites (Cely 2005). Kite nest locations should be incorporated into land management and protection efforts, including increases in public ownership, conservation easements, and fee-simple purchases (Cely 2005). Land managers and foresters should be supported in protection of kite nest sites during timber harvesting operations. Protection of habitat throughout the kites' migratory and wintering ranges is also critical for effective conservation of this species.

Literary Citations

ARCI (Avian Research and Conservation Institute). Unpublished data.

Beyeler, S. 2008. Swallow-tailed Kite Habitat Model Description. Unpublished.

Cely, J.E. 2005. Swallow-tailed Kite (*Elanoides forficatus*) Fact Sheet. South Carolina Department of Natural Resources. http://www.dnr.sc.gov/cwcs/pdf/Swallowtailedkite.pdf

Cely, J.E. and J.A. Sorrow. 1990. The American Swallow-tailed Kite in South Carolina. Nongame and Heritage Trust Section publication No. 1 South Carolina Wildlife and Marine Resources Department, Columbia, South Carolina.

Duffy, A. 2000. Chaparral Patch Preservation in the Elkhorn Slough Watershed. Unpublished. University of California, Santa Cruz. http://gis.ucsc.edu/Projects/student/duffy.pdf

IUCN 2008. 2008 IUCN Red List of Threatened Species. www.iucnredlist.org. Downloaded on 14 April 2009.

Langpap, C. 2006. Conservation of endangered species: Can incentives work for private landowners? Ecological Economics 57 (2006) 558-572.

MacArthur, R.H. and E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, NJ.

Malczewski, J. 1999. GIS and Multi-criteria Decision Analysis. Wiley, New York, NY.

Manomet Center for Conservation Sciences. 2006. Conservation Scorecard: A Tool for Prioritizing Land Conservation. Manomet, Massachusetts. www.manomet.org.

Meyer, K.D. and M.W. Collopy. 1995. Status, distribution, and habitat requirements of the American Swallow-tailed Kite in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA.

Meyer, K.D. 1995. Swallow-tailed Kite (*Elanoides forficatus*). *In* A. Poole and F. Gill, editors. The Birds of North America, Number 138. Academy of Natural Science, Philadelphia, PA, and American Ornithologists Union, Washington, D.C., USA.

Meyer, K.D. 2004a. Conservation and management of the Swallow-tailed Kite. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA.

Meyer, K.D. 2004b. Demography, dispersal, and migration of the Swallow-tailed Kite. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA.

Meyer, K.D. 2005a. Project Proposal: Modeling habitat selection and spatially-explicit demography of the Swallow-tailed Kites to target development of Candidate Conservation Agreements in Florida, Georgia, and South Carolina. October 2005.

Meyer, K.D. 2005b. Survival and fecundity of adult Swallow-tailed Kites breeding in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA.

Millsap, B.A., J.A. Gore, D.E. Runde, and S.I. Cerulean. 1989. Setting priorities for the conservation of fish and wildlife species in Florida. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Section. Tallahassee, FL.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion SD.

Platt, R.H. 2004. Land Use and Society: Geography, Law, and Public Policy. Island Press, Washington, D.C. p 229.

Robertson, W.B. 1988. American Swallow-tailed Kite. *In* R.S. Palmer, ed. Handbook of North American Birds, Vol. 4. Yale University Press, New Haven, CT.

Simberloff, D. and E.O. Wilson. 1969. Experimental zoogeography of islands – colonization of empty islands. Ecology 50: 278-296.

Strager, M.P. and R.S. Rosenberger. 2007. Aggregating high-priority landscape areas to the parcel level: An easement implementation tool. Journal of Environmental Management 82 (2007) 290-298.

Tecle, A., M.M. Fogel, and L. Duckstein. 1988. Multicriterion analysis of forest watershed management alternatives. Water Resources Bulletin – American Water Resources Association 24 (6), 1169-1177.

U.S. Fish and Wildlife Service. 1999. Notices: Announcement of Final Policy for Candidate Conservation Agreements with Assurances. Federal Register: Vol. 64, No.116, 17 Jun 1999.

Xiang, W. 1996. GIS-based riparian buffer analysis: injecting geographic information into landscape planning. Landscape and Urban Planning. 34: 1-10.

Appendix A

Land use descriptions classified as "Developed Land"

Airports, marinas, bus terminals, piers
Automotive repair, service, and sales
Boarding home (institutional)
Camps
Canneries, distilleries, wineries
Centrally assessed (railroad)
Churches
Clubs, lodges, and union halls
Colleges
Community Shopping Center
Condominiums
Cultural Organizations
Drive-in restaurants
Enclosed theater, auditoriums
Financial institutions
Florist, greenhouses
Fruit, vegetables, meat packing
Golf courses
Homes for aged
Hotels, motels
Industrial storage (fuel, equip, and material)
Light manufacturing
Lumber yards, sawmills, planning mills
Military
Mineral processing
Mixed use (i.e. storage and office)
Mobile homes
Mortuaries, cemeteries
Multi-family
Multi-family less than 10 units
Night Clubs, bars, cocktail lounges
One-story non-professional offices
Orphanages
Other food processing
Other municipal
Parking lots, mobile home sales
Poultry, bees, tropical fish, rabbits, etc.
Private hospitals
Professional service buildings
Public hospitals
Public Schools
Race horse, auto, dog tracks
Regional shopping malls
Repair service shops
Restaurants, cafeterias
Rights-of-way streets, roads, canals
Service stations
Sewage disposal, borrow pits, wetlands
Single family homes
Stores, one-story
Supermarket
Tourist attractions
Utilities
Warehouses and distribution centers
Wholesale, manufacturing, production outlets

Appendix B: Selected information on parcels scoring > 70.

Parcel ID	Assessed Value	Owner	Parcel Size (acres)	Description	Suitable Habitat w/in Parcel (acres)	Distance to Conservation Land (m)	Conservation Score
19048	$85,276	PLUM CREEK TIMBERLANDS	507.0	TIMBERLAND	477.1	4600	100.00
19065	$87,624	PLUM CREEK TIMBERLANDS	511.2	TIMBERLAND	484.8	6086	93.41
39608	$72,504	PLUM CREEK TIMBERLANDS	651.0	TIMBERLAND	501.2	259	92.70
43843	$107,864	PLUM CREEK TIMBERLANDS	663.4	TIMBERLAND	494.8	0	92.29
44878	$94,172	PLUM CREEK TIMBERLANDS	664.5	TIMBERLAND	501.9	0	91.96
44882	$94,660	PLUM CREEK TIMBERLANDS	665.4	TIMBERLAND	463.3	0	90.95
39237	$134,683	PLUM CREEK TIMBERLANDS	663.3	TIMBERLAND	576.0	845	90.75
39297	$113,032	PLUM CREEK TIMBERLANDS	631.6	TIMBERLAND	578.5	30	89.70
39614	$118,838	PLUM CREEK TIMBERLANDS	660.8	TIMBERLAND	597.7	517	89.47
40402	$97,808	PLUM CREEK TIMBERLANDS	643.4	TIMBERLAND	520.7	1034	88.81
12364	$109,241	PLUM CREEK TIMBERLANDS	612.6	TIMBERLAND	337.6	829	87.08
36938	$883,200	LEVY COUNTY	646.3	OTHER COUNTIES	519.4	1242	86.70
39298	$44,480	PLUM CREEK TIMBERLANDS	660.5	TIMBERLAND	562.6	1427	86.59
48577	$112,640	PLUM CREEK TIMBERLANDS	577.6	TIMBERLAND	549.1	377	86.18
38855	$144,274	PLUM CREEK TIMBERLANDS	602.7	TIMBERLAND	501.5	2362	85.30
39609	$89,600	PLUM CREEK TIMBERLANDS	669.1	TIMBERLAND	409.4	1761	85.29
40401	$57,336	PLUM CREEK TIMBERLANDS	478.5	TIMBERLAND	385.4	147	85.00
38859	$104,992	PLUM CREEK TIMBERLANDS	633.8	TIMBERLAND	626.7	803	84.83
40388	$105,113	PLUM CREEK TIMBERLANDS	647.8	TIMBERLAND	558.9	1505	84.34
44908	$88,880	PLUM CREEK TIMBERLANDS	666.3	TIMBERLAND	347.1	0	84.19
44976	$122,056	PLUM CREEK TIMBERLANDS	669.5	TIMBERLAND	502.7	0	83.43
7704	$106,301	PLUM CREEK TIMBERLANDS	555.2	TIMBERLAND	456.8	20	83.19
41112	$99,660	PLUM CREEK TIMBERLANDS	647.8	TIMBERLAND	579.8	2655	83.06
48579	$57,308	PLUM CREEK TIMBERLANDS	595.5	TIMBERLAND	517.0	384	82.85
45019	$61,504	PLUM CREEK TIMBERLANDS	524.8	TIMBERLAND	417.9	3277	82.57
14904	$111,821	PLUM CREEK TIMBERLANDS	643.0	TIMBERLAND	568.5	2372	82.34

42078	$78,030	PLUM CREEK TIMBERLANDS	474.9	TIMBERLAND	456.3	0	82.13
45415	$139,748	PLUM CREEK TIMBERLANDS	654.9	TIMBERLAND	565.6	3235	81.76
44907	$84,000	PLUM CREEK TIMBERLANDS	582.5	TIMBERLAND	552.7	0	81.10
44975	$110,614	PLUM CREEK TIMBERLANDS	659.7	TIMBERLAND	508.4	1630	80.66
31630	$86,963	PLUM CREEK TIMBERLANDS	538.1	TIMBERLAND	421.6	1237	80.55
40403	$91,904	PLUM CREEK TIMBERLANDS	637.9	TIMBERLAND	511.9	2580	80.02
40519	$89,600	PLUM CREEK TIMBERLANDS	646.3	TIMBERLAND	507.7	6255	79.70
39372	$94,505	PLUM CREEK TIMBERLANDS	567.3	TIMBERLAND	507.1	2426	79.66
41114	$103,769	PLUM CREEK TIMBERLANDS	653.0	TIMBERLAND	488.4	2411	79.65
44613	$72,520	PLUM CREEK TIMBERLANDS	564.3	TIMBERLAND	477.7	1773	79.36
40179	$113,366	PLUM CREEK TIMBERLANDS	621.0	TIMBERLAND	356.1	0	79.28
43293	$89,600	CABER CORPORATION	701.4	TIMBERLAND	573.8	0	79.28
44427	$89,600	PLUM CREEK TIMBERLANDS	638.0	TIMBERLAND	539.7	1710	79.18
45657	$102,056	PLUM CREEK TIMBERLANDS	662.0	TIMBERLAND	566.0	3224	79.02
36834	$54,274	PLUM CREEK TIMBERLANDS	317.8	TIMBERLAND	201.2	20	78.96
30234	$112,992	SLEEPY CREEK FARMS INC	674.7	TIMBERLAND	614.9	566	78.75
45021	$75,600	PLUM CREEK TIMBERLANDS	634.5	TIMBERLAND	505.9	905	78.71
45022	$111,104	PLUM CREEK TIMBERLANDS	647.0	TIMBERLAND	496.3	2512	78.60
30242	$108,252	SLEEPY CREEK FARMS INC	589.2	TIMBERLAND	494.1	524	78.48
40339	$103,518	PLUM CREEK TIMBERLANDS	664.0	TIMBERLAND	530.6	1770	78.47
43530	$89,600	PLUM CREEK TIMBERLANDS	648.5	TIMBERLAND	500.5	2810	78.43
38297	$129,331	PLUM CREEK TIMBERLANDS	637.2	TIMBERLAND	446.1	0	78.41
40338	$100,545	PLUM CREEK TIMBERLANDS	674.6	TIMBERLAND	448.9	2803	78.39
39659	$99,930	PLUM CREEK TIMBERLANDS	599.7	TIMBERLAND	495.2	1719	78.38
34929	$122,190	PLUM CREEK TIMBERLANDS	676.2	TIMBERLAND	390.5	1794	78.32
38858	$130,339	PLUM CREEK TIMBERLANDS	632.9	TIMBERLAND	581.6	2157	78.20
45509	$89,200	WOODROE FUGATE & SONS	628.3	TIMBERLAND	594.4	0	77.95
40634	$83,812	WOODROE FUGATE & SONS	608.1	TIMBERLAND	573.4	781	77.22
38811	$51,392	PLUM CREEK TIMBERLANDS	639.3	TIMBERLAND	512.8	1896	76.78
32659	$154,628	PLUM CREEK TIMBERLANDS	627.6	TIMBERLAND	468.4	807	76.59
35936	$96,708	WHITEHURST CATTLE CO	625.5	TIMBERLAND	471.5	2861	76.03

43529	$89,600	PLUM CREEK TIMBERLANDS	643.3	TIMBERLAND	523.5	3327	76.00
16177	$90,284	WOODLAND III LTD	513.9	TIMBERLAND	362.3	439	75.91
41848	$129,291	PLUM CREEK TIMBERLANDS	664.6	TIMBERLAND	526.8	4024	75.77
30251	$73,514	PLUM CREEK TIMBERLANDS	473.2	TIMBERLAND	356.8	0	75.65
44881	$89,600	PLUM CREEK TIMBERLANDS	689.7	TIMBERLAND	338.7	1227	75.63
44883	$143,071	PLUM CREEK TIMBERLANDS	584.2	TIMBERLAND	413.5	2913	75.53
42099	$110,595	PLUM CREEK TIMBERLANDS	660.9	TIMBERLAND	536.6	2825	75.43
34923	$99,301	PLUM CREEK TIMBERLANDS	640.3	TIMBERLAND	477.2	212	75.41
38210	$662,400	LEVY COUNTY	491.1	OTHER COUNTIES	321.0	0	75.32
16758	$70,188	PLUM CREEK TIMBERLANDS	477.6	TIMBERLAND	401.1	933	75.28
45393	$106,412	PLUM CREEK TIMBERLANDS	633.1	TIMBERLAND	424.8	4224	75.09
39610	$89,600	PLUM CREEK TIMBERLANDS	634.5	TIMBERLAND	373.1	3230	74.82
38151	$72,800	PLUM CREEK TIMBERLANDS	539.7	TIMBERLAND	295.5	613	74.52
48475	$69,256	PLUM CREEK TIMBERLANDS	664.0	TIMBERLAND	393.7	4250	74.39
44428	$89,600	PLUM CREEK TIMBERLANDS	619.2	TIMBERLAND	375.6	1340	74.07
41613	$112,108	PLUM CREEK TIMBERLANDS	523.3	TIMBERLAND	490.9	0	73.95
37045	$107,996	PLUM CREEK TIMBERLANDS	645.5	TIMBERLAND	419.5	1593	73.93
19036	$104,521	PLUM CREEK TIMBERLANDS	638.9	TIMBERLAND	484.5	6436	73.62
48581	$88,960	PLUM CREEK TIMBERLANDS	543.3	TIMBERLAND	477.7	358	73.57
48578	$22,850	PLUM CREEK TIMBERLANDS	564.3	TIMBERLAND	337.2	374	73.47
48582	$89,600	PLUM CREEK TIMBERLANDS	538.4	TIMBERLAND	441.1	353	73.38
43368	$89,600	PLUM CREEK TIMBERLANDS	664.2	TIMBERLAND	554.4	4243	73.11
41111	$93,915	PLUM CREEK TIMBERLANDS	572.0	TIMBERLAND	536.9	2299	72.97
38179	$77,280	SLEEPY CREEK FARMS INC	449.1	TIMBERLAND	303.5	0	72.66
45655	$102,676	PLUM CREEK TIMBERLANDS	535.2	TIMBERLAND	496.1	3545	72.58
45656	$97,012	PLUM CREEK TIMBERLANDS	546.8	TIMBERLAND	471.6	4771	72.34
34943	$104,280	PLUM CREEK TIMBERLANDS	651.6	TIMBERLAND	460.5	799	72.06
43292	$152,396	CABER CORPORATION	571.6	TIMBERLAND	539.5	0	71.69
45660	$95,704	PLUM CREEK TIMBERLANDS	659.0	TIMBERLAND	467.1	1611	71.56
34930	$99,506	PLUM CREEK TIMBERLANDS	651.4	TIMBERLAND	418.0	2878	71.45
44421	$89,600	PLUM CREEK TIMBERLANDS	631.5	TIMBERLAND	414.9	743	71.00

7150	$76,570	PLUM CREEK TIMBERLANDS	632.7	TIMBERLAND	468.5	1951	70.82
39613	$89,112	PLUM CREEK TIMBERLANDS	492.3	TIMBERLAND	406.5	20	70.67
19037	$42,632	PLUM CREEK TIMBERLANDS	276.8	TIMBERLAND	260.8	7645	70.56
40059	$83,895	PLUM CREEK TIMBERLANDS	517.4	TIMBERLAND	441.9	0	70.46
31650	$111,936	SLEEPY CREEK FARMS INC	651.3	TIMBERLAND	559.4	142	70.38
40738	$105,446	PLUM CREEK TIMBERLANDS	618.7	TIMBERLAND	377.2	805	70.14