

SUCCESSFUL TRANSLOCATION OF THE FLORIDA SCRUB LIZARD (*SCELOPORUS WOODI*) IN PALM BEACH COUNTY, FLORIDA, USA

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Abstract.—We translocated 48 male and 54 female Florida Scrub Lizards (*Sceloporus woodi*) to the Hypoluxo Scrub Natural Area (Hypoluxo) in Palm Beach County, Florida, USA, and established a reproducing population that persisted at least 2 y later. The translocation site has contained habitat suitable for *S. woodi* for at least 30 y, but populations were apparently extirpated for unknown reasons. The range of this endemic species, which has been petitioned for U.S. federal listing as Threatened, had contracted 77 km northward along the Atlantic Coast in the past 30 y, and this reintroduced population extends its current range 37 km southward. We monitored the population monthly during the first year and bimonthly thereafter using meander surveys. Lizards had dispersed at least 350 m south 17 mo after release. The success of this reintroduction, which required relatively little time and money, suggests the possibility of reestablishing additional populations where this species has been extirpated. Longer term monitoring of this population is warranted.

Key Words.—conservation; Hypoluxo; reintroduction; reptile

INTRODUCTION

Translocation can help conserve rare native species by increasing the number of populations, thus minimizing the risk of extinction from a catastrophic event, and by increasing the genetic diversity of a small population. The appropriateness of translocation for rare or threatened reptile species has been debated, however (Burke 1991; Dodd and Seigel 1991; Reinert 1991; Germano and Bishop 2009). Dodd and Seigel (1999) suggested that amphibian and reptile species are not suitable for translocation because most translocations have not produced a viable, self-sustaining population in the wild. Recently, however, Germano and Bishop (2009) reported a much higher success rate of herpetofaunal translocations.

The Florida Scrub Lizard (*Sceloporus woodi*) is an endemic Florida, USA, species in decline that was petitioned for U.S. federal listing as Threatened in 2012 (Adkins Giese et al. 2012). It inhabits primarily scrub communities, which are xeric upland habitats that are often targeted for development (Fernald 1989; Turner et al. 2006). Enge et al. (2021) recommended listing of the Atlantic Coast as an evolutionarily significant unit based on substantial range reduction and loss of occupied sites in the past 30 y. During this time, Atlantic Coast populations of *S. woodi* disappeared from Broward

County and all but two sites in northern Palm Beach County (Enge et al. 2021). Site occupancy declined from 67.7% in 1986 to 8.8% in 2016 in Palm Beach County (Enge et al. 2021), which has lost over 95% of its historical scrub habitat to development (Fernald 1989). The current southern extent of the range of the species is 77 km north of where it was 30 y ago; the species once occurred as far south as northern Miami-Dade County (Enge et al. 2021). A disjunct population along the southwestern Gulf Coast has apparently been extirpated, but populations are still widely distributed on four interior sand ridges from Marion County to Highlands County (Enge et al. 2021).

Within Palm Beach County, Hypoluxo Scrub Natural Area (Hypoluxo) was recommended as a candidate site for translocation of *S. woodi* based on presence of at least 24 ha of suitable-looking scrub habitat (Enge et al. 2021). Although *S. woodi* was not previously documented in Hypoluxo (Enge et al. 1986; Grace Iverson and Daniel Austin, unpubl. report), a population undoubtedly once occurred there based on nearby historical records and the fact that scrub habitat and *S. woodi* populations were more contiguous prior to development. Museum specimens (Northeast Louisiana University [NLU] 34131–13452) were collected in 1969 about 1.3 km to the west from what is now High Ridge Scrub Natural Area. According to a Palm Beach County Department of Environmental



FIGURE 1. Looking south from an observation tower on the northern boundary of Hypoluxo Scrub Natural Area, Palm Beach County, Florida, USA. The yellowish-orange coloration on trees and shrubs is due to Love Vine (*Cassytha filiformis*). (Photographed by Kevin M. Enge).

Resources Management (PBCDERM) database, *S. woodi* was last seen in 2003 in Lantana Scrub Natural Area, which is about 2.3 km north of Hypoluxo, and the only scrub preserve where the species has been observed since 2005 is Jupiter Ridge Natural Area in northern Palm Beach County. Possible reasons for extirpation of *S. woodi* populations from scrub preserves in Palm Beach County include improper habitat management practices, invasion of non-native flora, feral Cat (*Felis catus*) predation, proliferation of Love Vine (*Cassytha filiformis*; Enge et al. 2021), expansion of non-native Northern Curly-tailed Lizard (*Leiocephalus carinatus armouri*) populations (Smith et al. 2007), and catastrophic events such as three hurricanes in 2004 and 2005. Twelve feral Cats were trapped and removed from Hypoluxo in 2004 and 2005 (PBCDERM 2017), and they no longer seem to be a problem (Frank Griffiths, pers. comm.). Regardless of the history of the area, the current habitat at Hypoluxo

has been identified as suitable for *S. woodi* (Enge et al. 2021).

To maximize the probability of translocation success, we adhered to the recommendations of Seddon et al. (2007) to carefully determine the specific goals, overall ecological purpose, and inherent technical and biological limitations. Our specific goals were to determine the feasibility of translocating *S. woodi* and to expand its occupied geographic range farther south. Because we did not know if the reasons for the population extirpation at the proposed site were still in effect, we purposely expended relatively little time and effort in this experimental translocation. Hypoluxo was previously identified as containing potentially suitable habitat for *S. woodi* based on occupancy models that identified important covariates in hundreds of occupied *S. woodi* sites (Enge et al. 2021). Furthermore, *S. woodi* exhibits early sexual maturity and high fecundity (Ashton 2005; McCoy et al 2004), which are important characteristics for founding populations and allowed us to assess the criteria necessary to determine the success of our experiment. A translocation project is considered a success if it meets the criteria of evidence of a substantial addition of new recruits to the adult population due to successful reproduction at the translocation site and that there will be monitoring for at least the amount of time it takes the species to reach maturity (Dodd and Seigel 1991). Surveys conducted every 1 or 2 mo over a 2-y period allowed us to meet these criteria.

MATERIALS AND METHODS

Study area.—The 40.2-ha Hypoluxo Scrub Natural Area is located on the Pamlico Ridge in east-central Palm Beach County, Florida, USA, and contains 20.7 ha of scrub and 18.0 ha of scrubby flatwoods (PBCDERM 2017; Fig. 2). Ground elevations, which are 2.4–5.8 m

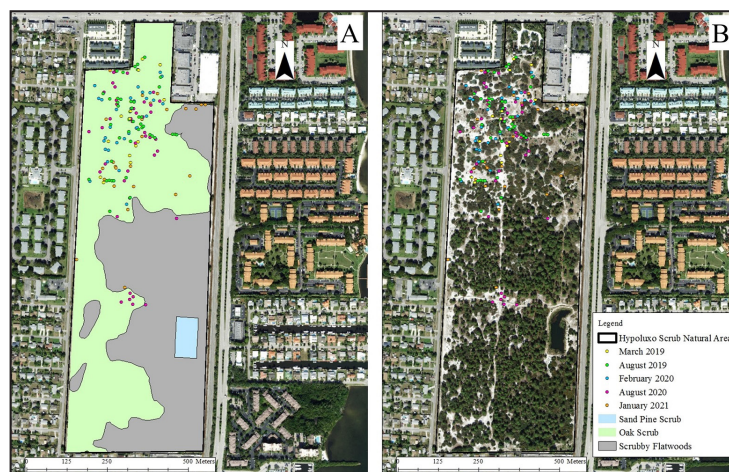


FIGURE 2. Locations of Florida Scrub Lizard (*Sceloporus woodi*) observed during meander surveys at 6-mo intervals plotted on landcover types (A) and aerial imagery (B) at Hypoluxo Scrub Natural Area, Palm Beach County, Florida, USA.

above mean sea level (MSL), are generally higher in the northern and western portions of the site where scrub is present (PBCDERM 2017). Hypoluxo is an isolated fragment of natural habitat that is bordered to the north by Hypoluxo Road, to the east by the Florida East Coast Railway and Dixie Highway, to the south by warehouses and medium-density residential subdivisions, and to the west by Overlook Road (Fig. 2).

The Hypoluxo site management plan provides a history of ownership and of disturbances that may have been responsible for extirpation of the *S. woodi* population (PBCDERM 2017). Most of Hypoluxo was cleared by 1964, and only a few scattered pine trees were left in the southeastern portion of the site. Based on historical aerial photographs, ground cover of the area was apparently mowed until at least 1968. In 1969 and 1970, the land was sold to the Florida East Coast Railway Company, which apparently stopped mowing the site between 1975 and 1979. Subsequently, native and non-native plants began to recolonize the site, and off-road vehicle usage, illegal dumping, and encroachments from adjacent developed lots became a problem. Google Earth imagery indicates that Hypoluxo has contained suitable habitat for *S. woodi* and remained relatively unchanged since 1992. The county purchased the site in 1999 to preserve, restore/enhance, and manage its ecological and historical resources, including the existing natural communities and their flora and fauna plus local groundwater resources (PBCDERM 2017).

Field methods.—In late February and early March 2019, we collected 22 male and 30 female *S. woodi* from Jonathan Dickinson State Park (JDSP) and 26 males and 24 females from Seabranck Preserve State Park (SPSP) in southern Martin County under permit from the Florida Park Service. These parks contain extensive scrub habitat and dense *S. woodi* populations (Enge et al. 2021), and they are located within 62 km of Hypoluxo. We hand caught lizards from two separate areas in each park to minimize population impacts and to maximize genetic diversity.

We measured snout-vent length (SVL) and recorded whether females were obviously gravid (egg bulges visible). We had intended to catch females before or early in their pregnancy to give them time to acclimate and locate suitable nest sites in a novel environment, but the nesting season apparently began earlier than mid-April, which was the earliest date reported in the literature for more northerly, inland populations (Jackson and Telford 1974; McCoy et al. 2004). The same day of capture, we released two or three lizards (both sexes) at a time at Hypoluxo in bare, sandy areas in scrub habitat within 340 m of the northern entrance (Fig. 2).

We intended to conduct meander surveys monthly for the first year after introduction and bimonthly

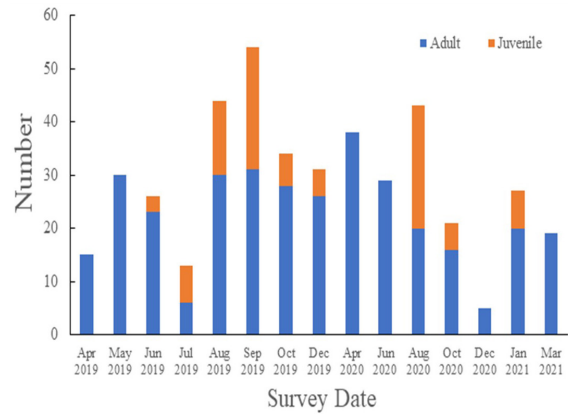


FIGURE 3. Number of adult and juvenile Florida Scrub Lizard (*Sceloporus woodi*) observed during meander surveys after 102 lizards were released in March 2019 in Hypoluxo Scrub Natural Area, Palm Beach County, Florida, USA.

thereafter to monitor populations; however, we could not conduct surveys between December 2019 and April 2020 because of COVID-19 restrictions on fieldwork. We surveyed for lizards by walking trails and areas of bare sand and using GPS to record the location of each lizard observed. We noted whether each lizard was adult or juvenile (< 30 mm SVL).

RESULTS

Sizes of released *S. woodi* averaged 48.2 mm (range, 36–55 mm) SVL for 26 males and 48.4 mm (range, 34–58 mm) SVL for 24 females from SPSP. Released lizards from JDSP averaged 46.2 mm (range, 36–55 mm) SVL for 22 males and 50.8 mm (range, 31–56 mm) SVL for 30 females. Fifteen females (27.8%) ranging from 50 to 58 mm SVL were obviously gravid when released.

During 15 meander surveys from April 2019 through March 2021, we observed between five and 54 *S. woodi* per survey, with a high of 31 adults and 23 juveniles during the September 2019 survey (Fig. 3). We detected the first hatchlings during a survey conducted on 12 June 2019. Although we could not detect any obvious trends in lizard numbers (Fig. 3), the population persisted two years after the introduction. By August 2020, 17 mo after the introduction, *S. woodi* had dispersed a minimum of 350 m south of where they were released (Fig. 2).

DISCUSSION

Our attempt to translocate a population of *S. woodi* to a scrub preserve in Palm Beach County was successful and extended the range of the species 37 km southward along the Atlantic Coast. Our project met both criteria of new recruitment and population maintenance beyond

the time it takes to reach sexual maturity. The largest females released at Hypoluxo were already gravid, but we observed hatchlings from subsequent clutches as late as November 2019 and through January 2021, indicating population recruitment is occurring on site. Female *S. woodi* reach sexual maturity in 6–8 mo and live an average of 12.6 mo, with a maximum longevity of 27 mo (McCoy et al. 2004). It is unlikely any of the founding lizards were still alive by the end of our study, so the presence of lizards during our later surveys suggest population reproduction and complete turnover.

Based on frequency of sightings, the translocated population is not as dense as the donor populations, where up to 37 *S. woodi* have been observed in 10 min (Enge et al. 2021), but the population does not yet inhabit the entire preserve. *Sceloporus woodi* is still expanding its distribution in Hypoluxo and can disperse about 400 m farther south of their occurrence in January 2021 before encountering the southern boundary of the preserve. *Sceloporus woodi* seldom disperse > 200 m to new sites when their habitat becomes unsuitable (Hokit et al. 1999). Hypoluxo contains 20.7 ha of suitable scrub habitat for *S. woodi*, and sand trails through scrubby flatwoods provide additional suitable habitat. Furthermore, occupancy studies of *S. woodi* populations suggest population recruitment, survivorship, and lizard abundance are positively associated with habitat patches 2–6 ha in size (Hokit and Branch 2003); only 14% of habitat patches < 2 ha were occupied (Enge et al. 2021), suggesting the 20.7 ha at Hypoluxo are more than sufficient. The large amount of suitable habitat increases the likelihood that the *S. woodi* population will continue to persist at Hypoluxo and may increase in density over time.

Causes of translocation failure include insufficient numbers, poaching or human collection, long-distance dispersal, lack of resources, and poor public support (Germano and Bishop 2009). We released 48 males and 54 females collected from two sites in two different parks, which should lead to sufficient genetic diversity and numbers for population maintenance. We suspect human collection will not be an issue, because this species is not commercially valuable and could be more easily and legally collected from sites farther north. Movement away from the release site is not an issue at Hypoluxo because it is an island of suitable habitat surrounded by residential and commercial development. Resources were not an issue because our translocation and monitoring of *S. woodi* at Hypoluxo required relatively little expenditure of funds and staff time, and volunteers assisted with collection efforts. Lastly, we extensively publicized the *S. woodi* translocation and received positive public feedback. A newspaper article on the translocation appeared in the 3 April 2019 issue of the *Palm Beach Post*. Fish and Wildlife Research Institute

(FWRI) staff produced a YouTube video documenting the translocation that reached 245,000 people (<https://www.youtube.com/watch?v=tENf2P80FFU&feature=youtu.be>). Another FWRI video was produced documenting the survey and collection effort 2 y post translocation. A flier posted in a kiosk at the main entrance of Hypoluxo provides information on the reintroduction and encourages protection of the species. Posters in two kiosks at Hypoluxo contain photos of *S. woodi* along with other native wildlife species present. The little time and effort necessary to translocate and monitor this population along with our high public engagement should increase the probability of long-term success.

Long-term monitoring is necessary for both the evaluation of projects and to determine whether intervention is needed for the survival of relocated populations (Seddon 1999). We recommend that the translocated *S. woodi* population at Hypoluxo be monitored at least annually in the future to detect declining population trends and to identify potential threats. Fortunately, population monitoring of *S. woodi* is easily conducted because it is a readily detectable species. A mean of 3.2 min. was required to detect the first *S. woodi* during successful surveys of Atlantic Coast sites (Enge et al. 2021). Control efforts could be initiated or increased to address potential threats such as presence of feral Cats, an increase in Northern Curly-tailed Lizard populations, or increased coverage of *Cassitytha filiformis*, but we do not feel augmentation of the existing *S. woodi* population is a viable solution to declining population trends. Reasons for the initial population extinction have not been identified and may be unrelated to these potential threats.

To the best of our knowledge, *S. woodi* is only the fourth native reptile species translocated for conservation purposes in Florida, not including relocation of sea turtle nests. From 2009 through 2021, 46,180 Gopher Tortoises (*Gopherus polyphemus*) were translocated from development sites to 43 long-term protected recipient sites in Florida with mixed success (Katherine Richardson, pers. comm.). A past attempt to reintroduce the Eastern Indigo Snake (*Drymarchon couperi*) to sites in the Florida Panhandle was unsuccessful (Speake et al. 1987), and it is too early to determine the success of reintroduction of the species to a single site in Liberty County, where 107 snakes were released from 2017 to 2022 (FWC, unpubl. data). Translocation of 300 Florida Sand Skinks (*Plestiodon reynoldsi*) from a future mine site to an unoccupied site succeeded in establishing a reproducing population (McCoy et al. 2014). Like *S. woodi*, the federally listed as Threatened *P. reynoldsi* is endemic and occupies the same xeric habitats, but it differs in being fossorial and less fecund, producing only two to three eggs annually and taking approximately three times longer to attain sexual maturity (Ashton

2005). McCoy et al. (2014) thought the mobile, resilient *P. reynoldsi* is able to exploit available habitat heterogeneity to find suitable microhabitats, and they speculated that these characteristics may contribute to successful translocation of xeric reptiles in general. If so, the population of *S. woodi* at Hypoluxo could benefit from these characteristics as well.

The U.S. Fish and Wildlife Service (USFWS) is interested in initiating conservation actions, such as translocations, for *S. woodi* prior to conducting its Species Status Assessment (Lourdes Mena, pers. comm.). After habitat improvement, *S. woodi* could be reintroduced to other scrub preserves in Palm Beach County or even Broward County; however, the difficulty in managing these urban scrub preserves using fire complicates long-term survival of *S. woodi* populations, unless alternative management practices are implemented to create and maintain open areas of bare sand. The use of prescribed fire is identified in the Hypoluxo management plan (PBCDERM 2017) but will probably not occur because of smoke issues (Barbara Bobsein, pers. comm.). Reduction of shrub height is achieved by mechanical means at Hypoluxo, but extensive areas will not be mechanically treated now that *S. woodi* is present, and the short-term negative impacts to *S. woodi* will be counteracted by hand removal of *C. filiformis* elsewhere (Barbara Bobsein, pers. comm.). Volunteers and PBCDERM staff removed 195 kg of *C. filiformis* on 21 February 2020, particularly from scrubby flatwoods habitat near the southern boundary. Only two *S. woodi* populations are apparently extant on the Winter Haven Ridge in Polk County (Enge et al. 2021), where the Lake Blue Unit of the Lake Wales Ridge Wildlife and Environmental Area could potentially support a reintroduced population after habitat improvement. Removal of lizards, however, from relatively small donor populations on the Winter Haven Ridge, which are on federal and private lands, may be detrimental. The most exciting possibility is the reintroduction of *S. woodi* to the southwestern Gulf Coast, where the last population apparently was extirpated in the 1990s in Collier County (Enge et al. 2021). These populations were genetically distinct; donor animals should come from ancestral populations on the southern Lake Wales Ridge in Highlands County (Branch et al. 2003), where the species is still common (Enge et al. 2021). Railhead Scrub Preserve in Naples, Collier County, contains extensive areas of bare sand in rosemary scrub habitat and is the most suitable reintroduction site.

Our study was a low-cost, experimental translocation of a lizard population to an unoccupied site with suitable habitat. Our results suggest that translocations of relatively rare reptile species can be feasible and effective conservation actions. The current success of our translocation also suggests that similar attempts could be made to reintroduce *S. woodi* to other areas within

its historical range where suitable habitat persists or has been restored.

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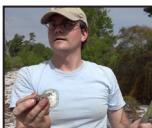
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