FINAL REPORT

AVIAN RESTORATION IN EVERGLADES NATIONAL PARK: EASTERN BLUEBIRD AND WILD TURKEY MONITORING (2008-2009)

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HOW TO READ THIS REPORT

This report serves as the final deliverable under Cooperative Agreement H5284080009 for research related to the monitoring of reintroduced populations of Eastern Bluebird and Wild Turkey in Everglades National Park during the period from 2007-2008. Section 1 of this report summarizes work related to the Eastern Bluebird, while Section 2 summarizes the Wild Turkey reintroduction and monitoring efforts. Although the research under this agreement spanned only 2-years (2007-2008), most research activities were initiated under previous agreements; for example, our study evaluating the use of nest excluders to reduce nest predation of bluebird nests. For those specific components of research that have continued across agreements, I have summarized the information from when the component was initiated so readers can obtain the full summary without cross-referencing previous work. Under the Wild Turkey Section, this report provides a full summary of the reintroduction and monitoring program since the inception of the project in 2000.

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INTRODUCTION

The pine rockland ecosystem only occurs in South Florida, the Bahamas, and Cuba, and is considered globally endangered (Noss et al. 1995, USFWS 1999, FNAI 2002). In south Florida, the extent of pine rocklands has been greatly reduced from pre-settlement times due to urban and agricultural development; many remaining lands have been degraded by fire and hydrological regimes that are not representative of historic patterns (Snyder et al. 1990). The Atlantic coastal ridge represents the most dramatic example of habitat loss, as > 90% of the historical extent of pine forests have been lost (Doren et al. 1993). Today, the largest tract of pine forest on the Atlantic coastal ridge lies in Everglades National Park (ENP) in a region called Long Pine Key.

Concomitant to the loss, fragmentation, and degradation of the pine rocklands in South Florida, several terrestrial bird species have declined or been extirpated. For example, in ENP six forest-breeding bird species were extirpated prior to 1965 (Brown-headed Nuthatch [*Sitta pusilla*], Eastern Bluebird [*Sialia sialis*], Red-cockaded Woodpecker [*Picoides borealis*], Southeastern American Kestrel [*Falco sparverius*], Wild Turkey [*Meleagris gallapova*], and Summer Tanager [*Piranga rubra*]), and another species, Hairy Woodpecker [*Picoides villosus*], has not been since 2000 (Robertson and Kushlan 1974, Ecostudies Institute, unpub. data).

While the majority of remaining pine rocklands, outside of the Florida Keys, have been protected and are no longer threatened by development, the restoration and long-term management of its plant and animal communities present significant challenges. In ENP, over 85% of this forest was logged during the late 1930's and early 1940's, prior to its establishment in 1947 (Olmstead et al. 1983). The pine rocklands are fire maintained, requiring fire to deter succession to hardwood hammock. The application of prescribed fire is the primary management activity in this ecosystem. In 2000, South Florida became the target of a large-scale hydrological restoration program, the Comprehensive Everglades Restoration Plan, which ultimately aims to restore a more natural pattern of hydrology, with respect to quantity and timing, through the Everglades System. Despite advances in the development and application of restoration and management strategies in the pine rocklands of ENP, it remains unclear if the factors that contributed to the extirpation of avian species have been eliminated. Indeed, research to examine reintroductions as a means to restore biotic losses in upland communities was identified as a critical information need and a necessary step in the restoration of the Greater Everglades ecosystem (Orians et al. 1996, Science Subgroup 1996). More recently, the need for research to identify the actions needed to restore, protect, and manage natural resources in South Florida and recover species of special concern have been further endorsed by the Department of Interior's Science Plan for South Florida (DOI 2005), the USFWS Multi-species Recovery Plan (USFWS 1999), and the Avian Conservation Implementation Plan for ENP (Watson 2003).

The reintroduction of two cavity-nesting species, Eastern Bluebird and Brown-headed Nuthatch, and the Wild Turkey were initiated in the late 1990's. The reintroduction of these species were considered experimental tests of restoration progress in the pine rocklands of ENP through the recovery of forest stands from logging and the application of appropriate fire management practices. The establishment and persistence of self-sustaining bird populations would serve as one indicator that restoration and management strategies currently employed in the pine rocklands were successful. The failure of reintroduced species to establish viable, self-sustaining populations, however, would serve as evidence that further modification of restoration and management strategies may be needed.

This report describes the research activities conducted on two of the reintroduced species from 2008-2009 in ENP, and it contains two sections corresponding to each reintroduction program. The first section reports on continued monitoring of Eastern Bluebirds. The second section of this report details the releases of Wild Turkeys to Long Pine Key and the subsequent monitoring efforts from the initiation of the project in 2000 through the 2009 breeding season.

1 POPULATION SIZE AND DEMOGRAPHIC MONITORING OF EASTERN BLUEBIRDS

During the period from 1997 to 2001, 47 adult Eastern Bluebirds and Brown-headed Nuthatches were translocated to Long Pine Key from large donor populations in Big Cypress National Preserve (BCNP) and, in the case of bluebirds, from golf courses in nearby Naples, FL (Slater 2001). At the completion of the 2001 breeding season, further translocations were deemed unnecessary, as 15 nuthatch and 18 bluebird territories were established and short-term success criteria had been met (Slater 2001). Subsequent monitoring during the two-year post-translocation period (2002-2003) found that population sizes increased and demographic parameters of reproduction and adult survival were similar between the reintroduced population and a high-quality reference population, both criteria providing further evidence of short-term reintroduction success (Slater 2004). However, additional monitoring was recommended because population sizes remained low and more demographic data were needed from the reintroduced population to evaluate long-term success criteria (i.e., population growth rates > 1.0).

During the period from 1998-2003, concomitant studies were conducted to identify habitat features (i.e., vegetation, fire, hydrology) associated with nuthatch and bluebird productivity to help guide habitat management of these species. For nuthatches, the number of large pine snags and, to a lesser extent, the number of small pine trees surrounding a nest site were found to be positively associated with productivity (Lloyd and Slater 2007). For bluebirds, the size (dbh) and height of the snag and the distance from the cavity to the closest branch were associated with productivity, habitat features likely reflecting a nest site's vulnerability to predation (Slater and Lloyd 2010). Overall, land managers in southern Florida were recommended to focus on providing abundant large pine snags because doing so would increase productivity and also may increase nest-site availability and the percentage of individuals that breed each year (Lloyd and Slater 2007). The primary management tool available in pine rocklands is prescribed burning. Although prescribed fire may be an effective way to increase the abundance of large pine snags by killing live trees, land managers should exercise caution because of the trade-off between snag recruitment and snag consumption that accompanies fire interval and fire season (Lloyd et al. *in review*). We recommended that fire management should aim to increase the spatial heterogeneity in fire-return interval, with some areas reaching fire intervals $\geq$ 5 years (Lloyd and Slater 2007).

The long-term success criterion for the nuthatch and bluebird reintroduction program was defined as populations exhibiting growth rates $\geq$1.0 following the cessation of translocations. Continued demographic monitoring during the period from 2005 – 2007 found that only the reintroduced nuthatch population met our long-term success criterion, as the population exhibited a population growth rate $\geq$1.0, on average, during the period from 2001-2007 (Lloyd et al. 2009). In contrast, the reintroduced bluebird population in ENP failed to meet our long-term criterion of success, as population models found λ <1.0 and ground surveys indicated a slowly declining population since the cessation of translocation (Lloyd et al. 2009, Slater and Lloyd 2010). Several hypotheses were proposed for the lack of population growth, including the lack of suitable habitat or some habitat feature (e.g., snags, fruit-producing shrub understory), high mortality due to vehicle collisions (e.g., low recruitment), and the vulnerability of populations at the southern edge of their range to environmental stochasticity. However, data were insufficient to allow for reliable tests of any of these hypotheses.

Two factors clearly appeared to be of some importance to the lack of population growth. First, bluebird productivity has declined substantially since translocations were discontinued, apparently from high levels of predation. Second, bluebirds, especially juveniles, appear vulnerable to mortality via vehicle collisions due to their propensity to nest and forage along roadsides. Management efforts to improve recruitment via increases in productivity and juvenile survival were recommended until better evidence of viability was determined (Lloyd et al. 2009). In response, beginning in 2006 video cameras were placed at nests to identify nest predators and, in 2007 we begun attaching cavity excluders onto nest cavities to reduce predation and increase productivity. Through ENP administrative channels, efforts to reduce and enforce posted speed limits in areas where Eastern Bluebirds were abundant were implemented, as well as erecting warning sign to inform drivers of the presence of breeding bluebirds.

During the period from 2008-2009, we continued demographic monitoring of the bluebird population to evaluate success further and implement management actions aimed at increasing productivity and decreasing roadside mortality. The primary goal of this research was aimed at identifying those factors depressing the bluebird population in Long Pine Key. The specific objectives were to 1) estimate population size and productivity of the reintroduced bluebird population; 2) identify nest predators through video monitoring; 3) increase productivity through the use of nest excluders; and 4) monitor road mortality.

In response to the failure of nest excluders to increase productivity and a desire to specifically address the potential limiting factors of cavity availability and cavity quality we also initiated a pilot nest box study in 2009. The objectives of the nest-box study were two-fold: 1) to quantify the use of nestboxes provided in bluebird territories, and 2) determine if nesting success and/or productivity is higher in nestboxes than natural cavities.

Overall, results from this research were aimed at providing a roadmap for how the reintroduction program should continue into the future.

METHODS

Study area

We studied the reintroduced Eastern Bluebird population in the Long Pine Key region of ENP. Long Pine Key is an 8,100 ha upland area that contains approximately 4,600 ha of pine forest (Snyder et al. 1990, Doren et al. 1993). Within the relatively continuous pine forest, embedded habitats include *Muhlenbergia* prairie, hardwood hammocks, and cypress forest (Olmstead et al. 1983). During the past decade, the fire management program has implemented a prescribed fire regime characterized by fire return intervals of 2-3 years and primary ignition periods in the rainy season (May-August; Slocum et al. 2003).

Population size and productivity.

We estimated the population size of Eastern Bluebirds during the breeding season by counting the number of adults observed on territories and non-territorial birds believed to be floaters. Adults that disappeared from their breeding territory were counted as part of the breeding population, even though we assumed they died; in only a few instances have adults left a breeding position for a new territory. The principal assumption of our estimate of population size is that all individuals were located.

We located bluebird nesting territories through systematic transects and playback vocalizations conducted in areas where territories were detected in previous years and in unoccupied areas of suitable habitat. Upon detection, individuals were followed until their breeding status was determined or a nest attempt was found. Nests were monitored every 3-5 days to determine their fate and were considered successful if they fledged at least one nestling. Clutch size was determined, when possible, using a Tree Top PeeperTM System (Sandpiper Technologies, Inc., Manteca, CA). The number of juveniles was determined from two counts conducted within three weeks from the date they fledged. Regardless of whether a nest was successful or failed, we re-surveyed territories later in the breeding season to account for any renesting attempts.

Video Monitoring

Three video camera systems were purchased in 2006 from Fuhrman Diversified (Fieldcam System, Fuhrman Diversified, Seabrook, TX) to identify predators of nests of Eastern Bluebirds. Video camera systems were employed at a sub-sample of nests each breeding season. We selected nests for monitoring based on their proximity to main or fire roads because of the logistical challenge of hauling heavy marine batteries over pine rockland topography.

The camera and video recorder units were expected to work day and night and were powered by marine batteries. At night, an infra-red beam, aligned to the cavity entrance, was reported by the vendor to provide enough illumination for the camera; we found the cameras rarely worked at night. Digital video was recorded on a hard drive. We typically put two batteries on each system to extend the time the unit worked under a single charge, and we switched out a single battery every 1-3 days. During the first year, batteries performed adequately, often lasting 2-3 days. However, their ability to hold a charge declined dramatically in subsequent years and in 2007 and 2008 additional batteries were purchased. In 2008, we also purchased solar panels to power the video camera units. These were very effective at keeping batteries charged. However, by that time the camera and digital video recorder units were working poorly. The cause of the problems was unclear but presumably was due to electrical connection and corrosion issues. We also found that rodents chewed through much of the video cable. In 2009, we were unable to use the cameras for monitoring nests.

Nest Excluders

Beginning in 2007, we placed aluminum flashing around bluebird nests that could be reached safely, to decrease the probability of nest depredation, and thus increase productivity

(Figure 1-1). Excluders were made of 12-inch aluminum flashing wrapped around the snag with a 1.5 inch opening placed at the cavity entrance. Because many nests failed in 2008, we used 24 inch flashing and glued a wooden plate at the entrance hole.

Nest Box Experiment

We placed four bluebird nestboxes (standard eastern bluebird cedar boxes; http://www.nabluebirdsociety.org/eastwestbox.htm) in half of the 14 breeding territories that were found in Long Pine Key in the 2008 breeding season (Figure 1-2). No boxes were placed in the Pine Island area. The seven territories that received nestboxes were determined by a stratified random selection process with fire blocks serving as strata. Boxes were only placed in the fire blocks of J, I2, I1. Nestboxes were placed on unusable snags (typically burnt heartwood stubs) using plastic zip ties, approximately 100 m apart. Where snags were not available, nestboxes were place on trees. All nestboxes were taken down at the end of the breeding season.

We will interpret the use of nestboxes by bluebirds to indicate that either cavities or high quality cavities may be limiting for bluebirds. While it is impossible to tease out the specific explanations for why a bluebird may select a nestbox, the use of nestboxes should prompt discussions aimed at increasing snag abundance, and how prescribed fire management may influence the abundance and retention of high-quality snags. We will interpret greater nesting success in nestboxes than natural cavities as evidence that high-quality snags, defined as their ability to produce offspring, are limiting.

RESULTS

Population size and productivity

In 2008, we located eighteen breeding territories (Figure 1-3), and in 2009 we located 15 breeding territories and one territory that appeared to contain only a single female (Figure 1-4; Table 1-1). Overall, we estimated that the population consisted of 37 adult birds in 2008 and 36 adults in 2009 (Figure 1-5). However, in 2009 the population sex ratio was strongly skewed (1:1.4) towards females. Single female floaters were observed in both years, but were particularly abundant in 2009, with $\geq$ 5 single females detected, some in western parts of Long Pine Key (Block C, the Pineland trail off of the Main Park Road). Several females were consistently observed in occupied breeding territories, where the breeding pair expended considerable time and energy trying to force them out of the territory. We observed one female helping a pair feed nestlings, and two single females were observed nest-building without the presence of a male.

In 2008, 29 nests were located, of which 9 (31%) were successful. Most pairs nested twice and three pairs nested three times. In one territory, we found no evidence of nesting; in two territories we found dependent juveniles after failing to find nests. Overall, 21 juveniles fledged and mean productivity (± S.E.) was 1.24 ± 0.33 young per breeding territory (Table 1). This was the highest productivity estimate since 2002. In 2009, we found 18 nests, of which six (33%) were successful. Only 11 juveniles fledged and bluebird productivity was 0.73 (± 0.27) young per breeding territory (Table 1-1). We did not find evidence of breeding in three of the fifteen territories, although one pair was found nestbuilding. Two of the six successful nests in 2009 were in nestboxes and produced a total of 3 young.

In general, productivity appears to have declined in Long Pine Key since around 2003. Productivity in Long Pine Key during the period 2005-2009 (mean = 0.84; 95% CI = 0.58, 1.1) was significantly lower than in Long Pine Key during the period from 1998-2003 (mean = 1.84; 95% CI = 1.34, 2.33). Recent productivity in Long Pine Key (2005-2009) was also lower than in the source population (Raccoon Point) during the period from 1998-2003, although differences were not significant (mean = 1.28; 95% CI = 1.03, 1.5).

We found no evidence of mortality due to vehicle collisions in 2008, the first year since 2001. This coincided with the use of new signs, aimed at drawing attention to the presence of bluebirds. We also did not find evidence of road mortality in 2009; however, during the course of the breeding season, four breeding adults disappeared under suspicious conditions. Two adults, a breeding male and female from territories adjacent to Research Road, disappeared within a week of each other during the period when Hole-In-The-Donut restoration activities had ceased and a high number of vehicles were pulling out of the restoration site. Two males also disappeared from breeding territories in the Pine Island area, another area where mortality due to vehicle collisions has been high. In 2010, we have also received reports that two bluebirds were found dead on Research road, one in February and one in August (Skip Snow, pers. comm.).

Video Monitoring

We began using video cameras at bluebird nest in 2006, late in the field season. During the season, we monitored nine nests, but at only eight were cameras operating at the end of the nesting period or when predation events occurred. We recorded five predations events, four during the day and one during the night. Three nests were depredated by Red-bellied Woodpeckers (*Melanerpes carolinus*) removing eggs, one nest was depredated by American Crows (*Corvus brachyrhynchos*) removing nestlings, and one nest was depredated by a snake (*Elaphe sp.*) (Figure 1-6). At two nests, cameras failed to record the final event of the nest; one nest was not illuminated during the depredation event, and one camera was not working when a nest successfully fledged.

In 2007, video cameras were monitoring six nests when the nests fledged or failed. We recorded two depredations (one Red-bellied Woodpecker taking eggs and one nest where crows removed eggs or nestlings) and one fledging. At three nests cameras were not working when the young fledged or the nest was depredated.

In 2008, we were video monitoring 10 nests at the time of failure or fledging. At four nests we recorded nest outcomes. Two nests were depredated, one by red imported fire ants (*Solenopsis sp.*) and one by a snake at night. We also recorded a partial depredation, as a Red-bellied Woodpecker removed at least one egg at a nest that later fledged juveniles. At one nest, the eggs were infertile. At five nests, the camera did not work when the nest was depredated. At one nest that failed, the video file was accidentally deleted.

Overall, we recorded 10 predation events on video, 8 during the day and two at night. The dominant predator was the Red-bellied Woodpecker, which were observed at 5 nests removing eggs. At two nests, crows depredated nests and at two nests snakes depredated nests. At one nest, ants were the cause of failure. Video cameras recorded outcomes at 3 other nests, two where the young fledged, and one that failed due to infertile eggs. At 10 nests (43%), the cameras failed to record the final event. In most cases this was due to mechanical failure, but on at least 2 occasions the infra-red camera failed to work at night when the predation occurred

Nest Excluders

In 2007, we placed flashing on four nest snags during the incubation period. All four nests failed. One failed within two days of the flashing being attached and the eggs were gone. At the remaining three nests, the eggs hatched, but failed during the feeding stage of unknown causes. In 2008, we used wider flashing and a wooden plate at the entrance hole. We attached excluders at five nests. At one nest the bluebird pair did not accept the excluder and after one hour we removed it; all other bluebird pairs accepted the excluder. Three of the four nests failed, all during the nestling stage. One nest failed due to fire ants, while the cause of failure of the remaining two was unknown. Bluebirds renested in the cavity that failed due to ants and were successful during the second attempt.

Overall, 7 of 8 nests (88%) that received an excluder failed. Unfortunately, we were unable to obtain video to identify the cause of most nest failures. It is curious that all of the failures except for one occurred during the nestling stage. Depredation by Red-bellied Woodpeckers, the most common nest predator, usually removed eggs.

Nest box study

During the early part of the breeding season, we observed bluebirds entering nestboxes in two territories and one pair ultimately nested in a nestbox. This nest failed during the incubation stage. Prior to nesting by the bluebirds, the opening of this nestbox had been enlarged, apparently by a woodpecker, and we suspect that predation was the cause of failure as all the eggs disappeared. Shortly afterwards, the pair renested in another nestbox that did not have an enlarged cavity opening, and successfully produced one juvenile.

In three of the territories where nestboxes were erected at the start of the breeding season, bluebirds did not occupy the territory. Consequently, on 22 May 2009 we moved four boxes from one of the vacant territories (EI) to an occupied territory (TI) in the campground where a pair had been unsuccessful in obtaining a nest cavity. During the last week of June, the pair began nestbuilding in one of the boxes and ultimately nested successfully, producing two juveniles. Overall, nestboxes were used in 2 of the 5 (40%) territories where nestboxes were provided. We found one Red-bellied Woodpecker nest in a nestbox, but no other nestboxes were used. The use of nestboxes was restricted to the area around the campground, and in that area 50% (6 of 12) of the nestboxes had enlarged openings.

DISCUSSION

Unless we improve our understanding of the factors limiting the Eastern Bluebird population in ENP and develop management strategies to address the problem, we suspect the population will remain at risk of extirpation. The reintroduction of viable populations of Eastern

Bluebirds and Brown-headed Nuthatches is one ecological indicator of restoration progress and appropriate management in the pine rocklands of Long Pine Key. Although the nuthatch population has increased in size and expanded their distribution, the viability of the bluebird population remains in question. Since 2002 the bluebird population has not grown in size, fluctuating around 35 adults, even though large areas of apparently suitable habitat remain vacant. Because of its small size, the bluebird population is vulnerable to demographic and environmental stochastic events. Evidence of demographic stochasticity emerged in 2009 with an increasingly skewed sex ratio, where $\geq$ 5 adult females were unmated. Equally troubling is that only 13 breeding territories remained at the end of 2009, due to the disappearance of 4 breeding adults, and only 11 juveniles were produced. We expect the population size in 2010 to be one of the lowest on record.

Low productivity appears to be a primary factor hindering population growth. Bluebird productivity during the period 2005-2009 was lower than during the first 6 years of the reintroduction (1998-2003) in both the reintroduced and donor population. Nesting success in 2008-2009 and in previous years has hovered around 30%, substantially lower than estimates from central Florida (43%; White and Woolfendon 1973) and other areas of South Florida (46%; Slater 1997).

Over the past decade, the number of snags in ENP appears to have declined, likely due to decay and prescribed fire activities. The abundance of snags in South Florida are affected by mechanisms independent of human control, such as pathogens or severe weather (e.g., hurricanes), and following Hurricane Andrew in 1992, snags were superabundant. Fire also drives snag population dynamics through killing trees (i.e., creating snags) and consuming snags (Morrison and Raphael 1993, Chambers and Mast 2005), and prescribed burning is the primary management activity in ENP. Recent modeling of snag dynamics in a South Florida slash pine forest found that burning in the dry season (or closer to the transition between the dry and wet season), with longer return intervals (>3 yr) was predicted to yield greater densities of snags than prescribed fires applied during the wet season and at a 3-year interval (Lloyd et al. in review). The latter prescription is the current management strategy employed by the fire management program in ENP (Slocum et al. 2003). However, we have no data to indicate if current fire management practices in ENP result in a net loss of snags over time.

Evidence of poor reproduction by bluebirds and the apparent decline in the number of snags over the last decade leads us to suspect that cavity availability or the availability of high-quality cavities (i.e., ability to protect from predators) may be limiting the bluebird population. Several lines of evidence support this hypothesis. First, in most years, some bluebird pairs have foregone breeding, an indication that they may have been unable to acquire a suitable cavity for nesting. Indeed, in 2009 one bluebird pair did not acquire a nest cavity until a nestbox was provided in its territory. Second, nest predation was very high in this population, and the Red-bellied Woodpecker, an aggressive cavity competitor, appears to be the primary nest predator. Third, in 2009 we found four cases where other cavity-nesting species (i.e., Red-bellied Woodpecker, Northern Flicker (*Colaptes auratus*), Great-Crested Flycatcher (*Myiarchus crinitus)* nested in bluebird cavities following nest failure, indicating that there is significant competition for existing nesting cavities. This result was slightly surprising, considering that both Red-bellies and flickers can excavate their own cavity. Finally, we know that cavity limitation may be particularly prevalent in Florida, as snag resources appear to be deficient for cavity-nesting species, particularly in slash pine forests (McComb et al. 1986).

In contrast to the bluebird, the Brown-headed Nuthatch, another reintroduced cavity-nester, appears to be flourishing. The nuthatch may not be as susceptible to cavity limitation because it can use a larger proportion of available snags, due to its small size and ability to excavate its own cavity. Moreover, its small size and early breeding reduces the likelihood of competition with other cavity-nesters.

Results from the pilot nestbox study, provide preliminary evidence that bluebirds are limited by cavity availability. Overall, bluebird pairs used a nestbox in two of the five (40%) territories where nestboxes were provided and one pair did not nest until boxes were placed in its territory. Both territories that used nestboxes successfully fledged young. However, nestboxes were only used in the campground, and thus it is unclear if this pattern extends to other areas of Long Pine Key. The campground is a favored area by bluebirds, presumably because campsites are mowed and provide high quality foraging habitats. Pineland habitat surrounding the campground has fewer snags because snags are removed for safety concern.

Several other hypotheses also have been identified to explain the lack of population growth including high mortality due to vehicle collisions (both adult and juvenile), food availability (breeding or non-breeding season), and genetic inbreeding. Mortality due to vehicles and its consequence on the population are hard to quantify, in part, because evidence suggests that the number of small animals, including birds, that are killed on roads is 12 to 16 times higher than that observed (Slater 2002). Bluebird mortality due to vehicle collisions has been observed in nearly every year of the project and juveniles appear to be more vulnerable. This density-independent mortality source likely has a strong impact when the population is small, such as in the current situation. Based on the average population size estimates over the last 5 years, the loss of 2 juveniles or 2 adults, translates to a 15% and 6% reduction in abundance per year, respectively. Mumme et al. (2000) found that road mortality resulted in a roadside population of Florida Scrub-Jays (*Aphelocoma coerulescens*) serving as a population sink that was only maintained via immigration from outside populations. Until the bluebird population grows in size and expands into habitats not adjacent to roads, we expect mortality due to vehicle collisions to continue having a significant negative impact on the population.

Recommendations

Given the precarious state of the bluebird population, we believe that additional translocations are needed immediately to avoid extirpation. We propose that at least five pairs of bluebirds should be released in unoccupied areas of suitable habitat in western Long Pine Key (Block C, E, south B) away from roads and the campground using techniques developed during initial reproduction efforts. An additional release of five single males should be conducted in areas where single females are observed, ideally away from roads. We suspect that at least 2-3 years of translocations will be needed.

In addition to translocations, research is needed to identify limiting factors in the bluebird population as that information is critical to identify long-term restoration and management actions that will benefit bluebirds. We believe the most important research need is the expansion of the experimental nestbox study to improve our understanding of the role of cavity limitation. We predict two outcomes if bluebirds are limited by the availability or quality of cavities in Long Pine Key. First, if the availability of cavities is limiting, then adding nest boxes should result in an increase in the proportion of adults that are breeding and/or earlier breeding, both of which should increase the number of young produced each year and ultimately population size. Second, if high quality cavities are limiting, then adding nest boxes should population size through increases in nesting success and productivity. If either of these predictions are found to be true, then discussions on how to increase snag abundance in the pine rocklands are warranted, and these discussions would likely center on how prescribed fire management may influence the abundance and retention of high-quality snags. Consequently, research addressing the effects of prescribed burning (i.e., fire interval, fire ignition period) and disturbance factors (hurricanes) on snag dynamics should also be a high priority. Another subject of research that would prove fruitful is the role of food abundance on overwinter survival and productivity in bluebirds and the effect of fire on the abundance of bluebird foods, particularly fruits of the shrub understory.

Table 1-1. Summary of Eastern Bluebird reproductive measures (± S.E.) in Long Pine Key, ENP during the period 1998-2009.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Territories	1	2	4	16	23	18	**	18	16	17	18	16
Breeding Territories	1	2	4	16	22	16	**	15	16	15	18	15
Mean incubation date (First attempts)		20 May (± 9)	16 April (± 6)	25 April (± 4)	22 April (± 4)	1 May (± 3)	**	7 May (± 6)	21 April (± 4)	2 May (± 2)	7 May (± 4)	23 April (± 4)
Clutch size (First attempts)			4.00 (± 0.58)	4.00 (± 0.23)	3.93 (± 0.18)	3.33 (± 0.19)	**	3.90 (± 0.31)	4.00 (± 0.17)	3.69 (± 0.21)	3.93 (± 0.21)	NA
Productivity (± SE; no. young/ breeding terr.)	2.00	3.00 (± 1.00)	4.00 (± 1.87)	2.38 (± 0.57)	1.73 (± 0.33)	1.20 (± 0.39)	**	0.47 (± 0.19)	1.13 (± 0.39)	0.73 (± 0.28)	1.24 (± 0.30)	0.73 (± 0.27)

** Population not monitored in 2004

Figure 1-1. Images of nest excluder used on Eastern Bluebird nests in the 2008 breeding season. The nest on the left was depredated by ants during the pair's first breeding attempt, but a second breeding attempt later in the season was successful. The nest on the right had one egg depredated prior to the excluder being placed on the cavity and was ultimately depredated by an unknown predator.

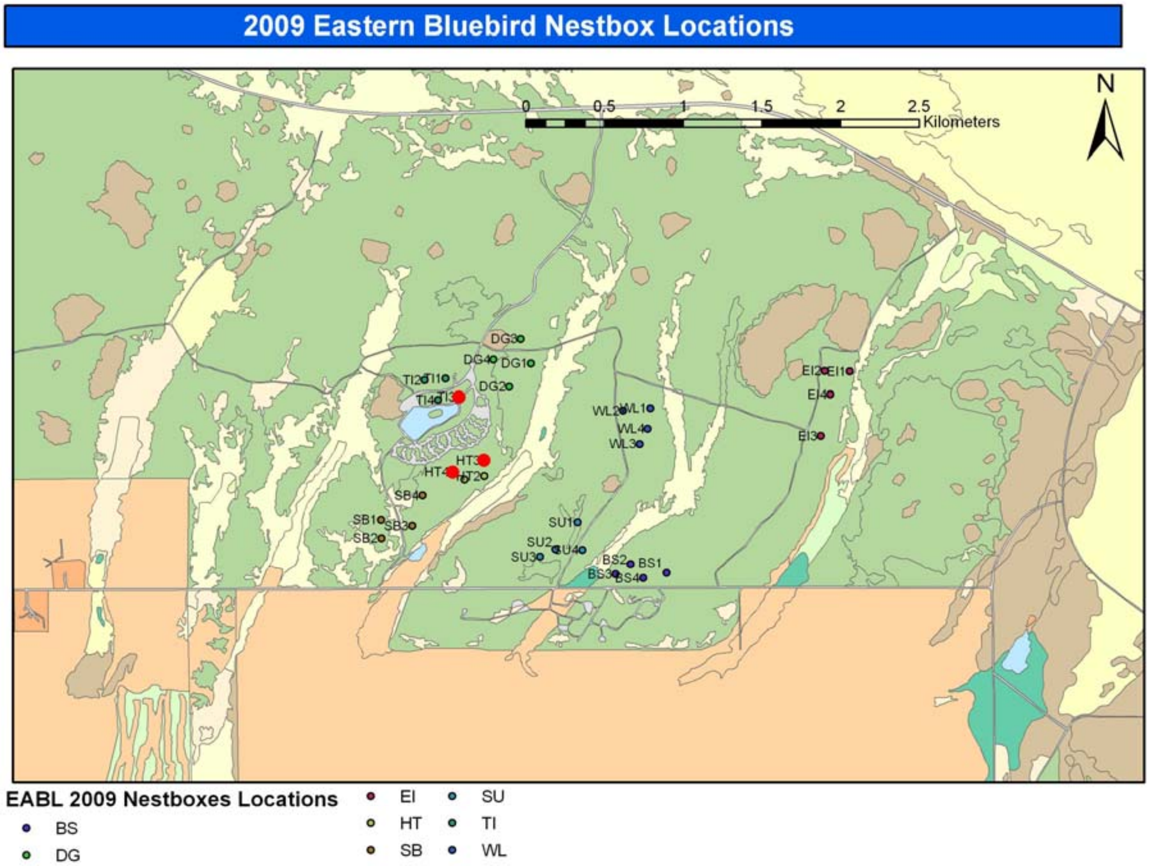

Figure 1-2. Map of nestbox locations put up in 2009 as part of the pilot nest box study conducted in Long Pine Key, ENP. Boxes first placed in the EI territory were moved to TI in June. Three territories where nestboxes were placed, EI, WL, and SB, were not occupied by bluebirds. Bluebirds nested in Boxes HT3, HT4, and TI3 which are highlighted in red.

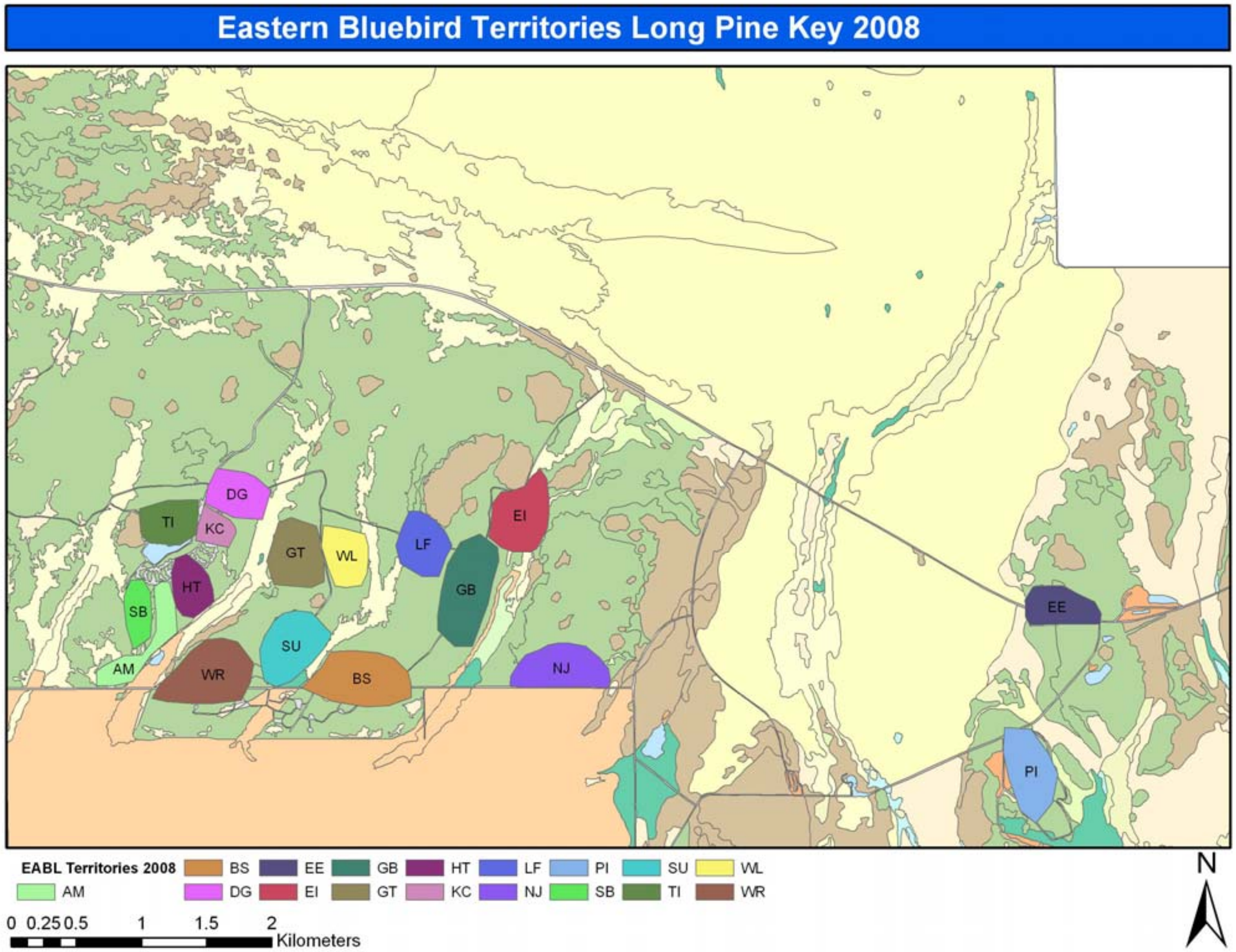

Figure 1-3. Map of Eastern Bluebird territories in Long Pine Key, ENB during the 2008 breeding season.

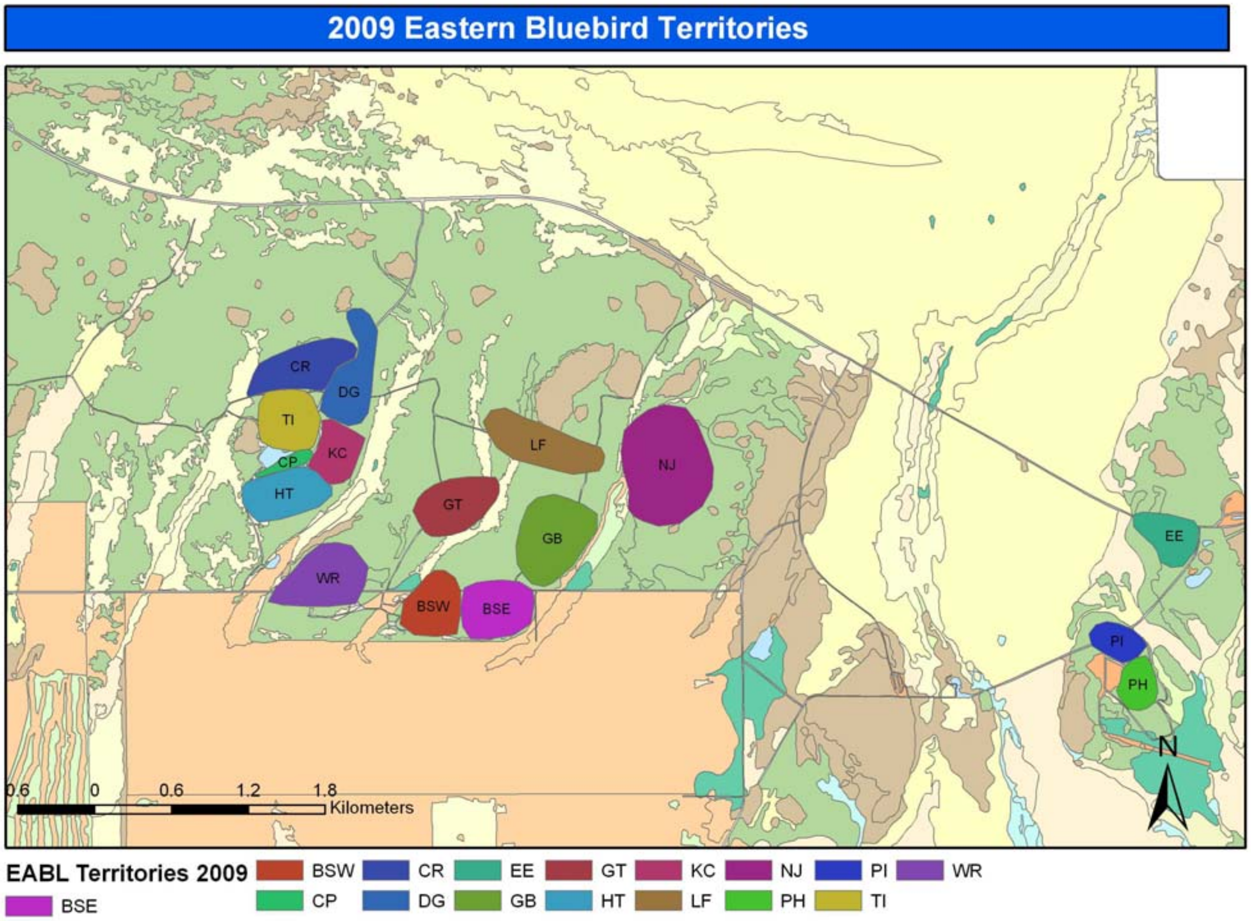

Figure 1-4. Map of Eastern Bluebird territories in Long Pine Key, ENP during the 2009 breeding season.

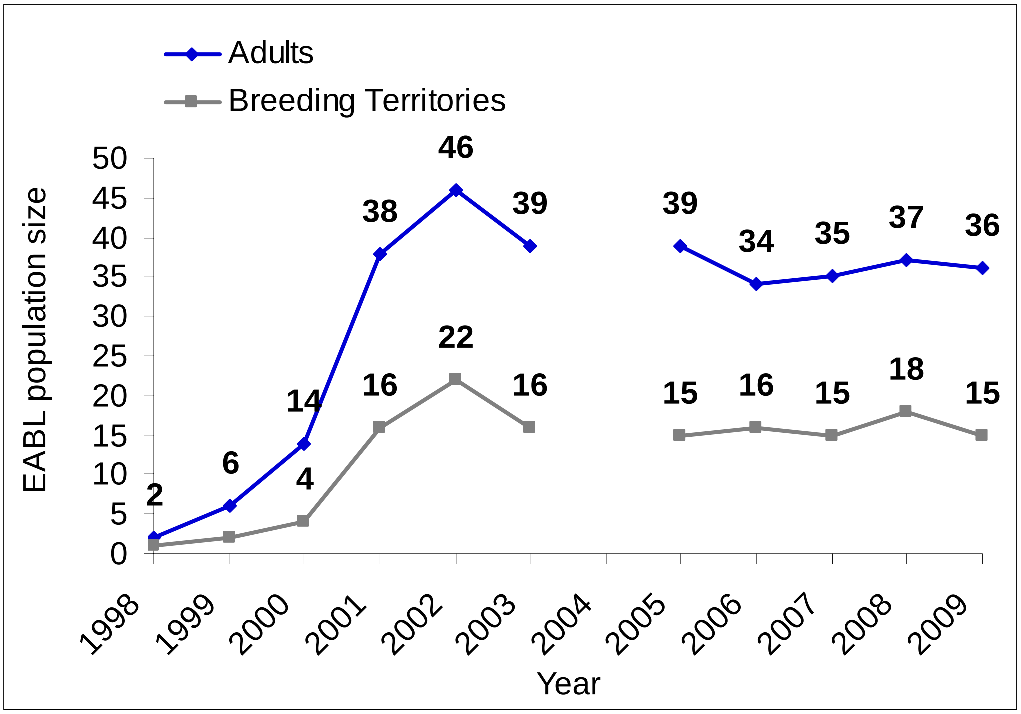

Figure 1-5. Estimated population size and number of breeding territories of Eastern Bluebird territories in Long Pine Key, ENP from 1998 - 2009.

Figure 1-6. Photos of bluebird nest predation events by Red-bellied Woodpecker (upper) and American Crow (lower).

2 WILD TURKEY MONITORING

The Florida Wild Turkey (*Meleagris gallopavo osceola*) was extirpated from the Long Pine Key region of Everglades National Park (ENP) in the mid- to late-1950's. Although the specific cause of the extirpation remains unknown, unregulated hunting on private in-holdings within the park boundaries (O. Bass, W. B. Robertson, Jr., G. Simmons, L. E. Williams, Jr.; pers. comm. to Skip Snow 1999), habitat loss and fragmentation of pine forests, and altered fire and hydrological regimes (Snyder et al. 1990) likely contributed to the species disappearance.

Historical records and verbal accounts suggest that several attempts were made to reintroduce turkeys to Long Pine Key following their extirpation. The first reintroduction attempt was believed to have been initiated by landowners on their private in-holdings sometime during the late 1940's. A second attempt may have taken place in the early 1960s. Verbal accounts suggest that approximately 20 to 30 birds were released and that successful reproduction occurred (O. Bass, W. B. Robertson, Jr., G. Simmons, L. E. Williams, Jr.; pers. comm. to Skip Snow 1999). However, these reintroduction efforts appear to have failed, perhaps due to continued hunting pressure. ENP wildlife observation records provide evidence of a possible third reintroduction, as several individuals were killed by vehicle collisions near Pine Island in the spring of 1971. The last ENP record of a Wild Turkey observation was near Pine Glades Lake in the spring of 1975, the year Hole-in-the-donut (HID) in-holdings were transferred to ENP ownership.

In 1999, a renewed interest in establishing a turkey population to ENP emerged for several reasons. First, significant progress towards restoration of the endangered pine rockland ecosystem in Long Pine Key had occurred. For example, the pine rockland forest had matured to approximately 60 years of age and the application of a putative natural fire regimes had been implemented. Second, unregulated hunting was no longer a threat to the persistence of a reintroduced population. Third, reintroduction efforts of other pineland bird species, the Eastern Bluebird (*Sialia sialis*) and Brown-headed Nuthatch (*Sitta pusilla*), were ongoing and appeared to be successful. Finally, natural reestablishment of turkeys was considered unlikely due to the long distance and the absence of suitable habitat corridors for dispersal between ENP and the closest source population in Big Cypress National Preserve.

In 2000, a reintroduction program was initiated by ENP, the Florida Fish and Wildlife

Conservation Commission (FFWCC), the Homestead Chapter of the National Wild Turkey Federation (NWTF), and Ecostudies Institute. This report details the releases of Wild Turkeys to Long Pine Key and the subsequent monitoring efforts from the initiation of the project in 2000 through the 2009 breeding season. The overarching goal of the turkey monitoring project was to evaluate the success of the reintroduction and provide long-term recommendations for monitoring the reintroduced population of turkeys. Monitoring the success of the reintroduction program is critical to gauge restoration progress, through the protection of forests and the application of a putative fire regime, in the pine rockland ecosystem in ENP. Using radio-telemetry, additional objectives of the project were to determine the survival of released individuals, estimate home range size, and evaluate habitat use.

METHODS

Study area

Long Pine Key is an 8,100 ha upland area that contains approximately 4,600 ha of pine forest (Snyder et al. 1990, Doren et al. 1993). Within the relatively continuous pine forest, which is mostly even-aged, embedded habitats include *Muhlenbergia* prairie, hardwood hammocks, and cypress forest (Olmstead et al. 1983). During the past decade, the fire management program has implemented a prescribed fire regime characterized by a fire return interval of 2-3 years and a primary ignition period in the rainy season (June-August; Slocum et al. 2003).

Turkey releases and survival

Wild Turkeys were first released in January 2000. A second release was conducted in January 2006 following two camera surveys that found the population size index for turkeys was $\leq$ 15 individuals, the criteria established by FFWCC to trigger a second release. FFWCC biologists captured birds on private lands in central Florida, where turkey populations were large enough to withstand harvest levels without impacting the population. All individuals were uniquely marked with patagial tags and United States Fish and Wildlife (USFWS) aluminum bands prior to transport to ENP. Ten individuals from each release were radio-tagged with transmitters equipped with a mortality switch that was triggered if the radio did not move for 8 hours. Radios transmitted in the 151 Mhz frequency range. Turkeys captured early in the morning at the donor site were transported and released the same day; turkeys captured later in the day were held overnight at the release site and were released the following morning. All of the turkeys were released in an area of open prairie habitat, approximately 100m south of the Long Pine Key Campground.

We monitored radio-tagged individuals daily for the first week following release because we assumed turkeys were most vulnerable to mortality and made their largest exploratory movements during this period. After this adjustment period, we obtained a signal from each radio-tagged turkey two times per week from fixed telemetry stations, located on paved and fire roads, approximately 1.5 km apart in the Long Pine Key region. Turkeys were detected using a directional "H" antenna and a TRX-2000S Wildlife Materials, Inc receiver. When we detected a mortality signal, we searched until we found the animal and looked for clues explaining cause of death.

Home range and habitat use

Following the second release of turkeys in 2006, we determined home range size of radio-tagged individuals and evaluated habitat use. We used the same fixed tracking stations from 2000 to search for individuals. When an individual was detected, we determined a compass bearing to its location. Then, we moved to a second “random” tracking station that allowed us to obtain a second compass bearing approximately perpendicular to the first. If necessary, we obtained additional bearings to increase the likelihood of successful bi- or triangulation. Most bearings were collected within 20 minutes of each other. We derived locations for each individual using LOAS (2005 Ecological Software Solutions) software. In most cases, we only used a set of bearings that were obtained within a 20 minute period. However, in some cases we used bearings taken within a 40 minute period, particularly if locations were collected midday, when we expected birds to be less active. Each location was considered independent because sequential locations were determined > 24 hours apart and the majority of points were > 48 hours apart. Using the Animal Movement extension in ArcView 3.2 (Hooge and Eichenlaub 1997), we calculated home range size at two scales: a 95% fixed kernel density utilization distribution or kernel home range (KHR) and a 50% KHR, corresponding to the areas in which there was a 95% or 50% probability of an individual being located. We consider the 95% KHR to represent the home range and the 50% KHR to represent the core area within the individual's home range.

We characterized habitat use by radio-tagged turkeys by determining composition of vegetation within 95% and 50% KHRs. We used the South Florida Mapping Project's GIS vegetation database (see Welch et al. 1999) as a base habitat map in determining the percentage of each habitat category.

Population monitoring

Camera surveys. Prior to implementation of a standardized monitoring program in 2004, information on the size of the Wild Turkey population was obtained from passive monitoring by FFWCC and ENP biologists. Camera surveys were conducted during the fall and early winter (approximately September – December) of 2000, 2001, and 2003, as part of the FFWCC's annual monitoring program for panthers (see Appendix 2-1). While this effort produced relative measures of turkey abundance, results were not comparable among years due to the use of different methodologies and effort levels. The absence of a standardized monitoring program was considered a significant information gap. In fall 2004, a standardized camera monitoring program was established to determine the relative size of the reintroduced population of Wild Turkeys in ENP and determine if additional translocations were needed. This monitoring effort was continued for 5 years, as agreed upon by ENP and FFWCC, to evaluate the success of the reintroduction effort.

We followed the FFWCC Wild Turkey Management Section's protocol for establishing a camera monitoring program (Appendix 2-1). We established ten permanent camera survey stations in Long Pine Key, configured a minimum of 1.6 km apart along the fire roads in Long Pine Key (Fig. 2-1). We conducted the first survey in October 2004. Subsequent surveys were conducted twice a year during two standardized periods recommended by FFWCC: late winter (January/February) and summer (June - September). At each camera site, cracked corn was placed in a single bait pile, spread thinly in front of the camera, and along two thin stringers in both directions away from the camera up to ¼ mile. Sites were pre-baited a minimum of one week prior to the start date of the camera survey. Each camera unit (CamTrakker, Watkinsville, GA) was placed on a tree adjacent to the fire road at a height where the infra-red sensor was approximately 15 inches above ground (Fig. 2-2). Cameras were programmed to be active from sunrise until sunset, with a delay of 5 minutes to avoid repeated pictures of a single feeding event and to record the date and time on each image. Pictures were downloaded every 2-3 days and bait sites were maintained as needed.

In the last couple of years of the 5-year monitoring effort, several of the CamTrakker units began malfunctioning. For example, the infra-red sensor did not detect movement when an object passed in front of it or the camera did not operate when the infra-red sensor was triggered. The cause of the malfunctions was unknown, but presumably was due to electrical connection and corrosion issues. To compensate for this problem, we rotated "good" units through the sites and we borrowed camera units from other programs. In the summer of 2008, we borrowed several infra-red/motion camera units from the mammal inventory program; in the summer of 2009, we borrowed five Trailmaster camera units from the Wild Turkey Management Section of FFWCC.

The summer camera survey was conducted with only nine camera stations, instead of ten, because Camera site 10 was inaccessible during the rainy season due to flooding. In 2005, the summer survey was cancelled due to high water across all the sites. During the summer survey of 2009, we surveyed for turkeys at only seven sites. We did not survey at Camera Site 1 because vegetation conditions had become unsuitable for a camera site. At this site, vegetation had increased in height and transitioned from a graminoid dominated understory to one dominated by hardwoods, presumably because driving was no longer allowed on the fire road. We did not survey at Sites 5 and 10 because of flooding. We also moved Camera Site 2 approximately 1 km south to an area of higher ground that was not flooded.

For each camera survey, we determined an overall and sex-specific population size index from the identification of unique individuals, verifiable from tags, bands, or other unique markings, or determined using the criteria that a turkey could move 1 mile/1 hour.

Personal observations. In addition to the camera surveys, records of personal observations by park visitors and personnel from NPS and other agency cooperators were collected beginning in January 2006. We maintained observation forms at the entrances of the Daniel Beard Research Center and the Bill Robertson building, allowing personnel to record observations of turkeys. We also recorded any reports of turkeys submitted by park visitors on Everglades National Park Wildlife Observation Forms. In the spring of 2005, we conducted a gobbling survey with the assistance of members of the Homestead Chapter of the NWTF. On the 10th and 12th of March, eight and four volunteers, respectively, surveyed along paved and fire roads from sunrise to 09:00. Volunteer surveyors called turkeys using a variety of methods approximately every ¼ mile in suitable habitat. Personal observations were important because they provided the best opportunity to determine if successful breeding occurred during the breeding season. Camera surveys were not effective in recording poults, presumably because they did not feed on grain.

Evaluating Success

We assessed the success of the Wild Turkey reintroduction effort by evaluating the results of the camera surveys and the personal observations. Seddon (1999) and Armstrong and Seddon (2008) proposed that reintroduction success is the product of 2 discrete events. The first event, population establishment, is characterized by survival of the released generation and breeding by the released generation and their offspring in their new environment. The second stage, population persistence, is achieved when the reintroduction sustains a non-negative rate of population growth, particularly once the carrying capacity of the reintroduction site is reached.

We followed this general model for evaluating the success of the turkey reintroduction. We had no way to estimate population growth rate of the turkey population, and thus we proposed two criteria to serve as surrogates of population persistence. First, we expected that turkey abundance, as measured by the population size index from camera surveys, should increase annually, at least until some point when the population reached the carrying capacity of Long Pine Key. The carrying capacity of Long Pine Key was estimated to range from 100-200 adult birds (Snow 1999), based on the assumption that turkey density in a low productivity area, such as the Everglades, approximated 1 turkey per 40 ha (Williams 1991, 1992). We were unable to relate the population index from camera surveys to the true population size. However, the FFWCC suggested that an index of $\geq$ 15 individuals were needed for them to feel secure about the stability of the population (Appendix 2-1), and thus we use this number as a relative benchmark for population persistence. Second, we proposed that annual evidence of successful reproduction was vital to the probability of maintaining a non-negative rate of population growth.

RESULTS

Releases and Survival

During the period from 3 - 8 January 2000, 29 Wild Turkeys (18 adult females, 4 juvenile females, 6 adult males, 1 juvenile male) were translocated and released to Long Pine Key (Table 2-1). Seven females and three males were fitted with radio-transmitters. By the first week of August, 6 of 10 (60%) radio-tagged turkeys and one non-radio-tagged turkey died. Two radio-tagged turkeys and one non-radio-tagged turkey were found within a month of being released less than 1 km from the release site. Three of the remaining four turkeys were found in the HID area and one turkey was found in the glade just west of the campground. In most cases, cause of death was unclear because most remains consisted only of scraps of bones and feathers. One turkey was found with its head removed, characteristic of Great-horned Owl (*Bubo virginianus*) predation. A second individual had teeth marks on several large bones and the transmitter, suggesting either predation by a bobcat (*Lynx rufus*) or post-mortality scavenging by a mammal. One turkey was found intact and in good condition with no obvious signs of trauma.

During the period 5 – 8 January 2006, thirty-one turkeys (16 adult females, 4 juvenile females, 5 adult males, 6 juvenile males) were released approximately 100 m south of the Long Pine Key campground (Table 2-1). Ten individuals, all females (8 adults, 2 juveniles) were radio-tagged. Four of the ten (40%) radio-tagged birds, all adult females, died within two months of their release. All four individuals were found in moderate to severe decay states. The cause of death was unknown for three individuals. The fourth individual was found cached in a solution hole in an area of dense shrubs with bite marks on the carcass and transmitter, all evidence pointing to predation by bobcat. The remaining six individuals were monitored until 1 July.

In general, turkeys moved widely within the first month before settling into one area. Even after appearing to settle in one area, several turkeys made long distance movements (> 5 km) to new locations. During the first release, many of the turkeys moved into the HID and at one point five radio-tagged turkeys were found using that area. No birds were found in the HID once the wet season began. We found no evidence that radio-tagged individuals from the first or second release attempted breeding following their release, as was expected.

Home range and habitat use

We obtained 29 – 46 independent locations for the six individuals from the second release that survived through the summer. Seamen et al. (1999) recommends greater than 30 independent locations to determine home range estimates. We reached this benchmark for all but one individual. Turkey home range varied from 5.7 - 33.7 km^2 (mean $\pm$ S.E., 16.9 $\pm$ 4.0) for the 95% KHR and 0.83 – 2.99 km^2 (1.8 $\pm$ 0.3) for the 50% KHR (Table 2-2)

Turkeys primarily used prairie/marsh and pine forest habitats. These broad categories made up >90% of the vegetation composition in both the 95% and 50% KHRs. The five most important specific habitat categories: Muhly prairie, pine savannah, Brazilian pepper (*Schinus terebinthifolius*), Slash Pine with hardwoods, and mixed graminoids, were identical in both the 95% and 50% KHR scale (Table 2-3, 2-4). Within the 50% KHR, Muhly prairie and pine forest comprised over 60% of the area, suggesting these habitats are particularly important to turkeys. For all six radio-tagged turkeys their core home range centered on the area south and west of the Long Pine Key campground. It is unclear if this is a result of the area having the highest habitat quality or that individuals simply did not wander from their release site.

Brazilian pepper was an important habitat category within both home range scales. This reflects the decision by many of the turkeys to use the HID area, which is categorized as Brazilian pepper in the base vegetation map. However, the base map does not include changes over the last decade due to restoration. In 2006, much of the area was restored to prairie habitats. Thus, we attribute this to turkeys selecting prairie habitats within the Brazilian pepper, as opposed to the Brazilian pepper.

Population monitoring

Camera surveys. Results of the passive monitoring by FFWCC in 2000, 2001, and 2003 are presented in Appendix 2-1. In brief, four, six, and seven distinct individuals were observed during the 2000, 2001, and 2003 surveys, respectively. Breaking these totals down by gender, the 2000-2003 surveys resulted in 1 and 3, 2 and 4, and 5 and 2 males to females, respectively. Surveys only confirmed successful reproduction in 2001, based on the photo capture of 2 unmarked individuals.

The first standardized camera surveys in October 2004 and February-March 2005 both yielded a population index of 4 (2 males, 2 females in 2004; 3 males, 1 female in 2005). In both surveys a tagged male from the 2000 release was detected. Four males were detected on the gobbling surveys in the spring of 2005, similar to the number detected on the camera surveys.

The population index increased dramatically to 17-22 individuals during the first three camera surveys following the second release of turkeys in January 2006 (Table 2-5, Figure 2-3). Turkeys were detected at 44-80% of camera sites. The ratio of males to females was relatively similar, except during the winter 2007 survey when over twice as many females (15) were detected as males (6).

However, subsequent surveys over the next 5 sampling period found lower, but relatively consistent, population index values. The turkey population index ranged from 6-11 individuals, with generally more males (4-10) detected than females (0-2). The percentage of camera sites where turkeys were detected was also lower during this period (29-56%) than during the surveys immediately following the 2006 release. At least two tagged individuals from the 2006 release were still alive in 2009 (Table 2-5).

Evidence of reproduction was not detected on camera surveys, except in the summer of 2008, when one picture was taken of an untagged adult female with a single poult.

Personal observations. Turkey observations, reported by visitors and NPS and other agency personnel, were most numerous following the 2006 release. Most individuals were observed along Research Road, which is not surprising because it bisects pine forest and prairie habitat and it is heavily traveled by NPS and other agency employees. Numerous detections of gobbling were also reported around the campground and pinelands to the east. The other location where turkeys were regularly observed was in the HID area, particularly on the spoil mounds and in other grassy openings.

Personal observations found evidence of successful reproduction by turkeys. During the 2006 breeding season, 1-3 tagged adult females were observed with 10-14 poults along research road on five different occasions. The highest juvenile count was 23 juveniles detected on 24 August 2006. The high number of poults suggest that at least 2 females successfully bred, as average clutch size in Florida is 10.3 (range = 5-17; Williams and Austin 1988). In 2007, personal observations indicated a minimum of four successful breeding events and 39 juveniles.

However, in 2008-2009, observations of turkeys by agency personnel were relatively rare during the breeding season and no observations of successful breeding (i.e., poults) were reported. Wild Turkeys were heard gobbling in many sites from the eastern edge of Long Pine Key (Block J) to slightly west of the campground by members of the bluebird reintroduction crew. The most recent observation of significance was reported on 16 January 2009 when nine turkeys were observed crossing Research Road. In 2010, there have also been no reports of poults, although up to 3 males and 2 females have been observed along Research Road (S. Snow, pers. comm.).

Evaluating Success

Evidence from the radio-tracking study, camera surveys, and personal observations indicated that members of the released generation survived and that both the released generation and their offspring successfully bred. Thus, we found that the turkey population met the success criteria of population establishment.

The success of the reintroduced turkey population based on the criteria of population persistence is less clear. The population index from the camera surveys reached 17-21 individuals following the second release of individuals in 2006, levels the FFWCC felt was sufficient to maintain a population. However, the population index declined to 6-11 individuals and has remained stable at that level since the summer of 2007. We observed breeding in 2006-2008 through personal observations and the camera surveys. Breeding in 2008 was limited to one observation of a single poult on a camera survey. We found no evidence of breeding in 2009.

DISCUSSION

The release of Wild Turkeys to the pine rocklands of ENP has resulted in the successful establishment of this once extirpated species. Radio-telemetry, camera surveys, and personal observations have shown that the released generation has survived and that the released generation and their offspring have reproduced. Survival estimates of radio-tagged individuals for the first 6-7 months following release, which ranged from 40-60% in this study, were similar to values found in other reintroductions (24 - 72%; Little and Varland 1981, Clark 1985, Hollis 1985). Most radio-tagged individuals that died did so shortly after their release, indicating that the cause of death was likely due to factors related to the release or risks associated with acclimating to a new area. The observation of a banded individuals in the 2005 and 2009 camera surveys that were ≥ 4 years old provides strong evidence that habitat in Long Pine Key was suitable for turkeys.

While a population of turkeys has clearly been established to Long Pine Key, the probability of long term persistence remains unclear because population size remains small and reproduction has not been recently observed. The population increased strongly following the second release of individuals in 2006 and reports of successful reproduction were numerous. Then, the population declined and remained relatively stable over the final 5 camera surveys. At the end of the survey period in 2009 the index was only slightly higher than in 2005, the same levels which triggered a second release.

Several hypotheses may explain the observed pattern found in the population index. First, the relatively stable population index during the last survey periods reflects a population at its carrying capacity. If so, then the initial reintroduction assessment that estimated Long Pine Key could support 100-200 birds was likely overestimated. Even though the camera surveys represent a subsample of the population, it is hard to imagine that the population index of 6-11 individuals translates to a population of > 100 turkeys in the 8,100 ha area of Long Pine Key. However, it is also hard to imagine that the initial carrying capacity was grossly overestimated considering it was based on the lowest assumed population density for turkeys (1 turkey per 40 ha). Second, the population may be declining and monitoring has not continued long enough to verify this decline. The population may be declining and at risk of extirpation due to an insufficient amount of suitable habitat or the presence of some other limiting factor (e.g., food availability, predation). If true, the decline would suggest that current restoration and management activities may need to be modified to benefit turkeys. We have little information on the factors that limit the population of turkeys. Factors related to successful breeding may be leading candidates for study, as camera surveys indicate many individuals have survived for several years, while successful reproduction has been variable. Third, low population index measures in the last several years may reflect decreasing detectability due to camera malfunctions. However, this hypothesis seems unlikely, particularly since we used active beam cameras borrowed from FFWCC in 2009, which have a better track record than infra-red systems (R. Shields, pers. comm.). Finally, the turkey population may simply be highly variable and subject to boom and bust cycles like many other species in the Everglades (Curnett et al. 1996). Long-term monitoring will be needed to reveal these types of fluctuations. Ultimately, we do not have the data to fully evaluate any of the hypotheses explaining population size index patterns. Additional monitoring of the population will be needed to improve our understanding of turkey population dynamics.

Our second criterion of annual reproduction has clearly not been met based on results from personal observations. Numerous reports of female turkeys with young in 2006 and 2007 were followed by virtually no sightings (i.e., one poult on camera survey) in 2008-2009. Initial reports also indicate that reproduction was not observed in 2010 (Skip Snow, pers. comm.). Unfortunately, we have no way to assess the strength and consistency of survey effort by volunteer observers across years, which makes it difficult to fully evaluate the lack of recent observations of successful breeding. However, because the sighting of poults is a fairly significant event in the park, we suspect that the lack of observations reflects a true lack of observations, as opposed to individuals not reporting a sighting of turkey poults.

The lack of observed reproduction during the 2008-2009 breeding seasons may also be related to environmental factors in South Florida. Both years were characterized by near record low water levels during the breeding season (Mar-May). Turkey reproduction in other areas of southwest Florida was low in 2009, presumably due to low water levels (D. Nicholson, FFWCC, pers comm.). Although turkeys may have attempted nesting later in the summer, success may have been hampered by the quickness in which water levels increased in the pinelands during May/June. Like the population survey, additional years of observations or different strategies may be needed to adequately evaluate the ability of the turkey population to reproduce successfully on a consistent basis.

Recommendations.

Overall, there are significant reasons to be concerned about the long term persistence of the turkey population, given the apparent small population size and low rate of successful reproduction. Additional monitoring will likely be needed to further evaluate success. Camera surveys have been a long-standing technique used to monitor the relative abundance of turkeys. However, in this study, we had some problems with cameras working consistently. We suspect that technology has improved. If additional surveys are implemented, we recommend the use of active beam systems, such as Trailmaster.

We also suggest that camera surveys need not be conducted in the summer. Summer camera surveys have typically been much less productive and more variable than winter surveys, making it more difficult to use the summer surveys as a gauge to evaluate the reintroduction (Slater 2007). One source of variability may be due to the fact that females with poults avoid camera sites. Indeed, poults have been reported within 1-3 km of camera stations on numerous occasions but not detected by cameras. Females may avoid bait stations because offspring rarely feed on grain, preferring a diet dominated by invertebrates until they are sub-adults (Eaton 1992). Water levels may also play a role in visitation rates by turkeys during the summer. High water levels make baiting camera stations problematic, as many of the roads are flooded in or near bait stations and bait stringers. Consequently, bait stringers are often shorter than the recommended length or covered with water, which likely results in more time needed for turkeys to find the bait stations. High water may also push turkeys into higher elevation interior pinelands away from camera locations. Another option that should be considered for monitoring the population is coordinated gobbling survey, perhaps with playbacks.

Additional research of radio-tagged individuals may also prove useful in evaluating the success of the reintroduction and identifying potential limiting factors. Previous telemetry studies in Long Pine Key have been successful in characterizing overall habitat use. Future studies should focus on evaluating reproductive success and identifying the specific habitat features that turkeys prefer for various life history activities (e.g., breeding, roosting).

Table 2-1. List of released Wild Turkeys in Everglades National Park in 2000 and 2006.

Release	Date	Date	Band #	Wing tag	Color	Sex	Age	Radio	Short Comment
First Release	1/3/2000	1/4/2000	56	192	Red	F	J	151.6	Found 4/4 near spoil mound
	1/3/2000	1/4/2000	4	193	Red	F	A	151.64	
	1/3/2000	1/4/2000	32	150	White	M	A	151.72	
	1/3/2000	1/4/2000	98	149	White	M	A	151.78	Found 1/18; Possible GHOW predation
	1/8/2000	1/8/2000	12	150	White	M	A	151.83	
	1/8/2000	1/8/2000	47	118	Red	F	A	151.86	Found 2/4; possible bobcat predation
	1/7/2000	1/7/2000	18	196	Red	F	A	151.89	
	1/7/2000	1/7/2000	94	198	Red	F	A	151.92	Found 7/14 in good condition
	1/7/2000	1/7/2000	34	200	Red	F	A	151.94	Found 9/5 in glade
	1/3/2000	1/4/2000	33	88	Red	F	A	151.99	Found 5/26 near spoil mound
	1/3/2000	1/4/2000	50	87	Red	F	J		
	1/3/2000	1/4/2000	36	190	Red	F	J		
	1/3/2000	1/4/2000	32	189	Red	F	A		
	1/3/2000	1/4/2000	48	89	Red	F	A		
	1/3/2000	1/4/2000	58	191	Red	F	A		
	1/3/2000	1/4/2000	41	86	Red	F	A		
	1/3/2000	1/4/2000	52	187	Red	F	A		
	1/3/2000	1/4/2000	96	195	Red	F	A		
	1/3/2000	1/4/2000	28	194	Red	F	A		
	1/3/2000	1/4/2000	46	188	Red	F	A		
	1/5/2000	1/5/2000	49	148	White	M	A		
	1/5/2000	1/5/2000	41	147	White	M	J		
	1/7/2000	1/7/2000	7	90	Red	F	A		
	1/7/2000	1/7/2000	99	197	Red	F	A		
	1/7/2000	1/7/2000	24	199	Red	F	A		
	1/7/2000	1/7/2000	98	186	Red	F	J		
	1/8/2000	1/8/2000	4	133	White	M	A		
	1/8/2000	1/8/2000	28	134	White	M	A		
	1/8/2000	1/8/2000	55	119	Red	F	A		
Second Release	1/5/2006	1/5/2006	329	2	red	F	J	151.640	
	1/5/2006	1/5/2006	483	1	red	F	A	151.780	Found 1/29 between Block A and B
	1/5/2006	1/5/2006	405	14	red	F	A	151.860	
	1/5/2006	1/5/2006	404	4	red	F	A	151.920	Found 2/12 2 km west of campground; bobcat predation?
	1/5/2006	1/5/2006	445	3	red	F	A	151.990	
	1/7/2006	1/8/2006	406	22	red	F	J	151.600	
	1/7/2006	1/8/2006	404	20	red	F	A	151.720	
	1/7/2006	1/8/2006	405	21	red	F	A	151.830	
	1/7/2006	1/8/2006	402	18	red	F	A	151.890	Found 2/27 in Dead Hammock
	1/7/2006	1/8/2006	403	19	red	F	A	151.940	Found 1/23 in Block I2
	1/5/2006	1/5/2006	332	5	red	F	A		
	1/5/2006	1/5/2006	326	6	red	F	A		
	1/5/2006	1/5/2006	334	7	red	F	A		
	1/5/2006	1/5/2006	61	8	red	F	A		
	1/5/2006	1/5/2006	310	9	red	F	A		
	1/5/2006	1/5/2006	320	10	red	F	A		
	1/5/2006	1/5/2006	365	17	red	F	A		
	1/5/2006	1/5/2006	418	15	red	F	A		
	1/5/2006	1/5/2006	366	16	red	F	J		
	1/5/2006	1/5/2006	778	64	white	M	A		
	1/5/2006	1/5/2006	688	57	white	M	A		
	1/5/2006	1/5/2006	669	56	white	M	A		
	1/5/2006	1/5/2006	776	66	white	M	A		
	1/5/2006	1/5/2006	777	65	white	M	A		
	1/6/2006	1/7/2006	670	55	white	M	J		
	1/6/2006	1/7/2006	771	70	white	M	J		
	1/6/2006	1/7/2006	773	69	white	M	J		
	1/6/2006	1/7/2006	772	71	white	M	J		
	1/6/2006	1/7/2006	774	68	white	M	J		
	1/6/2006	1/7/2006	775	67	white	M	J		
	1/7/2006	1/8/2006	311	11	red	F	J		

Table 2-2. Home range summary for radio-tagged Wild Turkeys.

Individual	**Size (Km^2)**		
	# locations	50% Kernel Home Range	95% Kernel Home Range
151.60	46	1.21	10.04
151.64	29	2.99	33.66
151.72	39	2.07	15.06
151.83	46	0.83	5.67
151.86	41	1.70	20.04
151.99	43	1.87	17.00

Table 2-3. Percentage of vegetation types within 95% KHR for 6 radio-tagged turkeys in Long Pine Key, ENP.

Broad Vegetation Type	Specific vegetation Type	Turkey 60	Turkey 64	Turkey 72	Turkey 83	Turkey 86	Turkey 99	Mean	SD	Cumulative %
Prairie/Marsh/Exotic	Brazilian Pepper	40.2	46.4	38.3	18.5	51.4	30.2	37.5	11.8	37.5
Pine Forest	Pine Savanna	26.8	10.7	33.6	39.7	16.4	30.3	26.2	10.9	63.7
Prairie/Marsh	Muhly	13.0	16.4	9.0	17.6	14.4	20.0	15.1	3.8	78.8
Prairie/Marsh	Mixed Graminoids	5.6	13.3	4.2	7.9	6.0	3.3	6.7	3.6	85.5
Pine Forest	Slash Pine with Hardwood	6.4	2.7	4.1	8.3	4.3	3.6	4.9	2.1	90.4
Prairie/Marsh	Sawgrass	1.5	0.7	1.6	2.5	0.9	5.3	2.1	1.7	92.5
Human	Road	1.9	1.5	1.8	1.6	1.4	1.5	1.6	0.2	94.1
Hardwood Forest	Subtropical Hardwood Forest	1.2	0.7	1.3	2.3	1.1	2.6	1.5	0.7	95.6
Scrub	Hardwood Scrub	1.3	1.2	1.3	0.4	1.0	1.8	1.2	0.5	96.8
Scrub	Groundsel Bush	0.8	3.3	0.3	0.5	1.7	0.2	1.1	1.2	97.9
Cypress Forest	Dwarf Cypress	0.0	0.0	3.6	0.0	0.0	0.0	0.6	1.5	98.5
Cypress Forest	Cypress Savanna	0.0	2.2	0.1	0.0	0.0	0.0	0.4	0.9	98.9
Water	Water	0.6	0.2	0.4	0.7	0.0	0.3	0.4	0.2	99.3
Human	Human Influence	0.4	0.3	0.3	0.0	0.4	0.6	0.3	0.2	99.6
Shrub wetland	Willow (Salix caroliniana)	0.2	0.1	0.2	0.0	0.3	0.3	0.2	0.1	99.8
Shrub wetland	Bayhead	0.1	0.2	0.0	0.0	0.3	0.1	0.1	0.1	99.9
Prairie/Marsh	Spike-Rush (Eleocharis cellusoa)	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	99.9
Scrub	Saw Palmetto Scrub	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	100.0
Cypress Forest	Cypress Strand/Head	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Cypress Forest	Cypress Dome	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Prairie/Marsh	Non-graminoid Emergent Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 2-4. Percentage of vegetation types within 50% KHR for 6 radio-tagged turkeys in Long Pine Key, ENP.

Broad Vegetation Type	Specific vegetation Type	Turkey 60	Turkey 64	Turkey 72	Turkey 83	Turkey 86	Turkey 99	Mean	SD	Cumulative %
Prairie/Marsh	Muhly	40.8	20.1	36.8	42.8	27.4	26.2	32.4	9.1	32.4
Pine Forest	Pine Savanna	32.4	23.7	29.2	39.5	24.4	30.7	30.0	5.8	62.4
Prairie/Marsh/Exotic	Brazilian Pepper	8.4	33.9	10.2	9.9	38.1	20.9	20.2	13.1	82.6
Pine Forest	Slash Pine with Hardwood	17.2	7.9	19.7	7.3	6.1	7.0	10.9	5.9	93.4
Prairie/Marsh	Mixed Graminoids	0.9	11.1	1.3	0.1	3.0	14.2	5.1	6.0	98.5
Human	Road	0.0	0.8	2.1	0.0	0.8	0.6	0.7	0.8	99.2
Scrub	Saw Palmetto Scrub	0.3	0.1	0.2	0.4	0.2	0.2	0.2	0.1	99.4
Scrub	Hardwood Scrub	0.0	0.8	0.3	0.0	0.0	0.0	0.2	0.3	99.6
Scrub	Groundsel Bush	0.0	0.6	0.0	0.0	0.0	0.0	0.1	0.3	99.7
Prairie/Marsh	Sawgrass	0.0	0.4	0.0	0.0	0.0	0.2	0.1	0.2	99.8
Water	Water	0.0	0.2	0.3	0.0	0.0	0.0	0.1	0.1	99.9
Human	Human Influence	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.1	100.0
Shrub wetland	Willow (Salix caroliniana)	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	100.0

Table 2-5. Summary of camera survey results for the period from Fall 2004 to Summer 2007 in Long Pine Key, ENP.

							Unique individuals			Tagged individuals	
Survey Period	Survey Dates[a]	Number camera days[b]	Number images	No. sites detected (%)	Images per camera day	Population index	♂	♀	Unk	♂	♀
39 Fall 2004	5 - 12 Nov.	80	12	3 (30%)	0.15	4	2	2		1	
Winter 2005	2 Feb. - 4 Mar.	178	95	5 (50%)	0.53	4	3	1		1	
Summer 2005	Cancelled due to weather										
January 2006 - ------Turkey Released											
Winter 2006	12 Feb. - 17 Mar.	185	261	8 (80%)	1.4	22	10	12		8	11
Summer 2006	4-19 July	144	292	4 (44%)	2.0	17	9	8		8	8
Winter 2007	2 - 18 Feb.	*	64	6 (60%)	*	21	6	15		2	9
Summer 2007	2-10 July	81	34	4 (44%)	0.40	6	5	0	1	2	
Winter 2008	29 Jan. – 11 Mar.	70	13	3 (30%)	0.19	6	5	1		3	
Summer 2008	30 May – 17 June	60	40	5 (56%)	0.67	11	10	1		2	
Winter 2009	12 Feb – 4 Mar.	48	64	3 (30%)	1.33	7	5	2			1
Summer 2009	3 July – 4 Aug.	69	20	2 (29%)	0.29	6	4	2		1	

[a] Date when baiting began and date when last camera removed

[b] Total number of days with functioning camera unit; not estimated during Winter 2007 survey.

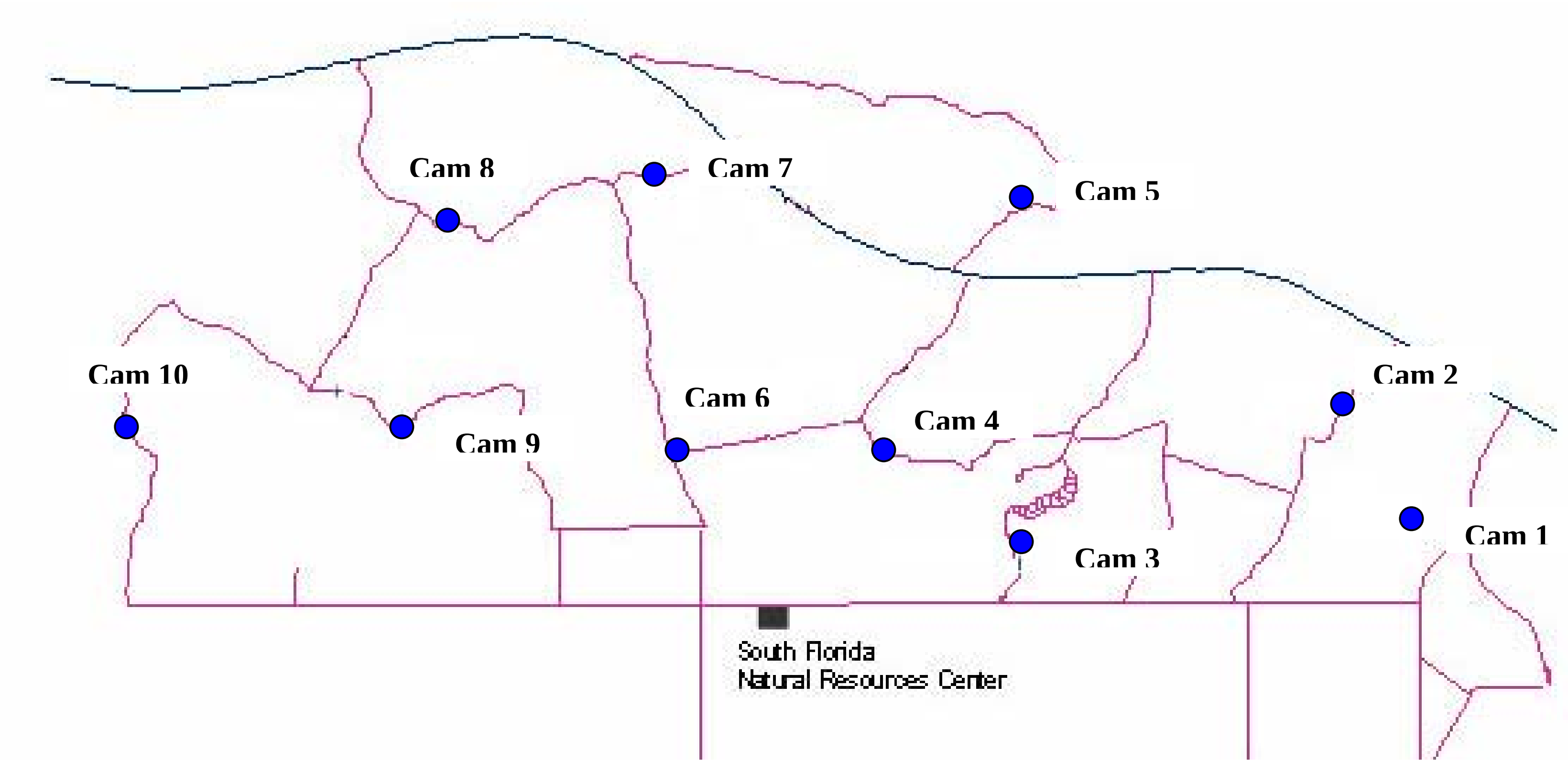

Figure 2-1. Location of camera sites for Wild Turkey surveys

Figure 2-2. Image of camera unit on pine tree at survey station.

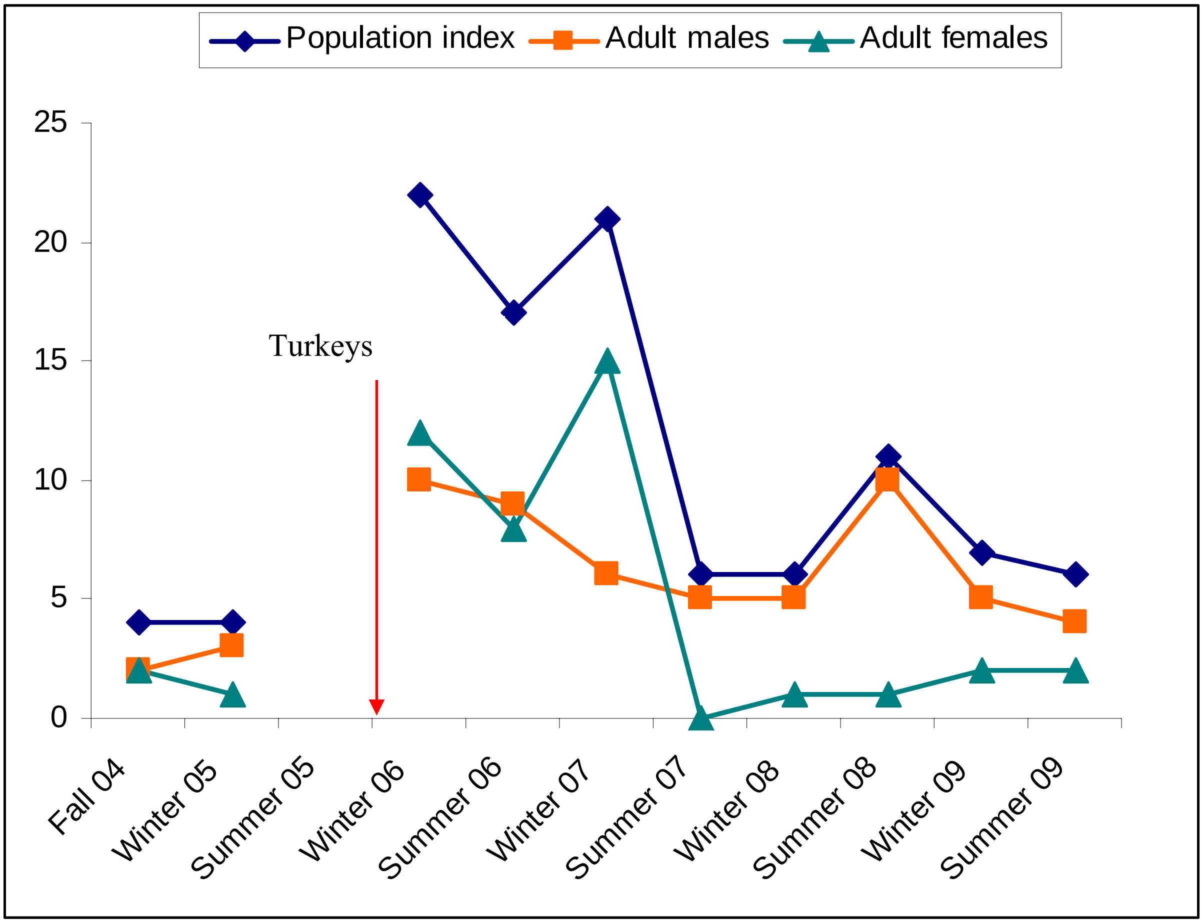

Figure 2-3. Population index of Florida Wild Turkey in Long Pine Key during winter and summer camera surveys from Fall 2004- Summer 2009. The second release of Wild Turkeys occurred 3 weeks prior to the Winter 2006 survey period. No camera survey was implemented in Summer 2005 due to high water levels.

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APPENDIX 2-1. PROTOCOL FOR WILD TURKEY SURVEYS AND REVIEW OF CAMERA SURVEYS FROM 2000-2003

Protocols for Wild Turkey population surveys using cameras.

Wild Turkey Management Section
Florida Fish and Wildlife Conservation Commission
July 22, 2002

1. Place cameras in expected turkey use areas to maximize counts associated with minimum population estimates, while keeping cameras well dispersed throughout the area and maintaining at least 1.6 km (1 mile) between sites (preferably 2 miles) with approximately 1 camera system / 1,215 ha (3,000 acres). Cameras should be placed in secure areas and locations with minimal disturbance from any recreational users. Efforts to conceal camera systems are needed in some cases. On areas that may have potential recreational users in the proximity of cameras, it may be warranted to place cameras off roads or trails to minimize theft and disturbance. Camera sites placed off roads and trails should still be located in areas that are relatively open to facilitate capturing turkeys within the photographs. Bait stringers should be utilized to attract turkeys off the road to the camera site. Surveys should be scheduled such that camera systems are not in the field for more than one weekend. If possible, conduct surveys prior to the issuance of quota permits, as more hunters will be in the field scouting once permits are issued.

2. Camera sites should remain the same for each survey unless turkeys were not observed at a site in previous sampling attempts and moving a site would likely increase the observations of turkeys. **This should only be done when using the camera systems to establish a minimum population index and not when the surveys are used to determine population indexes for between year comparisons or trends.**

3. Cameras should be placed where the area between the monitor and transmitter is fully visible in the camera viewfinder. Avoid placing the camera where it or the receiver is hit by direct sunlight, which can cause glare in the slides and can trigger the receiver (when cameras are in open areas, try to position cameras such that they are facing North). Additionally, consideration should be given to the amount of light, as very shaded areas can make it difficult to distinguish individual animals in the slides, especially at dawn and dusk.

4. The distance between the transmitter and receiver should be 9-12 meters (30-40 feet). The camera should be placed in close proximity to the receiver so that the camera cord can be concealed to help prevent rodents from chewing on the cord.

5. Cameras should be set to record the time and date on each slide. Film should be 200 ASA color slide film, preferably 36 exposure to prevent missed events.

6. Cameras should be active from sunrise until sunset, rounded to the nearest quarter hour, during surveys.

7. The receiver sensitivity should be set at 4 (i.e., 4 pulses should be missed before recording an event).

8. The beam should be set approximately 38 cm (15 inches) above the ground.

9. Camera delay should be set at 5 minutes (e.g., 5 minutes will elapse between snapshots).

10. Sites should be pre-baited for 7 days using cracked corn. The actual survey should be conducted for 7 full days (sunrise to sunset). For example, if cameras were set up on Aug. 15, the survey would run from Aug. 16 through Aug. 22 (7 full days), with the cameras being picked up on Aug. 23.

11. Cameras and monitors should be inspected daily for exposed film and events. If the roll of film is nearly completed or is expected to be completed before it is checked again, it should be replaced. Make a note of the time and date if all frames are exposed. Also, download (or delete) the events from the monitor if it is likely that it may exceed 1,000 events by the next day (the unit will stop functioning after 1,000 events are recorded and stored in memory).

12. Bait sites should be maintained as needed. Cracked corn should be spread **thinly** (no bait piles) to reduce the attraction of deer or hogs. If corn is visible in the slides, it's too much. Bait stringers should be extended from the bait site for approximately 0.4 km (1/4 mile) in either direction. Once turkeys have found the bait site, stringers should be discontinued in order to concentrate turkeys on the bait site. If turkeys quit using the bait site, then reestablish the stringers. The bait site should be located centrally between the receiver and transmitter and be fully visible within the central area of the camera's viewfinder (i.e., turkeys feeding at the sides of the bait will be identifiable in the picture). The method of baiting at bait sites should be consistent, i.e., you should not use mechanical feeders at some sites while manually baiting other sites unless the amount of corn deposited at the site is similar and is placed the same number of times a day. For instance, feeders triggered several times a day would likely impact visitations and photo opportunities differently than manually baiting one time per day.

13. Attempts should be made to visit the sites at approximately the same times each day, preferably at night or the middle of the day. In addition, a log should be kept of the actual time each site is visited.

14. **Surveys should be conducted during late winter (late January or February) and/or late summer (late August or early September).** Once data are available to test for survey efficiency between periods, a preferred time period will be recommended.

Review of turkey photo captures from Everglades National Park, 2000-2003

Camera surveys of Long Pine Key (LPK) in the Everglades National Park (ENP) were conducted during the fall and early winter of 2000, 2001, and 2003. The surveys were conducted by FWC biologists from the Panther Section as part of their annual monitoring for panthers. Panther Section biologists conducted fairly rigorous sampling (i.e., 15-30 individual cameras) during the 2000 and 2001 surveys, but only ran a few (n=5-6) cameras during the 2003 survey. Photo captures of wild turkeys during the 2000 and 2001 surveys represent incidental observations as no bait was placed at the camera sites to attract turkeys. However, during the 2003 survey, ENP biologists placed bait at camera sites in an attempt to actively attract turkeys to the camera sites. Thus, photo captures in 2003 were not incidental.

Wild turkeys observed during these surveys represent a mixture of birds originally translocated to LPK (n=29) in January 2000, determined by the presence of patagial wing tags affixed at time of release, and offspring of these original birds, determined by direct observation of juvenile morphological characteristics of photo captured birds or assumed based on the absence of wing tags.

The 2000 survey failed to document the occurrence of any offspring and captured only a single bird in each photograph (n=11). Turkeys were captured at 4 of 15 camera sites between September 26 and November 19. The 2001 survey again predominantly produced photographs (n=9) of individual original birds; however, two photos contained lone unmarked birds (one appeared to be a female of unknown age, the other a juvenile male). Turkeys were captured at 7 of 30 camera sites between October 9 and December 14. During the 2003 survey, turkeys were captured at three of six camera sites between November 22 and December 25. Many more photographs (n=99) of turkeys were collected during this survey than during earlier surveys, presumably due to the placement of bait at the camera sites. However, the large number of photos is misleading because the camera delay between photographs was apparently set at zero enabling multiple pictures to be taken of turkeys feeding for prolonged periods on bait at camera sites. As a result, the large number of photographs actually represents only about 26 individual feeding bouts (normally, the delay is set to 5-minutes to prevent exposing entire rolls on a single feeding bout). Moreover, the many photographs obtained during the 2003 survey are possibly all of just two groups of individuals. The survey observed a maximum of only two female turkeys in a single photograph and all observations of females occurred at the same camera site; as many as five males were simultaneously photographed during the survey, but all photographs were from just two sites with similar numbers of similarly aged birds and no temporal overlap in observations between the two sites. The linear distance separating the two camera sites (LPK04 and LPK05, see map below) was approximately 3 miles, well within the distance that adult males could be expected to travel in a few days time.

Calculating the maximum number of verifiably different individual turkeys (akin to a minimum population estimate) resulted in four, six, and seven distinct individuals being observed during the 2000, 2001, and 2003 surveys, respectively. Breaking these totals down by gender, the 2000-2003 surveys resulted in 1 and 3, 2 and 4, and 5 and 2 males to females, respectively.

Because the use of bait can attract turkeys and enable photo-captures that would not occur by chance, it is difficult to compare the results between baited and unbaited surveys and to identify evolving trends from this survey data. Therefore, the apparent increase in the number of individual turkeys present on the area (from four in 2000 to seven in 2003) may be misleading. These data represent, when taken with supplemental incidental observations, three different types of data, all of which provide clues to the status of the ENP turkey population, but which do not individually nor collectively enable a reliable determination of the population to be made. A thorough and complete camera survey, using at least 10 well-distributed, baited camera sites, taken together with other supplemental forms of data, would be more useful in being able to make a conclusive determination of population status. Nevertheless, some information can be gained by examining these existing surveys.

Although none of the turkeys photographed in 2003 appeared definitively to be hatch-year birds, none were tagged either. Such results suggest several suppositions. First, that few, if any, originally released birds are still alive on LPK. Data from these surveys and supplemental incidental observations by park staff and visitors indicate a simultaneous decline in observations of marked birds and an increase in observations of unmarked birds. Even so, one cannot say with certainty that all original birds have died. A short period of supplementary data collection in April 2003 was able to document the continued survival of an original gobbler (#147) not documented during any of these camera surveys. Second, and more importantly, the presence of unmarked birds suggests that a fair level of successful reproduction and recruitment occurred at least once in previous years and that the offspring are surviving. Spurs and beards visible in the photographs of unmarked adult males indicate that these birds are at least 2-½ years old. Further, surveys of this type typically capture only a sample of the birds available on an area, so one might well expect that more turkeys are present on LPK than were captured during this survey period. Also, observations of both males and females during this latest survey provide evidence for the potential of future reproduction. At the same time, the survey results do not necessarily indicate a high degree of reproductive success capable of sustaining the population. Although the absence of obvious hatch-year birds in this survey cannot be taken to confirm that reproduction was totally unsuccessful during 2003, this survey provided no evidence of successful reproduction either. Further, successful reproduction has not been positively confirmed (i.e., observations of poults or positive identification of hatch-year males) for any year except 2001.

Although we, the Wild Turkey Management Section, do not feel an adequate camera survey has yet to be conducted and until one is conducted we are hesitant to move forward with any plans, the latest survey is a step in the right direction of a *bona fide* camera survey. Based on the 2003 survey, it seems that at least seven individuals exist and possibly more given the distance between cameras. Considering the length of time the cameras were operated, we would have expected to see more photos of different individuals during the 2003 survey if many more turkeys were present in LPK. However, as mentioned, with the wide spacing of cameras during this last survey it also seems quite likely that there are other turkeys in the area that were not captured. The question then, which still remains, is how many additional turkeys are there that were not captured.

In order for us to better answer the question of how many turkeys likely remain and to determine if additional releases are warranted, we would like to see a formal turkey survey be conducted, similar to that described by our existing protocol (see end of document). Then, if the photos from the survey, along with coordinates of the camera sites, are provided to us, we will review the photos and evaluate the population status. If, through a future survey, 15 or more individual turkeys and fairly even sex ratios are documented on the area, we feel that additional stocking would not be necessary, thinking that if the turkeys are going to make it in the long-term, they ought to be able to do it growing from that number. If indeed the area is down to a handful of turkeys, then additional stocking may be beneficial and we would proceed with plans for such.

Please be aware that the above thoughts are those of the Wild Turkey Management Section members and not those of the Commissioners *per se*. If ENP wants to request FWC assistance through the Commissioners or our supervisors, then our section may receive specific direction to proceed with additional stocking or other actions regardless of the concerns and issues we have presented here. Also, the ENP may seek to relocate additional turkeys without FWC assistance, if so desired, and our section can facilitate your obtaining the necessary permits to do so.

For what it is worth, several curious trends and observations emerged from the results of the three camera surveys. Encouragingly, in all three surveys, turkeys were captured at camera sites distributed widely across LPK (see map below). Oddly though, male turkeys were generally photo captured on the western side of LPK whereas females were observed only on the eastern side. Being unfamiliar with the habitat conditions and plant communities of LPK, we have no explanation for this observation other than pure coincidence, but thought it an interesting observation. Also, a mildly curious finding was that no females were observed at the site near the campground (Mosier Hammock) during the 2003 survey when in previous years they had consistently been observed there, both in the passive panther camera surveys and by incidental observations of park staff and visitors. Changes in habitat conditions, due to prescribed burning for example, or increased levels of disturbance from greater numbers of park visitors could have caused turkeys to shift their home ranges resulting in the observed difference.

I hope these comments better explain the difficulty we have in determining the status of ENP turkeys and further actions to take. Please feel free to contact us if you have any additional questions or would like to discuss this further.

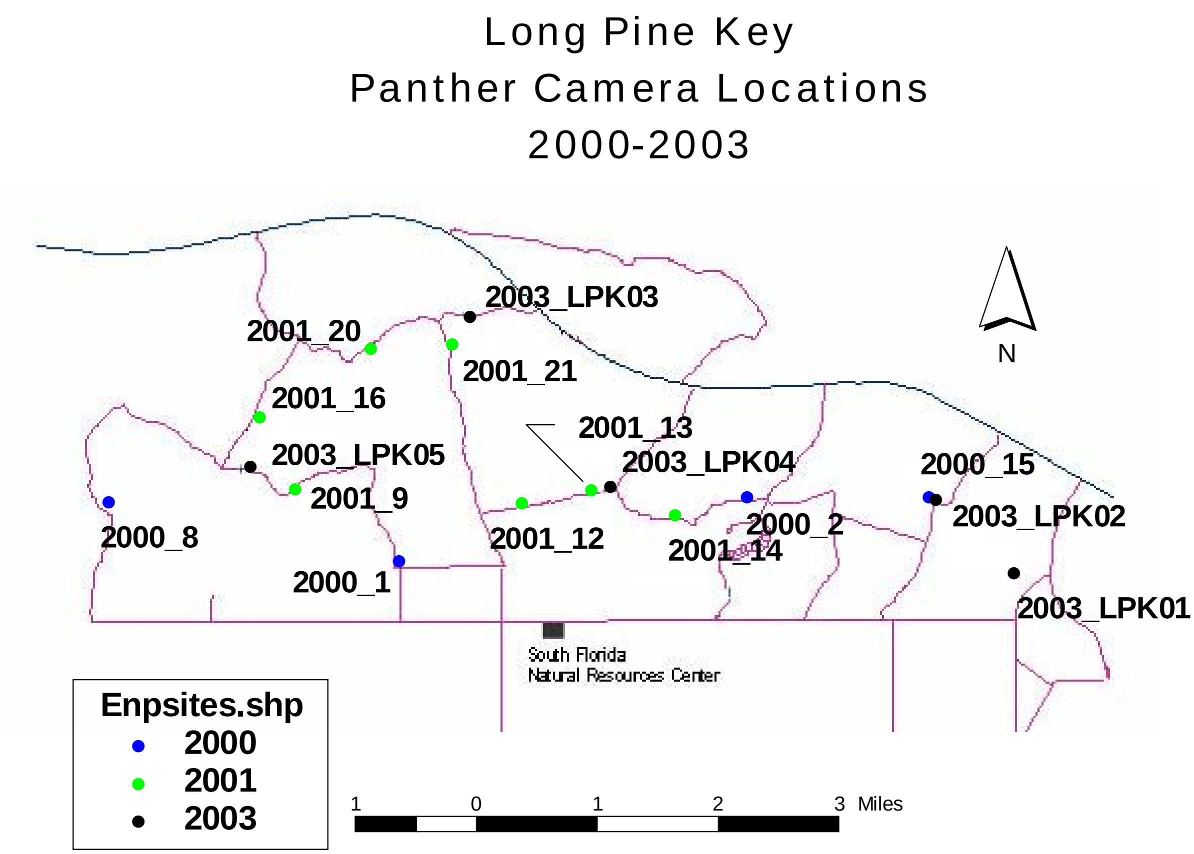

Figure 1. Location of camera sites that photographed wild turkeys during surveys conducted on Long Pine Key, Everglades National Park, 2000-2003.