Florida Field Naturalist

PUBLISHED BY THE FLORIDA ORNITHOLOGICAL SOCIETY

VOL. 43, NO. 2 MAY 2015 PAGES 47-104

Florida Field Naturalist 43(2):47-61, 2015.

FEASIBILITY OF RED-COCKADED WOODPECKER (*Picoides borealis*) REINTRODUCTION INTO THE PINE FLATWOODS COMMUNITIES OF JONATHAN DICKINSON STATE PARK, FLORIDA

KATIE O'GARA[1], JESSICA MILES[2], AND REBECCA MAY[2]

[1]*Present address: 1000 FGCU Campus Housing, Pilot, 001. Fort Myers, Florida 33965*

E-mail: ogarakn@my.palmbeachstate.edu

[2]*Department of Environmental Science Technology MS#45, Palm Beach State College, Palm Beach Gardens, Florida 33410*

Abstract.—The endangered Red-cockaded Woodpecker (*Picoides borealis*), a specialist species, once inhabited Jonathan Dickinson State Park (JDSP), located in Martin and Palm Beach counties in South Florida, but it has not been documented in the park since 1983 (FDEP 2000). JDSP is considering the reintroduction of the Red-cockaded Woodpecker into its pine flatwoods ecosystems, to contribute to their nationwide recovery. To examine the feasibility of this goal, a fixed-area plot vegetation survey was performed at JDSP to collect baseline data on the current suitability of Red-cockaded Woodpecker nesting and foraging habitat. A total of 58 plots from JDSP management zones C2, C3, C4, C5, D8, E7, E9, E11, and E13 were surveyed. In each plot, tree heights, tree diameter, basal area (BA) per stand, overstory density, understory density, and understory and midstory height were gathered, to describe each stand. Results were compared with the South Central Florida Recovery Unit (SCFRU) foraging habitat guidelines for RCWs (FWC 2008). The preliminary data show that JDSP's pine flatwoods contain many large-diameter trees, over 9 in (22.86 cm) diameter at breast height (DBH), some medium trees 4 to 8 in (10.16 to 20.32 cm) DBH, and few small diameter trees <4 in (10.16 cm) DBH, satisfying habitat structure characteristics necessary for the support of RCWs. Zones C5, E7, E9, and E13 demonstrated a total BA per stand of at least 3,000 ft^2 (278.7 m^2), meeting the SCFRU foraging habitat guidelines standard. Zones C4, C5, E7, E9, and E13 fulfilled the requirement for having at least 2,000 ft^2 (185.8 m^2) of BA of pine with DBH ≥9 in (22.9 cm), as did the results for the 4 to 8 in (10.16 to 20.32 cm) DBH category, showing that zones C5, E7, and E9 had slightly greater than 1,000 ft^2 (92.9 m^2) of BA required per stand. Zones C3, D8, E11, and E13 had zero pine trees with DBH <4 in (10.2 cm). Zone E13, in meeting all the guideline requirements studied, indicates

JDSP is in a position to consider further analysis on RCW reintroduction feasibility at this time. Additionally, seven of the nine management zones studied exhibited an ample amount (≥40%) of herbaceous ground cover, supporting RCW foraging needs; therefore, these satisfactory vegetation survey results should be used in conjunction with future habitat assessments to determine whether JDSP satisfies recovery guidelines for optimal Red-cockaded Woodpecker foraging habitat, according to the United States Fish and Wildlife Service (USFWS 2003).

The Red-cockaded Woodpecker (*Picoides borealis*; RCW) is endemic to southeastern pine flatwoods communities in the United States (Franzreb 1999). These cooperatively breeding birds live in groups of two to seven individuals in a cluster of several cavity trees (Lennartz et al. 1987, Walters et al. 1988, Franzreb 1999). Groups generally consist of one breeding pair and often several helpers, usually males, which assist the breeding pair with raising the young (Walters 1990, Conner et al. 1998, Franzreb, 1999).

RCWs are adapted for survival in pine landscapes, showing a preference for older, live pine trees for the construction of cavities used for night roosting and as nest sites (Jackson et al. 1979, Jackson and Jackson 1986, Rudolph and Conner 1991, Conner et al. 1994, Conner et al. 1998, Franzreb 1999). The woodpeckers puncture "resin wells" on a daily basis around a cavity tree entrance to create a copious flow of resin (Ligon 1970). These actions create a smooth, sticky surface around cavity openings that deters predators, such as rat snakes, from climbing up the tree and reaching the cavity (Leonard 2009). In general, the availability of older pine trees suitable for cavity excavation is a critical limiting factor for RCWs at both a group and population level (Kappes and Costa 2008).

RCWs are listed as near-threatened with a decreasing global population of 14,500 adults (IUCN 2013), and they are a federally endangered species, given protection by the Endangered Species Act in 1973, although their decline was noted decades earlier (Bent 1939). Unsuitable habitat conditions are attributed to fire suppression (Franzreb 1997), habitat loss (only 3% of longleaf habitat survives today in the United States) (Jackson 1986, Ortego and Lay 1988, Conner and Rudolph 1989, Williams 1989), and habitat fragmentation and degradation (Hooper 1988, Costa and Escano 1989, Rudolph and Conner 1991). Since the enactment of the Endangered Species Act, drastic RCW declines were curtailed by intensive emergency management that peaked in the 1990s and led to the stabilization or increase of many extant populations (USFWS 2003). Measures taken for RCW recovery, such as prescribed burning, also help maintain populations of a multitude of other species.

One valuable recovery method is translocation of RCWs to new potential breeding sites. Extensive criteria must be met before a site

can be considered as a translocation donor or receiver. For example, donor sites must have fifty 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 ten active clusters (USFWS 2003). Additionally, basal area (BA), defined as the cross-sectional area of pine trees measured in diameter at breast height (DBH), standards have been set in the RCW recovery plan, but they 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 Florida Fish and Wildlife Conservation Commission developed the South Central Florida Recovery Unit (SCFRU) foraging-habitat guidelines (Kappes and Costa 2008). 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 quantities of hardwood midstory, and plenty of herbaceous groundcover (USFWS 2003). The USFWS guidelines take into account the habitat characteristics and the larger range needed by RCWs in the south and central Florida regions (FWC 2008). According to SCFRU guidelines, RCWs need a site with:

1) at least 3,000 ft^2 (278.7 m^2) of total pine BA area
2) at least 2,000 ft^2 (185.8 m^2) of the 3,000 ft^2 (278.7 m^2) total pine BA area consisting of pine trees with DBH ≥ 9 in (22.9 cm), and the remaining 1,000 ft^2 (92.9 m^2) can be pines with a 4 to 8 in (10.16 to 20.32 cm) DBH. Pine trees <4 in (10.16 cm) are not included in the calculation toward the total 3,000 ft^2 (278.7 m^2) of pine BA area (FWC 2008).

In addition to the BA requirements clarified by the SCFRU, foraging habitat is required to contain zero or a very limited amount of midstory, and according to the recovery standard foraging guidelines (RSFG) presented in the Recovery Plan (USFWS 2003), native herbaceous plants must consist of a total of 40% or more of the groundcover. Furthermore, hardwood midstory must be sparse and less than 7 ft (213.4 cm) tall or nonexistent because when a hardwood midstory develops, RCWs abandon cavities (USFWS 2003; Fig. 1). Canopy hardwoods must be nonexistent or less than 10% of the canopy structure (FWC 2008). Finally, foraging habitat must be within 0.5 mi (804.7 m) of the cluster center and not be separated by more than 200 ft (61 m) of nonforaging land (i.e., water bodies, hardwood stands, etc.) (USFWS 2003).

Figure 1. Example of suitable pine flatwoods understory and midstory at Jonathan Dickinson State Park (Zone C5) for Red-cockaded Woodpeckers (with at least 40% herbaceous understory, no midstory, and low woody plants).

Translocation of RCW populations has been a part of the recovery effort since the late 1980s (Hess and Costa 1995). There are more than ten sites presently hosting RCWs in Florida that received RCWs from donor sites either in Florida or from other states such as South Carolina (Lauerman, Witter, and Costa 2013). One particular recipient site, J. W. Corbett Wildlife Management Area (WMA), in southeast Florida's Palm Beach and Martin counties, received twelve RCWs from Citrus WMA in northwest Florida in 2010 (Parker and Ferraro 2010). Because of several previous translocations, J. W. Corbett WMA now has fifteen active clusters of twelve breeding groups; eight groups produced a total of twelve fledglings in 2010 (Parker and Ferraro 2010). Another park, Jonathan Dickinson State Park (JDSP), which previously hosted RCWs and is only about 37 km from J. W. Corbett WMA, is a potential site for reintroduction; however, additional studies, of which the present study is a part, are necessary to determine JDSPs present status of habitat suitability and its potential as a receiver site prior to proceeding with any translocation efforts.

Jonathan Dickinson State Park, Florida – A Potential RCW Receiver Site

Jonathan Dickinson State Park (JDSP), located in southeast Florida, in Martin and Palm Beach counties, is one potential RCW reintroduction site (State of Florida Department of Environmental Protection 2000). JDSP, is an ecologically significant site covering 4,642.1 hectares (ha), including the northwest and north forks of the Loxahatchee River (FDEP 2000). JDSP encompasses thirteen distinctive natural vegetative communities including scrub, depression marsh, hydric hammock, sandhill, scrubby flatwoods, and wet flatwoods. Three of these communities, the 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 JDSP's pine flatwoods are wet flatwoods, represented by a South Florida slash pine (*Pinus elliotti var. densa*) overstory, a saw palmetto (*Serenoa repens*) midstory, and a wiregrass (*Artistida beyrichiana*) understory (Fig. 1).

Many ecosystems in Florida have evolved to prosper in the midst of fires ignited by lightning. 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, a prescribed-fire program was implemented in 1971. 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 vary according to community type. For example, fire should be applied to mesic flatwoods habitat every 2 to 5 years, while 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.

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. By using prescribed fire as a preventative measure, the probability of unpredictable wildfire

eruption is decreased and this in turn helps to protect reintroduced populations of birds (FDEP 2010).

Additionally, JDSP's pine flatwoods forest structure, with a sparse, woody understory and herbaceous groundcover (Fig. 1), maintained by the prescribed fire program, is crucial for RCW recovery. The landscape's predominantly herbaceous understory improves RCW group size and reproductive success, as their fitness is linked to a correlation between herbaceous groundcover and the availability and quality of arthropod prey on the pine tree boles where the birds forage (Hanula and Franzreb 1998). Hanula and Franzreb's (1998) research supports the observation that RCWs require abundant herbaceous groundcover.

The past, present, and future of Red-cockaded Woodpeckers in Jonathan Dickinson State Park.

Historically, RCWs were found in sandhill and pine flatwoods ecosystems in JDSP. 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 Camp Murphy, a WWII U.S. Army base (FDEP 2000). Fire exclusion, in particular, caused more intense fires to occur in the long unburned areas, leading to the loss of some suitable cavity trees.

Nevertheless, former RCW nesting cavities remain 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 assessing the feasibility of reintroducing RCWs into its pine flatwoods communities, as stated in the JDSP's management plan (FDEP 2000). RCW reintroduction into the park would establish new groups that will link isolated populations in southeast Florida across the Loxahatchee Greenway. To achieve this goal, a preliminary fixed-area-plot vegetation survey was performed at JDSP for the collection of baseline data on the existence of potentially suitable pine flatwoods habitat for RCWs. 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 40,469 m^2 research zone (FDEP 2000; Fig. 2). A total of fifty-eight 404.7 m^2 plots, in nine management zones, were surveyed in the park's pine flatwoods communities. Types of pine flatwoods 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). Biologists from FDEP and the Florida Fish and Wildlife Conservation Commission (FWC) decided which JDSP zones would likely support RCWs, and zone selections for this study were based on knowledge from agency professionals, as well as foraging guidelines from the USFWS (2003) Red-cockaded Woodpecker Recovery Plan and the South Central Florida Recovery Unit (FWC 2008). This reintroduction-feasibility study involved specific selection of management zones with pockets of old-growth pine trees. A more detailed evaluation of measurable parameters (e.g., tree diameter) was then performed on those selected sites. After the parameters were quantified, results were compared to the SCRFU foraging habitat guidelines. We collected data weekly (2 to 3 days a week) from 7 January 2011 to 25 March, 2011.

Fixed area plot sampling and associated parameters.—The fixed-area plot sampling method was used to inventory forest parameters for pine flatwoods. In each surveyed zone, randomly selected 404.7 sq. m. circular plots were set up, based on likely RCW usage described in the recovery plan (USFWS 2003). Only pine stands were sampled because RCWs do not exploit wetland areas, cypress stands, or scrub habitat lacking a pine overstory. One plot was sampled for every 8.1 ha to accurately describe the stand composition. For example, we established ten plots in the 86.3 ha zone E7. A Garmin GPS unit was used to mark the center of each plot and coordinates were collected (Fig. 3).

From the center of each plot, a tape measure was used to pace out a radius of 11.3 m in four directions (DNRS 2011). Flagging tape was used to mark the circumference of each circular plot. Within each plot, the DBH in centimeters was obtained for every tree with the use of a Lufkin 6.5 m tree-diameter tape (DNRS 2011). Then, BA was calculated to gauge tree density per plot, per hectare, and per stand (DFG 2011). Values obtained for BA per stand were separated into categories outlined by the guidelines in the SCFRU (FWC 2008; Table 1). These categories include BA of trees with a DBH of ≥ 9 in (22.9 cm), BA of trees 4 to 8 in (10.2 to 20.3 cm), and BA <4 in (10.2 cm) (USFWS 2003). BA per stand amounts (which depended on the number of trees in the plot) for each category were calculated using ((DBH (cm)^2*0.0001 + DBH (cm)^2*0.0001 +…)10*zone acreage). Also, tree heights were gathered with the use of a Brunton Clino Master clinometer. Height (m) was acquired at a distance of 66 ft (20.1 m) from each tree.

Overstory density was estimated with a spherical densiometer (CDPR 2004), and groundcover composition was measured subjectively. To estimate groundcover percentages for saw palmetto and herbaceous groundcover, each plot was visually divided into four sections, based on cardinal directions. Estimated percentages of cover for each of the four sections were averaged, for both saw palmetto and herbaceous understory portions, and a resulting value (percentage) was derived for the entire plot. Moreover, average height (Categories: <3 ft (1 m), 3 to 6 ft (1 to 2 m), and >6 ft (2 m)) for the saw palmetto midstory and herbaceous understory were measured with a tape measure. Where bare sand, woody shrub, or hardwood midstory occurred, percentages and heights were noted. These data were compiled as part of a site suitability analysis.

Results

For each management zone, results for BA per stand for each SCFRU foraging habitat guideline category are summarized in Table

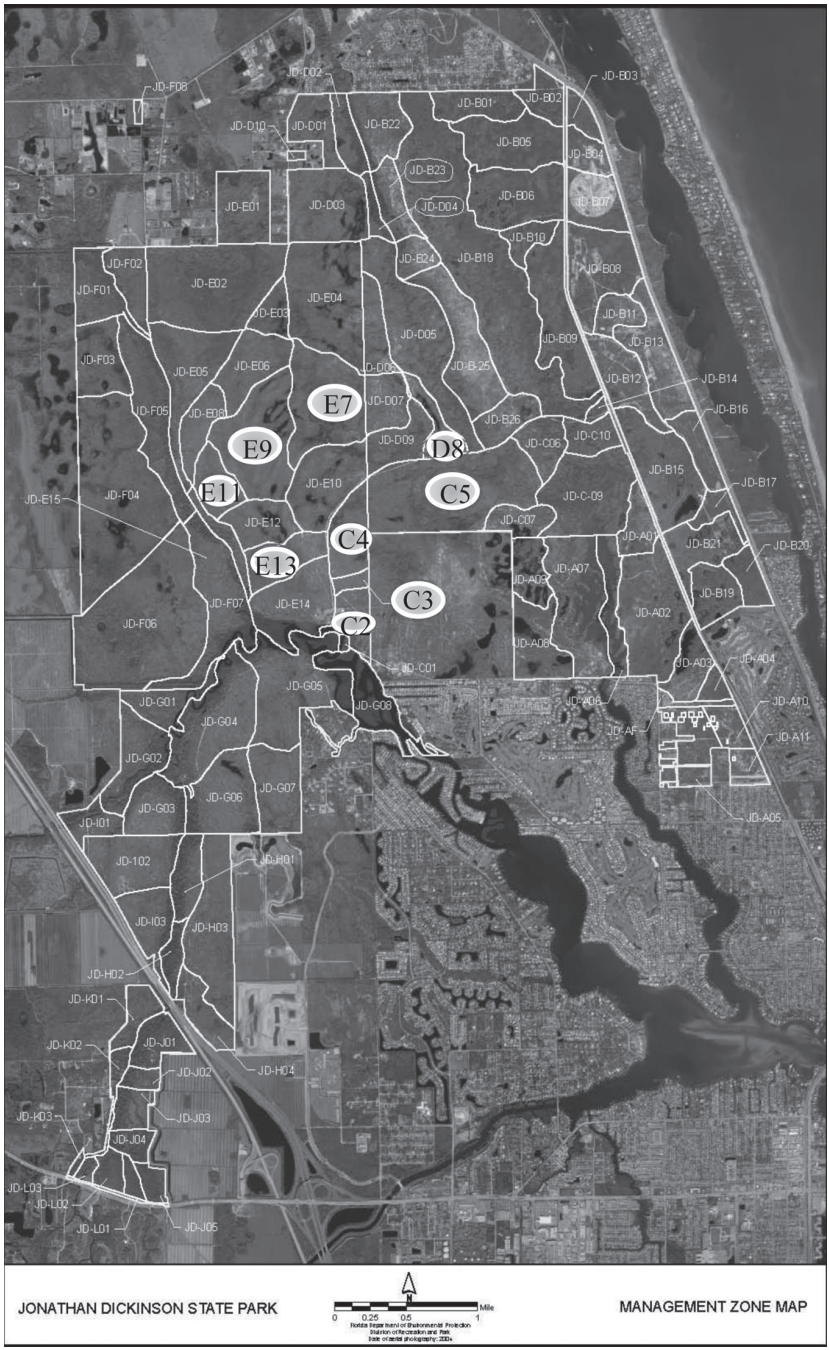

Figure 2. Map of JDSP and the surveyed management zones C2, C3, C4, C5, D8, E07, E09, E11, and E13 as indicated.

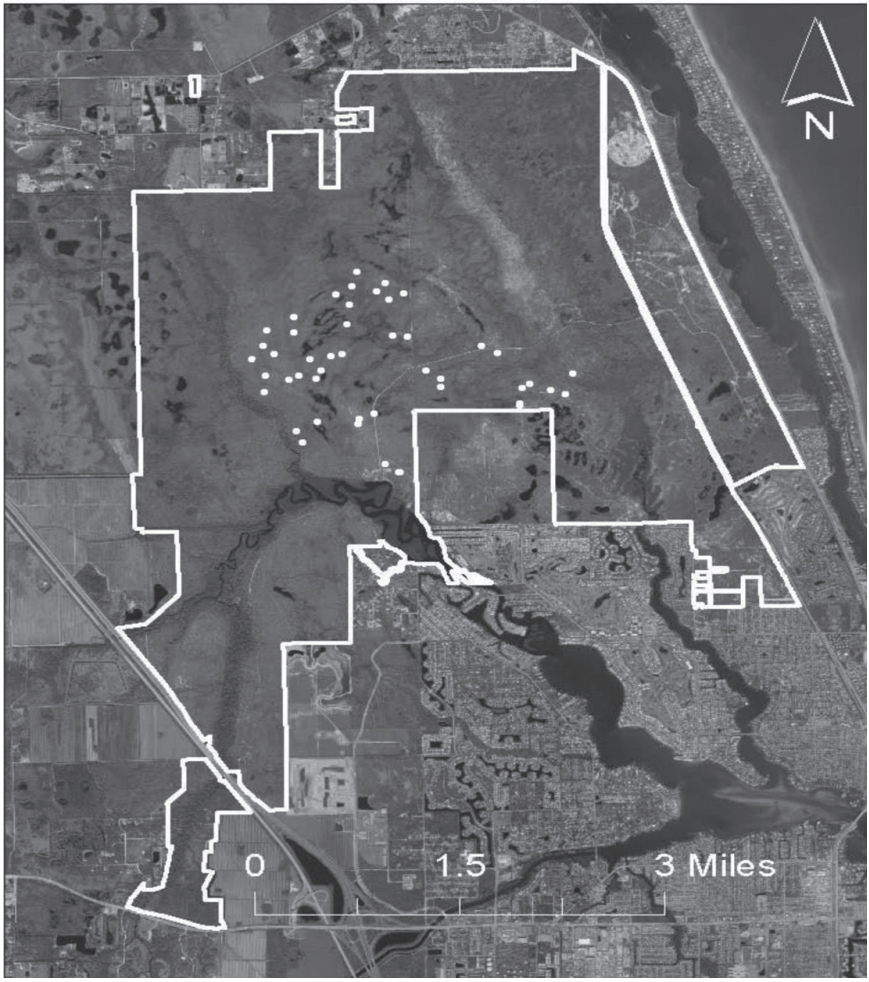

Figure 3. Map of coordinate locations taken at the center of each circular plot sampled (n = 58; white dots) in management zones C2, C3, C4, C5, D8, E7, E9, E11, and E13 in Jonathan Dickinson State Park.

1. Burn zone C5 greatly exceeded the 3,000 ft^2 (278.7 m^2) BA per stand, and zones E7, E9, and E13 also qualified under this standard. Zone C4, C5, E7, E9, and E13 fulfilled the requirement for having at least 2,000 ft^2 (185.8 m^2) of BA of pine with DBH ≥9 in (22.9 cm). Results for the 4 to 8 in (10.2 to 20.3 cm) DBH category showed that zones C5, E7, and E9 had slightly greater than 1,000 ft^2 (92.9 m^2) of BA. Zones C3, D8, E11, and E13 had zero pine trees with DBH <4 in (10.2 cm) (Table 1).

Compliance with the standards for herbaceous groundcover and hardwood midstory in the nine management zones was also examined.

Table 1. Comparison of JDSP sampled zones to the South Central Florida Recovery Unit (SCFRU) foraging habitat guidelines categories.

Zone	Total BA/stand (ft^2) (SCFRU Guideline: ≥ 3000 ft^2)	BA/stand (ft^2) ≥ 9 in (22.9 cm) DBH (SCFRU Guideline: ≥ 2000 ft^2)	BA/stand (ft^2) 4 to 8 in (10.16 cm to 20.32 cm) DBH (SCFRU Guideline: ≥ 1000 ft^2)	BA/stand (ft^2) < 4 in (10.16 cm) DBH (SCRFU Guideline: these trees are not included in the calculation toward the 3000 ft^2 requirement)	Last burn (as of the date of the study)	Average percentage of herbaceous understory (%) (SCFRU Guideline: ≥40%)	Number of plots with <40% average percentage of herbaceous understory	Average herbaceous height (ft) (SCFRU Guideline: midstory < 7 ft)	Average saw-palmetto height (SCFRU Guideline: midstory < 7 ft)
C2	1627.2	1519.8	58.0	49.4	2009	30	1 of 1	<3 ft (1 m)*	3 to 6 ft (1 to 2 m)*
C3	374.9	306.0	68.9	0	2009	40*	0 of 1	<3 ft (1 m)*	<3 ft (1 m)*
C4	2970.5	2491.7*	460.1	18.7	2009	48.8*	1 of 4	<3 ft (1 m)*	3 to 6 ft (1 to 2 m)*
C5	9084.6*	7801.9*	1201.4*	81.3	2009	37.9	8 of 17	<3 ft (1 m)*	3 to 6 ft (1 to 2 m)*
D8	937.0	908.1	28.9	0	2010	40*	1 of 3	<3 ft (1 m)*	<3 ft (1 m)*
E7	5395.6*	3929.8*	1452.2*	13.6	2010	45*	3 of 10	3 to 6 ft (1 to 2 m)*	3 to 6 ft (1 to 2 m)*
E9	5331.1*	4132.6*	1170.0*	28.5	2010	50.4*	3 of 11	3 to 6 ft (1 to 2 m)*	3 to 6 ft (1 to 2 m)*
E11	1944.7	1696.2	248.5	0	2010	50.8*	2 of 6	3 to 6 ft (1 to 2 m)*	3 to 6 ft (1 to 2 m)*
E13	3199.4*	2276.4*	922.9**	0	2010	44*	2 of 5	3 to 6 ft (1 to 2 m)*	3 to 6 ft (1 to 2 m)*

*Met SCFRU Guideline standard for that measure.

**According to the SCFRU Guidelines, the BA/stand value for the 4 to 8 in (10.16 to 20.32 cm) category can be added to the BA/stand value for the ≥9 in (22.86 cm) category for a total of 3000 ft^2 to qualify (which is satisfied in the case of Zone E13).

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 1). Herbaceous understory height averaged ≤ 3 ft (1 m) in the plots studied. Hardwood midstory was sparse and canopy hardwoods numbered well below 10% of the canopy structure in all zones, and Zone C3, plot 1, contained the only occurrence of a tree other than a slash pine (turkey oak, *Quercus laevis*). Average saw palmetto height fell within the 3 to 6 ft (1 to 2 m) category and rarely equaled or exceeded 6 ft (2 m) in the plots studied. Therefore, all the plots studied met the herbaceous understory height standard.

An analysis of the zones regarding their satisfaction of all of the SCFRU guidelines studied was also completed. Zone E13 satisfied all requirements for the SCFRU guideline categories studied (FWC 2008). No other zone qualified under all the guideline requirements studied.

Discussion

Preliminary results from the data showed that zone E13 met all requirements for the SCFRU guideline categories studied (Table 1). Zone E13 had at least 3,000 ft^2 (278.7 m^2) of BA, and at least 2,000 ft^2 (185.81 m^2) of this zone contained ≥9 in (22.9 cm) DBH trees. Also, Zone E13 had no pine trees <4 in (10.2 cm). This site alone, since it qualifies with all the guideline requirements, puts JDSP in a position to consider further analysis on reintroduction feasibility at this time.

Zone C4 approached fulfillment of all SCFRU guideline categories. Zone C4 had a total of 2,971 ft^2 (276.0 m^2) of BA, just shy of the 3,000 ft^2 (278.7 m^2) requirement, with at least 2,000 ft^2 (185.8 m^2) of zone containing ≥9 in (22.9 cm) DBH pines (Table 1). Although pines <4 in (10.2 cm) in DBH were sampled in zone C4, the density in this category was low at 18.7 BA. Regardless of being slightly less than the 3,000 ft^2 (278.7 m^2) requirement, this zone demonstrates potential as a RCW foraging habitat. Zone C4 is the site of many abandoned, large DBH trees with cavities previously inhabited by the now extirpated JDSP RCW population.

Additional zones also showed promising signs of near compliance with the guidelines. Zone C5 met all the BA category criteria in excess but was slightly below the herbaceous understory requirement of ≥ 40%, with a result of 38% (Table 1). It should be noted that Zone C5 was a large zone that encompassed 144.1 ha, and the highest number of plots were sampled in this zone (i.e., 17). This zone may have potential for foraging habitat, but this cannot be confirmed at this time until additional studies are completed. As previously stated, foraging habitat must be within 0.05 mi (80.5 m) of the cluster center (USFWS 2003).

Zones C2, C3, D8, and E11 were underrepresented because few plots were sampled in these zones due to time constraints; however, further analysis of these zones is encouraged. Additionally, the stand acreage extent was low in these four zones, as compared to the other five zones. For example, only three plots were sampled in D8, a 22.258 ha zone, whereas, Zone E13, a 36.017 ha zone, contained more than double the stand acreage of Zone D8 and likewise contained two additional plots. It should also be noted that all nine management zones were in close proximity to each other (Fig. 2). Therefore, when contemplating RCW foraging habitat, neighboring zones will not be separated from each other unless a barrier greater than 200 ft (60.96 m) exists (USFWS 2003).

Seven of nine management zones exhibited an ample amount (≥40%) of herbaceous ground cover (Table 1). 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 was successful in reducing hardwood midstory development and in promoting herbaceous growth (Fig. 1). Each zone surveyed was burned recently and showed adequate herbaceous understory growth (Table 1). Zones C2 and C5 were a year behind the other zones in their occurrence of a prescribed burn, but they did not have less than a 30% herbaceous understory (Table 1). Furthermore, data showed that saw palmetto height rarely equaled or exceeded 6 ft (2 m), and the herbaceous understory height was generally ≤3 ft (1 m) (Table 1). Hardwood midstory and canopy were sparse, and 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 a scrubby pine flatwoods or sandhills ecosystem, occurred in three plots and, on average, comprised <4% of groundcover for all three plots. A midstory layer was present in one plot and included mostly dead shrubs that did not exceed 6 ft (2 m).

Conclusion

The USFWS (2003) Red-cockaded Woodpecker Recovery Plan states that, in South Florida slash pine communities, such as those in JDSP, 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 does show, however, that RCWs require larger areas of habitat in the South Florida slash pine communities compared to the more optimal longleaf pine communities, mainly as a result of these slash pine communities not

containing equivalent pine size (DBH) and pine density, as is observed in longleaf pine communities (Nesbitt et al. 1983, Delotelle et al. 1987). The foraging habitat range in this community type should be at least 200 acres (80.9 ha), and 300 acres (121.4 ha; the longleaf pine range standard) of good quality habitat with large mature pine trees is needed. For South Florida slash pine ecosystems, different standards must be evaluated and established to ascertain "good quality foraging habitat" (USFWS 2003).

When viewed from a general perspective, JDSP appears to have optimal foraging habitat, although this is inconclusive at this stage of study. This paper's research results showed that JDSP's pine flatwoods contain plenty of large DBH trees over 9 in (22.9 cm), some medium trees, and few small DBH trees, suggesting that JDSP had adequate foraging habitat. Hanula et al. (2000) concluded that RCWs select trees greater than 9 in (22.9 cm) in DBH 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 also influence arthropod activity on the tree bole and thus support RCWs dietary needs (Hanula et al. 2000). Therefore, JDSP is in an acceptable condition, with the application of management tools (silviculture practices, prescribed burning, and mechanical removal), to fashion suitable foraging habitat to meet specific RCW needs.

Five management zones (C5, C4, E13, E7, and E9) met the requirements for good quality foraging habitat, whereas the remaining four zones (D8, C2, C3, E11) did not, most likely because of low acreage and few sampled plots. In consideration of whether JDSP contains good quality habitat to support RCW reintroduction, future surveys will need to encompass additional management zones. There are seventy-one other management zones that could and should be analyzed for RCW habitat suitability. Forty-four of those zones appear to have adequate foraging habitat. In subsequent studies, zones B, C, D, E, F, and G should receive thorough attention. If the RCW reintroduction stage is to be concretely realized, future research should employ a more accurate forest inventory technique, such as the longitudinal transect method. Perhaps in the future JDSP will be included in SCFRU list of thriving Red-cockaded Woodpecker population sites.

Acknowledgments

This study was supported by Palm Beach State College's Department of Environmental Science Technology and the Florida Department of Environmental Protection's Jonathan Dickinson State Park. Thanks go to Red-cockaded Woodpecker biologist, Mike Baranski; Park Biologist, Robin Rossmanith; and Park Service Specialist, Scott Tedford for their valued collaboration and support with this project. We are grateful to Sara Zeigler for many constructive suggestions that improved the manuscript.

Literature Cited

Benmeadows.Com. 2011. Instruction Manual for Brunton Clino Master. <http://www.benmeadows.com/store/assets/support_documents/102240manual.pdf>.

Bent, A. C. 1939. Life Histories of North American Woodpeckers. Dover Publications reprint of U.S. National Museum Bulletin 174.

CDPR [California Department of Pesticide Regulation], Environmental Monitoring Branch. 2004. Standard operating procedure: Instructions for the Calibration and Use of a Spherical Densiometer. Sacramento, California. <http://www.cdpr.ca.gov/docs/emon/pubs/sops/fsot00201.pdf>.

Conner, R. N., and D. C. Rudolph. 1989. Red-cockaded Woodpecker Colony Status and Trends on the Angelina, Davy Crockett, and Sabine National Forests. U.S. Forest Service Research Paper SO-250.

Conner, R. N., D. D. Rudolph, D. Saenz, and R. R. Schaefer. 1994. Heartwood, sapwood, and fungal decay associated with red-cockaded woodpecker cavity trees. Journal of Wildlife Management 58:728-734.

Conner, R. N., D. Saenz, D. D. Rudolph, W. G. Ross, and D. L. Kulhavy. 1998. Red-cockaded Woodpecker nest-cavity selection: Relationships with cavity age and resin production. Auk 115:447-454.

Costa, R., and R. Escano. 1989. Red-cockaded Woodpecker: Status and Management in the Southern Region in 1986. U.S. Forest Service Technical Publication R8-TP12.

Delotelle, R. S., R. J. Epting, and J. R. Newman. 1987. Habitat use and territory characteristics of Red-cockaded Woodpeckers in central Florida. Wilson Bulletin 99:202-217.

DFG [Department of Forestry and Geology], Sewanee: The University of the South. 2011. Basal Area. <http://www.sewanee.edu/Forestry_Geology/watershed_web/Emanuel/ BasalArea.htm>.

DNRS [Department Of Natural Resource Sciences], Washington State University: Rural Technology Initiative. 2011. Lesson 4: Establishing fixed plots. <http://www.ruraltech.org/ virtual_cruiser/lessons/lesson_04/Lesson_4_PDF.pdf>.

FWC [Florida Fish and Wildlife Conservation Commission]. 2008. South Central Florida Recovery Unit Foraging Guidelines for Satisfying the Standard for Managed Stability. Found in Appendix I within http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CCUQFjAB&url=http%3A%2F%2Fwww.dep.state.fl.us%2Flands%2FARC%2FAgendas%2F2008%2FJuly_SpecialAgenda%2FBabcock%2FFINAL%2520BRP_RCW_mgmt_plan.doc&ei=72EcVMuyE_WUsQTSzoCgAQ&usg=AFQjCNFgbdh92_XyhjJdk9c08eC4b4G_QA&bvm=bv.75774317,d.cWc>.

Franzreb, K. E. 1997. Success of intensive management of a critically imperiled population of Red-cockaded Woodpeckers in South Carolina. Journal of Field Ornithology 68:458-470.

Franzreb, K. E. 1999. Factors that influence translocation success in the Red-cockaded Woodpecker. Wilson Bulletin 111:38-45.

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

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

Hess, C., and R. Costa. 1995. Augmentation from the Apalachicola National Forest: The development of a new management technique. Pages 385-388 *in* D. L. Kulhavy, R. G. Hooper, and R. Costa, Eds. Red-cockaded Woodpecker: Recovery, Ecology and Management. Center for Applied Studies in Forestry, College of Forestry, Stephen F. Austin State University, Nacogdoches, Texas.

Hooper, R. G. 1988. Longleaf pines used for cavities by red-cockaded woodpeckers. Journal of Wildlife Management 52:392-398.

IUCN [International Union for Conservation of Nature]. 2013. The IUCN Red List of Threatened Species. <http://www.iucnredlist.org/details/22681158/0>.

Jackson, J. A., C. D. Cooley, and M. B. Hayes. 1979. A new trap for capturing cavity roosting birds. Inland Bird Banding News 51:42-44.

Jackson, J. A., and B. J. S. Jackson. 1986. Why do red-cockaded woodpeckers need old trees? Wildlife Society Bulletin 14:318-322.

Kappes, J., and R. Costa. 2008. Babcock Ranch Preserve Red-cockaded Woodpecker Management Plan. Florida Fish and Wildlife Conservation Commission. <http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CCUQFjAB&url=http%3A%2F%2Fwww.dep.state.fl.us%2Flands%2FARC%2FAgendas%2F2008%2FJuly_SpecialAgenda%2FBabcock%2FFINAL%2520BRP_RCW_mgmt_plan.doc&ei=72EcVMuyE_WUsQTSzoCgAQ&usg=AFQjCNFgbdh92_XyhjJdk9c08eC4b4G_QA&bvm=bv.75774317,d.cWc>.

Lauerman, S., K. Witter, and R. Costa. 2013. SERPPAS Red-cockaded woodpecker translocation project 2012 Annual Report. <http://serppas.org/Files/OtherIssueAreas/RCW/2012%20Annual%20Report%20-%20February%202013.pdf>.

Lennartz, M. R., R. G. Hooper, and R. F. Harlow. 1987. Sociality and cooperative breeding of red-cockaded woodpeckers (*Picoides borealis*). Behavioral Ecology and Sociobiology 20:77-88.

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

Ligon, J. D. 1970. Behavior and breeding biology of the Red-cockaded Woodpecker. Auk 87:255-278.

Nesbitt, S. A., A. E. Jerauld, and B. A. Harris. 1983. Red-cockaded Woodpecker summer home range sizes in southwest Florida. Pages 68-71 *in* Red-cockaded Woodpecker Symposium II (D. A. Wood, Ed.). Florida Game and Freshwater Fish Commission, and U. S. Fish and Wildlife Service, Tallahassee, Florida.

Ortego, B., and D. Lay. 1988. Status of red-cockaded woodpecker colonies on private land in east Texas. Wildlife Society Bulletin 16:403-405.

Parker, K., and G. B. Ferraro. 2010, 29 October. 12 red-cockaded woodpeckers have a new home [Press release]. < http://myfwc.com/news/news-releases/?p=33&category=1221>.

Rudolph, D. C., and R. N. Conner. 1991. Cavity tree selection by Red-cockaded Woodpeckers in relation to tree age. Wilson Bulletin 103:458-467.

FDEP [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.

FDEP [State Of Florida Department Of Environmental Protection], Division of Recreation and Parks. 2010. Resource Management Standard: Fire Management. Department of Environmental Protection, Tallahassee.

USFWS [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, Georgia.

Walters, J. R. 1990. Red-cockaded Woodpeckers: A "primitive" cooperative breeder. Pages 67-101 *in* Cooperative Breeding in Birds, Long-term Studies of Ecology and Behavior (P. B. Stacey and W. D. Koenig, Eds.). Cambridge University Press, Cambridge, United Kingdom.

Walters, J. R., P. D. Doerr, and J. H. Carter, III. 1988. The cooperative breeding system of the red-cockaded woodpecker. Ethology 78:275-305.

Williams, M. 1989. Americans and Their Forests: A Historical Geography. Cambridge University Press, Cambridge, United Kingdom.