Vegetation Survey Report:

Feasibility of Red-cockaded Woodpecker Reintroduction into Pine Flatwoods Communities at Jonathan Dickinson State Park – Preliminary Study

April 2011

Project by:

Katie O'Gara

Palm Beach State College

Department of Environmental Science Technology

ABSTRACT

The endangered Red-cockaded woodpecker (*Picoides borealis*; RCW) is a specialist vulnerable to variation in the spatial arrangement of its habitat (USFWS, 2003). Jonathan Dickinson State Park (JDSP), located in Martin and Palm Beach counties in South Florida, is considering the reintroduction of the RCW into suitable pine flatwoods ecosystems to contribute to nationwide RCW recovery. To initiate the achievement of this goal, a fixed area plot vegetation survey was performed at JDSP to collect baseline data on potential RCW foraging habitat. A total of 58 plots from 9 management zones within the Park were surveyed. In each plot, tree heights, tree diameter, basal area per stand, overstory density, understory density, and understory and midstory height were gathered. Results were compared with the South Central Florida Recovery Unit (SCFRU) foraging habitat guidelines (USFWS, 2006). Preliminary data showed that JDSP's pine flatwoods contain plenty of large diameter trees over 9 inches, some medium trees, and few small diameter trees. Four recently burned zones demonstrated a BA of at least 3,000 square feet (sq. ft.). Five additional zones fulfilled the requirement for at least 2,000 sq. ft. of pine with BA ≥9 inches in diameter. Results for the 4 to 8 inch DBH category showed that three zones had slightly greater than 1,000 sq. ft. of BA. Lastly, four zones had zero pine trees <4'' in diameter. Vegetation survey results will be used in conjunction with future habitat assessments to determine whether JDSP satisfies recovery guidelines for optimal RCW foraging habitat according to the USFWS (2003).

INTRODUCTION

To protect biological diversity, conservation biology must receive considerable attention. One component of conservation biology involves establishing an understanding of species richness, a desirable characteristic for anthropogenic purposes related to economics and aesthetics but also, and more importantly, for the support of an ecologically healthy ecosystem (Bolen & Robinson, 2003). The United States is an important location for implementing conservation biology principles because of the country's general concern for environmental issues, establishment of biological and natural resource management agencies and institutions, and secure ownership of federal and state lands. In the U.S., large tracts of public land, under government ownership, are managed by professional scientists and governed by legislation relevant to wildlife and natural resource protection and conservation (Bolen & Robinson, 2003). Private lands are equally important for wildlife management; however, private lands are not subject to the same restrictive legal regulations that govern state parks, national parks, and wildlife refuges. Additionally, it is difficult to manage conservation efforts between private lands owners because they may lack professional understanding, agreeable land use plans, and the organizational structure to do so (Bolen & Robinson, 2003).

Fortunately for the public, in government parks, wildlife managers are directed to sustain nature for current and preceding generations (Bolen & Robinson, 2003). National and state parks are retreats where guests enjoy a close relationship with nature through such activities as hiking, photography, camping, and birding (Bolen & Robinson, 2003). Birding is most notable in the United States' most southern state, Florida, where birders flock to observe its approximately 500 avian species. Even though birds are abundant here, only 127 of 500 species are year round natives and 37 of those natives are rare (Rapoza, 2007).

Red-cockaded Woodpecker Characteristics and Population Decline

The Red-cockaded woodpecker (*Picoides borealis*; RCW), one of those native Florida rarities, is endemic to the southeastern pine flatwoods ecosystems of the United States (United States Fish and Wildlife Service, USFWS, 2003). RCWs use the pine landscapes to their advantage with regard to predator defense. In pine flatwoods communities, RCWs utilize resin produced by pine trees as a barrier against predators. The birds puncture "resin wells" around a cavity tree entrance daily to create a copious flow of resin (USFWS, 2003). In conjunction with bark scaling, the smooth surface created deters predators such as rat snakes from climbing up the tree and reaching the RCW cavity (Leonard, 2009). Cavity excavation in live pines is advantageous because the trees take significantly less time to excavate than dead pine trees. As a result of this behavior, RCWs have a higher nest success rate than other woodpeckers in the same range (Leonard, 2009).

These resourceful cooperative breeding birds live in family breeding groups (PBG) of two to four individuals in a cluster of several cavity trees. Family groups consist of one breeding pair and one or two young helpers from past breeding seasons. The helpers, usually males, assist the breeding pair with raising the young. When mortality of a breeding bird occurs, the helper replaces the lost breeding partner. As a result of this breeding structure, RCWs are vulnerable to variation in the spatial arrangement of their habitat (USFWS, 2003). Listed as endangered in 1970, RCWs declined 97% since European settlement. The approximately 14,000 (3%) RCWs that remain in existence today continue to struggle with unsuitable habitat conditions. This decline is attributed to fire suppression, habitat loss (3% of longleaf habitat survives today), habitat fragmentation, and habitat degradation, all of which contribute to genetic isolation and inbreeding. RCW survival during the 1800s was due to the preservation of residual trees left behind to be harvested later for resin or because they may have been infected with heartwood rot, however, those residual trees continue to be destroyed today (USFWS, 2003).

Since the enactment of the Endangered Species Act of 1973, drastic RCW declines were curtailed by intensive emergency management which peaked in the 1990s and caused many populations to stabilize and some to increase (USFWS, 2003). RCW management is practical because measures taken for RCW recovery, such as prescribed burning, also help a multitude of other species. About 27 vertebrate species such as Eastern Bluebirds and southern flying squirrels take advantage of RCW cavities. RCWs are the only species of woodpeckers to excavate in live pines; therefore, their exploitation of a distinctive niche provides many pine flatwoods vertebrates' refuge. The scarcity of shelter motivates many species, even other woodpeckers, to steal active or abandoned RCW cavities; thus, RCWs are keystone as well as indicator species (USFWS, 2003). Increased biodiversity signifies a healthy, productive ecosystem (USFWS, 2003).

Due to the collaborative efforts of scientists, government agencies, and citizens in eleven states, emergency translocation of birds from sites with large increasing populations has augmented some sites with smaller populations (USFWS, 2003). From 1989 to 1992, Florida's Apalachicola National Forest (ANF) was an important donor population for seven other national forests across the RCWs range. During that period, ANF supported the only recovered RCW population and was able to donate 18 birds to depleted sites. Today, ANF protects the United States' largest and most viable population of RCWs (1000 Friends of Florida, 2011). On the other hand, Avalon Park in Florida became a successful recipient site in 1998. As of 2001, seven potential breeding groups have been observed in Avalon Park (USFWS, 2003). Another recipient site, J.W. Corbett Wildlife Management Area (WMA) in southeast Florida's Palm Beach and Martin counties, received 12 RCWs from Citrus WMA in northwest Florida in 2010 (Parker & Ferraro, 2010). Because of several previous translocations, Corbett WMA now has 15 active clusters of 12 PBGs. Eight groups successfully hatched a total of 12 fledglings in 2010 (Parker & Ferraro, 2010).

Extensive criteria must be met before a site can be considered as a translocation donor or receiver. For example, donor sites must have 50 active clusters with at least a 3% annual increase. On the other hand, receiver sites must have a prescribed burning program and be able to support at least 10 active clusters (USFWS, 2003). Besides augmentation to increase small populations, the emergency translocation recovery technique is also used for reintroduction. But unlike augmentation, introducing pioneer populations into suitable habitats is still in the experimental phase and not commonly practiced. Nonetheless, reintroduction has great potential to be used as a management tool for conserving local biodiversity (USFWS, 2003).

Jonathan Dickinson State Park, Florida

Jonathan Dickinson State Park (JDSP), located in south-east Florida in Martin and Palm Beach Counties, is one potential RCW reintroduction site (State of Florida Department of Environmental Protection, FDEP, 2000). JDSP, established in 1947 and receiving additional property in the 1960s, is an ecologically significant site of 11,471 acres which includes the Northwest and North Forks of the Loxahatchee River and an abundance of native wildlife species (FDEP, 2000). Jonathan Dickinson State Park encompasses 13 distinctive natural vegetative communities including scrub, depression marsh, hydric hammock, sandhill, scrubby flatwoods, and wet flatwoods. Three of these communities - sandhill, scrubby flatwoods, and pine flatwoods (wet and mesic) - are generally open tracts of land with dispersed pine trees, sparse understories, and herbaceous groundcover (Fig. 1). Characteristics of these three habitat types support RCW populations. The majority of the Parks' pine flatwoods are wet flatwoods, which are represented by a South Florida slash pine (*Pinus elliotti var. densa*) overstory, a saw palmetto (*Serenoa repens*) midstory, and wiregrass (*Aristida beyrichiana*) understory (FDEP, 2000; Figure 1).

Many ecosystems in Florida have evolved to prosper in the midst of natural lightning ignited fires. For example, pine flatwoods and scrub ecosystems are responsive to fires, having some species of vegetation even requiring fire in order to propagate. In order to restore JDSP's fire-dependent natural communities to historic conditions, an effective prescribed fire program was implemented in 1971 (R. Rossmanith, Park Biologist, personal communication, April 18, 2011). In 2003, the Division of Recreation and Parks began updating its fire management plan with improvements such as annual fire planning and a statewide fire database (FDEP, 2010). The fire management plan's annual fire planning process provides a burn schedule that dictates when each management zone will be burned. Burn frequency is dependent on several factors such as habitat condition, fuel hazards, and season (FDEP, 2010). In addition, fire prescriptions are associated with community type. For example, fire should be applied to the mesic flatwoods habitat type every 2 to 5 years (FDEP, 2010). On the other hand, wet flatwoods should be burned every 2 to 6 years (FDEP, 2010). Fire dependent communities are scattered within fire independent habitat types. As prescribed fire moves through each burn zone, patches will burn according to ecosystem type. The result is a natural patchwork of burned and unburned zones (FDEP, 2010). Aside from the many ecological benefits including removal of invasive exotic species and nutrient replenishment, the prescribed fire program also prevents wildfires. Prescribed fires reduce the conditions that fuel wildfires by consuming accumulated debris, including pine needles, in a controlled manner. With the preventative measure of prescribed fire, the probability of unpredictable wildfire eruption is decreased (FDEP, 2010).

Figure 1
Example of suitable pine flatwoods understory and midstory at Jonathan Dickinson State Park (zone C5) for RCWs (at least 40% herbaceous understory, no midstory, low woody plants).

Influence of Habitat Characteristics on Arthropods in Tree Bole

The Park's pine flatwoods forest structure, with a sparse woody understory and herbaceous ground cover (Fig. 1), has been maintained by the prescribed fire program and is crucial to RCW recovery. The landscape's predominantly herbaceous understory improves RCW group size and reproductive success (USFWS, 2003). RCW fitness may be related to a correlation between increased herbaceous groundcover and the availability and quality of arthropod prey on the pine tree boles where the birds forage (USFWS, 2003). Hanula and Franzreb (1997) revealed in their study that arthropods emerged from the forest floor and used the bole of the pine tree as a route to the canopy. For example, two frequently captured weevil species, *H. pales* and *P.picivorus*, used the bole as a rest area until they were able to reach canopy feeding sites. *H. pales* and *P. picivorus* are nocturnal feeders that forage in the canopy and seek refuge in the leaf litter by day (Hanula & Franzreb, 1997). The researchers noted that wood roaches – omnivores that are regularly exploited by RCWs – were evenly distributed from tree base to canopy (Hanula & Franzreb, 1997). Hanula (1997) concluded that the majority of the arthropod community on the pine tree bole originated from the understory. This research supports the observation that RCWs require plenty of herbaceous groundcover.

However, in a subsequent study, it was discovered that tree bark thickness is directly proportional to arthropod biomass (Hanula, Franzreb, & Pepper, 2000). Therefore, though wood roaches were found high on the tree bole where the bark was thinnest, they were smaller in size. Any large roaches found high on the tree were only using dead branches. In this study, mature large diameter trees possessed more dead branches and the thickest bark with the highest arthropod biomass (Hanula et al., 2000).

In order to effectively manage RCW foraging habitat, more studies on tree characteristics (age, size, and species) must be carried out to decisively determine the arthropod ecology in pine flatwoods. A more complete understanding of the diverse arthropod community on pine trees will aide prescribed fire programs and silviculture practices in managing RCW foraging habitat more effectively (Hanula et. al., 2000).

RCW Past, Present, and Future in Jonathan Dickinson State Park

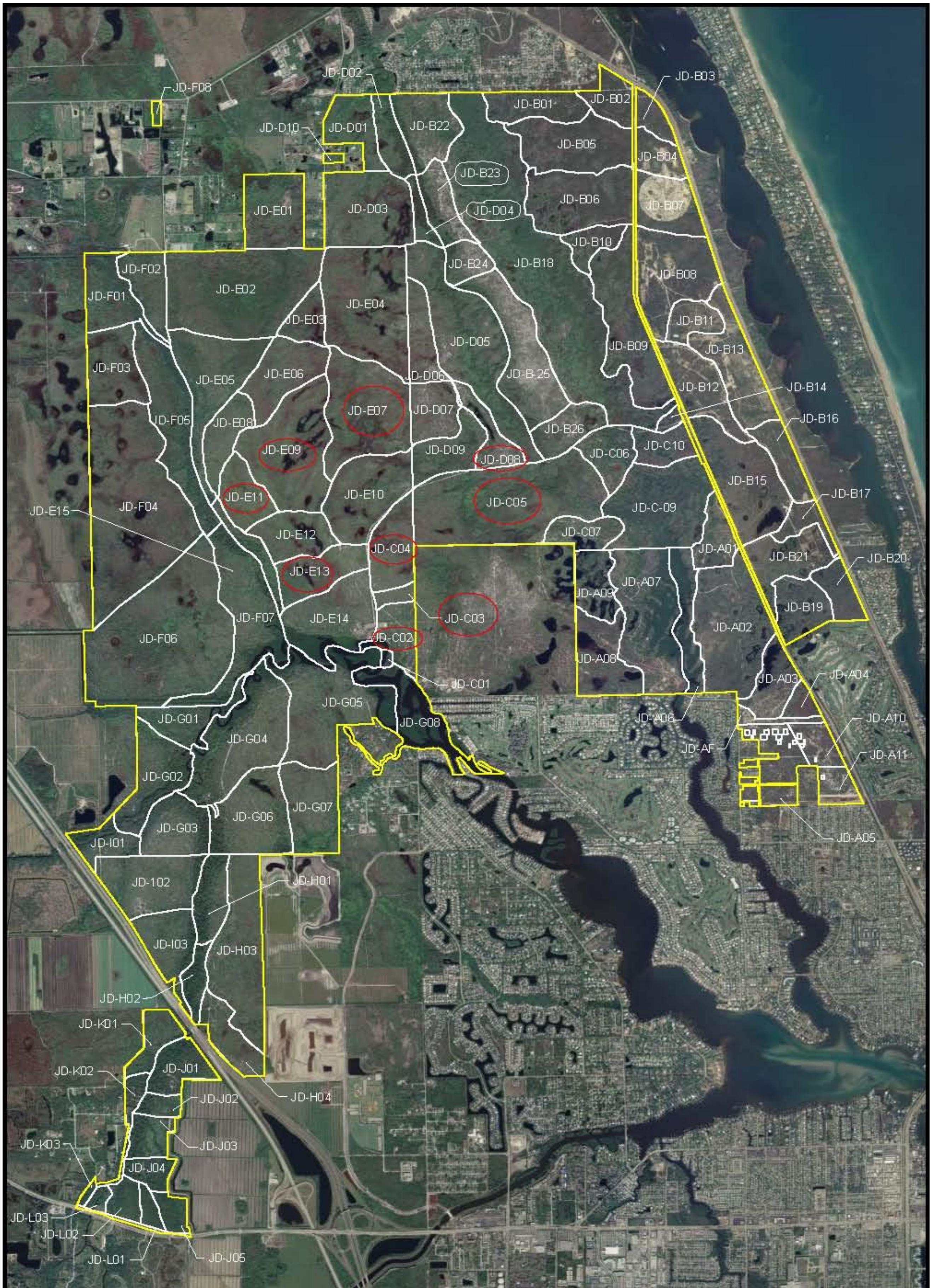
Historically, RCWs were found within JDSP's sandhills and pine flatwoods ecosystems. However, the woodpeckers have not been documented in the park since 1983 (FDEP, 2000). Extirpation of this habitat specialist was due to past logging practices, fire suppression (USFWS, 2003), habitat destruction around JDSP, and the construction and operation of a WWII U.S. Army base called Camp Murphy (FDEP, 2000). Together, these factors altered the landscape in unnatural ways. Past fire exclusion, in particular, caused more intense fires to occur in the long unburned areas once fire returned. This resulted in the loss of cavity trees (S. Tedford, Park Service Specialist, personal communication, March 11, 2011).

Nevertheless, former RCW nesting cavities exist in the park today and are still being maintained by park biologists (FDEP, 2000). With the implementation of the park's prescribed burning program, natural conditions in many of the management zones have been restored (FDEP, 2000). Therefore, it is conceivable that JDSP may, in the future, be able to support RCWs dispersing from the J.W. Corbett Wildlife Management Area and the Pal Mar wetland greenway corridor. In the interest of continuing park improvement, JDSP is considering the possibility of reintroducing RCWs into its pine flatwoods communities, as stated in the Parks' management plan (FDEP, 2000). RCW reintroduction into the Park will establish new groups that will link isolated populations in southeast Florida across the Loxahatchee Greenway. This reintroduction initiative will serve to broaden park biodiversity which, in turn, will benefit the enjoyment and education of park patrons (FDEP, 2000). To achieve this goal, a preliminary fixed area plot vegetation survey was performed at JDSP to collect baseline data on potential RCW pine flatwoods habitat quality. Vegetation survey results will be used in conjunction with future habitat assessments to determine whether JDSP satisfies recovery guidelines for optimal RCW foraging habitat according to the USFWS (2003).

METHODS

Site Description

JDSP is divided into 97 management zones, several no-burn zones, and a ten acre research zone (FDEP, 2000; Figure 2). A total of 58 1/10th acre plots from nine management zones were surveyed in the park's pine flatwoods communities. Pine flatwoods types are differentiated by plant species and hydrological period and those studied included mesic flatwoods, scrubby flatwoods, wet flatwoods, and sandhills (FDEP, 2010). The nine management zones examined were C2, C3, C4, C5, D8, E7, E9, E11, and E13 (Fig. 2). Zones were selected for study only if they appeared to be adequate enough for RCW occupation. Biologists from FDEP and the Florida Fish and Wildlife Conservation Commission (FWC) decided which JDSP zones would support RCWs.



JONATHAN DICKINSON STATE PARK

Florida Department of Environmental Protection
Division of Recreation and Park
Date of aerial photography: 2004

MANAGEMENT ZONE MAP

Figure 2
Map of surveyed management zones C2, C3, C4, C5, D8, E07, E09, E11, and E13 (circled in red) in Jonathan Dickinson State Park, Florida. Yellow line indicates the boundary of the park.

Conclusions as to the quality of the habitat at JDSP were based on knowledge from agency professionals and the USFWS (2003) RCW Recovery Plan and the South Central Florida Recovery Unit (USFWS, 2006; SCRFU) foraging guidelines. Biologists agreed to begin the reintroduction feasibility study in management zones with pockets of old growth pine trees (R. Rossmanith, Park Biologist, pers. comm., April 18, 2011). A more detailed evaluation of measurable parameters (i.e. tree diameter) was then performed on those selected sites. After the parameters were quantified, results were compared to the SCRFU foraging habitat guidelines. This weekly (2 to 3 days a week) data collection occurred from January 7th, 2011 to March 25th, 2011.

Fixed Area Plot & Associated Parameters

The fixed area plot sampling method was used to inventory pine flatwoods forest parameters. In each surveyed zone, randomly selected 1/10th acre circular plots were setup based on likely RCW usage described in the RCW recovery plan (USFWS, 2003). Only pine stands were sampled because RCWs do not exploit wetland areas and cypress stands or scrub habitat lacking a pine overstory (R. Rossmanith, Park Biologist, pers. comm., March 31 2011). One plot was sampled for every 20 acres to accurately describe the stand composition. For example, the 213.3 acre zone E7 received 10 plots (R. Rossmanith, Park Biologist, pers. comm., January 13, 2011). A Garmin GPS unit was used to mark the center of each plot and collect coordinates. Coordinates from the GPS unit were downloaded into ArcGIS mapping software. A map of the entire surveyed area generated with ArcGIS was produced (Fig. 3).

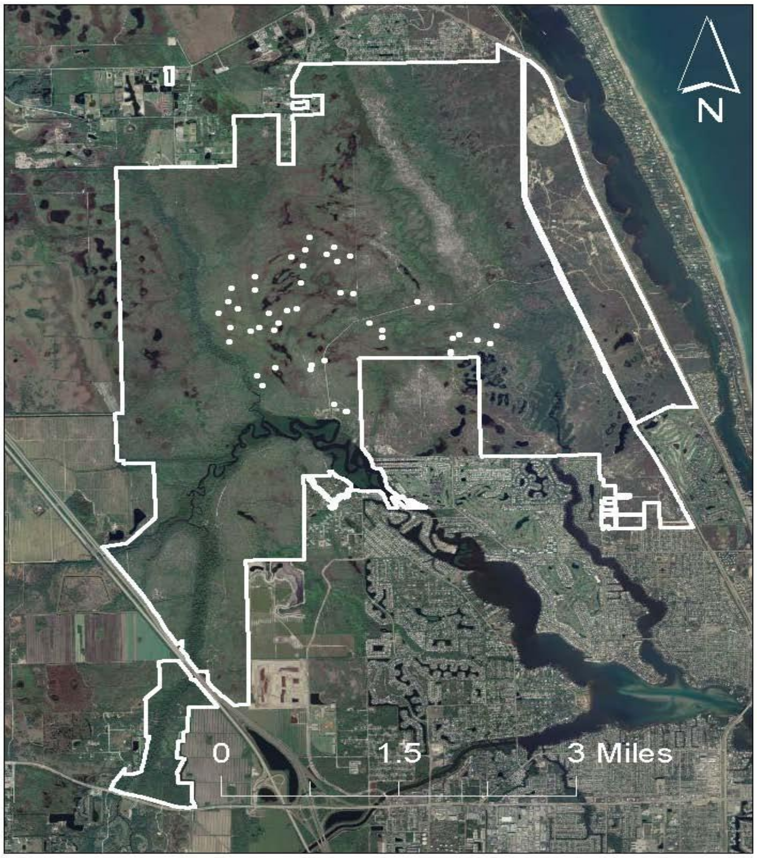


Figure 3
Map of surveyed zones C2, C3, C4, C5, D8, E7, E9, E11, and E13 in Jonathan Dickinson State Park.

From the center of each plot, a tape measure was used to pace out a radius of 37.2 feet in four directions (DNRS, 2011). Flagging tape was used to visualize the extent of each circular plot. Within each plot, the diameter and height of every tree was obtained with precision instruments and recorded. Overstory density was estimated with a spherical densiometer and groundcover composition was measured subjectively. To estimate groundcover percentages on saw palmetto and herbaceous groundcover, each plot was visually divided into four sections. Results were averaged to obtain both saw palmetto and herbaceous understory percentages for each particular plot.

For the purpose of convenience, a lumber crayon was used to assign each tree a letter. If a tree's inclusion was questionable, a tape measure was used to reassess its distance from the center of the plot (37.2 feet). When the distance landed at least at the center of the tree or was beyond the tree, it was included in the plot. However, when the tape measure reached out to less than half of the tree, the tree was excluded. The diameter at breast height (DBH) in centimeters was obtained for included trees with the use of a Lufkin 6.5m tree diameter tape (DNRS, 2011).

Results of the DBH measurements were used to calculate basal area (BA) per plot, basal area per acre, and basal area per stand. First, to make measurements compatible with the basal area in feet equation:

$$(1) \quad \text{BA (ft}^2) = \text{DBH (in)}^2 * 0.005454$$

The above equation (1) is a simplified version of equation (2):

$$(2) \quad \text{BA} = \frac{\pi}{4 \times 144} \text{DBH}^2$$

Equation (1) and (2) are the same equations used to calculate BA. In equation (1), the number 0.005454 performs the same function as:

$$\frac{\pi}{4 \times 144}$$

which is to convert from square inches to square feet (Larsen, 2010). DBH in cm values were converted to DBH in inches by the multiplying DBH centimeter values by 0.3937 inches (1 cm equals 0.3937 inches). Basal area per plot was calculated by multiplying DBH^2 by 0.005454 for each tree and thereupon adding the products. Ultimately, basal area per plot calculations were multiplied by 10 (0.1 acres) to get the BA per acre of individual plots (DFG, 2011; Table 1). BA per stand values were separated into categories outlined by the guidelines in the SCFRU (USFWS, 2006; Table 1). These categories include BA of trees with a DBH of ≥ 9 inches, BA of trees 4 to 8 inches, and BA <4 inches (USFWS, 2003). BA per stand amounts (which depended on the number of trees in the plot) for each category were calculated with the following formula:

$$(\text{DBH (in)})^2 * 0.005454 + \text{DBH (in)})^2 * 0.005454 + \ldots)10 * \text{zone acreage}$$

Tree heights were gathered with the use of a Brunton Clino Master clinometer. Height in feet (read from the left side of the clinometer's dial) was acquired at a distance of 66 feet from the tree. With the clinometer's scale superimposed onto the object, the dial scale was read with the black bearing line adjacent to the tree. Beginning from eye level, the clinometer was tilted upward to get the reading from the top of the tree. After the first measurement was taken, the clinometer was tilted downward to read the second measurement at the base of the tree. The two values were summed to determine tree height (BenMeadows.com, 2011).

For consistency, overstory readings were taken in the center of the plot with a spherical densiometer. To keep the densiometer steady, the device was placed on top of a PVC stand which also served as a marker for the plot center. Four readings were taken – facing North, East, South, and West – then recorded and averaged to estimate overstory density for each plot. A compass was used to locate cardinal direction (CDPR, 2004). In addition, the position of the sun was also used to find cardinal direction. Midstory and understory percentages (extent of plot composed of saw palmettos versus herbaceous cover) were estimated subjectively. Each plot was visually divided into four sections and percentages were averaged for both saw palmetto and herbaceous understory portions for the entire plot. Moreover, average height (Categories: ≤1m, 1-2m, >2m) of the saw palmetto midstory and herbaceous understory was measured with a tape measure (TNC, 2009). Where bare sand or woody shrub or hardwood midstory occurred, percentages and heights were noted.

RESULTS

For each management zone, results for basal area per stand within each SCFRU foraging habitat guideline category are summarized in Table 1 below. Burn zones C5, E7, E9, and E13 demonstrated a BA of at least 3,000 sq. ft. and zone C4 neared the standard with a total BA of 2,970. Total BA for zone C5 drastically exceeded 3,000 sq. ft. Zones C4, C5, E7, E9, and E13 fulfilled the requirement for at least 2,000 sq. ft. of pine BA ≥9 inches in diameter. Results for the 4 to 8 inch DBH category showed that zones C5, E7, and E9 had slightly greater than 1,000 sq. ft. of BA. Overall, zone E13 satisfied all requirements for the SCFRU guideline categories (USFWS, 2006). Zones C3, D8, E11, and E13 had zero pine trees <4’’ in diameter (Table 1).

Table 1:
Average basal area (ft^2) per stand for each burn zone according to the South Central Florida Recovery Unit (SCRFU) foraging habitat guideline categories (3).

Zone	Total BA/stand	Total BA/stand (SCFRU: ≥3,000 ft^2)	BA/stand ≥ 9"	BA/stand ≥ 9" (SCFRU: ≥ 2,000 ft^2)	BA/stand 4" to 8"	BA/stand 4" to 8" (SCRFU ≤ 1,000 sq ft^2; can be added to column 2 to = at least 3,000 ft^2)	BA/stand <4" (SCRFU: 0 BA)
C2	1627.23		1519.79		58.05		49.39
C3	374.92		306.04		68.89		0
C4	2970.49		2491.70	2491.70	460.10		18.69
C5	9084.55	9084.55	7801.91	7801.91	1201.35		81.30
D8	937.01		908.11		28.90		0
E7	5395.64	5395.64	3929.84	3929.84	1452.15		13.65
E9	5331.12	5331.12	4132.64	4132.64	1169.99		28.49
E11	1944.71		1696.17		248.54		0
E13	3199.36	3199.36	2276.45	2276.45	922.91	922.91	0

In the nine management zones examined, zones C2 and C5 did not fulfill the standard for herbaceous groundcover (≥40%). However, zones C3, C4, D8, E7, E9, E11, and E13 each had a ≥ 40% herbaceous understory (Table 2). Herbaceous understory height averaged ≤ 1 meter. Hardwood midstory was sparse and canopy hardwoods numbered well below 10% of the canopy structure. Zone C3 plot 1 contained the only occurrence of a tree other than a slash pine (turkey oak). Average saw palmetto height fell within the 1-2 meter category and rarely equaled or exceeded 2 meters. Foraging habitat range criterion was not addressed by this study because it is not required at this preliminary stage.

Table 2:
Average percentage of herbaceous understory per zone with burn year for each zone. Again note here why the c2 and C5 are red.

Zone	Last burn	Avg. herbaceous understory (%)	Number of plots <40%
C2	2009	30	1 of 1
C3	2009	40	0 of 1
C4	2009	48.75	1 of 4
C5	2009	37.94	8 of 17
D8	2010	40	1 of 3
E7	2010	45	3 of 10
E9	2010	50.45	3 of 11
E11	2010	50.83	2 of 6
E13	2010	44	2 of 5

Table 3
Average herbaceous groundcover and saw palmetto height.

Zone	Avg. herbaceous height	Avg. saw palmetto height
C2	<1m	1-2m
C3	<1m	<1m
C4	<1m	1-2m
C5	<1m	1-2m
D8	<1m	<1m
E7	1-2m	1-2m
E9	1-2m	1-2m
E11	1-2m	1-2m
E13	1-2m	1-2m

DISCUSSION

The USFWS (2003) RCW recovery plan defines good quality RCW foraging habitat as being comprised of some large mature pines, few small and medium pine trees, low hardwood midstory, and plenty of herbaceous groundcover (USFWS, 2003). BA standards in the recovery plan do not apply to longleaf pine and South Florida slash pine flatwoods ecosystems in the South and Central Florida RCW distribution range. Habitats in this region have a lower BA and pine trees are generally smaller (in diameter and height). Therefore, to meet the Standard for Managed Stability (SMS) of RCW populations, the USFWS (2006) developed the SCFRU foraging habitat guidelines. These guidelines take into account the habitat characteristics and the larger range needed by RCWs in the South and Central Florida region (USFWS, 2006). According to SCFRU guidelines, RCWs need at least 3,000 square feet (sq. ft.) of pine BA area. At least 2,000 sq. ft. of that total must be pine trees ≥9 inches in diameter and the remaining 1,000 sq. ft. can be pines with a 4 to 8 inch DBH. Pine trees <4'' are not included (USFWS, 2006). Basal area is defined as the cross-sectional area of pine trees measured in diameter at breast height which is used to gauge tree density (DFG, 2011). In addition to the basal area requirements clarified by the SCFRU, native herbaceous cover of foraging habitat must be at least 40% of ground cover and midstory vegetation (USFWS, 2003). Furthermore, hardwood midstory must be sparse and less than 7 feet tall or nonexistent. When a hardwood midstory develops RCW cavity abandonment occurs (USFWS, 2003; Figure 4). Canopy hardwoods must be nonexistent or less than 10% of the canopy structure (USFWS, 2006). Foraging habitat must be within 0.5 miles of the center of cluster and not separated by more than 200 ft. of non-foraging land; i.e. water bodies, hardwood stands, etc. (USFWS, 2003). Further studies must be completed in the future to evaluate nesting habitat parameters.

Figure 4
Example of hardwood encroachment at Jonathan Dickinson State Park in zone C5.

Preliminary results from the data showed that zone E13 met all requirements for the SCFRU guideline categories (Table 1). E13 had at least 3,000 sq. ft. of basal area and at least 2,000 sq. ft. of it was ≥9'' diameter trees. The limit for the 4'' to 8'' category was 1,000 sq. ft. of which zone E13 contained 923 sq. ft. Furthermore, zone E13 had no pine trees <4''. Zone C4 approached fulfillment of all SCFRU guideline categories. C4 had a total of 2,971 BA with at least 2,000 sq. ft. of ≥9'' diameter pines (Table 1). Although pines <4'' in diameter were sampled in zone C4, the density in this category was a low 18.69 BA. Regardless of being slightly less than 3,000 sq. ft., this zone has potential for RCW foraging habitat. Zone C4 is the site of abandoned large diameter trees with cavities previously inhabited by the now extirpated JDSP RCW population (S. Tedford, Park Service Specialist, pers. comm.). Zone C5 met all basal areas categories in excess and was slightly below the herbaceous understory requirement (38%; Table 2). However, this was a large zone that encompassed 356 acres and the highest number of plots were sampled in zone C5 (17). This zone may have potential for foraging habitat but cannot be confirmed at this time until additional studies are completed. As previously stated, foraging habitat must be within 0.5 miles of the center of cluster (USFWS, 2003). In addition, zones E7 and E9 met all categories in slight excess but generally appear to have a sufficient number a pine trees in each category. In the <4'' category for zones E7 and E9, there was a low density of pine trees present (Table 1).

Zones C2, C3, D8, and E11 were under represented because few plots were sampled in these zones. Additionally, the stand acreage extent was low compared to the other five zones. For example, three plots were sampled in 55 acre zone D8. On the contrary, 89 acre zone E13 was more than double the size of zone D8 with two additional plots. It should be noted that all nine management zones are in close proximity to each other (Figure 2). Therefore, when contemplating RCW foraging habitat, neighboring zones will not be separated from each other unless a barrier greater than 200 ft. exists (USFWS, SCFRU).

Seven of nine management zones exhibited an ample amount (≥40%) of herbaceous ground cover (Table 2). The average herbaceous groundcover for zones C2 and C5 did not meet the standard for at least 40% herbaceous understory. Overall, results illustrated that the fire management plan is successfully reducing hardwood midstory development and promoting herbaceous growth (Figure 1). Each zone surveyed was burned recently and showed adequate herbaceous understory growth (Table 2). C2 and C5 were a year behind the other zones but did not have less than a 30% herbaceous understory (Table 2). Further, data showed that saw palmetto height rarely equaled or exceeded 2 meters and the herbaceous understory height was generally ≤1 meter (Table 3). Hardwood midstory and canopy was sparse, observations were recorded if hardwood stands were nearby. For example, one turkey oak was sampled in stand C3 but there was a large area of adjacent turkey oaks in the distance. Also, cypress stands were not far away from the transitional area plots with both wetlands and flatwoods in zone C5. Bare sand, indicative of scrubby pine flatwoods or sandhills ecosystem, occurred in three plots and, on average, comprised <4% of groundcover for all three plots. Midstory was present in one plot and was mostly dead shrubs that did not exceed 2 meters.

CONCLUSION

The USFWS (2003) RCW recovery plan states that in South Florida slash pine communities, such as those in Jonathan Dickinson State Park, little research on RCW foraging ecology exists. Thus, additional extensive studies will increase the knowledge base on South Florida slash pine foraging habitat. Existing research shows that RCWs require larger areas of habitat in the South Florida slash pine communities compared to the more optimal longleaf pine communities. South Florida slash pine communities are less than optimal because they may not contain the recommended pine size and pine density. The foraging habitat range in this type should be at least 200 and 300 acres (the longleaf pine range standard) of good quality habitat with large mature pine trees. For South Florida slash pine ecosystems, different standards must be evaluated to ascertain "Good quality foraging habitat" (USFWS, 2003). Silviculture practices, such as tree harvesting methods (i.e. irregular shelterwood or single-tree selection) and age distribution (i.e. uneven versus even aged stands), are recognized as specific management tools tailored to ecosystem types (USFWS, 2003).

When viewed from a general perspective, JDSP appears, although inconclusive at this stage of study, to have optimal foraging habitat. The results showed that JDSP's pine flatwoods contain plenty of large diameter trees over 9 inches, some medium trees, and few small diameter trees. This is one reason why JDSP appeared to have adequate foragaing habitat. Hanula et al. (2000) concluded that RCWs select trees greater than 9 inches in diameter because those trees have a higher arthropod biomass. In addition, this study concluded that JDSP has adequate herbaceous cover (at least 40%). Abundant herbaceous cover may influence arthropod activity on the tree bole and thus support RCWs (Hanula et al., 2000). JDSP is in an acceptable condition therefore, with the application of management tools (silviculture practices, prescribed burning, and mechanical removal) suitable foraging habitat can be fashioned to meet specific RCW needs (USFWS, SCFRU).

Five management zones (C5, C4, E13, E7, and E9) met the requirements for good quality foraging habitat while the remaining four zones (D8, C2, C3, E11) did not because of low acreage and few sampled plots. In consideration of whether Jonathan Dickinson State Park contains good quality habitat to support RCW reintroduction, future surveys will encompass addition management zones. There are 71 other management zones that appear to be suitable RCW habitat. Forty four of those zones appear to be adequate foraging habitat. In subsequent studies, zones B, C, D, E, F, and G will receive thorough attention. Furthermore, to reduce variability and thus increase accuracy of the data in these baseline studies, plots per zone amounts should be increased (M. Baranski, Red-cockaded woodpecker Biologist, personal communication, March 17th, 2011). Other factors such as habitat range (foraging and non-foraging land) and tree age must also be scrutinized in later study phases. If the RCW reintroduction stage is concretely realized, additional research will employ a more accurate forest inventory technique such as the longitudinal transect method (R. Rossmanith, Park Biologist, pers. comm., February 28th, 2011). Perhaps in the future JDSP will be included in SCFRU list of RCW populations. This could be a milestone for the scientific advancement in endangered species reintroduction as well as for the history of JDSP (M. Baranski, RCW biologist, pers. comm., January 20, 2011).

ACKNOWLEDGEMENTS

This study was funded by Palm Beach State College's Department of Environmental Science Technology and the Florida Department of Environmental Protection's Jonathan Dickinson State Park. I thank Red-cockaded woodpecker biologist Mike Baranski, Professor Jessica Miles, Park Biologist Robin Rossmanith, and Park Service Specialist Scott Tedford for their appreciated collaboration on this project. I am grateful for their help in brainstorming, designing, and implementing this survey. I am also thankful for the data collection assistance provided by my colleagues Bryan Henning, Sara Houpt, John Hurt, Todd Lanier, Rachel Morreale, and Erinn Mullen.

Literature Cited

BenMeadows.com (2011). Instruction manual for Brunton Clino Master. Retrieved March 27, 2011 from http://www.benmeadows.com/store/assets/support_documents/102240manual.pd

Bolen, E.G., & Robinson, W.L. (2003). *Wildlife ecology and management* (5th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

California Department of Pesticide Regulation (CDPR), Environmental Monitoring Branch (2004). Standard operating procedure: Instructions for the calibration and use of a spherical densitometer. Sacramento, California. Retrieved January 13, 2011, from http://www.cdpr.ca.gov/docs/emon/pubs/sops/fsot00201.pdf

Department of Forestry and Geology (DFG), Sewanee: The University of the South (2011). *Basal area*. Retrieved from http://www.sewanee.edu/Forestry_Geology/watershed_web/Emanuel/BasalArea.htm

Department of Natural Resource Sciences (DNRS), Washington State University: Rural Technology Initiative (2011). *Lesson 4: Establishing fixed plots*. Retrieved from http://www.ruraltech.org/virtual_cruiser/lessons/lesson_04/Lesson_4_PDF.pd

1000 Friends of Florida (2011). The Apalachicola National Forest. Retrieved April 22, 2011 from http://www.1000friendsofflorida.org/pubs/apalachee/theANC.asp

Hanula, J.L., Franzreb, K., & Pepper W.D. (2000). Longleaf pine characteristics associated with arthropods available for red-cockaded woodpeckers. *Journal of Wildlife Management, 64* (1), 60-70.

Hanula, J.L., & Franzreb, K. (1997). Source, distribution and abundance of macroarthropods on the bark of longleaf pine: potential prey of the red-cockaded woodpecker. *Forest Ecology and Management*, *102* (1998), 89-102.

Larsen, D.R. (2010). *Natural resource biometrics*. Retrieved from http://oak.snr.missouri.edu/nr3110/topics/basalarea.html

Leonard, D.L. (2009). Do abandoned woodpecker cavities provide secondary cavity nesters protection from climbing snakes? *Southeastern Naturalist*, *8*(1),121-128.

Parker, K. & Ferraro, G.B. (2010, October 29). *12 red-cockaded woodpeckers have a new home* [Press release]. Retrieved April 21, 2011 from MyFWC.com Website: http://myfwc.com/news/news-releases/2010/october/29/woodpeckers/

Rapoza, B. (2007). *Birding Florida: Over 200 Prime Birding Sites at 54 Locations*. Guilford, Connecticut: Morris Book Publishing.

State of Florida Department of Environmental Protection, Division of Recreation and Parks. (2000). *Jonathan Dickinson State Park unit management plan*. Department of Environmental Protection, Tallahassee, FL. 186 pp.

State of Florida Department of Environmental Protection, Division of Recreation and Parks. (2010). *Resource Management Standard: Fire Management.* Department of Environmental Protection, Tallahassee, FL. 90 pp.

The Nature Conservancy (TNC) (2009). Jay Watch volunteer training manual. The Nature Conservancy, Babson, Fl. 25 pp.

United States Fish and Wildlife Service. (2003). *Recovery plan for the Red-Cockaded Woodpecker* (Picoides borealis): *Second revision*. U.S. Fish and Wildlife Service, Atlanta, GA. 296 pp.

United States Fish and Wildlife Service. (2006). South Central Florida Recovery Unit Foraging Guidelines for Satisfying the Standard for Managed Stability.