United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
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January 23, 2018

Jason A. Kirk, Colonel
District Commander
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Service Consultation Code: 04EF2000-2015-F-0261
Corps Application Number: SAJ-2006-06379 (SP-EWG)
Date Received: July 6, 2015
Formal Consultation Initiation Date: April 7, 2017
Applicant: Troy Van Haastrecht
Project: Argo Corkscrew Crossing

Dear Colonel Kirk:

The U.S. Fish and Wildlife Service (Service) has received the U.S. Army Corps of Engineers (Corps) request for consultation dated July 6, 2015, for Troy Van Haastrecht's (Applicant) Argo Corkscrew Crossing proposal (Project). This document transmits the Service's biological opinion based on our review of the proposed Project located in Lee County, Florida, and its effects on endangered Florida panther (*Puma concolor coryi*; panther) and the threatened eastern indigo snake (*Drymarchon corais couperi*). It also includes and summarizes our concurrences for the Corps' determinations regarding the endangered Florida bonneted bat (*Eumops floridanus*; FBB), endangered red-cockaded woodpecker (*Picoides borealis*; RCW) and threatened wood stork (*Mycteria Americana*). This document is submitted in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 et seq.).

This biological opinion is based on information provided in the Corps July 6, 2015 consultation request letter and other information provided by Ken Passarella and Associates, Incorporated (Consultant; KPA) via telephone conversations, meetings, and emails. A complete record of this consultation is on file at the Service's South Florida Ecological Service's Office in Vero Beach, Florida.

Consultation history

On July 14, 2008, the Corps issued a public notice for the proposed "Monte Cristo" Project under Corps application number SAJ-2006-6379 (IP-MJD). The former "Monte Cristo" proposal has been renamed "Argo Corkscrew Crossing".

By letter to the Service dated July 15, 2008, the Corps determined the "Monte Cristo" proposal may affect the panther, RCW, and wood stork; and requested initiation of formal consultation for these species. The Corps also determined that the proposed work may affect, but is not likely to adversely affect the threatened eastern indigo snake and requested our concurrence with that determination.

By letter to the Corps dated December 15, 2008, the Service stated that we did not have sufficient information to initiate formal consultation for the proposed Project's effects to the panther, RCW and wood stork. The Service did however concur with the Corps' determination regarding the eastern indigo snake.

On September 3, 2014, the Service met with staff from KPA to discuss the "Argo Monte Cristo" proposal. This discussion focused on the proposal's development plans including a proposed wildlife corridor east of the proposed residences.

By email to KPA dated September 8, 2014, the Service recommended several revisions to the proposal.

On September 10, 2014, the Service discussed the "Argo Monte Cristo" development plan with the Florida Fish and Wildlife Commission (FWC) the Florida Wildlife Federation (FWF). The Service also teleconferenced with KPA staff and offered additional recommendations regarding site design strategies to reduce the risk of panther-human interactions.

By letter to the Service dated July 6, 2015, the Corps determined the "Argo Corkscrew Crossing" (formerly known as Argo Monte Christo) proposal may affect the panther, RCW, wood stork, and FBB; and requested initiation of formal consultation for these species. The Corps also determined that the proposed work may affect, but is not likely to adversely affect the threatened eastern indigo snake and requested our concurrence with that determination. The Corps' July 6, 2015, consultation request to the Service was written to address the FBB, in addition to the other federally-listed species considered in the original consultation request.

By email to the Corps and KPA dated October 15, 2015, the Service requested geographic information system data regarding the proposal.

By email to the Service dated October 29, 2015, the Corps notified the Service that they had not received the Applicant's alternatives analysis for the proposal. The Corps also provided the Service a copy of the South Florida Water Management District's (SFWMD) October 22, 2015, letter to the Applicant requesting additional Project information. The Corps' email also included

comment letters from adjacent property owners and a letter from ADA engineering written on behalf of the Conservancy of Southwest Florida.

By letter to the Corps dated May 23, 2016, the Service stated that we did not have sufficient information to initiate formal consultation for the proposed Project's effects to the panther and wood stork. The Service did however recommend the Corps revise their determinations for the FBB and RCW to "may affect, not likely to adversely affect." We advised the Corps that if they decided to change their determinations for the FBB and RCW to "may affect, not likely to adversely affect", then our May 23, 2016, letter could be used as concurrence of that finding.

By email to the Corps dated August 7, 2017, the Service recommended the Corps revise their determination for the eastern indigo snake to "may affect".

BIOLOGICAL OPINION

This biological opinion provides the Service's opinion as to whether the proposed Project is likely to jeopardize the continued existence of the panther and eastern indigo snake. There is no designated critical habitat for the panther or eastern indigo snake; therefore, this biological opinion will not address destruction or adverse modification of critical habitat.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which describes the range-wide condition of the species, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which analyzes the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the Effects of the Action, which determine the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) the Cumulative Effects, which evaluate the effects of future, non-federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed federal action in the context of the current status of the species, taking

into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

DESCRIPTION OF THE PROPOSED ACTION

The Applicant's proposed Project is construction of a residential development on a 395.55-acre (ac) parcel. Upon completion, the developed portion of the Project site will contain 563 single-family dwelling units and 62 multi-family dwelling units; as well as a clubhouse, roads and associated infrastructure. The Project will have one gated vehicle ingress/egress connecting the Project's internal roads to Corkscrew Road. The site consists of 342.86 ac of forested and herbaceous wetlands, including wetland hardwoods, cypress, hydric pine, and freshwater marsh habitats; and 52.69 ac of uplands including palmetto prairie, pine, pine flatwoods, and disturbed land. The development will occupy 177.43 ac of the Project site. The remaining 218.12 ac of the site will be maintained as an on-site wetland and wildlife mitigation area. The property is bounded by the Wildcat Run subdivision to the west, the Preserve at Corkscrew (a.k.a. Cypress Shadows) subdivision and the Bella Terra (a.k.a. The Habitat) subdivision to the east, Corkscrew Road and the undeveloped WildBlue subdivision to the North, and the undeveloped Agri Partners parcel to the south (Figure 1). The Project is located within the Estero River Basin at Latitude 26.438686 and Longitude -81.74338 in unincorporated Lee County, Florida (Figure 2).

Minimization and conservation measures

Eastern indigo snake

The Applicant has agreed to adhere to the Service's *Standard Protection Measures for the Eastern Indigo Snake* (Service 2013) to minimize potential harm, or harassment, to any resident snakes during land clearing and construction activities. Additionally, the proposed 218-ac onsite preserve is expected to provide suitable habitat for the eastern indigo snake.

Florida panther

A total of 1,988 Panther Habitat Units (PHUs) (Table 1) would offset the loss of panther habitat in the Project's construction footprint. The Applicants have offered to provide a total of 1,810 PHUs through 218.12 ac of on-site habitat preservation and restoration (Figure 1). The on-site conservation area will be preserved, enhanced, restored, and placed under conservation easement to ensure that it remains in its natural state in perpetuity. As a financial assurance to provide sufficient funds for the perpetual maintenance and monitoring of the preserve area the Applicant has offered to create a perpetual funding mechanism, such as a Community Development District (CDD) or similar legal entity approved by the Service with the authority to assess ad valorem taxes and/or special assessments on all developed property within the Project.

Because the on-site preserve provides only 1,810 PHUs, the Applicant has offered to purchase the remaining balance of 178 PHUs from a Service-approved conservation or mitigation bank located within the panther primary zone. The proposed compensation plan is consistent with goal 1.1.1.2.3 in the Panther Recovery Plan (Service 2008) which states that habitat preservation and restoration be provided, especially within the Primary Zone, in situations where land use intensification cannot be avoided. The Applicant's compensation will provide equivalent habitat protection and restoration, to compensate for both the function and value of the lost habitat. The Applicant has agreed not to begin construction on the Project until: (1) they provide the Service with a receipt (in the form of a letter or email) from a Service-approved conservation or mitigation bank stating at least 178 PHUs have been acquired by the Applicant, and (2) the Corps and the Applicant have received an email or letter from the Service indicating we have received the receipt from the Service-approved conservation or mitigation bank.

Action Area

The action area is defined as all areas to be directly or indirectly affected by the Federal action and not merely the immediate area involved in the action.

The Service considers the action area for the Project as all lands within the footprint of the Project, and all lands within 25 miles (mi) (40.2 kilometers [km]) of the Project footprint (Figure 3). The 25-mi buffer around the Project footprint is designed to encompass mean dispersal distance of subadult male panthers which was reported by Maehr et al. (2002) to be 23.2 mi (37.3 km) and by Comiskey et al. (2002) to be 24.9 mi (40.0 km). The 25-mi (40.2-km) buffer distance encompasses the dispersal distance of both male and female panthers because male panther dispersal distances are known to exceed those reported for female panthers (Maehr et al. 2002; Comiskey et al. 2002). The size of the action area for this consultation is consistent with action areas defined in our recent biological opinions for the panther, and it encompasses the wide ranging movements of subadult panthers and the large home territories of adult panthers.

For purposes of our analysis of the Project's effects on the eastern indigo snake, the area considered will be a subset of the greater action area and will focus on the areas where the Project has the potential to affect this species. This area is identified in the Status of the Species in the Action Area section.

SPECIES NOT LIKELY TO BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

FBB and RCW

The Service recommended the Corps revise their determinations for the FBB and RCW to "may affect, but is not likely to adversely affect." We advised the Corps that if they decided to change

their determinations for the FBB and RCW to "may affect, but is not likely to adversely affect," our May 23, 2016, letter could be used as concurrence of that finding.

Wood stork

The Corps determined the proposed Project may affect the wood stork and requested initiation of formal consultation for this species. The Project is located within the 30 km (18.6 mi) Core Foraging Area of three wood stork nesting colonies (619041, 619018, and 619310). A wood stork foraging habitat analysis was conducted for the Project. The analysis followed the methodology as established by the Service (2012). Based on this analysis, unavoidable wetland impacts from development activities will result in the loss of 74.25 kg (kg) of fish and crayfish biomass potentially vulnerable to predation by wood storks. The proposed wetland mitigation activities within the wetland preserves of the Project will compensate for 70.70 kg of prey biomass potentially vulnerable to predation by wood storks. This yields a net loss of 3.55 kg of fish and crayfish biomass potentially vulnerable to predation by wood storks. As such, the proposed on-site mitigation activities are insufficient in offsetting the loss in prey biomass. Therefore, the remaining 3.55 kg of fish and crayfish biomass will be provided via the purchase of credits from an approved wetland mitigation bank. Therefore, we recommend you revise your determination for the wood stork to "may affect, but is not likely to adversely affect." Should the Corps decide to change its determination for the wood stork to "may affect, but is not likely to adversely affect," this letter can be used as concurrence of that finding.

STATUS OF THE SPECIES

Eastern indigo snake

Please see Enclosure for the Status of the Species for the eastern indigo snake.

Florida panther

Please see Enclosure for the Status of the Species for the panther.

Summary of threats to the species

Eastern indigo snake

The primary threats to the eastern indigo snake include habitat loss and fragmentation from ongoing commercial and residential development throughout the state of Florida. Collisions with motor vehicles on Florida's extensive roadway system may be a significant source of indigo snake injury and mortality.

Florida panther

The panther is a wide-ranging species that requires large areas of diverse landscape to survive. Dispersing subadult males wander widely through unforested and disturbed habitat. Human

population in South Florida has dramatically increased, from 1 million in 1950 to 6.6 million in 2010, resulting in secondary disturbances such as increased human presence and noise, light, air, and water pollution. In southwest Florida, where the reproducing panther population is primarily located, human population has increased from 833,892 in 2000, to an estimate of 1,231,100 in 2010, representing an increase of 47.6 percent over the 10-year period (University of Florida 2009). Increasing human population has resulted in increasing impacts on native habitat, and flora and fauna. Resulting threats to panthers include direct effects, such as human disturbance from Project construction, and habitat loss and fragmentation; and indirect effects from road mortality, human disturbance following construction, and intra-specific aggression. Table 2 provides a yearly tabulation of the population counts of the panther with the annual mortalities also shown.

The threats posed by human disturbance during and after Project construction, habitat loss and fragmentation, road mortality, and intra-specific aggression are relevant to this Project and will be discussed in the remainder of this biological opinion.

ENVIRONMENTAL BASELINE

Status of the species within the action area

Eastern indigo snake

The eastern indigo snake is known to use about every habitat type except for bodies of water (Layne and Steiner 1996, Service 1999). All of the habitat types on the Project site are habitat types that eastern indigo snakes can use. In addition, the Project site is surrounded by similar habitats. Eastern indigo snakes are also known to use gopher tortoise burrows for refugia (Lawler 1977; Moler 1985; Layne and Steiner 1996).

The Service's GIS database for recorded locations of federally listed threatened and endangered species included a sighting of an eastern indigo snake 0.73 mi northeast of the Project site. Due to the presence of suitable on-site and off-site habitat, refugia, and proximity to an eastern indigo snake observation, we have concluded that eastern indigo snakes may occupy suitable habitat within the entire 395-ac Project site. Therefore, we consider the occupied area for the eastern indigo snake as the entire 395-ac Project site. The size of the occupied area represents a small portion of the combined acreage of all habitats usable by eastern indigo snakes in South Florida.

It is difficult to estimate the density of eastern indigo snakes in the Project area due to a general lack of existing data. Therefore, data from other eastern indigo snake studies in Florida were used to estimate an approximate snake density on the Project site. A 26-year study conducted by Layne and Steiner (1996) at Archbold Biological Station (ABS), Lake Placid, Florida, determined the average home range size for a female was 46 ac and that of a male was 184 ac.

Considering overlap between the sexes there could be up to two males and eight females within the Project area. Because eight female snakes are estimated present, we also estimate eight nests with eggs could be present.

Florida panther

The Service used current and historical radio-telemetry data, information on habitat quality, prey base, and evidence of uncollared panthers to evaluate panther use in the action area. Panther telemetry data are collected three days per week from fixed-wing aircraft, usually in early to midmorning. However, researchers have shown panthers are most active between dusk and dawn (Beier 1995) and are typically at rest in dense ground cover during daytime monitoring flights (Land 1994). Comiskey et al. (2002) suggested that, because data is collected when panthers are least active, these locations may present an incomplete picture of activity patterns and habitat use. However, this potential bias was not detected in a recent analysis by Land et al. (2008) using GPS satellite location data collected throughout a 24 hour day. This study revealed panther habitat selection patterns are similar when using either aerial telemetry data collected during the day or 24-hour satellite GPS location data. Both methods showed upland and wetland forests were the habitats most selected by panthers. The study also indicated that grassland-dry prairie habitats were used more at night than during daytime hours.

Only a subset of the panther population has been radio-collared. For example, 42 radio-collared panthers, representing about 40 percent of the estimated panther population, were monitored in 2013. However, the large database of telemetry locations taken from radio-collared panthers south of the Caloosahatchee River can be used to estimate the size and number of home ranges and travel corridors south of the Caloosahatchee River. The FWC also uses observational data collected during telemetry flights to assess the yearly breeding activity of radio-collared panthers. Female panthers accompanied by kittens or male panthers within proximity of an adult female are assumed to have engaged in breeding activity during that year.

There have been 160 panther deaths documented within 25 mi of the proposed Project (Figure 4). FWC-Fish and Wildlife Research Institute (2017a) data shows that 121 of those deaths were attributed to motor vehicles.

According to telemetry records collected by the FWC-Fish and Wildlife Research Institute (2017b), there have been 694 telemetry point locations for radio-collared panthers detected within 5 mi of the proposed Project site between April 14, 1989, and June 15, 2016 (Figure 5). There have been 14 panther deaths documented within 5 mi of the proposed Project (Figure 5). Ten of these panther deaths were caused by collisions with vehicles. Ten of these 14 dead panthers were uncollared. The status and activities of living uncollared panthers within the action area are unknown. The Service believes the area surrounding the Project site is used by

other non-collared panthers because the majority of panthers killed within 5 mi of the Project were uncollared, and the Project vicinity has been used historically by panthers as indicated by telemetry locations (Figure 5).

Factors affecting the species environment within the action area

Factors that affect the species environment (positively and negatively) within the action area include, but are not limited to Federal, State, or private actions and other human activities in the action area, such as: construction of highways and urban development, agriculture operations, resource extraction, public lands management (prescribed fire, public use, exotic eradication, *etc.*), hydrological restoration projects, and public and private land protection efforts.

Eastern indigo snake

Development activities may result in avoidance or limited use of suitable habitat by eastern indigo snakes, as well as habitat loss and degradation.

Public and private land management practices can have a positive, neutral, or negative effect, depending on the management goals. Land protection efforts will help to stabilize the extant population

Florida panther

Past and ongoing Federal and State actions that could affect panther habitat in the action area include the issuance of Corps' permits and State of Florida Environmental Resource Permits authorizing the filling of wetlands for development projects and other purposes. Since 1982, the Corps and the State have had a joint wetland permit application process, where all permit applications submitted are distributed to both agencies.

Conservation lands acquired through the land acquisition programs of Federal, State and County resource agencies within the action area have benefited panthers by preserving and maintaining habitat in perpetuity. Public conservation lands within the action area include the State of Florida's Corkscrew Regional Ecosystem Watershed, Picayune Strand State Forest and the Service's Florida Panther National Wildlife Refuge.

Climate Change

Panther and Eastern indigo snake

Our analyses under the Act include consideration of observed or likely environmental effects related to ongoing and projected changes in climate. As defined by the Intergovernmental Panel on Climate Change (IPCC), "climate" refers to average weather, typically measured in terms of the mean and variability of temperature, precipitation, or other relevant properties over time; thus "climate change" refers to a change in such a measure which persists for an extended period,

typically decades or longer, due to natural conditions (e.g., solar cycles) or human-caused changes in the composition of the atmosphere or in land use (IPCC 2013, p. 1450). Detailed explanations of global climate change and examples of various observed and projected changes and associated effects and risks at the global level are provided in reports issued by the IPCC (2014 and citations therein). Information for the United States at national and regional levels is summarized in the National Climate Assessment (Melillo *et al.* 2014 entire and citations therein; see Melillo *et al.* 2014, pp.28-45 for an overview). Because observed and projected changes in climate at regional and local levels vary from global average conditions, rather than using global scale projections, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species and the conditions influencing it. (See Melillo *et al.* 2014, Appendix 3, pp. 760-763 for a discussion of climate modeling, including downscaling). In our analysis, we use our expert judgment to weigh the best scientific and commercial data available in our consideration of relevant aspects of climate change and related effects.

Climate change may result in an increase in the intensity or frequency of tropical storms and hurricanes in Florida. The Atlantic Multi-decadal Oscillation (AMO) influences rain patterns in Florida. We are currently in an AMO warm phase that is predicted to persist through 2020 (Miller 2010). The increased rainfall associated with both of these factors could reduce our ability to effectively use prescribed burning to manage habitat in optimal conditions for indigo snakes, panthers, and their prey. Increased rainfall could also reduce the amount of area suitable for indigo snakes, and panther denning, by increasing the area covered with standing water or the duration of inundation of seasonally wet areas.

It is difficult to estimate, with any degree of precision, which species will be affected by climate change or exactly how they will be affected. The Service will use Strategic Habitat Conservation planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (Service 2006).

EFFECTS OF THE ACTION

Eastern indigo snake

Adverse effects

Development projects may have a number of direct and indirect effects on the eastern indigo snake and their habitat. The effects that this Project will have on the eastern indigo snake include: (1) an increase in the potential for injuries and mortalities due to construction activities;

(2) the permanent loss of habitat for the species; (3) fragmentation and isolation of remaining undeveloped habitat within the property; (4) interaction with people and pets following completion of the Project.

Increase in the potential for injuries and mortalities due to construction activities

Due to the nature of the proposed action (*i.e.*, vegetation removal, earth moving and piling, earth scraping, grading), the Service estimates some of the eastern indigo snakes present at the time of the action could be adversely affected by the Project. Eastern indigo snakes in suitable habitat slated for land clearing are probably most at risk for injury or mortality. The habitat clearing, earth moving, scraping and piling have the potential to crush eastern indigo snakes, their nests and eggs. Snakes can also be buried in their burrows and other refugia. For example, during the excavation of gopher tortoise burrows on the Project site, eastern indigo snakes occupying these burrows may be injured or killed.

The timing of construction for this Project, relative to sensitive periods of the eastern indigo snake's lifecycle, is unknown. Eastern indigo snakes may be found on and adjacent to the proposed construction footprint year-round. The Project will be constructed in one phase and result in the permanent loss and alteration of a majority of the existing ground cover in the Project's development footprint. The time required to complete construction of the Project is not exactly known. The disturbance associated with the Project will be permanent and result in a loss of habitat currently available to the eastern indigo snake.

The loss of habitat within the Project footprint is expected to force eastern indigo snakes to leave the Project site and establish new home ranges. These individuals would be more vulnerable to predation and intraspecific aggression as they attempt to establish new home ranges. The loss of habitat (home range) would be expected to impair their ability to feed, breed, and shelter until new home ranges are established.

Increased vehicular traffic during land clearing activities has the potential to increase the risk of snake mortality. Because the conditions in the Standard Protection Measures (SPM) require the education of contractors and equipment operators, posting of speed limit signs on all roadways during Project construction and operation, on-site signs explaining the penalties of intentionally running over snakes, and that construction will cease if snakes are observed, we anticipate the risk of injury or death on all the Project's internal roads to be low.

Additionally, visual and vibrational disturbance from personnel and machinery during site clearing and preparation activities could also cause eastern indigo snakes to leave the Project area. This may result in missed foraging and mating opportunities and these individuals may be more vulnerable to predation and intraspecific aggression. Disturbed eastern indigo snakes may

also hide in refugia on site. This may result in missed foraging and mating opportunities, and these individuals may be more vulnerable to injury or mortality during land clearing or gopher tortoise burrow excavation.

Permanent loss of habitat for the species

The Project will result in a permanent loss of 177.43 ac of eastern indigo snake habitat, through habitat destruction, fragmentation, and isolation that could result in the loss of up to ten eastern indigo snakes and up to eight nests. Some snakes displaced by the Project may move to the Project's adjoining conservation area.

Fragmentation and isolation of remaining undeveloped habitat within the property

The Project site, once developed, may further restrict movement of eastern indigo snakes from larger tracts of undeveloped land through fragmentation of habitat. The preserved lands adjacent to Project site will continue to serve as suitable eastern indigo snake habitat; but will provide less land for any snakes currently occupying the Project site.

Interaction with people and pets following completion of the Project

The activities of humans living in the residential development following completion of the Project may indirectly adversely affect eastern indigo snakes. The presence of humans and their pets will increase the potential for injuries or mortalities of any snakes remaining in the Project footprint or preserve area. Some humans fear snakes and may indiscriminately attack or kill eastern indigo snakes when encountered. Free-roaming pets of residents may also injure or kill snakes. Finally, collisions from motor vehicles using the roads in the new development will increase the potential that any eastern indigo snakes occurring in the Project area will be injured or killed.

Beneficial effects

Beneficial effects are those effects of the proposed action that are completely positive, without any adverse effects to the listed species or its critical habitat. The proposed action will not result in beneficial effects to the eastern indigo snake.

Interrelated and interdependent actions

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that does not have independent utility apart from the action under consultation. Interrelated or interdependent actions are not expected to result from the Project.

Florida panther

Adverse effects

The Project site contains panther habitat and is located within the geographic range of the panther. The timing of construction for the Project, relative to sensitive periods of the panther's lifecycle, is unknown. Panthers may be found on and adjacent to the proposed construction footprint year-round. The Project will be constructed in one phase and result in the permanent loss and alteration of a majority of the existing ground cover in the Project's development footprint. The time required to complete construction of the Project is not known, but it is likely that land clearing associated with the development will be undertaken in a single phase at the start of development activities. The disturbance associated with the Project will be permanent and result in a loss of habitat currently available to the panther.

The Project's lands to be developed for residential use currently provide 177.43 ac of habitat for the panther. This habitat is located in the Primary zone of the Focus Area (Kautz et al. 2006), and within the northwestern portion of the panther's current range. The majority of the land to be developed consists of hydric pine flatwoods that provides habitat for the panther and its prey. A variety of wildlife species that provide potential prey for the panther are known to occur within the action area. Potential prey include: white-tailed deer (*Odocoileus virginianus*), feral hog (*Sus scrofa*), wild turkey (*Meleagris gallopavo*), nine-banded armadillo (*Dasypus novemcinctus*), striped skunk (*Mephitis mephitis*), Eastern grey squirrel (*Sciurus carolinensis*), Eastern cottontail (*Sylivilagus floridanus*), and various species of small mammals, wading birds, amphibians, and reptiles.

The Service developed a Panther Habitat Assessment Methodology and refugia design in 2003 to help guide the agency in evaluating permit applications for projects that could affect panther habitat. This methodology provided a way to assess the level of impacts to panthers expected from a given project, and to evaluate the effect of any proposed compensation offered by the project's Applicants. The Habitat Assessment Methodology was updated in 2009. A full description of our Habitat Assessment Methodology can be found at: http://www.fws.gov/verobeach/MammalsPDFs/20120924_Panther%20Habitat%20Assessment%20Method_Appendix.pdf.

The Service used our panther Habitat Assessment Methodology to evaluate the panther habitat lost due to the Project, and the panther habitat provided as compensation. The proposed action will result in development of 177.43 ac of panther habitat in Panther Focus Area and Panther Consultation Area (Service 2007) (Figure 6). Because the on-site credits provide only 1,810 PHUs, the Applicant has agreed to purchase the remaining balance of 178 PHUs from a Service-approved conservation or mitigation bank located within the panther primary zone. The proposed compensation plan is consistent with goal 1.1.1.2.3 in the Panther Recovery Plan

(Service 2008) which states that habitat preservation and restoration be provided, especially within the Primary Zone, in situations where land use intensification cannot be avoided. The Applicant's compensation will provide equivalent habitat protection and restoration, to compensate for both the function and value of the lost habitat. The Applicant has agreed not to begin construction on the Project until: (1) they provide the Service with a receipt (in the form of a letter or email) from a Service-approved conservation or mitigation bank stating at least 178 PHUs have been acquired by the Applicant, and (2) the Corps and the Applicant have received an email or letter from the Service indicating we have received the receipt from the Service-approved conservation or mitigation bank.

Development projects may have a number of direct and indirect effects on the panther and panther habitat which include: (1) the permanent loss of habitat for panthers and their prey; (2) a reduction in the geographic distribution of habitat for the species; (3) harassment of panthers due to construction activities; (4) increased potential for panther mortality due to motor vehicle collisions; (5) increased disturbance to panthers and their prey due to human activities; (6) an increase in the potential for intraspecific aggression among panthers due to reduction of the geographic distribution of habitat of the panther; and (7) an increase in the potential for panther-human interactions.

Permanent loss of habitat for panthers and their prey

The Project will result in the loss of 177.43 ac of panther habitat in the Primary Zone. The land will be converted to land uses that aren't expected to be used by panthers or their prey. The habitat lost due to the Project may adversely affect the panther by decreasing the spatial extent of lands available to the panther and their prey. We anticipate any resident panthers with home ranges overlapping in the vicinity of the Project area will adjust the size and location of their ranges to account for this loss and disturbance, and the adjustment is anticipated to occur in concert with Project construction.

Reduction in the geographic distribution of habitat for the species

The Project will result in the loss of about 177.43 ac of undeveloped land within the Focus Area. This loss represents 0.02 percent of the 1,202,699 ac of available non-urban private lands available to the panther. The habitat value lost due to the Project will be offset to some extent by the habitat compensation proposed by the Applicant. The lands proposed for preservation are consistent with the Service's panther conservation strategy to locate, preserve, and restore lands containing sufficient area, access, and appropriate cover types to ensure the long-term survival of the panther south of the Caloosahatchee River.

Harassment by construction activities

The timing of construction for the Project, relative to sensitive periods of the panther's lifecycle, is unknown. However, land clearing associated with the Project will be completed in a single phase at the start of development activities. There are no known den sites within the Project boundaries. Therefore, we find it is unlikely that the Project construction will result in direct panther mortality, but it may result in temporary disturbance to resident or dispersing panthers.

Risk of panther injury and mortality from motor vehicle collisions

Panther vehicle injury and mortality was discussed in the Environmental Baseline section of this document. In evaluating a Project's potential to increase injuries and mortalities to panthers resulting from motor vehicle collisions, we consider the location of the Project in relation to surrounding native habitats, preserved lands, and wildlife corridors that are frequently used by the panther. We also consider the current configuration and traffic patterns of surrounding roadways and the projected increase and traffic patterns expected to result from the proposed action. Panther vehicle injury and mortality throughout the action area is also discussed in the Environmental Baseline section of this document.

The Project will result in increased vehicular traffic in the Project vicinity during and after construction. The Project involves construction of internal roads, but these are not expected to pose a high risk to panthers because the speed limit will be lower than main roads; and access to these internal roads by panthers coming from natural areas is minimized due to houses, retention ponds, and wildlife control fencing separating the natural areas from the roads. The Service also used traffic data from the Florida Department of Transportation Data & Analytics Office (FDOT 2017) and the Applicant's traffic impact statement (TIS) to estimate the risk to the panther from the Project's projected increase in traffic. JMB Engineering, Incorporated, prepared a TIS that examined the effects of the Project's traffic on nearby roads. Based on information in the TIS, the Project will generate 5,574 annual average daily trips (AADT). The traffic generated from the Project site will use existing roads, with majority of traffic (95% or 5,295 AADT) expected to occur west of the Project site on Corkscrew Road. Five percent of the traffic (264 AADT) is expected to occur east of the Project site on Corkscrew Road. The majority traffic volume partitions at the Ben Hill Griffin Parkway/Corkscrew Road intersection with 35% (1,951 AADT) going to Ben Hill Griffin Parkway and the remaining 60% (3,344 AADT) continuing west on Corkscrew Road to Interstate 75 and downtown Estero (Figure 7). The current risk to panthers from traffic was assessed by looking at the number of panthers killed in the past 5 years within the TIS study area. Within this study area, one panther was killed in 2016 on Corkscrew Road and another died on Ben Hill Griffin Boulevard in 2016 (Figure 8). According to FDOT data, the current traffic volume on Corkscrew Road is 3,800 AADT and Ben Hill Griffin Parkway supports 32,000 AADT. The current number of vehicle trips leading to panther deaths was calculated for these roads by multiplying the five-year total AADT (AADT times 1,825 days),

and dividing this number by the number of panther road kills during the last five years. This calculation provides a baseline estimate of the number of vehicle trips that lead to a roadkill based on the current AADT and panther mortality data over a 5-year period. Using this calculation, we estimated that currently one panther is killed for every 6.94 million vehicle trips on Corkscrew Road, and one panther is killed for every 58.40 million vehicle trips on Ben Hill Griffin Parkway. Assuming that the rate of panther road kills is proportional to the AADT, we estimated changes in panther road kills from the projected changes in AADT caused by the Project. This was done by multiplying current 5-year ratio of panther kills per vehicle trips by the projected number of trips occurring in 5-years. On Corkscrew Road, the traffic volume is expected to increase to 9,095 AADT (3,800 AADT plus 5,295 AADT) as a result of the Project. Using the above described calculation, we estimated that panther road kills on Corkscrew Road will increase from 1 roadkill to 2.4 road kills every five years as a result of the increase in traffic from the Project. The projected increase in road kills on Ben Hill Griffin Parkway is from 1 to 1.06 road kills every 5 years. Therefore, we estimated an increase in road kills on these two roads from 2 to 3.6. This is a net increase of 1.6 more road kills than the current baseline. Since this estimation of take is for a whole animal, the estimated 1.6 net increase in panther road kills is rounded to 2 individual panthers.

However, this estimate of increased vehicular mortality does not consider the effect of the recently-permitted wildlife underpass and fencing on Corkscrew Road expected to be constructed adjacent to the Project site in 2018. The Service anticipates that this wildlife underpass/fencing will reduce likelihood of panther deaths from the increased traffic volume on Corkscrew Road.

Disturbance to panthers and panther prey from an increase in human activities

The construction of the Project will increase human activities at the Project site. The disturbance resulting from human activities at the Project site could affect the movements of panthers and panther prey species. Consequently, panthers and panther prey species may be less likely to approach the Project site, or they may choose to avoid the Project corridor altogether. The additional human activity at the Project in conjunction with the loss of panther habitat resulting from the Project may change panther use patterns in the Project area, and panthers may avoid the Project area.

Increased potential for intraspecific aggression

As discussed in the Status of the Species, panther mortalities resulting from attacks of con-specifics are known to occur in the panther population (*e.g.*, males may kill other rival males when defending a territory). Habitat loss may increase the potential for intraspecific aggression among panthers in the action area. Fourteen panther deaths due to intraspecific aggression have

been documented within the action area between 1999 and 2017. The Project will result in the loss of 177.43 ac of panther habitat. According to the most current home range estimates of the panther (Lotz et al. 2005), this loss represents 0.61 percent of a female panther's average home range (29,059 ac) and 0.28 percent of a male panther's average home range (62,542 ac). As discussed above, construction of the Project will result in a small increase in the spatial extent of disturbance from human activity in the Project area. However, based on the amount of panther habitat lost, the Service finds the Project should not significantly increase the potential for intraspecific aggression in the action area.

Increase in the potential for panther-human interactions

The Project footprint is within a known panther movement corridor. The Service believes there is an increased risk for adverse human-panther interactions due the Project's location in this corridor. These interactions can result in harm to humans, panthers, or both. In some instances, human-panther interactions lead to the relocation of a panther to another area; or removal of a panther from the wild.

Beneficial effects

Beneficial effects are those effects of the proposed action that are completely positive, without any adverse effects to the listed species or its critical habitat. The proposed action will not result in beneficial effects to the panther.

Interrelated and interdependent actions

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. Interrelated or interdependent actions are not expected to result from the Project.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

Eastern indigo snake

The effects to the eastern indigo snake do not extend beyond the Project footprint. Therefore, cumulative effects to the eastern indigo snake are not expected to occur from the Project.

Florida panther

The ongoing State and County actions (non-federal) affecting panther habitat within the action area include: (1) State of Florida Development of Regional Impact (DRI) Orders; (2) County Comprehensive Plan Amendments; (3) County Zoning Amendments; (4) County Planned Unit Developments (PUDs); (5) Florida Department of Environment Protection Permits; and (6) South Florida Water Management District's Environmental Resources Permits (ERPs). To estimate future non-federal actions, the Service chose to identify and tabulate recent non-federal actions and project this level of development as representative of future non-federal actions.

The projections of non-federal actions (*i.e.*, cumulative effects) in the action area incorporates Florida Land Use Cover and Forms Classification System (FLUCCS) mapping to determine if a property may be exempt from the Federal Clean Water Act, section 404 wetland regulatory review by the Corps. To predict if a development project would likely be exempt from regulatory review, the Service identified the percentage of the property site that was classified as wetland habitat based on FLUCCS 600 series (wetland), and the 411 and 419 (hydric pine flatwood) mapping unit classifications. Projects on properties with less than 5 percent wetlands were assumed to be exempt from the Corps' regulatory review, because impacts to wetlands could likely be avoided by project design. However, this assumption can overestimate the number of non-federal projects because many project proponents choose to apply for DA authorization for projects with less than 5 percent wetland coverage.

Using the above section criteria on ERP applications from 2012 through 2015, 675 projects in the action area affecting 9,833 ac of land were assumed exempt from Corps regulatory review. Therefore, the Service estimates that approximately 2,458 ac per year (9,833 ac / 4 years = 2,458 ac/year) would be exempt from regulatory review in the action area. We find this value representative of future yearly development likely to occur in the action area. Many unforeseen factors can affect the rate of development in the action area. Therefore, the Service acknowledges that it is difficult to forecast the rate of development as it relates to non-federal actions in the action area with certainty. However, the Service believes this estimate provides the best approximation available of future non-federal development actions reasonably certain to occur based on ERP data. This level of development represents 8.5 percent of a female panther's average home range (29,059 ac) and 3.9 percent of a male panther's average home range (62,542 ac). Based on the above analysis, we believe the loss of the habitat associated with these lands is insignificant in the short term, but may adversely impact the panther as development continues to occur in the future in the action area.

CONCLUSION

Eastern indigo snake

After reviewing the current status of the eastern indigo snake, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Project, as proposed, is not likely to jeopardize the continued existence of the eastern indigo snake. We have reached this conclusion because: (1) the Project will permanently destroy 177.43 ac of suitable habitat; however, this represents a small portion of the combined acreage of all habitats usable by eastern indigo snakes throughout their range in Florida and Georgia; 2) other large tracts of undeveloped and protected lands adjoin the Project site and snakes from the Project site could move there; (3) the level of expected mortality (ten individuals and up to eight nests with eggs) is a small fraction of the number of indigo snakes that potentially occupy the suitable habitat throughout this species' range; and (4) the Applicant will implement the SPMs for the eastern indigo snake during land clearing and construction of the Project, which should reduce any mortality caused by vehicles, equipment, or if a snake is encountered by workers. Therefore, the loss of 177.43 ac eastern indigo snake habitat within the Project footprint is not expected to appreciably affect the overall survival and recovery of the eastern indigo snake.

Panther

After reviewing the current status of panther, the environmental baseline for the action area, the effects of the proposed Project, and the cumulative effects, it is the Service's biological opinion that the Project, as proposed, is not likely to jeopardize the continued existence of the panther. We have reached this conclusion because: (1) the permanent loss of 177.43 ac of habitat currently used by panthers and panther prey is a small percent of a male (0.3 percent) and female (0.6 percent) panther territory; (2) the estimate of increased vehicular mortality associated with increased traffic is expected to be ameliorated by the wildlife underpass and fencing on Corkscrew Road scheduled to be constructed adjacent to the Project site in 2018. The Service anticipates that this wildlife underpass/fencing will reduce likelihood of panther deaths from increased traffic volume on Corkscrew Road; (3) the small reduction in panther habitat from the Project is not expected to result in increased potential for intraspecific aggression among panthers in the action area; and (4) the loss of panther habitat due to the Project will be offset through the on-site habitat preservation and restoration of 218.12 ac that will provide 1,810 PHUs, and the purchase of an additional 178 PHUs from a Service-approved conservation or mitigation bank.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined

as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of the agency action, is not considered to be prohibited taking under the Act provided such taking is in compliance with the terms and conditions of this incidental take statement.

The terms and conditions described below are nondiscretionary and must be undertaken by the Corps so they become binding conditions of any grant or permit issued to the Applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps 1) fails to assume and implement the terms and conditions or 2) fails to require the Applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Applicant must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR § 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE ANTICIPATED

Eastern indigo snake

The Service anticipates incidental take of the eastern indigo snake will be difficult to detect and quantify for the following reasons: (1) it has a wide ranging distribution; (2) it has a patchy distribution within suitable habitat; (3) it has limited detectability due to use of burrows or holes for shelter; (4) there is unlikely unoccupied suitable habitat; (5) juveniles have limited detectability due to their affinity for thick vegetation; and (6) it may use cryptic sheltering areas that may be temporarily established during construction (*e.g.*, brush piles, equipment stockpiles, and dirt mounds). The lack of practical methods to survey, in conjunction with wide-ranging activity and usage of a variety of habitat types, makes it difficult to determine the exact number of eastern indigo snakes that will be affected by the action.

Therefore, the Service calculated the likely number of eastern indigo snakes present on the Project site from the reported densities of eastern indigo snakes at ABS (Layne and Steiner 1996). We estimate that ten eastern indigo snakes and eight eastern indigo snake nests could be taken by development of the proposed Project. Because take will be difficult to detect for the reasons already stated, we will use habitat lost (177.43 ac) as a surrogate for this take. If, during

the course of this action, this level of take is exceeded, such take would represent new information requiring review of the reasonable and prudent measures provided. The Federal agency must immediately reinitiate consultation with the Service.

The Service has reviewed the biological information for the eastern indigo snake, information presented by the Applicant, and other available information relevant to this action. The Service anticipates 177.43 ac of eastern indigo snake habitat could be taken as a result of this proposed action. The incidental take is expected to be in the form of injury, mortality, or harassment incidental to Project construction. Additional take is expected in the form of impairment of normal feeding, breeding, and sheltering behaviors due to the loss of home range territories, and injury or mortality due to predation and intraspecific aggression as they attempt to establish new home ranges.

Florida panther

The Service anticipates incidental take of the panthers will be difficult to detect because monitoring panthers in their large territories is difficult, especially for un-collared panthers. Therefore, the Service will use 177.43 ac of habitat as a surrogate for the panthers using the Project site. If, during the course of this action, this level of take is exceeded, such take would represent new information requiring review of the reasonable and prudent measures provided. The Federal agency must immediately reinitiate consultation with the Service.

The Service has reviewed the biological information for the panther, information presented by the Applicant, and other available information relevant to this action. The Service anticipates all panthers using 177.43 ac of panther habitat could be taken as a result of this proposed action. The incidental take is expected to be in the form of harm due to habitat loss, and harassment due to construction and post-construction activities.

The Service finds that no more than 177.43 ac of panther habitat will be incidentally taken as a result of the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined this level of anticipated take is not likely to result in jeopardy to the eastern indigo snake or panther.

REASONABLE AND PRUDENT MEASURES

When providing an incidental take statement, the Service is required to give reasonable and prudent measures it considers necessary or appropriate to minimize the take, along with terms and conditions that must be complied with to implement the reasonable and prudent measures.

However, the Service is not aware of any reasonable and prudent measures that can be implemented to minimize take of the eastern indigo snake or panther beyond those that are already part of the proposed action; however, specific reporting and monitoring requirements are described below.

MONITORING AND REPORTING REQUIREMENTS

Pursuant to 50 CFR § 402.14(i)(3), the Corps must provide adequate monitoring and reporting to determine if the amount or extent of take is approached or exceeded. In order to monitor the impacts of incidental take, the Corps will require the Applicant to report the progress of the final developed acreage, and its impacts on the eastern indigo snake and panther to the Service as specified in the Incidental Take Statement.

DISPOSITION OF DEAD OR INJURED SPECIMENS

Upon locating a dead, injured, or sick threatened or endangered species, initial notification must be made to the nearest Service Law Enforcement Office: 20501 Independence Blvd., Groveland, Florida 34736; 352-429-1037. Secondary notification should be made to FWC: South Region; 3900 Drane Field Road; Lakeland, Florida; 33811-1299; 1-800-282-8002. Notification should also be made to the Service's Endangered Species Program Supervisor at the South Florida Ecological Services Office at 772-562-3909. Care should be taken in handling sick or injured specimens to ensure effective treatment and in the handling of dead specimens to preserve biological material in the best possible state for later analysis as to the cause of death. In conjunction with the care of sick or injured specimens, or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed. Notify the Service if any listed species is injured or killed during routine Project activities. Contact the Endangered Species Program Supervisor at the South Florida Ecological Services Office at 772-562-3909 to provide this notification.

CONSERVATION RECOMMENDATIONS

Section 7 (a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service is not proposing any conservation recommendations at this time.

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the Project consultation request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where

discretionary Corps involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded (177.43 acres of panther and eastern indigo snake habitat, or more than 10 dead eastern indigo snake are found, or more than 8 eastern indigo snake nests are destroyed); 2) new information reveals effects of the Corps action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the Corps action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

Thank you for your cooperation and effort in protecting federally listed species and fish and wildlife resources. If you have any questions regarding this Project, please contact Chuck Kelso by email at Charles_Kelso@fws.gov, or by phone at 772-469-4241.

Sincerely yours,

Roxanna Hinzman
Field Supervisor
South Florida Ecological Services Office

Enclosures

cc: electronic only
Corps, Ft. Myers, Florida (Robert Tewis)
FWC, Tallahassee, Florida (FWC-CPS)
Service, Athens, Georgia (Michele Elmore)

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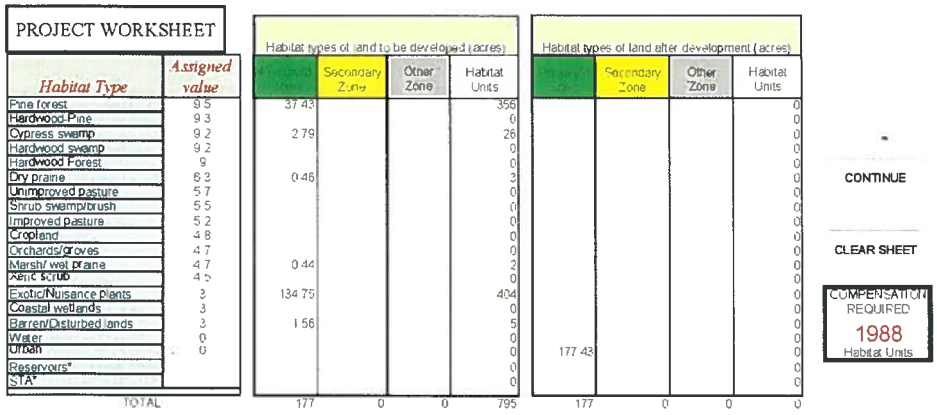
Table 1. Panther habitat unit compensation ledger for the Argo Corkscrew Crossing Project.



PROJECT WORKSHEET

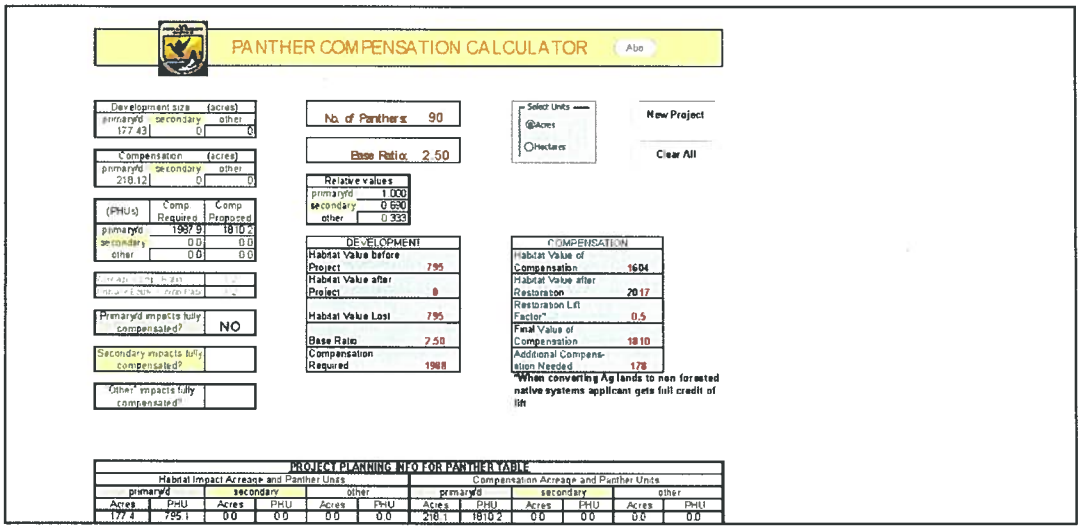
Habitat Type	Assigned value	Habitat types of land to be developed (acres) Primary Zone	Secondary Zone	Other Zone	Habitat Units	Habitat types of land after development (acres) Primary Zone	Secondary Zone	Other Zone	Habitat Units
Pine forest	9.5	37.43			356				0
Hardwood-Pine	9.3				0				0
Cypress swamp	9.2	2.79			26				0
Hardwood swamp	9.2				0				0
Hardwood Forest	9				0				0
Dry prairie	6.3	0.46			3				0
Unimproved pasture	5.7				0				0
Shrub swamp/brush	5.5				0				0
Improved pasture	5.2				0				0
Cropland	4.8				0				0
Orchards/groves	4.7				0				0
Marsh/ wet prairie	4.7	0.44			2				0
Xeric scrub	4.5				0				0
Exotic/Nuisance plants	3	134.75			404				0
Coastal wetlands	3				0				0
Barren/Disturbed lands	3	1.56			5				0
Water	0				0				0
Urban	0				0	177.43			0
Reservoirs*					0				0
STA*					0				0
TOTAL		177	0	0	795	177	0	0	0

CONTINUE

CLEAR SHEET

COMPENSATION REQUIRED 1988 Habitat Units

*NOTE: The assigned value for Reservoirs and STAs varies by size, proposed future management, and their position in the landscape. See the associated methodology document for guidance on starting values and considerations.



PANTHER COMPENSATION CALCULATOR

Development size (acres): primaryfd 177.43; secondary 0; other 0

Compensation (acres): primaryfd 218.12; secondary 0; other 0

(PHUs)	Comp Required	Comp Proposed
primaryfd	1937.9	1810.2
secondary	0.0	0.0
other	0.0	0.0

Primaryfd impacts fully compensated? NO

Secondary impacts fully compensated?

Other* impacts fully compensated?

No. of Panthers: 90

Base Ratio: 2.50

Relative values: primaryfd 1.000; secondary 0.600; other 0.333

DEVELOPMENT

Habitat Value before Project	795
Habitat Value after Project	0
Habitat Value Lost	795
Base Ratio	2.50
Compensation Required	1988

Select Units: Acres / Hectares

New Project

Clear All

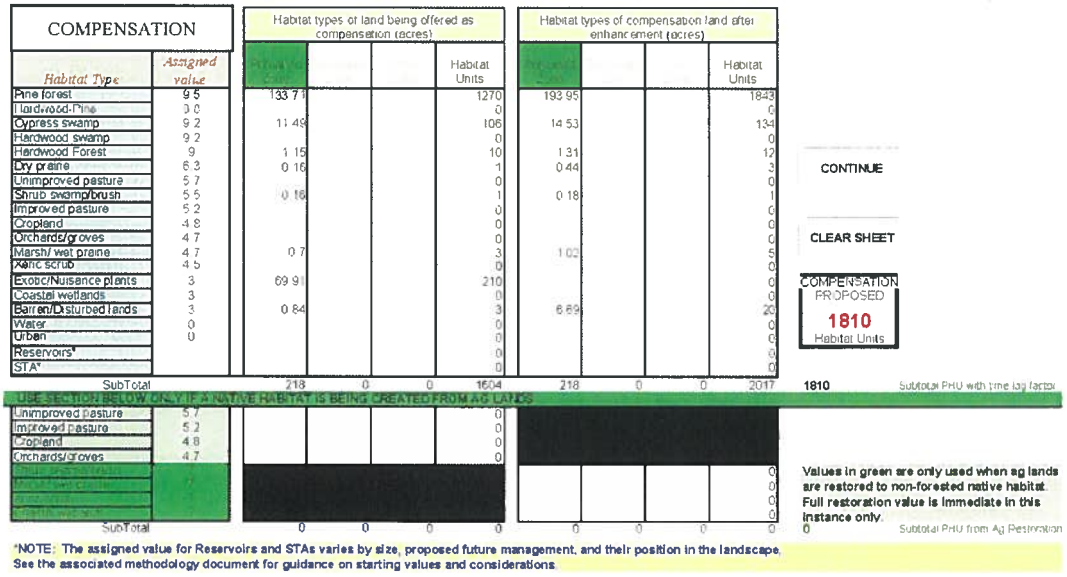
COMPENSATION

Habitat Value of Compensation	1604
Habitat Value after Restoration	2017
Restoration Lift Factor*	0.5
Final Value of Compensation	1810
Additional Compensation Needed	178

*When converting Ag lands to non forested native systems applicant gets full credit of lift

PROJECT PLANNING INFO FOR PANTHER TABLE

Habitat Impact Acreage and Panther Units						Compensation Acreage and Panther Units					
primaryfd		secondary		other		primaryfd		secondary		other	
Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU
177.4	795.1	0.0	0.0	0.0	0.0	218.1	1810.2	0.0	0.0	0.0	0.0



COMPENSATION

Habitat Type	Assigned value	Habitat types of land being offered as compensation (acres) Primary Zone	Secondary Zone	Other Zone	Habitat Units	Habitat types of compensation land after enhancement (acres) Primary Zone	Secondary Zone	Other Zone	Habitat Units
Pine forest	9.5	133.71			1270	193.95			1843
Hardwood-Pine	9.3				0				0
Cypress swamp	9.2	11.49			106	14.53			134
Hardwood swamp	9.2				0				0
Hardwood Forest	9	1.15			10	1.31			12
Dry prairie	6.3	0.16			1	0.44			3
Unimproved pasture	5.7				0				0
Shrub swamp/brush	5.5	0.16			1	0.18			1
Improved pasture	5.2				0				0
Cropland	4.8				0				0
Orchards/groves	4.7				0				0
Marsh/ wet prairie	4.7	0.7			3	1.02			5
Xeric scrub	4.5				0				0
Exotic/Nuisance plants	3	69.91			210				0
Coastal wetlands	3				0				0
Barren/Disturbed lands	3	0.84			3	6.89			20
Water	0				0				0
Urban	0				0				0
Reservoirs*					0				0
STA*					0				0
SubTotal		218	0	0	1604	218	0	0	2017

1810 Subtotal PHU with time lag factor

USE SECTION BELOW ONLY IF A NATIVE HABITAT IS BEING CREATED FROM AG LANDS

Unimproved pasture	5.7				0				0
Improved pasture	5.2				0				0
Cropland	4.8				0				0
Orchards/groves	4.7				0				0
SubTotal		0	0	0	0	0	0	0	0

Values in green are only used when ag lands are restored to non-forested native habitat. Full restoration value is immediate in this instance only.

0 Subtotal PHU from Ag Restoration

CONTINUE

CLEAR SHEET

COMPENSATION PROPOSED 1810 Habitat Units

*NOTE: The assigned value for Reservoirs and STAs varies by size, proposed future management, and their position in the landscape. See the associated methodology document for guidance on starting values and considerations.

Table 2. Reported minimum panther population counts.

Year	Total	Mortality	Net
2000	62	13	49
2001	78	11	67
2002	80	14	66
2003	87	24	63
2004	78	20	58
2005	82	12	70
2006	97	19	78
2007	117	25	92
2008	104	23	81
2009	113	24	89
2010	115	24	91
2011	111	24	87
2012	123	29	94
2013	133	29	104
2014	138	24	114
2015	140	41	99
2016	*	43	*

*Data not yet available

Figure 1. Corkscrew Crossing (Project) site in Lee County, Florida.

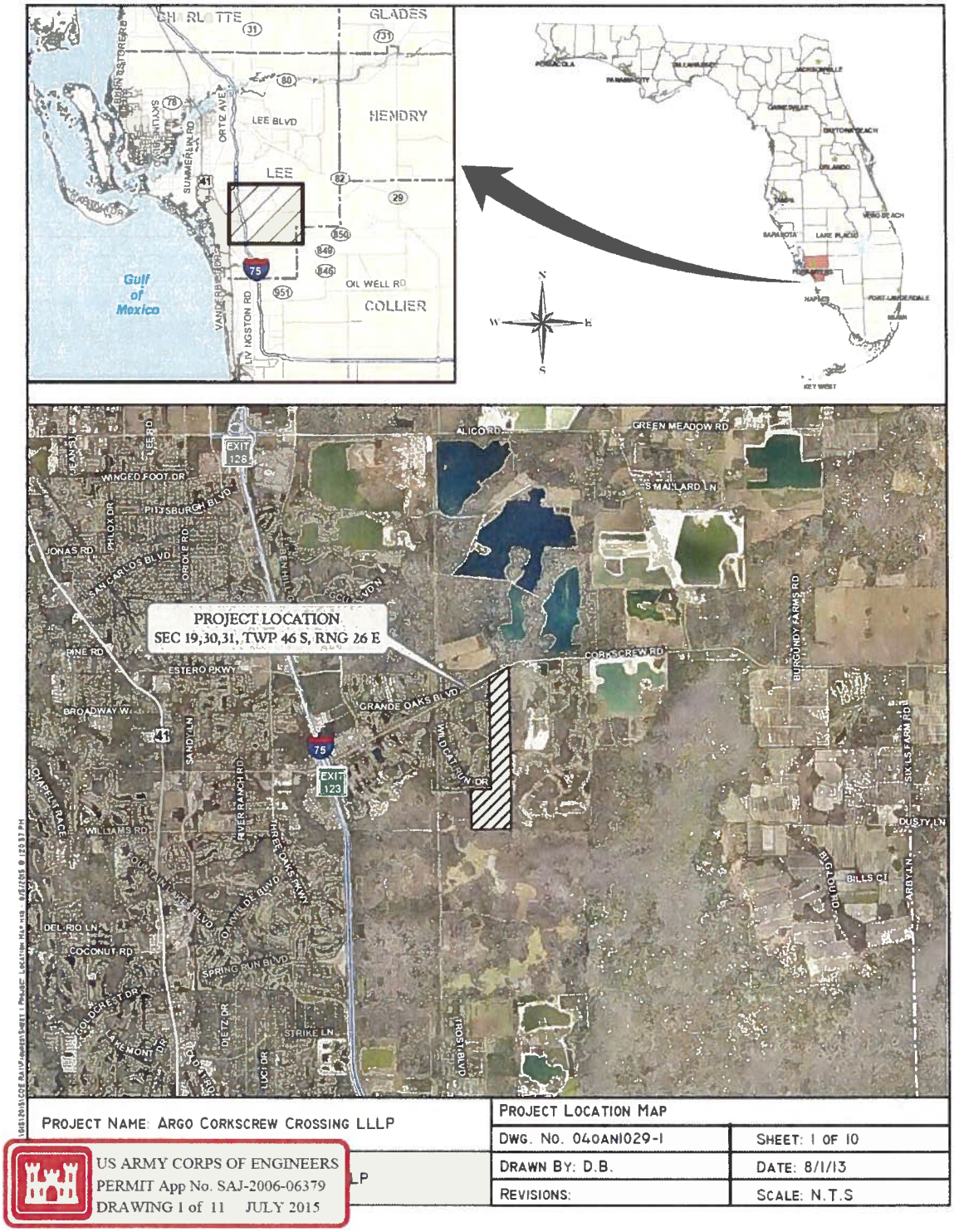


Figure 2. Argo Corkscrew Crossing Project location in Lee County, Florida.

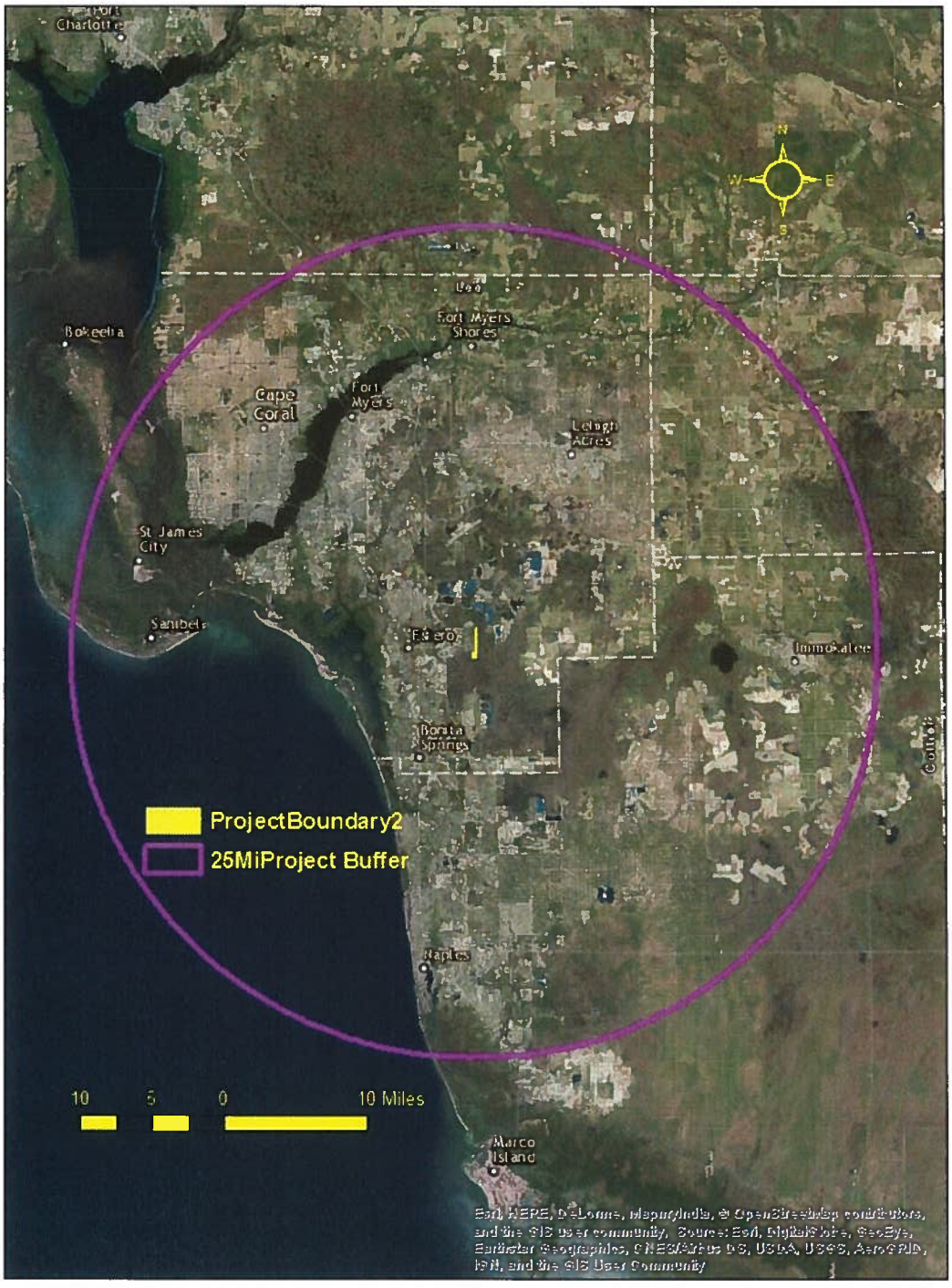


Figure 3. Action area for the Argo Corkscrew Crossing Project (25-mile buffer).

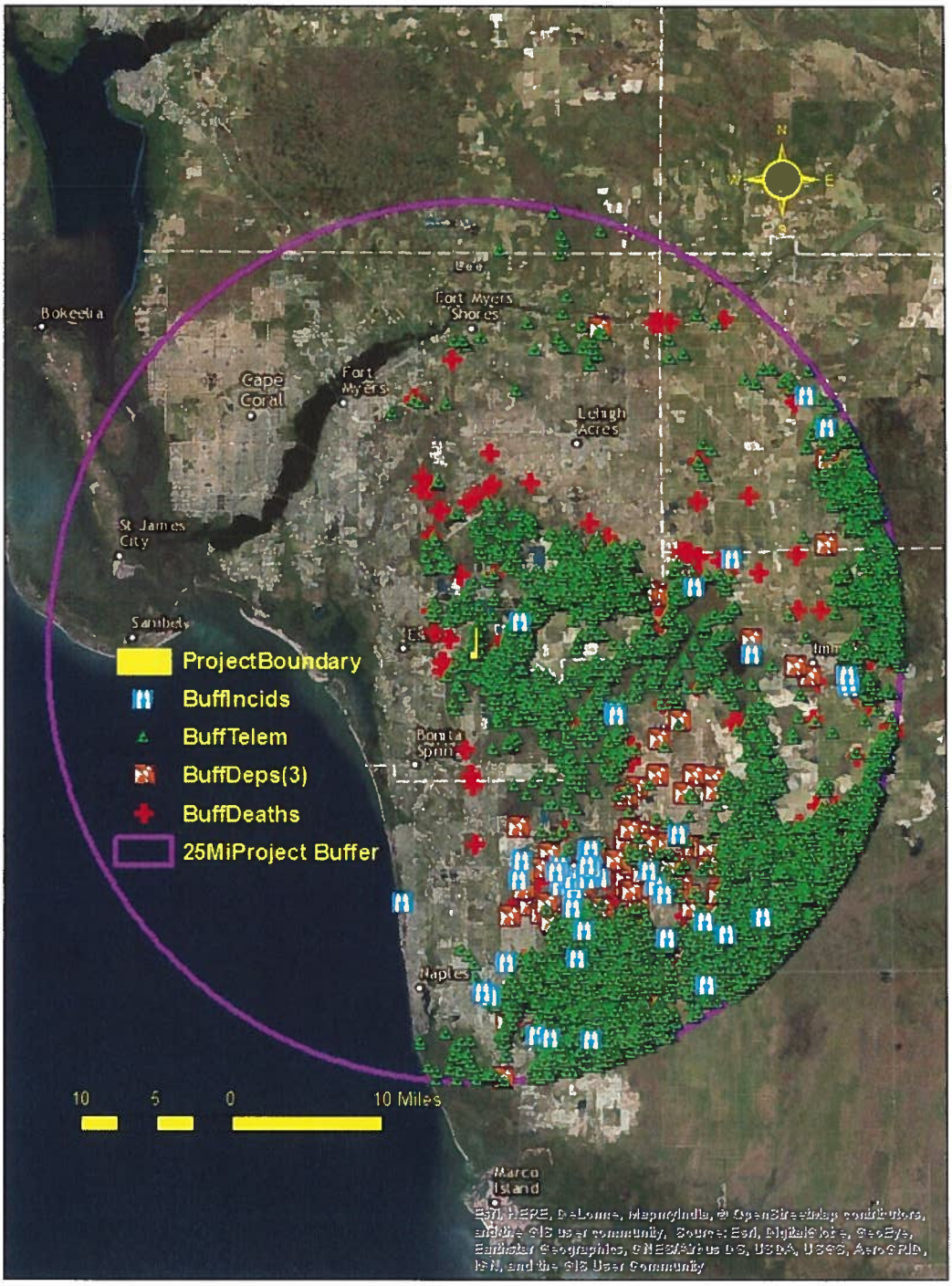


Figure 4. Panther telemetry, mortality, human interactions and livestock depredations within the action area for the Argo Corkscrew Crossing Project.

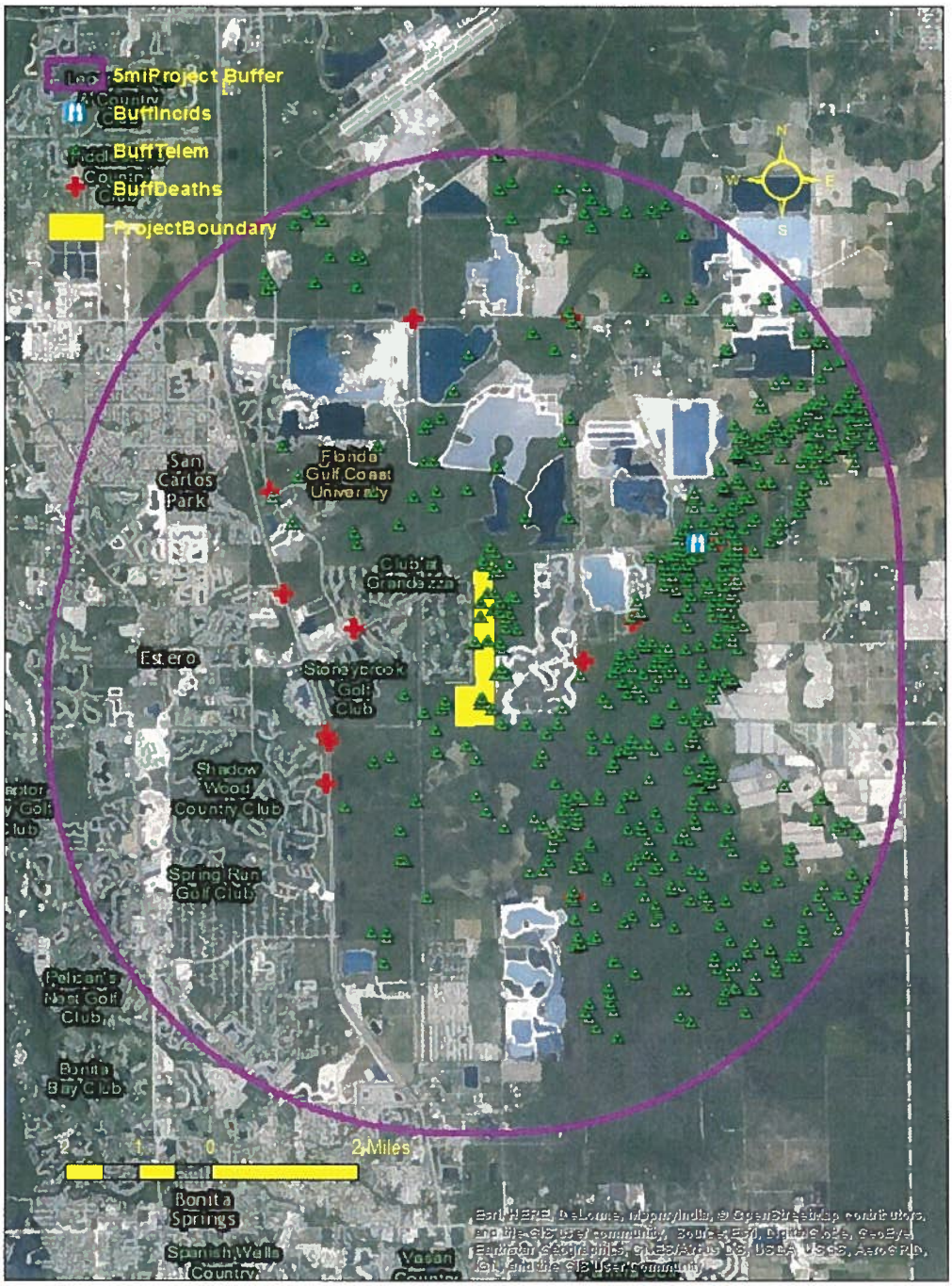


Figure 5. Panther telemetry, mortality, human interactions and livestock depredations within 5 miles of the Argo Corkscrew Crossing Project site.

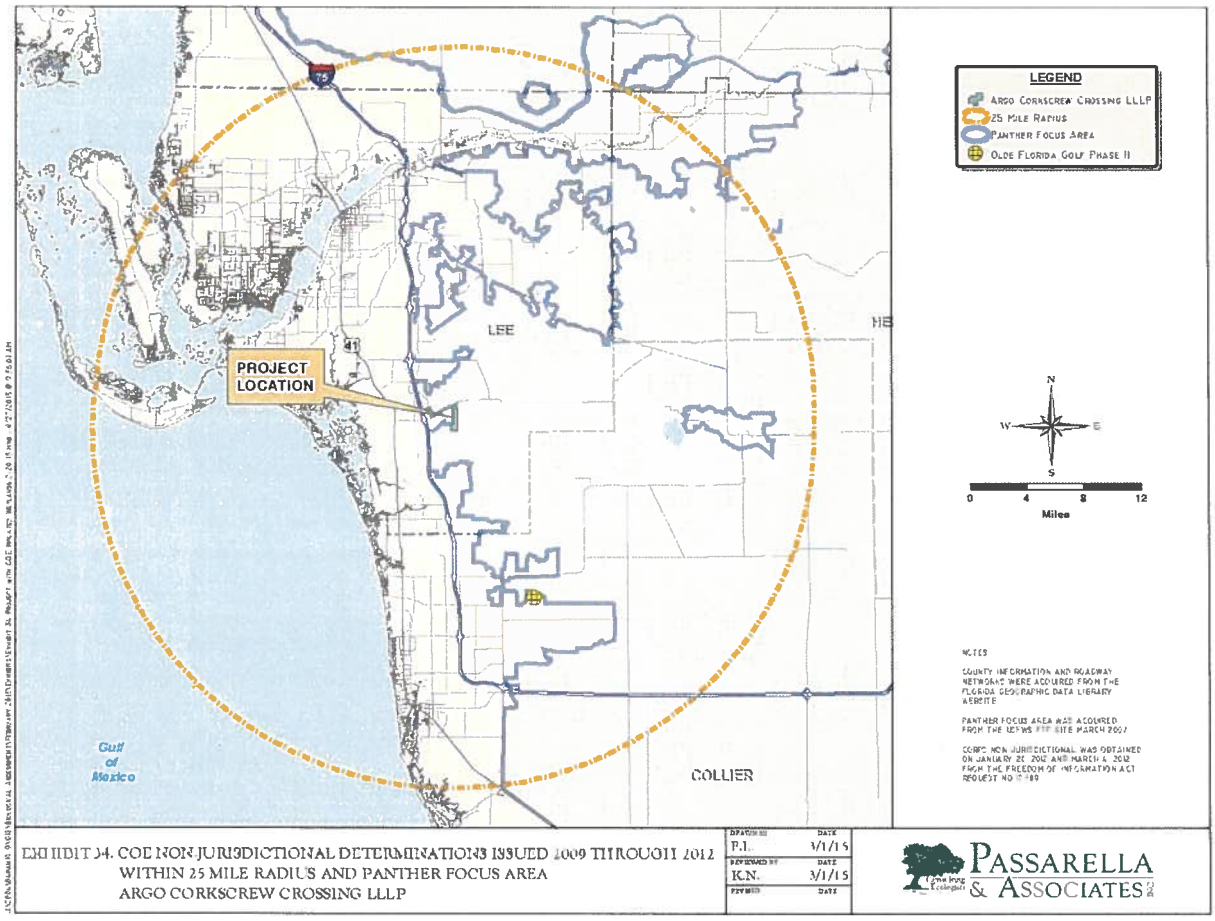
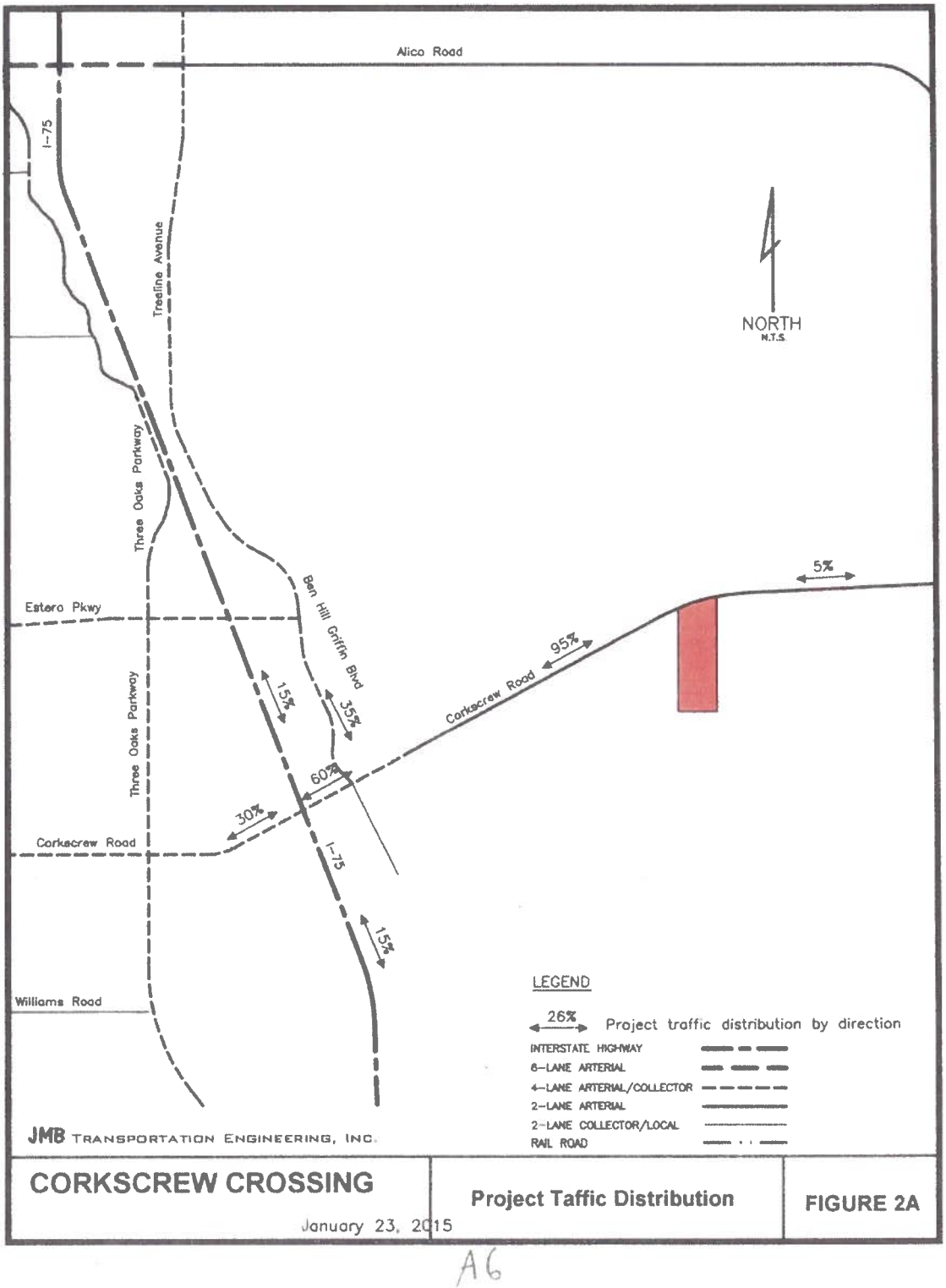


Figure 6. Argo Corkscrew Crossing Project location within the Panther Focus Area.



A6

Figure 7. Projected traffic distribution from the Argo Corkscrew Crossing Project.

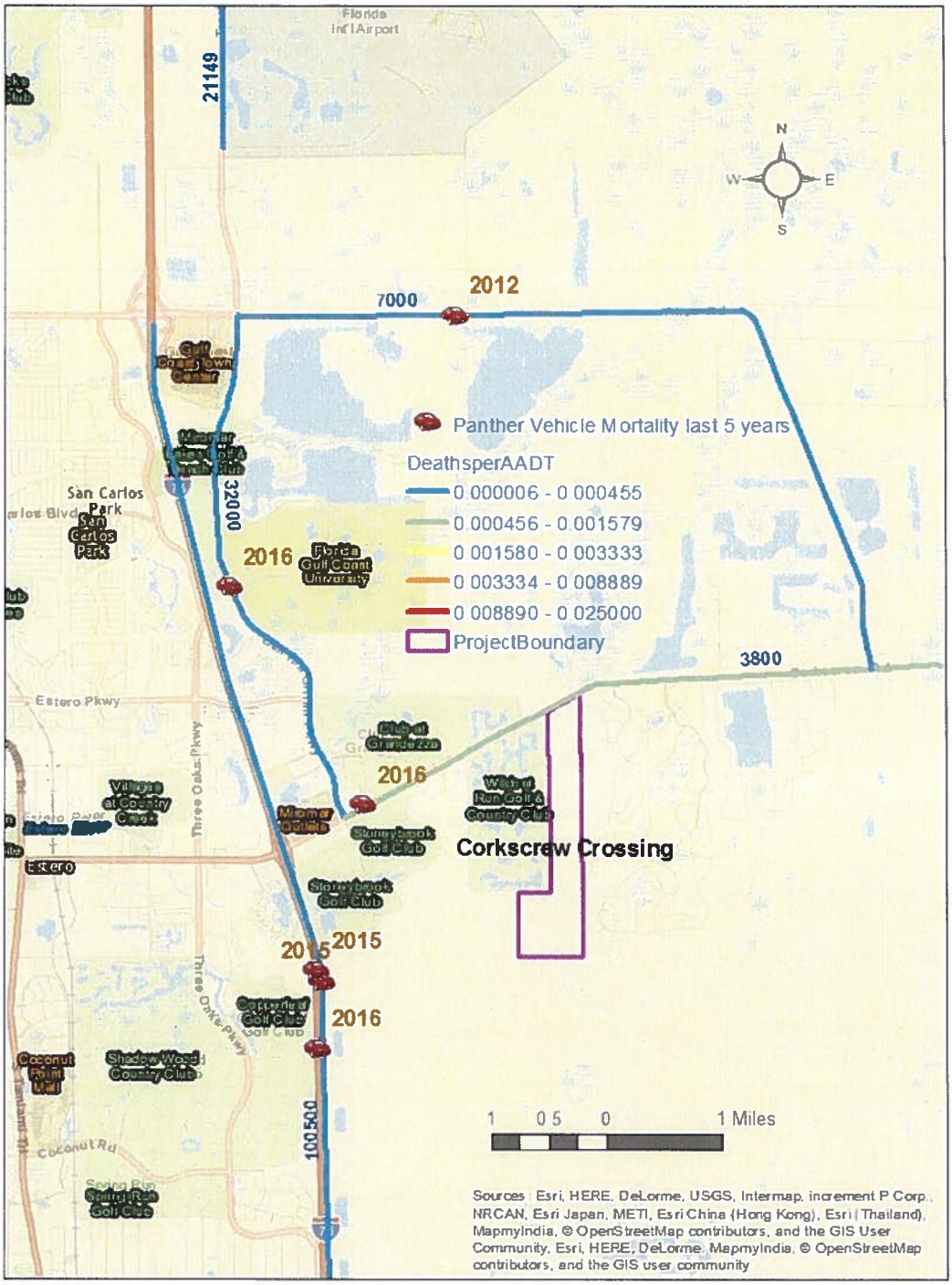


Figure 8. Current Average Annual Daily Trips (AADTs), panther road kills over the last five years in the Argo Corkscrew Crossing Project's traffic impact statement (TIS) study area, and panther road kills per AADT for the last five years in the TIS study area.

STATUS OF THE SPECIES – Florida panther (*Puma concolor coryi*)

Legal Status – On March 11, 1967, the Service listed the panther as endangered (32 FR 4001) throughout its historic range, and they received Federal protection under the passage of the Act in 1973. In addition, the Florida Panther Act (Florida Statute 372.671), a 1978 Florida State law, made killing a panther a felony. The panther is listed as endangered by the States of Florida, Georgia, Louisiana, and Mississippi in addition to its Federal listing. Critical habitat has not been designated for the panther.

Species Description

Appearance/Morphology

An adult panther is unspotted and typically rusty reddish-brown on the back, tawny on the sides, and pale gray underneath. Adult males can reach a length of 7 feet (ft) (2.1 meters [m]) from their nose to the tip of their tail and may exceed 161 pounds (lbs) (73 kg) in weight; but, typically adult males average around 116 lbs (52.6 kg) and stand about 24 to 28 inches (in) (60 to 70 centimeters [cm]) at the shoulder (Roelke 1990). Female panthers are smaller with an average weight of 75 lbs (34 kg) and length of 6 ft (1.8 m) (Roelke 1990). Panther kittens are gray with dark brown or blackish spots and five bands around the tail. The spots gradually fade as the kittens grow older and are almost unnoticeable by the time they are 6 months old. At this age, their bright blue eyes slowly turn to the light-brown straw color of the adult (Belden 1988).

Three external characteristics: a right angle crook at the terminal end of the tail, a whorl of hair or cowlick in the middle of the back, and irregular, white flecking on the head, nape, and shoulders – not found in combination in other subspecies of *Puma* (Belden 1986), were commonly observed in panthers through the mid-1990s. The kinked tail and cowlicks were considered manifestations of inbreeding (Seal 1994); whereas the white flecking was thought to be a result of scarring from tick bites (Maehr 1992). Four other abnormalities prevalent in the panther population prior to the mid-1990s were cryptorchidism (one or two undescended testicles), low sperm quality, atrial septal defects (the opening between two atria in the heart fails to close normally during fetal development), and immune deficiencies; and these were suspected to be the result of low genetic variability (Roelke et al. 1993).

Taxonomy

The panther was first described by Charles B. Cory in 1896 as *Felis concolor floridana* (Cory 1896). The type specimen was collected in Sebastian, Florida. Bangs (1899), however, believed the panther was restricted to peninsular Florida and could not intergrade with other *Felis* sp. Therefore, he assigned it full specific status and named it *Felis coryi* since *Felis floridana* had been used previously for a bobcat (*Lynx rufus*).

Culver et al. (2000) examined genetic diversity within and among the described subspecies of *Puma concolor* using three groups of genetic markers and proposed a revision of the genus to include only six subspecies, one of which encompassed all puma in North America including the panther. They determined the panther was one of several smaller populations that had unique features. Specifically, the number of polymorphic microsatellite loci and amount of variation were lower, and it was highly inbred. The degree to which the scientific community accepted the results of Culver et al. (2000) and the proposed change in taxonomy is not resolved (Service 2008). The panther remains listed as a subspecies, and continues to receive protection pursuant to the Act.

Life History

Male panthers are polygynous, maintaining large, overlapping home ranges containing several adult females and their dependent offspring. Breeding activity peaks from December to March (Shindle et al. 2003). Litters (n = 82) are produced throughout the year, with 56 to 60 percent of births occurring between March and June (Jansen et al. 2005; Lotz et al. 2005). The greatest number of births occurs in May and June (Jansen et al. 2005; Lotz et al. 2005). Average litter size is 2.4 ± 0.91 (standard deviation) kittens. Seventy percent of litters are comprised of either two or three kittens.

Panther dens are usually located closer to upland hardwoods, pinelands, and mixed wet forests and farther from freshwater marsh-wet prairie (Benson et al. 2008). Most den sites are located in dense saw palmetto (*Serenoa repens*), shrubs, or vines (Maehr 1990a; Shindle et al. 2003, Benson et al. 2008). Den sites are used for 6 to 8 weeks by female panthers and their litters from birth to weaning (Benson et al. 2008). Independence and dispersal of young typically occurs at 18 months, but may occur as early as one year (Maehr 1992).

Benson et al. (2009) analyzed survival and cause-specific mortality of subadult and adult panthers. They found that sex and age influenced panther survival, as females survived better than males, and older adults (≥10 years) survived poorly compared with younger adults. Genetic ancestry strongly influenced annual survival of subadults and adults after introgression, as F1 generation admixed panthers survived longer than pre-introgression panthers and non-F1 admixed individuals (Benson et al. 2009).

Mortality records for uncollared panthers have been kept since February 13, 1972, and for radio-collared panthers since February 10, 1981 (FWC 2013, and FWC unpublished data). Through June 25, 2014, 424 mortalities have been documented (FWC 2014). Of the 424 total mortalities, 181 were radio-collared. Intraspecific aggression was the leading cause of mortality for radio-collared panthers, and was more common for males than females (Benson et al. 2009). Older-adult males had significantly higher, and subadult males had marginally higher, mortality due to intraspecific aggression than adult males in their prime (Benson et al. 2009). Most

intraspecific aggression occurs between male panthers; but, aggressive encounters between males and females have occurred, resulting in the death of the female. Defense of kittens or of a kill is suspected in half (five of ten) of the known instances through 2003 (Shindle et al. 2003).

Following intraspecific aggression, the greatest causes of mortality for radio-collared panthers was from unknown causes, vehicles, and other (Benson et al. 2009). From February 13, 1972, through June 30, 2014, 215 panthers (radio-collared and uncollared) were hit by vehicles (FWC 2014). These collisions resulted in 203 panther fatalities and 12 non-fatal injuries. The number of panther/vehicle collisions per year is positively correlated with the annual panther count (McBride et al. 2008).

Female panthers are considered adult residents if they are older than 18 months, have established home ranges, and have bred (Maehr et al. 1991). Land et al. (2004) reported 23 of 24 female panthers first captured as kittens survived to become residents and 18 (78.3 percent) produced litters; 1 female was too young to determine residency. Male panthers are considered adult residents if they are older than 3 years and have established a home range that overlaps with females. Thirty-one (31) male panthers were captured as kittens and 12 (38.7 percent) of these cats survived to become residents (Jansen et al. 2005). "Successful male recruitment may depend on the death or home range shift of a resident adult male" (Maehr et al. 1991). Turnover in the breeding population is low with documented mortality in radio-collared panthers being greatest in subadult and non-resident males (Maehr et al. 1991; Shindle et al. 2003).

Den sites of female panthers have been visited since 1992 and the kittens tagged with passive integrated transponder chips. Annual survival of these kittens has been determined to be 0.328 ± 0.072 (SE) (Hostetler et al. 2009). There was no evidence survival rate differed between male and female kittens or was influenced by litter size. Hostetler et al. (2009) found kitten survival generally increased with degree of admixture with introduced Texas pumas and decreased with panther abundance. Kitten survival is lowest during the first 3 months of their lives (Hostetler et al. 2009).

Panther dispersal begins after a juvenile becomes independent from its mother and continues until it establishes a home range. Dispersal distances are greater for males than females. The maximum dispersal distance recorded for a young male was 139.2 mi (224.1 km) over a 7-month period followed by a secondary dispersal of 145 mi (233 km). Comiskey et al. (2002) found males disperse an average distance of 25 mi (40 km) and females typically remain in or disperse short distances from their natal ranges. Female dispersers establish home ranges less than one average home range width from their natal range (Maehr et al. 2002a). Maehr et al. (2002a) reported all female dispersers ($n = 9$) were successful at establishing a home range whereas only 63 percent of males ($n = 18$) were successful. Dispersing males usually go through a period as transient (non-resident) subadults, moving through the fringes of the resident population and often occupying suboptimal habitat until an established range becomes vacant (Maehr 1997).

Most panther dispersal occurs south of the Caloosahatchee River. However, panthers have been documented north of the Caloosahatchee River many times since February 1972 through field signs (*e.g.*, tracks, urine markers, scats), camera-trap photographs, carcasses from vehicle-related mortalities, telemetry from radio-collared animals (Land and Taylor 1998; Land et al. 1999; Shindle et al. 2000; Maehr et al. 2002b; Belden and McBride 2005), captured animals (one of which was radio collared), and one skeleton.

The Caloosahatchee River, a narrow (295-328 ft [90-100 m]), channelized river, is probably not a significant barrier to panther movements. Western subspecies of *Puma* are known to cross wide, swift-flowing rivers up to a mile in width (Seidensticker et al. 1973; Anderson 1983). However, the combination of the river, SR 80, and land uses along the river seems to have somewhat restricted panther dispersal northward (Maehr et al. 2002b). Documented physical evidence of at least 15 uncollared male panthers has been confirmed north of the river since 1972, but neither female panthers nor reproduction have been documented in this area since 1973 (Belden and McBride 2005).

Panthers require large areas to meet their needs. Numerous factors influence panther home range size, including: habitat quality, prey density, and landscape configuration (Belden 1988; Comiskey et al. 2002). Home range sizes of six radio-collared panthers monitored between 1985 and 1990 averaged 128,000 ac (51,800 hectares [ha]) for resident adult males and 48,000 ac (19,425 ha) for resident adult females; transient males had a home range of 153,599 ac (62,160 ha) (Maehr et al. 1991). Comiskey et al. (2002) examined the home range size for 50 adult panthers (residents greater than 1.5 years old) monitored in south Florida from 1981 to 2000 and found resident males had a mean home range of 160,639 ac (65,009 ha) and females had a mean home range of 97,920 ac (39,627 ha). Beier et al. (2003) found home range size estimates for panthers reported by Maehr et al. (1991) and Comiskey et al. (2002) to be reliable.

Annual minimum convex polygon home range sizes of 52 adult radio-collared panthers monitored between 1998 and 2002 ranged from 15,360 to 293,759 ac (6,216 to 118,880 ha), averaging 89,600 ac (36,260 ha) for 20 resident adult males and 44,160 ac (17,871 ha) for 32 resident adult females (Land et al. 1999, 2002; Shindle et al. 2000, 2001). The most current estimate of home-range sizes (minimum convex polygon method) for established, non-dispersing, adult, radio-collared panthers averaged 29,056 ac (11,759 ha) for females ($n = 11$) and 62,528 ac (25,304 ha) for males ($n = 11$) (Lotz et al. 2005). The average home range was 35,089 ac (14,200 ha) for resident females ($n = 6$) and 137,143 ac (55,500 ha) ($n = 5$) for males located at Big Cypress National Preserve (BICY) (Jansen et al. 2005). Home ranges of resident adults tend to be stable unless influenced by the death of other residents.

Activity levels for panthers are greatest at night with peaks around sunrise and after sunset (Maehr et al. 1990b). The lowest activity levels occur during the middle of the day. Female panthers at natal dens follow a similar pattern with less difference between high and low activity periods.

Telemetry data indicate panthers typically do not return to the same resting site day after day, with the exception of females with dens or panthers remaining near kill sites for several days. The presence of physical evidence such as tracks, scats, and urine markers, confirms panthers move extensively within home ranges, visiting all parts of the range regularly in the course of hunting, breeding, and other activities (Maehr 1997; Comiskey et al. 2002). Males travel widely throughout their home ranges to maintain exclusive breeding rights to females. Females without kittens also move extensively within their ranges (Maehr 1997). Panthers are capable of moving large distances in short periods of time. Nightly panther movements of 12 mi (20 km) are not uncommon (Maehr et al. 1990a).

Adult females and their kittens interact more frequently than any other group of panthers. Interactions between adult male and female panthers last from 1 to 7 days and usually result in pregnancy (Maehr et al. 1991). Aggressive interactions between males often result in serious injury or death. Independent subadult males have been known to associate with each other for several days and these interactions do not appear to be aggressive in nature. Based on radio-collared panthers, aggression between males is the most common cause of male mortality (FWC 2014) and an important determinant of male spatial and recruitment patterns based on (Maehr et al. 1991; Shindle et al. 2003).

Primary panther prey species are white-tailed deer and feral hog (*Sus scrofa*) (Maehr et al. 1990b; Dalrymple and Bass 1996). Generally, feral hogs constitute the greatest biomass consumed by panthers north of the Alligator Alley section of I-75, while white-tailed deer are the greatest biomass consumed to the south (Maehr et al. 1990b). Secondary prey species include raccoons (*Procyon lotor*), nine-banded armadillos (*Dasypus novemcinctus*), marsh rabbits (*Sylvilagus palustris*) (Maehr et al. 1990b), and American alligators (*Alligator mississippiensis*) (Dalrymple and Bass 1996). No seasonal variation in diet has been detected. Maehr et al. (1990b) rarely observed domestic livestock in scats or kills of the panther, although cattle were readily available in the study area. In a study of calf depredation on two ranches in southwest Florida (Main and Jacobs 2014), panthers were determined to be the cause of calf mortality for 0.5 percent of calves on one ranch and 5.3 percent of calves on the other ranch.

Little information on the feeding frequency of the panther is available. However, the feeding frequency of the Puma is likely similar to the feeding frequency of the panther. Ackerman et al. (1986) reported a resident adult male puma generally consumes one deer-sized prey every 8 to 11 days. Moreover, a resident female puma will consume one deer-sized prey item every 14 to 17 days, and one deer-sized prey item every 3.3 days for a female with three 13-month-old kittens.

Habitat

Noss and Cooperrider (1994) considered the landscape implications of maintaining viable panther populations. Assuming a male home range size of 137,599 ac (55,685 ha) (Maehr 1990), an adult sex ratio of 50:50 (Anderson 1983), and some margin of safety, they determined a reserve network as large as 15,625 to 23,438 mi^2 (40,469 to 60,703 km^2) would be needed to

support an effective population size of 50 individuals (equating to an actual adult population of 100 to 200 panthers [Ballou et al. 1989]). However, to provide for long-term persistence based on an effective population size of 500 individuals (equating to 1,000 to 2,000 adult panthers [Ballou et al. 1989]), could require as much as 156,251 to 234,376 mi^2 (404,687 to 607,031 km^2). This latter acreage corresponds to roughly 60 to 70 percent of the panther's historical range. Although it is uncertain whether this much land is needed for panther recovery, it does provide some qualitative insight into the importance of habitat conservation across large landscapes for achieving a viable panther population (Noss and Cooperrider 1994).

Radio-collar data and ground tracking indicate that panthers use the mosaic of habitats available to them as resting and denning sites, hunting grounds, and travel routes. The majority of telemetry locations (Belden 1986; Belden et al. 1988; Maehr 1990; Maehr et al. 1991; Maehr 1992; Smith and Bass 1994; Kerkhoff et al. 2000; Comiskey et al. 2002, Cox et al. 2006, Kautz et al. 2006, Land et al. 2008) and natal den sites (Benson et al. 2008) were within or close to forested cover types, particularly cypress swamp, pinelands, hardwood swamp, and upland hardwood forests. Global Positioning System data has shown panthers (n = 12) use all habitats contained within their home ranges by selecting for forested habitat types and using all others in proportion to availability (Land et al. 2008).

Kautz et al. (2006) found that the smallest class of forest patches (*i.e.*, 9 to 26 ac [3.6 to 10.4 ha]) were the highest ranked forest patch sizes within panther home ranges. The diverse woody flora of forest edges probably provides cover suitable for stalking and ambushing prey (Belden et al. 1988; Cox et al. 2006). Also, dense understory vegetation comprised of saw palmetto provides some of the most important resting and denning cover for panthers (Maehr 1990; Benson et al. 2008). Shindle et al. (2003) estimated 73 percent of panther dens were in saw palmetto thickets.

Between 1981 and 2010, more than 90,000 locations were collected from more than 180 radio-collared panthers. Belden et al. (1988); Maehr et al. (1991); Maehr and Cox (1995); Maehr (1997); Kerkoff et al. (2000); Comiskey et al. (2002); Cox et al. (2006); and Kautz et al. (2006) provide information on habitat use based on various subsets of these data. Land et al. (2008), investigated habitat selection of 12 panthers in the northern portion of the breeding range using Global Positioning System (GPS) telemetry data collected during nocturnal and diurnal periods, as well as VHF telemetry data collected only during diurnal periods, and found analysis of both types of telemetry data yielded similar results.

Even though some suitable panther habitat remains in south-central Florida, it is widely scattered and fragmented (Belden and McBride 2005). Thatcher et al. (2006) used a statistical model in combination with a geographic information system (GIS) to develop a multivariate landscape-scale habitat model based on the Mahalanobis distance statistic (D^2) to evaluate habitats in south central Florida for potential expansion of the panther population. They identified four potential habitat patches: the Avon Park Bombing Range area, Fisheating Creek/Babcock-Webb Wildlife Management Area (WMA), eastern Fisheating Creek, and the Duette Park/ Manatee County area. These habitat patches are smaller and more isolated compared with the current panther

range, and the landscape matrix where these habitat patches exist provides relatively poor habitat connectivity among the patches (Thatcher et al. 2006, 2009). Major highways and urban or agricultural development isolate these habitat patches, and they are rapidly being lost to the same development that threatens southern Florida (Belden and McBride 2005).

Travel and dispersal corridors

In the absence of direct field observations/measurements, Harrison (1992) suggested landscape corridors for wide-ranging predators should be half the width of an average home range size. Following Harrison's (1992) suggestion, corridor widths for panthers would range from 6.1 to 10.9 mi (9.8 to17.6 km) depending on whether the target animal was an adult female or a transient male. Beier (1995) suggested that corridor widths for transient male puma in California could be as small as 30 percent of the average home range size of an adult panther; however, topography in California is dramatically different from that in Florida. Without supporting empirical evidence, Noss (1992) suggests regional corridors connecting larger hubs of habitat should be at least 1.0 mi (1.6 km) wide. Beier (1995) makes specific recommendations for very narrow corridor widths based on short corridor lengths in a California setting of wild lands completely surrounded by urban areas; he recommended corridors with a length less than 0.5 mi (0.8 km) should be more than 328 ft (100 m) wide, and corridors extending 0.6 to 4 mi (1 to 7 km) should be more than 1,312 ft (400 m) wide. The Dispersal Zone, which connects lands between the Panther Focus Area south of the Caloosahatchee River and the Panther Focus Area north of the Caloosahatchee River, encompasses 44 mi^2 (113 km^2) with a mean width of 3.4 mi (5.4 km) (Figure 5). Although it is not adequate to support a single panther, the Dispersal Zone is strategically located and expected to function as an important landscape linkage to south-central Florida (Kautz et al. 2006). Transient male panthers currently use this zone as they disperse northward into south-central Florida.

Distribution

The panther is the last subspecies of *Puma* (also known as mountain lion, cougar, panther, or catamount) still surviving in the eastern United States. Historically occurring throughout the southeastern United States (Young and Goldman 1946), today the panther is restricted to less than 5 percent of its historic range located in south Florida.

When Europeans first came to this country, pumas roamed most all of North, Central, and South America. Early settlers attempted to eradicate pumas by every means possible. By 1899, it was believed panthers had been restricted to peninsular Florida (Bangs 1899). By the late 1920s to mid-1930s, it was thought by many the panther had been completely extirpated (Tinsley 1970). In 1935, Dave Newell, a Florida sportsman, hired Vince and Ernest Lee, Arizona houndsmen, to hunt for panthers in Florida. They killed eight in the Big Cypress Swamp (Newell 1935). Every survey conducted since then confirmed a breeding panther population in southern Florida south of the Caloosahatchee River, and no survey since then has been able to confirm a reproducing panther population outside of southern Florida.

Although generally considered unreliable, sightings of panthers regularly occur throughout the southeast. Nonetheless, a reproducing population of panthers has not been documented to occur outside of south Florida for at least 30 years despite an extensive search effort (Belden et al. 1991; McBride et al. 1993; Clark et al. 2002). Survey reports and more than 70,000 locations of radio-collared panthers recorded between 1981 and 2004 clearly define the panther's current breeding range. Reproduction is known only in the Big Cypress Swamp and Everglades physiographic region in Collier, Lee, Hendry, Miami-Dade, and Monroe Counties, south of the Caloosahatchee River (Belden et al. 1991). As discussed previously, panthers occasionally disperse north of the Caloosahatchee River. However, these animals are likely all males searching to establish new territories. There is no evidence of female panthers or successful panther reproduction currently occurring north of the Caloosahatchee River (Nowak and McBride 1974; Belden et al. 1991; Land and Taylor 1998; Land et al. 1999; Shindle et al. 2000; McBride 2002; Belden and McBride 2005). In 1973, McBride captured one female in Glades County (Nowak and McBride 1974). This was the last time a female panther was identified north of the Caloosahatchee River.

Population Dynamics

McBride et al. (2008) and McBride (2010) reported minimum population counts (*i.e.*, number known alive) based on physical evidence (*e.g.*, tracks, urine markers, panther treed with hounds, trail-camera photos). They counted adult and subadult panthers, but not kittens at the den. Three rules were used to distinguish individuals: (1) gender was determined by track size or stride length; (2) time (freshness) was determined by known events within the past 24 hours, such as wind or rain; and (3) distance between individual track sets. These rules were used as an exclusionary tool to avoid over-counting (McBride et al. 2008). The number of panthers detected and verified by physical evidence from 1981 to 1994 fluctuated between a high of 30 and a low of 19 adult and juvenile panthers, with the lowest point occurring in 1991 following the removal of seven juveniles and three kittens to initiate a captive breeding program (McBride et al. 2008). In 1995, eight female pumas from Texas were released to address suspected deleterious effects of inbreeding. From 1996 to 2003, the panther population increased at a rate of 14 percent per year with 26.6 kittens being produced annually (Johnson et al. 2010). The effective population size (N_e) rose from 16.4 in 1995 to 32.1 in 2007, with corresponding census populations (N) of 26 and 102, respectively. The population tripled since 1995 (McBride et al. 2008, Johnson et al. 2010), reaching a high of 117 by 2007 (mortalities not subtracted). Data reported in McBride (2000, 2001, 2002, 2003, 2004, 2006, 2007,2008, and 2009), McBride et al. (2010, 2011, 2012, and 2013), and Johnson et al. (2010) noted minimum population counts of 62 panthers in 2000, 78 in 2001, 80 in 2002, 87 in 2003, 78 in 2004, 82 in 2005, 97 in 2006, 117 in 2007, 104 in 2008, 113 in 2009, 115 in 2010, 111 in 2011, 123 in 2012, and 133 in 2013.

Maehr et al. (1991) provide an estimate of population density of 1 panther per 27,520 ac, based on 17 radio-collared and 4 uncollared panthers. They extrapolated this density to the area occupied by radio-collared panthers (1,245,435 ac) during the period 1985 to 1990 to achieve a

population estimate of 46 adult panthers for southwest Florida (excluding Everglades National Park [ENP], eastern BICY, and Glades and Highlands Counties). Beier et al. (2003), however, argued this estimate of density, although "reasonably rigorous," could not be extrapolated to other areas because it was not known whether densities were comparable in those areas. Kautz et al. (2006) provided a density estimate of 1 panther per 31,923 ac by dividing the panther count at that time (67) by the area within the Primary Zone. This estimate does not take into account the variability in panther densities across the landscape. Using an average of the 2007 to 2009 panther counts in the eight survey units covered by McBride et al. (2008) and Kautz et al. (2006), the density estimates range from a low of one panther per 81,479 ac to a high of one panther per 7,850 ac for the Primary Zone lands within these survey units.

The FWC (2010) provided an upper bound population estimate of 0.0177 panthers per square-kilometer (km^2) or one panther per 13,929 ac. Applying this density estimate to the Primary Zone (9,189 km^2) (2,270,652 ac) yields an upper estimate of 163 adult panthers. The FWC's lower estimate is 100 panthers (1.09 panthers per 100 km^2 or 1 panther per 22,707 ac) and is based on annual verified panther sign data (McBride et al. 2008) and minimum number of panthers known to be alive (FWC 2010). Applying the four densities to the Primary Zone would yield a population based on Kautz et al.'s (2006) density estimate of 71 panthers (1 panther per 31,923 ac). Maehr et al.'s (1991) estimate would yield a population of 83 panthers (1 panther per 27,520 ac) and the FWC's (2010) estimate would yield a low of 100 panthers (1 panther per 22,707 ac) and a high of 163 panthers (1 panther per 13,929 ac). For our evaluations however, the Service is continuing to use the average densities provided by Kautz et al. (2006) of one panther per 31,923 ac (12,919 ha) or one panther per 129 km^2.

Population Viability Analysis (PVA) has emerged as a key component of endangered species conservation. This process is designed to incorporate demographic information into models that predict if a population is likely to persist in the future. PVAs incorporate deterministic and stochastic events including demographic and environmental variation, and natural catastrophes. PVAs have been criticized as being overly optimistic about future population levels (Brook et al. 1997) and should be viewed with caution; however, they are and have been shown to be surprisingly accurate for managing endangered taxa and evaluating different management practices (Brook 2000).

Shaffer (1981) originally defined a viable population as follows: "a minimum viable population for any given species in any given habitat is the smallest isolated population having a 99 percent chance of remaining extant for 1,000 years despite the foreseeable effects of demographic, environmental and genetic stochasticity, and natural catastrophes." However, the goal of 95 percent probability of persistence for 100 years is the standard recommended by population biologists and is used in management strategies and conservation planning, particularly for situations where it is difficult to accurately predict the future (Shaffer 1978, 1981, 1987).

From 1981 through 2010, 182 panthers were been radio-collared and monitored on public and private lands throughout south Florida (FWC 2010). Radio-collar data were used by researchers to estimate survival rates and fecundity and were incorporated into PVA models previously developed for the panther (Seal and Lacy 1989, 1992; Cox et al. 1994; Maehr et al. 2002b). These models incorporated a range of different model parameters such as sex ratios, kitten survival rates, age distributions, and various levels of habitat loss, density dependence, and intermittent catastrophes or epidemics. The outputs of these models predicted a variety of survival scenarios for the panther and predicted population levels needed to ensure the survival of the species.

Root (2004) developed an updated set of PVA models for the panther based on RAMAS GIS software (Akçakaya 2002). These models were used to perform a set of spatially explicit PVAs. Three single-sex (*i.e.*, females only) models were constructed using demographic variables from Maehr et al. (2002b) and other sources. A conservative model was based on Seal and Lacy (1989), a moderate model was based on Seal and Lacy (1992), and an optimistic model was based on the 1999 consensus model of Maehr et al. (2002b). In each model, first-year kitten survival was set at 62 percent based on information from panther population monitoring (Shindle et al. 2001). All of the models assumed a 1:1 sex ratio, a stable age distribution, 50 percent of females breeding in any year, and an initial population of 41 females (82 individuals), which was the approximate population size in 2001 and 2002 (McBride 2001, 2002).

The basic versions of each model incorporated no catastrophes or epidemics, no change in habitat quality or amount, and a ceiling type of density dependence. The basic versions of the models incorporated a carrying capacity of 53 females (106 panthers with a 50:50 sex ratio). The models were run with differing values for density dependence, various levels of habitat loss, and intermittent catastrophes or epidemics. Each simulation was run with 10,000 replications for a 100-year period. The minimum number of panthers needed to ensure a 95 percent probability of persistence for 100 years was estimated in a series of simulations in which initial abundance was increased until probability of extinction at 100 years was no greater than 5 percent. More detailed information concerning the PVA model parameters appears in Root (2004).

The results of an earlier, conservative PVA model run done by Seal and Lacy (1989) predicted a probability of extinction of 78.5 percent in 100 years with a mean final total abundance of 3.5 females. Also, the probability of a large decline in abundance (50 percent) was 94.1 percent. Later work based on improved panther modeling and a larger sample of monitored panthers produced both a moderate and optimistic scenario (Root 2004). The moderate model resulted in a 5 percent probability of extinction and a mean final abundance of 42.3 females in 100 years. The probability of panther abundance declining by half the initial amount was 20 percent in 100 years under the moderate model. The optimistic model resulted in a 2 percent probability of extinction and mean final abundance of 51.2 females in 100 years. The probability of panther abundance declining by half the initial amount was only 9 percent in 100 years under the

optimistic model. These models also provide a probability of persistence (100 percent minus probability of extinction) over a 100-year period of 95 percent for the moderate model and 98 percent for the optimistic model.

Model results were also provided by Root (2004) for probability of extinctions for 1 percent loss of habitat per year, within the first 25 years of the model run, based on both the moderate and optimistic scenarios. The 1 percent loss of habitat equates to essentially all remaining non-urban privately owned lands in the Primary Zone and corresponds to the estimated rate of habitat loss from 1986 to 1996 for the five southwest counties based on land use changes (Root 2004). For the moderate model, the model runs predict a probability of extinction increase of about 1 percent to 6 percent with 1.0 percent habitat loss per year for the first 25 years. For the optimistic model, probability of extinction increased from about 2 percent with no loss of habitat to 3 percent with 1.0 percent habitat loss per year, for the first 25 years. These models also predicted the mean final abundance of females would decrease from 41 to 31 females, a 24.3 percent reduction for the moderate model and from 41 to 38 females, a 7.3 percent reduction for the optimistic model.

The probability of persistence over a 100-year period with a 1 percent loss of habitat changed to approximately 94 percent for the moderate model and 97 percent for the optimistic model. The model runs also predicted a mean final abundance of 62 individuals (31 females and 31 males) for the moderate model and 76 individuals (38 females and 38 males) for the optimistic model.

The results of the PVA lead to the development of population guidelines for the panther. Kautz et al. (2006) developed recommendations for panther population size as it relates to persistence following review of the output of Root's PVA models (2004) and those of other previous PVAs for the panther. These recommendations are: (1) populations of less than 50 individuals are likely to become extinct in less than 100 years; (2) populations of 60 to 70 are barely viable and expected to decline by 25 percent over 100 years; (3) populations of 80 to 100 are likely stable but would still be subject to genetic problems (*i.e.*, heterozygosity would slowly decline); and (4) populations greater than 240 have a high probability of persistence for 100 years and are demographically stable and large enough to retain 90 percent of original genetic diversity. Kautz et al.'s (2006) population recommendations, when applied to the populations predicted by Root's (2004) moderate models, describe the "with habitat loss" population (62 panthers) as barely viable and expected to decline by 25 percent over a 100-year period. The "without habitat loss" population (84 panthers) is likely stable but would still be subject to genetic problems.

The Service believes McBride's verified population of 97 panthers in 2006, 117 panthers in 2007, 104 in 2008, 113 in 2009, 115 in 2010, and 111 in 2011, 123 in 2012, and 133 in 2013 is within Kautz et al.'s (2006) population recommendations representing a population that is likely stable but still may be subject to genetic problems.

The Service also believes the model runs show lands in the Primary Zone are important to the survival and recovery of the panther, and sufficient lands need to be managed and protected in south Florida to provide for a population of 80 to 100 panthers, the population range defined as likely stable over 100 years, but subject to genetic problems.

Critical Habitat

Critical habitat has not been designated for the panther.

Threats

Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range

Panthers, because of their wide-ranging movements and extensive spatial requirements, are particularly sensitive to habitat fragmentation (Harris 1984). Mac et al. (1998) defines habitat fragmentation as: "The breaking up of a habitat into unconnected patches interspersed with other habitat which may not be inhabitable by species occupying the habitat that was broken up. The breaking up is usually by human action, as, for example, the clearing of forest or grassland for agriculture, residential development, or overland electrical lines." The reference to "unconnected patches" is a central underpinning of the definition. For panther conservation, this definition underscores the need to maintain contiguous habitat and protected habitat corridors in key locations in south Florida and throughout the panther's historic range. Habitat fragmentation can result from road construction, urban development, and agricultural land conversions.

Roads and highways facilitate the movement of people and goods by cars and trucks, and may adversely affect the panther. The construction of new roads and the widening of existing roads can result in the direct loss of wildlife habitat (Forman et al. 2003). In addition, disturbance resulting from motorized vehicles may cause panthers to avoid busy roads. Maher (1990) reported that female panthers are less likely to cross busy highways. Consequently, roads may act as barriers affecting panther movement and fragmenting panther habitat. Panthers can also be injured or killed due to collisions with motorized vehicles when attempting to cross highways, and the potential for collisions increases as traffic increases. Adverse effects resulting from roads and highways represent a potential threat to the existing panther population.

Collisions with motor vehicles on highways are a significant source of mortality for the panther. The FWC documented 165 vehicle-related panther mortalities and 8 vehicle-related panther injuries from 1972 to the present on highways in south Florida. In portions of the panther's range, the rate of panther vehicle-related mortalities may be increasing. Smith et al. (2006) found that vehicle-related panther mortalities in Collier

County increased by a factor of four from 2000 to 2005, compared to previous decades. This increase in panther mortality is likely related to the increase in traffic from Collier County's population growth. Unfortunately, the effect of vehicle-related mortality on the existing panther population is largely unknown.

Wildlife underpasses, or crossings, can be constructed within highway corridors to reduce the potential for panther injuries and mortalities resulting from vehicle collisions. Underpasses allow panthers and other wildlife to safely cross under busy roadways, and maintain connectivity and gene flow within the panther population. Underpasses usually consist of a bridge, prefabricated concrete box, or culvert (Forman et al. 2003). Effective crossing structures are large enough to allow the passage of panthers and include adequate wing fencing to funnel panthers to the crossing site. Crossings should be designed so panthers have an unobstructed view of habitat on the opposite side of the underpass (Foster and Humphrey 1995). The status of lands adjacent to the crossing site should also be considered when determining the location of a crossing. Unprotected private lands adjacent to the crossing could be developed and render the crossing unviable. Accordingly, lands adjacent to crossings should be acquired or placed under a conservation easement or other protective covenant to ensure the crossing will function in perpetuity. A number of wildlife crossings with associated fencing have already been constructed on major roadways in southwest Florida to benefit the panther and other wildlife species. In 1991, the FDOT finished the construction of 28 wildlife crossings within the I-75 corridor from U.S. Highway 27 to just west of Everglades Boulevard.

The FDOT also constructed six wildlife crossings on SR 29 between Oil Well Road and US 41. Crossings A, B, C, and D are located north of I-75 and Crossings E and F are located south of I-75. Crossings A and B were constructed in 2007, Crossings C and D were constructed in 1995, Crossing E was constructed in 1997, and Crossing F was constructed in 1999. Prior to construction of the SR 29 Crossings, a total of 10 vehicle-related panther mortalities were recorded near the locations of Crossings A and B from 1980 through 2004, and 2 vehicle-related panther mortalities were recorded near the location of Crossings C and D from 1979 through 1990. Vehicle-related panther mortalities have not been recorded in the vicinity of Crossings A, B, C, or D following their installation. A total of two vehicle-related panther mortalities were documented within 3.5 mi of the location of Crossing E prior to construction, and vehicle-related panther mortalities were not observed within 2.5 mi of the location of Crossing F prior to construction. Following construction of Crossings E and F, a total of four vehicle-related panther mortalities have been reported within 3 mi of Crossing E, and two vehicle-related panther mortalities have been documented within 1 mi of Crossing F.

Lee County, Collier County, and other entities have been working with the Service to construct additional needed crossings for the panther. For example, the Collier County Road Department recently constructed two wildlife underpasses and barrier fencing

within the Oil Well Road (CR 858) corridor at Camp Keais Strand, in association with the Oil Well Road widening project. Lee County constructed a wildlife underpass and barrier fencing on Corkscrew Road in 2004. Moreover, in 2011, a wildlife underpass and barrier fencing was installed east of Immokalee on County Road (CR) 846 in Collier County, as part of a Habitat Conservation Plan. A wildlife underpass has also been installed on Immokalee Road near CR 951.

Although these wildlife crossings have contributed to minimization of panther-vehicle interactions, more crossings are needed within the major roadways of south Florida to further reduce this threat to the panther and other wildlife species (Smith et al. 2006). Recent studies have been conducted to identify locations for wildlife crossings in south Florida. Swanson et al. (2005) used a Least Cost Pathway (LCP) modeling approach to identify the most likely travel routes for panthers among six major use areas in southwest Florida. LCP modeling takes into consideration elements in the landscape that permit or impede panther movement when traveling. Swanson et al. (2005) identified 20 key highway segments where LCPs intersected improved roadways. Smith et al. (2006) studied the movements of the panther, the Florida black bear, and other wildlife species along SR 29, CR 846 and CR 858 in Collier County, Florida. Data analyzed in the study were obtained from roadkill and track surveys, infra-red camera monitoring stations, existing data provided by the FWC (panther radio telemetry and vehicle mortality reports), and other studies. Smith et al. (2006) recommended new wildlife crossings be considered at various sites along these roadways to reduce vehicle-related mortality of panthers and other wildlife species, and to increase connectivity among wildlife populations. The Service continues to work with the FDOT, county road departments, and other entities to ensure wildlife crossings are installed as needed to promote safe passage of panthers and other wildlife across roadways.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Prior to 1949, panthers could be killed in Florida at any time of the year. In 1950, the Florida Game and Fresh Water Fish Commission (now Florida Fish and Wildlife Conservation Commission [FWC]) declared the panther a regulated game species due to concerns over declining numbers. The FWC removed panthers from the game animal list in 1958 and gave them complete legal protection. On March 11, 1967, the Service listed the panther as endangered (32 FR 4001) throughout its historic range, and these animals received Federal protection under the passage of the Act in 1973. In addition, the Florida Panther Act (Florida Statute 372.671), a 1978 Florida State law, made killing a panther a felony. The panther is listed as endangered by the States of Florida, Georgia, Louisiana, and Mississippi in addition to its Federal listing.

Restricted Range

Historically occurring throughout the southeastern United States (Young and Goldman 1946), today the panther is restricted to south Florida in an area that is less than 5 percent of its historic range.

Ongoing Conservation Efforts

Habitat protection has been identified as being one of the most important elements to achieving panther recovery. While efforts have been made to secure habitat, continued action is needed to obtain additions to and inholdings for public lands, assure linkages are maintained, restore degraded and fragmented habitat, and obtain the support of private landowners for maintaining property in a manner that is compatible with panther use. Conservation lands used by panthers are held and managed by a variety of entities including the Service, NPS, Seminole Tribe of Florida, Miccosukee Tribe of Indians of Florida, FWC, Florida Department of Environmental Protection (DEP), Florida Division of Forestry (FDOF), Water Management Districts, non-governmental organizations, counties, and private landowners.

To further refine the land preservation needs of the panther, and to specifically develop a landscape-level program for the conservation of the panther population in south Florida, the Service appointed a Florida Panther Subteam in February 2000. The Subteam was charged with developing a landscape-level strategy for the conservation of the panther population in south Florida. The results of this collaborative effort are partially presented in Kautz et al. (2006). One of the tasks for this subteam was to identify a strategically located set of lands containing sufficient area and appropriate land cover types to ensure the long-term survival of the south Florida population of the panther. Kautz et al. (2006) focused their efforts on the area south of the Caloosahatchee River, where the reproducing panther population currently exists.

Kautz et al. (2006) created an updated panther potential habitat model. The potential habitat map was reviewed in relation to telemetry data, recent satellite imagery (where available), and panther home range polygons. Boundaries were drawn around lands defined as the Primary Zone, the most important area needed to support a self-sustaining panther population. Kautz et al. (2006) referred to these lands as essential; however, as observed in the two previous plans (Logan et al. 1993; Cox et al. 1994), lands within the boundaries of the Primary Zone included some urban areas and other lands not considered to be panther habitat (*i.e.*, active rock and sand mines). The landscape context of areas surrounding the Primary Zone was modeled and results were used to draw boundaries of the Secondary Zone (Figure 5), the area capable of supporting the panther population in the Primary Zone, but where habitat restoration may be needed (Kautz et al. 2006).

Kautz et al. (2006) also identified, through a LCP model, the route most likely to be used by panthers crossing the Caloosahatchee River and dispersing out of south Florida into south-central Florida. Kautz et al. (2006) used GIS-based analysis to construct the LCP models and identify

optimum panther dispersal corridor(s). The LCP models operated on a cost surface that ranked suitability of the landscape for use by dispersing panthers with lower scores indicating higher likelihood of use by dispersing panthers. Those dispersal routes connecting lands between the Panther Focus Area south of the Caloosahatchee River and the Panther Focus Area north of the Caloosahatchee River were defined as the Dispersal Zone (Kautz et al. 2006). The preservation of lands within this zone is important for the survival and recovery of the panther, as these lands are the dispersal pathways for expansion of the panther population.

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STATUS OF THE SPECIES – Eastern indigo snake (*Drymarchon corais couperi*)

Legal Status – *threatened*

The U.S. Fish and Wildlife Service (Service) listed the eastern subspecies of indigo snake (*Drymarchon corais couperi*) as threatened under the Endangered Species Act of 1973, as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 et seq.) in the Federal Register on January 31, 1978. The State of Florida recognizes the eastern indigo snake as Federally-designated Threatened. There is no designated critical habitat.

Species Description

Appearance/Morphology

The eastern indigo snake is the largest native snake species in North America with a maximum recorded length of 8.5 feet (ft) in length (2.6 meters [m]) (Moler 1992) and an unofficial record as having reached 10 ft long in the past (Holbrook 1842). Its color is uniformly lustrous-black, dorsally and ventrally, except for a red or cream-colored suffusion of the chin, throat, and sometimes cheeks. The head is small in proportion to the size of the body, slightly ovular, narrow, and flattened with an elongated snout. The eyes are large relative to the size of the head with black pupil and iris. The vertical plates, frontal plates, and superior orbital are broad with the former being pentagonal in shape. Its scales are large, hexagonal, and smooth in 17 scale rows at mid-body (the central 3 to 5 scale rows are lightly keeled in adult males). Its anal plate is undivided (Holbrook 1842). In the Florida Keys, adult indigo snakes seem to have less red on their faces or throats compared to mainland specimens (Lazell 1989).

Taxonomy

Holbrook (1842) first described all indigo snakes of North America as a monotypic taxon within the Linnaean genus *Coluber* (racers and whipsnakes), *Coluber couperi*. In 1843 Leopoldo Fitzinger moved indigo snakes from genus *Coluber* into their own genus, *Drymarchon.* Over time twelve subspecies of *Drymarchon corais* came to be recognized and at the time of listing the eastern indigo snake was considered one among these twelve subspecies (*Drymarchon corais couperi* [43 FR 4026 4029]). In 1991, Collins elevated this lineage to specific status based on allopatry and diagnosibility. Subsequent taxonomic work based on morphology has supported the designation of *Drymarchon couperi* as a distinct species within the genus (Wuster et al. 2001). Currently, the eastern indigo snake (*Drymarchon couperi*) is accepted by the scientific community as one of three separate species in genus *Drymarchon*, (Crother 2000, ITIS 2016).

Life History

The eastern indigo snake is an apex predator among snakes, eating any vertebrate it can overpower, especially other snakes (Keegan 1944; Belson 2000; Ernst and Ernst 2003, Stevenson et al. 2010).

It is a generalized predator immune to the toxins of the venomous snakes it encounters and is only limited by its gape and ability to overpower its prey. Food items include fish, frogs, toads, snakes, lizards, turtles, turtle eggs, small alligators, birds, and small mammals (Keegan 1944; Babis 1949; Kochman 1978; Steiner et al. 1983).

In south-central Florida, indigo snake breeding extends from June to January, egg-laying occurs from April to July, and hatching occurs during mid-summer to early fall (Layne and Steiner 1996). Young hatch approximately 3 months after egg-laying and there is no evidence of parental care. Indigo snakes in captivity take 3 to 4 years to reach sexual maturity (Speake and Smith 1987). It is possible female indigo snakes can store sperm and delay fertilization of eggs for significant periods of time or are parthenogenetic (Carson 1945). Carson (1945) concluded that sperm storage and delayed fertilization were the most likely explanation for the fertile eggs produced by an indigo snake that he had kept in captivity for more than 4 years. However, there have been several recent reports pathogenesis in other snakes, so it is possible sperm storage may not explain Carson's (1945) example (Moler 1998). There is no information on indigo snake lifespan in the wild, although one captive individual survived 25 years, 11 months (Shaw 1959).

Habitat

Indigo snakes are active and spend a great deal of time foraging for food and searching for mates within their territories, with most activity occurring in the summer and fall (Speake and Smith 1987; Moler 1985a). Adult males have larger home ranges than adult females and juveniles; their home ranges average 554 acres (ac), reducing to 390 ac in the summer (Moler 1985b). In contrast, a gravid female may use from 3.5 to 106 ac (Speake and Smith 1987). In Florida, home ranges for females and males range from 5 to 371 ac and 4 to 805 ac, respectively (Smith and Dyer 2003). At Archbold Biological Station, the average home range size for females was determined to be 46 ac, and overlapping male home range size determined to be 184 ac (Layne and Steiner 1996).

Relative to other snake species, adult eastern indigo snakes have very large activity ranges and can move considerable distances in short periods of time (Service 2008). Habitat use varies seasonally between upland and wetland areas, especially in the more northern parts of the species' range. In southern parts of their range eastern indigo snakes are habitat generalists which utilize most available habitat types. Movements between habitat types in northern areas of their range may relate to the need for thermal refugia (protection from cold and/or heat).

In northern areas of their range indigo snakes prefer an interspersion of tortoise-inhabited sandhills and wetlands (Landers and Speake 1980). In these regions indigo snakes most often use forested areas rich with gopher tortoise burrows, hollowed root channels, hollow logs, or the burrows of rodents, armadillos, or land crabs as thermal refugia during cooler seasons (Lawler 1977; Moler 1985a; Layne and Steiner 1996). The eastern indigo snake in this region is typically classified as a longleaf pine savanna specialist because here, in the northern four-fifths of its range, the indigo snake is typically only found in vicinity of xeric longleaf pine–turkey oak sandhills inhabited by the gopher tortoise (Means 2006).

In the milder climates of central and southern Florida comprising the remaining one fifth of its range thermal refugia such as those provided by gopher tortoise burrows may not be as critical to survival of indigo snakes. Consequently, indigo snakes in these regions use a more diverse assemblage of habitats such as pine flatwoods, scrubby flatwoods, floodplain edges, sand ridges, dry glades, tropical hammocks, edges of freshwater marshes, muckland fields, coastal dunes, and xeric sandhill communities; with highest population concentrations of indigo snakes occurring in the sandhill and pineland regions of northern and central Florida (Service 1999). Indigo snakes have also been found in agricultural lands with close proximity to wetlands (Zeigler 2006).

In extreme south Florida (*i.e.*, the Everglades and Florida Keys), indigo snakes also utilize tropical hardwood hammocks, pine rocklands, freshwater marshes, abandoned agricultural land, coastal prairie, mangrove swamps, and human-altered habitats. Though eastern indigo snakes have been found in all available habitats of south Florida it is thought they prefer hammocks and pine forests since most observations occur there and use of these areas is disproportionate compared to the relatively small total area of these habitats (Steiner et al. 1983).

Distribution

Historically, the eastern indigo snake occurred throughout Florida and in the coastal plain of Georgia, Alabama, and Mississippi (Loding 1922, Haltom 1931, Carr 1940, Cook 1954, Diemer and Speake 1983, Lohoefener and Altig 1983, Moler 1985a). Most, if not all, of the remaining viable populations of the eastern indigo snake occur in Georgia and Florida (Service 2008).

Population Dynamics

Due to their use of subterranean refugia and frequent long-distance dispersal, detectability of eastern indigo snakes is low and estimates of mortality difficult (Hyslop et al. 2012). Consequently, the exact size and viability of the range wide population is unknown (Service 2008). However, there is no information indicating the range of eastern indigo snake has expanded or retracted, so it's presumed the population is stable.

Threats

Throughout the eastern indigo snake's range expanding urban areas are creating barriers to the dispersal of individuals and gene flow between populations, and habitat loss and degradation are a threat to the species (Lawler 1977, Moler 1985b). In northern areas of its range in Georgia and peninsular Florida the species is impacted by a decline in longleaf pine forests, gopher tortoises, and gopher tortoise habitat (Van Lear et al. 2005). In central and southern Florida the eastern indigo snake is less dependent on any one habitat type, but does avoid developed areas (Lawler 1977, Moler 1985a, Hyslop 2007). Throughout Florida developed areas are expanding rapidly with population growth at the expense of wildlife habitat (Cerulean 2008).

At the time of listing, other threats to the eastern indigo snake included commercial collection for the pet trade and mortality during the gassing of gopher tortoise burrows by individuals

attempting to drive rattlesnakes out for collection (43 FR 4026 4029). Since their listing additional potential threats to the species have expanded to include disease, road mortality, kills of indigo snakes by land owners and pets, and ATV use in gopher tortoise habitat (Service 2008).

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