# Potential Impacts of the Southwest-Central Florida Connector on the Florida Panther and Its Habitat

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**Executive Summary**: The Nature Conservancy commissioned Mr. Randy Kautz, wildlife ecologist, to summarize potential impacts of the proposed Southwest-Central Florida Connector toll road on Florida panthers, their habitats, and other components of Florida's biodiversity. Current projections for the growth of the human population in Southwest Florida and the prediction of a rise in sea levels of 1.0 m due to climate change by 2070 would likely result in the loss of 34% of the Florida panther Primary Zone, 30% of the Secondary Zone, 34% of the Dispersal Zone, 21% of the Primary Dispersal/Expansion Area north of the Caloosahatchee River, and 26% of the core range of breeding age adults. Specific areas of impact include the loss of habitats northwest of Corkscrew Swamp to panthers; degradation of the existing corridor along Camp Keais Strand; loss of areas of the Primary Zone and core breeding habitat in the vicinity of the East Collier Rural Lands Stewardship Area; severing of the landscape linkage into Central Florida provided by the Dispersal Zone; and the conversion of high-quality habitats in Glades and Charlotte counties to human developments. Absent careful growth management and acquisition of key parcels of conservation lands, future development and sea level rise have the potential to threaten the continued existence of the Florida panther, likely negating the great strides in recovery that have been accomplished during the last 25 years of intensive management.

The construction of a new toll road expressway from Central into Southwest Florida is likely to have two primary effects on Florida panthers. First, there will be a direct loss of panther habitat within the footprint of the new road. Second, the toll road will accelerate the predicted loss of panther habitats, increase roadkill mortality, result in increasing fragmentation of remaining panther habitats, and likely jeopardize panther population survival by facilitating the movement of new residents and developments into regions of Southwest Florida that are now rural.

**Panther Legal Status**: The Florida panther (*Puma concolor coryi*) is a wide-ranging predator listed as endangered under the U.S. Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). The ESA defines endangered as any species that is in danger of extinction throughout all or a significant portion of its range. The ESA protects endangered species and their habitats by prohibiting the "take" of listed animals except under a Federal permit. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Through regulations, the term "harm" is defined as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." The Florida Fish and Wildlife Conservation Commission [FFWCC] lists the Florida panther as a Federally-designated Endangered Species (68A-27.003, *Florida Administrative Code*), which is defined by the State of Florida as "species of fish or wild animal life, subspecies or isolated populations of species or subspecies, whether vertebrate or invertebrate, that are native to Florida and classified as Endangered and Threatened under Commission rule by virtue of designation by the United States Departments of Interior or Commerce as endangered or threatened under the Federal Endangered Species Act, 16 U.S.C. § 1532 et seq. and rules thereto..." (68A-27.001(2) *Florida Administrative Code*). State rules pertaining to take are similar to those defined in the ESA.

**Panther Distribution and Population Status**: The range of the Florida panther includes all counties of peninsular Florida south of I-4 based on Very High Frequency (VHF) and Global Positioning System (GPS) telemetry records, mortality records, verified sightings, and wildlife camera detections (Figure 1). Most panthers are members of a single breeding population located in southern Florida, and they comprise the only breeding population of pumas east of the Mississippi River (Kautz et al. 2006, USFWS 2008, Frakes et al. 2015). Until recently, panthers that had been documented north of the Caloosahatchee River had been dispersing adult and sub-adult males. However, two adult female panthers, one with kittens, were confirmed north of the Caloosahatchee River in 2017, one on Babcock Ranch Preserve (BRP) (Charlotte County) and one on Platt Branch Wildlife and Environmental Area (Highlands County. These were the first times that females had been confirmed north of the Caloosahatchee River since a female was captured in Glades County in 1973 (Nowak and McBride 1973, FFWCC 2017). While the absence of the original female at BRP has been confirmed, wildlife cameras detected a new female in eastern BRP, another female was photographed at Fisheating Creek (FEC) in Glades County, and a dependent-aged panther was confirmed at Bob Janes Preserve in Lee County (Kelly and Onorato 2020). Males were photographed in the company of the females in spring 2020, a likely indication of reproduction. If current levels of panther activity are sustained and recruitment can be documented at BRP and FEC, it would suggest that eastern Charlotte County and western Glades County may support a reproductively viable portion of the panther population (Kelly and Onorato 2020).

The current panther population consists of 120 to 230 adults and subadults (FFWCC 2017). Panthers were widely distributed throughout the southeastern United States prior to European colonization. However, by the late 1980s and early 1990s, the Florida panther population had been reduced to 20-30 animals south of the Caloosahatchee River following two centuries of persecution, bounty hunting, and habitat loss (Onorato et al. 2010). Fearing that the small and inbred panther population was in imminent danger of extinction, 8 female pumas from Texas were introduced into the south Florida population in 1995 in an attempt to restore the genetic viability of the panther population. The project has been deemed a success as evidenced by restored genetic vigor and the increasing size of the panther population (Johnson et al. 2010, Hostetler et al. 2013, van de Kerk et al. 2019).

Recent population viability analysis (PVA) models assessed the likelihood that the current population of panthers could survive for the next 100 years (Hostetler et al. 2013, van de Kerk et al. 2019). Both of these models indicated that (1) the panther population is characterized by a positive growth rate, (2) population growth rate is most sensitive to survival, especially kitten survival, and (3) probability of quasi-extinction in the next 100 years was 7.2% (Hostetler et al. 2013) and 1.4% (van de Kerk et al. 2019) when demographic factors alone are considered. However, quasi-extinction rose to 17% in the next 100 years when incorporating the impacts of genetic erosion (van de Kerk et al. 2019). Quasi-extinction occurs when the modeled population reaches a critical size below which recovery is so unlikely that the population will eventually go extinct. The critical population size for quasi-extinction in the PVA models was set at 10 individuals. Releasing 5 female western pumas into the Florida population every 20-40 years was found to be the most cost-effective means to combat the effects of inbreeding depression (van de Kerk et al. 2019).

**Panther Habitats in South Florida**: A large landscape south of the Caloosahatchee River covering approximately 12,588 $km^2$ (3.11 million acres) was identified by Kautz et al. (2006) as regionally significant panther habitats. This region included three specific areas: (1) a Primary Zone defined as occupied high-quality panther habitats covering 9189 $km^2$ (2.27 million acres); (2) a Secondary Zone of

lower quality landscapes occasionally used by transient animals (3287 $km^2$ [0.81 million acres]); and (3) a Dispersal Zone, a wildlife corridor of 113 $km^2$ (27,880 acres) leading into Central Florida. A smaller area that functions as the core range of breeding-age adult panthers comprises approximately 5579 $km^2$ (1.38 million acres), most of which is within the Primary Zone south of the Caloosahatchee River (Frakes et al. 2015).

**Panther Habitats in Central Florida**: Models of potentially suitable panther habitats in Central Florida have been produced by Kautz et al. (2006), Thatcher et al. (2009), and R. Kautz (unpublished data). For the purposes of this report, the model of habitats potentially suitable for panthers published by Kautz et al. (2006) was updated using the same methodology but with land cover data from 2016 (FFWCC 2016, R. Kautz unpublished data). Thatcher et al. (2009) used Euclidean distance modeling to identify patches of potentially suitable panther habitat in Central Florida, and then identified a subset of those patches as of highest priority for supporting an expanding panther population at some time in the future. Thatcher et al. (2009) also used least cost path modeling to identify the paths that panthers would most likely traverse while moving among habitat patches within the Central Florida landscape. The linkages were revised by R. Kautz (unpublished data) to better reflect the current state of land cover and public ownership of conservation lands in Central Florida.

**Panther Focus Area**: The U.S. Fish and Wildlife Service (USFWS) Ecological Services Office in Vero Beach combined the map of Primary, Secondary, and Dispersal zones (Kautz et al. 2006) with the patch of potentially suitable habitat immediately north of the Caloosahatchee River (Thatcher et al. 2009) to produce a map referred to as the Panther Focus Area (PFA) (USFWS letter to the U.S. Army Corp of Engineers [ACOE], February 19, 2007) (Figure 2). The PFA is used by ACOE wetlands regulatory staff as an aid in identifying development projects that may have an effect on the Florida panther and result in the need for consultation with USFWS under Section 7 of the ESA. The ultimate goal of federal review is that development projects avoid, minimize, or mitigate adverse impacts on panthers and their habitats.

**Threats to Panther Survival**: Habitat loss associated with an expanding human population has been identified as a key factor affecting the long-term survival and recovery of the Florida panther (Maehr 1992, USFWS 2008, Onorato et al. 2010, van de Kerk et al. 2019). Specific types of habitat loss frequently mentioned include conversion of natural lands, particularly forest cover, to agriculture or urban development, road construction, dredging of artificial surface water drainage systems, and mining. These types of human activities not only destroy panther habitats, but they also degrade the quality of remaining habitats or they fragment and isolate remining patches such that they are smaller, farther apart, and isolated from areas panthers may use. Other factors that threaten the continued existence of the panther include collisions with motor vehicles; removal from the wild of panthers that prey on hobby animals, livestock, or domestic pets; panther-human conflicts and human intolerance due to public safety concerns; diseases and environmental contaminants; and illegal shootings.

**Road and Highway Mortality**: From February 10, 1982, through February 28, 2018, the leading cause of mortality of **radio-collared** panthers was intraspecific aggression, which accounted for 40% of recorded mortalities (Onorato et al. 2010). During this period, the second leading cause of mortality of **radio-collared** panthers was collisions with motor vehicles, which accounted for 21% of known mortalities. However, when records of radio-collared and uncollared panthers are pooled, vehicle collisions accounted for 60% of all panther mortalities recorded during this period (FFWCC unpublished data). Vehicle mortalities have risen since 2000 as the panther population has increased following the

introduction of 8 female pumas from Texas into South Florida in the mid-1990s. Prior to 2000, panther roadkills were 4 or fewer per year, but since 2000, these numbers have ranged from 6 to 34 annually. The deadliest year for panther roadkills was 2016 when 34 vehicle mortalities were documented.

The Transportation Sub-Team of the USFWS-sponsored Panther Recovery Implementation Team was formed in recognition that collision with motor vehicles is a leading cause of panther injuries and death, and that poorly planned roads can eliminate and fragment habitat and result in sprawling development that increases the occurrence of human-panther conflicts. The Transportation Sub-team was directed to consider a broad range of options, including engineered alternatives, avoidance, mitigation, education, enforcement, and policy recommendations. The Sub-Team has reviewed existing information on locations of panther roadkills, locations of wildlife crossings, and wildlife crossing and fencing guidelines, and has identified panther roadkill hot spots and targeted specific road segments for possible construction of wildlife crossings in the future to reduce panther roadkill mortality. Swanson et al. (2008) used least-cost-path modeling to identify key road segments that could be targeted for wildlife crossings based on paths likely to be followed by panthers moving around the South Florida landscape.

**Direct and Indirect Impacts of Roads**: The direct effects of new roads are those associated with the loss of wildlife habitat within the footprint in which the road is constructed. Habitat loss is generally considered complete wherever new pavement is laid down, and the conversion of roadside rights-of-way or median strips to grass cover typically lowers the quality of habitats in those areas affected by new road construction. Indirect effects, on the other hand, are those that result from increased land development or urban sprawl as a consequence of improved access to previously rural landscapes. Proximity to roads or highway intersections is considered to be a factor that attracts new developments and is used as a variable in modeling the locations of future growth (Carr and Zwick 2016). Highway density and roadless area patch size are variables often used to assess regional habitat quality for many species of wildlife (Kautz and Cox 2001, Forman et al. 2003, Frakes et al. 2015, Oetting et al. 2016). Other indirect effects of highways include habitat fragmentation, increased roadkill mortality, flow of environmental contaminants into adjacent natural areas, increased edge effect, lower quality habitat immediately adjacent to roads, behavioral responses of wildlife using habitats near to roads, and reduced landscape connectivity (Forman et al. 2003, Hilty et al. 2006, Lindenmayer and Fischer 2006).

**Future Population Growth**: The human population of Florida is projected to increase from 18.8 million residents in 2010 to 33.7 million in 2070 based on medium growth projections (Carr and Zwick 2016). Thus, an estimated 14.9 million new people will have to be accommodated by 2070, but population change will not be evenly distributed. Most of the new residents will be absorbed into central and south Florida. The population of Lee, Collier, and Hendry counties where most of the occupied panther habitat occurs is expected to increase from 979,400 to 2,252,700 residents between 2010 and 2070, a projected increase of 1,273,300 residents (Carr and Zwick 2016) (Table 1). Most of the new growth in Southwest Florida (99.8%) is projected to occur in Lee and Collier counties. By contrast, the 6 counties of the study area north of the Caloosahatchee River are expected to increase from 936,336 to 1,679,635 residents, an increase of 743,299 residents. Most of the growth in this region (83%) is projected to occur in Polk County, and one county, Desoto, is projected to lose 791 residents (Table 1).

**Sea Level Rise**: Global mean sea levels have risen approximately 0.2 m (8 inches) since 1880; the rate of sea level rise (SLR) has roughly doubled in the last 20 years; and the rate of global mean SLR since 1900 has been faster than during any comparable period over the last 2800 years (Melillo et al. 2014, Sweet

et al. 2017). The most recent projections of SLR from the U.S. National Oceanic and Atmospheric Administration (NOAA) are for an increase between 0.3 m (1 foot) to an "extreme" possibility of a 2.5 m (8.2 feet) globally by 2100 (Sweet et al. 2017). At the local level, Florida is extremely susceptible to the effects of SLR caused by climate change due to a combination of low land elevations, a high water table, peninsular geography, vulnerability to tropical storms, and a large and growing human population that is mainly concentrated near the coasts (Noss et al. 2014). Sweet et al. (2017) concluded that it is reasonable to assume that sea levels around Florida could rise by as much as 0.5 m (1.6 feet) by the year 2040 and by as much as 1.0 m (3.3 feet) by the year 2070.

**Effects of Future Development and Sea Level Rise on Panther Habitats**: Carr and Zwick (2016) modeled the locations of future growth and development in Florida from 2010 through 2070 using a variety of GIS data layers including census data, gross development density, suitability of landscapes for development, proximity to roads, and proximity to water. The Carr and Zwick (2016) Trend 2070 model assumed current trends in development patterns would prevail through 2070 and no additional conservation lands would be protected from development. Noss et al. (2014) used a Digital Elevation Model (DEM) of Florida topography to identify areas of Florida that would be inundated by a rise in sea levels of 0.5 m, 1.0 m, 1.5 m, and 2.0 m by the year 2100.

If future development in the region of the PFA in South Florida progressed according to the Carr and Zwick (2016) Trend 2070 model and sea level rose by 1.0 m as suggested by Sweet et al. (2017), expected losses would be 3095 $km^2$ (34%) of the Primary Zone, 993 $km^2$ (30%) of the Secondary Zone, 38 $km^2$ (34%) of the Dispersal Zone, 400 $km^2$ (21%) of the Primary Dispersal/Expansion Area north of the Caloosahatchee River, and 1436 $km^2$ (26%) of core adult breeding range (Table 2) (Figure 3). Primary Zone and core breeding range habitats northwest of Corkscrew Swamp would likely be lost as panther habitat. The existing corridor along Camp Keais Strand from Florida Panther National Wildlife Refuge to Corkscrew Swamp would be severely compromised. Significant areas of panther habitat would be lost in the East Collier Rural Land Stewardship Area (RLSA), a 793 $km^2$ (0.196 million acres) region proposed for future development, and remaining habitats in the RLSA would be highly fragmented. The Dispersal Zone north of the Caloosahatchee River would be completely severed, likely precluding future dispersal of panthers into Central Florida. Large areas of panther habitat along SR 29 between LaBelle in Hendry County and Palmdale in Glades County would no longer be able to support future expansion of the panther population (Figure 3). The core breeding range of panthers would likely support only 76% of the number of breeding age panthers that now occur in the area.

Most new development by 2070 north of the PFA is projected to occur in Polk and Hardee Counties south of I-4. The large block of potentially suitable panther habitat southeast of Tampa identified by Thatcher et al. (2009) is likely to become so fragmented that it would no longer function as an area that could support panthers. In addition, the landscape linkage between Babcock-Webb Wildlife Management Area in Charlotte County and Myakka River State Park in Sarasota County is likely to be severed.

**Biodiversity Patterns in the Study Area**: US 27, one of the primary highways suggested for co-location of a new north-south toll road, originally was built along the Lake Wales Ridge, a well-known hot spot of biodiversity in Florida. Lake Wales Ridge is characterized by deep xeric soils that formed as sand dunes during ancient high sea level stands. The original longleaf pine (*Pinus palustris*)-xeric oak (*Quercus* spp.) sandhills and sand pine (*Pinus clausa*) scrub habitats on the ridge were and still are host to a wide

variety of xeric-adapted animals and plants, many of which are listed as endangered or threatened species. The number of records of rare and imperiled species and natural communities in the Florida Natural Areas Inventory (FNAI) natural heritage database is testimony to the biological richness of Lake Wales Ridge (Figure 4). Listed animals that occur along the Lake Wales Ridge include blue-tailed mole skink, sand skink, Florida pine snake, gopher tortoise, short-tailed snake, Florida scrub-jay, and Florida burrowing owl (Table 3).

The original vegetation types in the study area also included large landscapes of pine flatwoods, prairie grasslands west of Lake Okeechobee, forested wetlands in Big Cypress Swamp, and some patches of sandhill in Polk, Hardee, and Desoto counties (Figure 4). Many areas of former flatwoods and prairie grasslands have long since been converted to improved pastures in which crested caracaras and Florida sandhill cranes often are found. Red-cockaded woodpeckers now occur only in open mature pine forests, most of which are on public lands including Babcock-Webb Wildlife Management Area, Babcock Ranch Preserve, Big Cypress National Preserve, Picayune Strand State Forest, and Avon Park Air Force Range. Listed species of wildlife that occur within the Central Florida study area appear in Table 3.

Consultation with the USFWS under either Section 7 or Section 10 of the ESA will be necessary for federally listed species that may be impacted by the construction of new roadways. This regulatory process is designed to ensure that impacts on listed species are avoided, minimized, and mitigated appropriately.

**Recommendations**: First, the Southwest-Central Florida Connector Task Force should include "No Build" in the set of project alternatives. This is standard practice in the review of new projects under the National Environmental Policy Act, which is likely to be applicable to a new expressway. The proposed toll road has the potential to greatly accelerate the arrival of new residents and expand the footprint of projected development in the study area, particularly in Southwest Florida. As a consequence, the toll road has the potential to adversely affect the survival potential of the endangered Florida panther due to loss of habitat, increased roadkill mortality, increased incidences of human-panther conflicts as more people come in contact with panthers, and indirect effects such as behavioral changes in the vicinity of new roads.

Second, the US 27 alignment should be rejected altogether because it follows along the Lake Wales Ridge, a biodiversity hot spot in Florida. Following US 27 would result in impacts on many species of wildlife and plants listed as endangered or threatened, and would require protracted permitting and costly mitigation as a result of review under Section 7 or Section 10 of the ESA. The US 27 alignment also has the negative consequence of connecting with SR 29 in Glades County and extending south along SR 29 to I-75 in Collier County. The SR 29 alignment would spur future development in Glades County in areas of habitat now occupied by an expanding panther population, and it would deliver more humans into and spark more development in the heart of panther habitat south of Immokalee.

Third, construction of an expressway along the SR 31 alignment between US 17 in Desoto County and SR 80 in Lee County should be rejected. SR 31 passes through the Babcock-Webb Wildlife Management Area and Babcock Ranch Preserve. These public conservation lands are important to many species of wildlife, including endangered and threatened species, and one of the first female panthers to occur north of the Caloosahatchee River since 1973 had a litter of kittens not far east of SR 31. The direct and secondary effects of a new expressway through this region of natural habitats should be avoided.

Fourth, the east-west highway SR 74 through Charlotte and Glades counties between US 17 and SR 29 should not be expanded as part of the toll road project. This rural highway traverses the Primary Dispersal/Expansion Area of the PFA north of the Caloosahatchee River. This is an area where female panthers and kittens have been observed since 2017. This is the region most likely to support an expanding population of panthers into Central Florida. Highway improvements along CR 74 are likely to result in increased roadkill mortality, stimulate loss of natural habitats due to development of natural areas, and threaten the contribution of this portion the South Florida landscape to panther recovery.

Finally, information on roadkill hot spots, road segments targeted for wildlife crossings, and locations of landscape linkages should be used to plan for wildlife crossings to prevent future roadkill mortalities, not only in Southwest Florida but throughout the Southwest-Central Florida Connector study area.

**Literature Cited**

Carr, M. H., and P. D. Zwick. 2016. Florida 2070: mapping Florida's future – alternative patterns of development in 2070. Technical report. Geoplan Center, University of Florida, Gainesville, FL.

Davis, J. H., 1967. General map of natural vegetation of Florida. Circular S-178. Institute of Food and Agricultural Sciences, University of Florida Gainesville, FL.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2016. Cooperative land cover, version 3.2 – published October 2016. FFWCC, Tallahassee, FL. (http://myfwc.com/research/gis/applications/articles/Cooperative-Land-Cover)

Florida Fish and Wildlife Conservation Commission (FFWCC). 2017. Determining the size of the Florida panther population. FFWCC, Tallahassee, FL. (http://myfwc.com/media/4156723/DeterminingPantherPopulation2017.pdf)

Forman, R. T. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road ecology: science and solutions. Island Press, Washington, D.C.

Frakes, R. A., R. C. Belden, B. E. Wood, and F. E. James. 2015. Landscape analysis of adult Florida panther habitat. PLoS ONE 10(7):e0133044. doi:10.1371/journal.pone.0133044.

Hilty, J. A., W. Z. Lidicker, Jr., and A. M. Merenlender. 2006. Corridor ecology: the science and practice of linking landscapes for biodiversity conservation. Island Press, Washington, D.C.

Hostetler, J. A., D. P. Onorato, D. Jansen, and M. K. Oli. 2013. A cat's tale: the impact of genetic restoration on Florida panther population dynamics and persistence. Journal of Animal Ecology 82:608-620.

Johnson, W. E., D. P. Onorato, M. E. Roelke, E. D. Land, M. Cunningham, R. C. Belden, R. McBride, D. Jansen, M. Lotz, D. Shindle, J. Howard, D. E. Wildt, L. M. Penfold, J. A. Hostetler, M. K. Oli, and S. J. O'Brien. 2010. Genetic restoration of the Florida panther. Science 329 (24 September 2010):1641-1645.

Kautz, R. S., and J. A. Cox. 2001. Strategic habitats for biodiversity conservation in Florida. Conservation Biology 15(1):55-77.

Kautz, R., R. Kawula, T. Hoctor, J. Comiskey, D. Jansen, D. Jennings, J. Kasbohm, F. Mazzotti, R. McBride, L. Richardson, and K. Root. 2006. How much is enough? Landscape-scale conservation for the Florida panther. Biological Conservation 130:118-133.

Kelly, B., and D. Onorato. 2020. Assessment of the distribution of Florida panthers north of the Caloosahatchee River. Central Florida panther study interim report, 1 March 2019 – 30 June 2020. Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Naples, FL.

Lindenmayer, D. B., and J. Fischer. 2006. Habitat fragmentation and landscape change: an ecological and conservation synthesis. Island Press, Washington, D.C.

Maehr, D. S. 1992. Florida panther. Pages 176-189 *in* S. R. Humphrey, editor. Rare and endangered biota of Florida. Volume I: mammals. University Press of Florida, Gainesville, FL.

Melillo, J. M., T. C. Richmond, and G. W. Yohe (editors). 2014. Climate change impacts in the United States: the third national climate assessment. U. S. Global Climate Change Research Program, Washington, DC. (http://www.nca2014.globalchange.gov/downloads).

Noss, R., J. Reece, T. Hoctor, M. Volk, and J. OettingJ. 2014. Adaptation to sea-level rise in Florida: biological conservation priorities. Final Report. Kresge Foundation, Troy, MI.

Nowak, R. M., and R. McBride. 1974. Status survey of the Florida panther. Pages 237-242 *in* P. Jackson, editor. World Wildlife Yearbook 1973-74. World Wildlife Fund, 1110 Morges, Switzerland.

Onorato, D., C. Belden, M. Cunningham, D. Land, R. McBride, and M. Roelke. 2010. Long-term research on the Florida panther (*Puma concolor coryi*): historical findings and future obstacles to population persistence. Pages 453-469 *in* MacDonald, D. W., and A. J. Loveridge (editors). Biology and Conservation of Wild Felids, Oxford University Press, New York, NY.

Oetting, J., T. Hoctor, and M. Volk. 2016. Critical lands and waters identification project (CLIP): version 4.0. Florida Natural Areas Inventory, Florida State University, Tallahassee, FL.

Swanson, K., D. Land, R. Kautz, and R. Kawula. 2008. Use of least-cost pathways to identify key road segments for Florida panther conservation. FWRI technical report TR-13, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Sweet, W. V., R. E. Kopp, C. P. Weaver, J. Obeysekera, R. M. Horton, E. R. Thieler, and C. Zervas. 2017. Global and regional sea level rise scenarios for the United States. Technical Report NOS CO-OPS 083. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Thatcher, C. A., F. T. van Manen, and J. D. Clark. 2009. A habitat assessment for the Florida panther population expansion into central Florida. Journal of Mammalogy 90:918-925.

U.S. Fish and Wildlife Service (USFWS). 2008. Florida panther recovery plan (*Puma concolor coryi*). Third Revision. U.S. Fish and Wildlife Service, Atlanta, GA.

Van de Kerk, M., D. Onorato, J. Hostetler, B. Bolker, and M. Oli. 2019. Dynamics, persistence, and genetic management of the endangered Florida panther population. Wildlife Monographs 203:3-35.

**Table 1**. Medium projections of growth human population between 2010 and 2070 in the 9 counties within the Southwest-Central Connector study area (Carr and Zwick 2016).

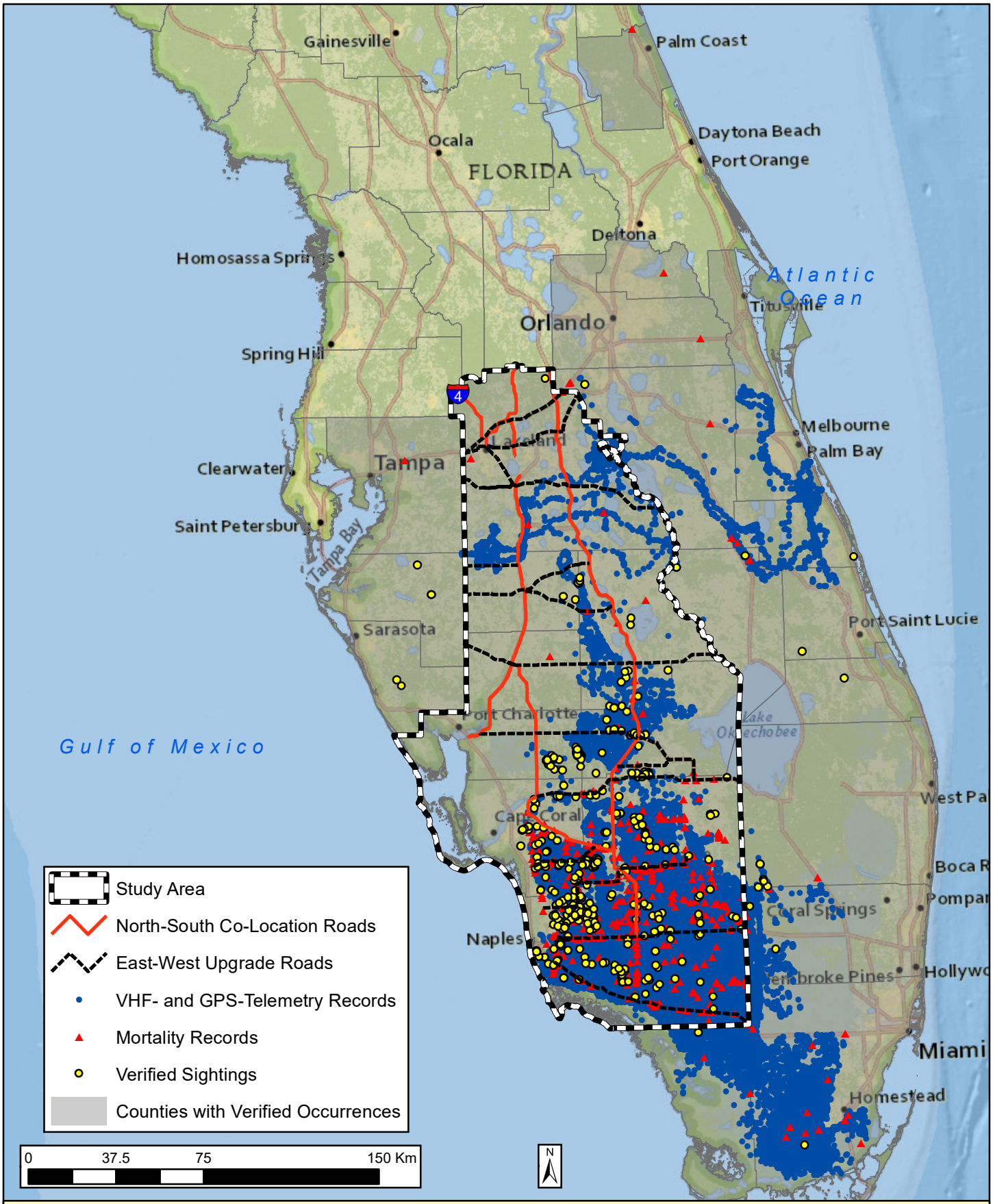
| | Human Population | | | |
|---|---|---|---|---|
| **County** | **2010** | **2070** | **Growth** | **% Increase** |
| Polk | 602,095 | 1,215,943 | 613,848 | 102.0 |
| Hardee | 27,731 | 28,689 | 958 | 3.5 |
| Desoto | 34,862 | 34,071 | -791 | -2.3 |
| Highlands | 98,786 | 145,065 | 46,279 | 46.8 |
| Charlotte | 159,978 | 237,515 | 77,537 | 48.5 |
| Glades | 12,884 | 18,352 | 5,468 | 42.4 |
| Lee | 618,754 | 1,550,924 | 932,170 | 150.7 |
| Hendry | 39,140 | 42,110 | 2,970 | 7.6 |
| Collier | 321,520 | 659,687 | 338,167 | 105.2 |
| | | | | |
| North | 936,336 | 1,679,635 | 743,299 | 79.4 |
| South | 979,414 | 2,252,721 | 1,273,307 | 130.0 |
| | | | | |
| Total | 1,915,750 | 3,932,356 | 2,016,606 | 105.3 |

**Table 2**. Projected loss of panther habitat in the Panther Focus Area and adult breeding range by 2070 as a result of the combined effects of human population growth (Carr and Zwick 2016) and an expected sea level rise of 1.0 m (Sweet et al. 2017).

| **Habitat Loss 2070** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Total Area** | **Loss Due to 2070 Trend Model** | | **Sea Level Rise 1.0 m** | | **Developments and Sea Level Rise Combined** | |
| **Region** | **km²** | **km²** | **%** | **km²** | **%** | **km²** | **%** |
| Primary Zone | 9,189 | 644 | 7.0 | 2,451 | 26.7 | 3,095 | 33.7 |
| Secondary Zone | 3,286 | 953 | 29.0 | 40 | 1.2 | 993 | 30.2 |
| Dispersal Zone | 113 | 38 | 33.8 | 0 | 0.0 | 38 | 33.8 |
| Expansion Area | 1,945 | 400 | 20.6 | 0 | 0.0 | 400 | 20.6 |
| PFA Total | 14,533 | 2,035 | 14.0 | 2,491 | 17.1 | 4,526 | 31.1 |
| Adult Breeding Range | 5579 | 461 | 8.3 | 975 | 17.5 | 1,436 | 25.7 |

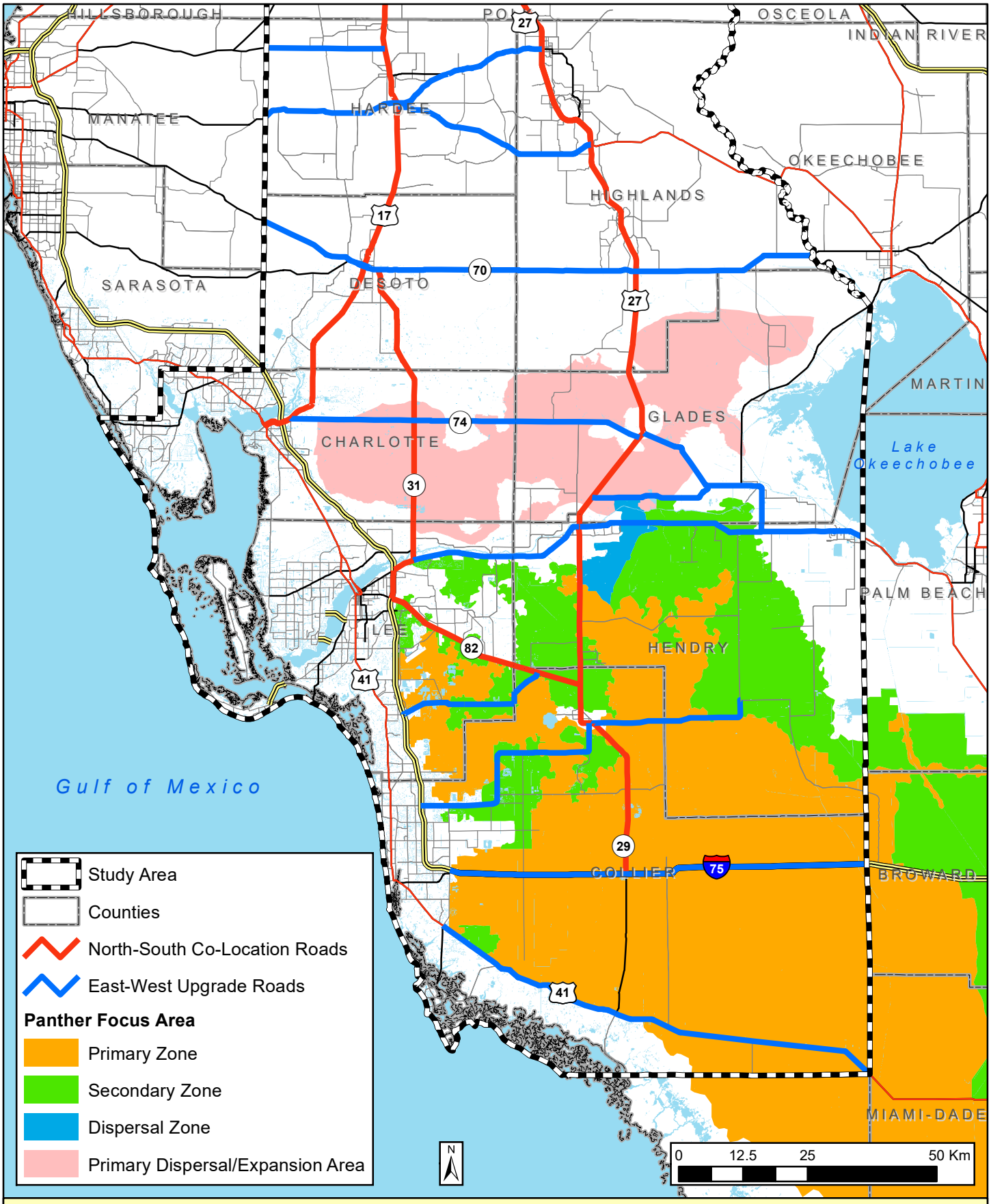
**Table 3**. Common and scientific names of species of wildlife listed as endangered (E) or threatened (T) by either the U.S. Fish and Wildlife Service (F) or the Florida Fish and Wildlife Conservation Commission (S) that occur within the Southwest-Central Connector study area, the general regions of the study area where they are found, and the habitat types most often used by each species.

| Common Name | Scientific Name | Status | Region | Habitats |
|---|---|---|---|---|
| Blue-tailed mole skink | *Plestiodon egregius lividus* | FT | Lake Wales Ridge | Scrub, sandhill |
| Sand skink | *Plestiodon reynoldsi* | FT | Lake Wales Ridge | Scrub, sandhill |
| Eastern indigo snake | *Drymarchon corais couperi* | FT | Throughout | Natural areas |
| Florida pine snake | *Pituophis melanoleucaus mugitus* | ST | North of Caloosahatchee R. | Sandy soils |
| Gopher tortoise | *Gopherus polyphemus* | ST | Lake Wales Ridge, many other areas | Scrub, sandhill, flatwoods |
| Short-tailed snake | *Lampropeltis extenuata* | ST | Northern Lake Wales Ridge | Xeric soils |
| Crested caracara | *Polyborus plancus* | FT | Highlands, Glades, Hendry | Praire, pasturelands |
| Everglade snail kite | *Rostrhamus sociabilis plumbeus* | FE | Lake Okeechobee, Lake Kissimmee | Freshwater marsh, water |
| Florida grasshopper sparrow | *Ammodramus savannarum floridanus* | FE | Avon Park, Kissimmee prairie | Prairie grasslands (nearly extinct) |
| Florida scrub-jay | *Aphelocoma coerulescens* | FT | Lake Wales Ridge, scattered patches of scrub in region | Oak scrub |
| Red-cockaded woodpecker | *Picoides borealis* | FE | Webb WMA, Avon Park AFR, Big Cypress NP | Mature pine forests |
| Wood stork | *Mycteria americana* | FT | Throughout | Wetlands |
| Florida burrowing owl | *Athene cunicularia floridana* | ST | Throughout | Xeric soils |
| Florida sandhill crane | *Antigone canadensis pratensis* | ST | Throughout | Pasturelands, fresh marshes |
| Little blue heron | *Egretta caerulea* | ST | Throughout | Wetlands |
| Tricolored heron | *Egretta tricolor* | ST | Throughout | Wetlands |
| Big Cypress fox squirrel | *Sciurus niger avicennia* | ST | South of Caloosahatchee R. | Open woodlands |
| Florida bonneted bat | *Eumops floridanus* | FE | Where it occurs | Not well known |
| Florida panther | *Puma concolor coryi* | FE | Primarily SW Florida | Forest cover |



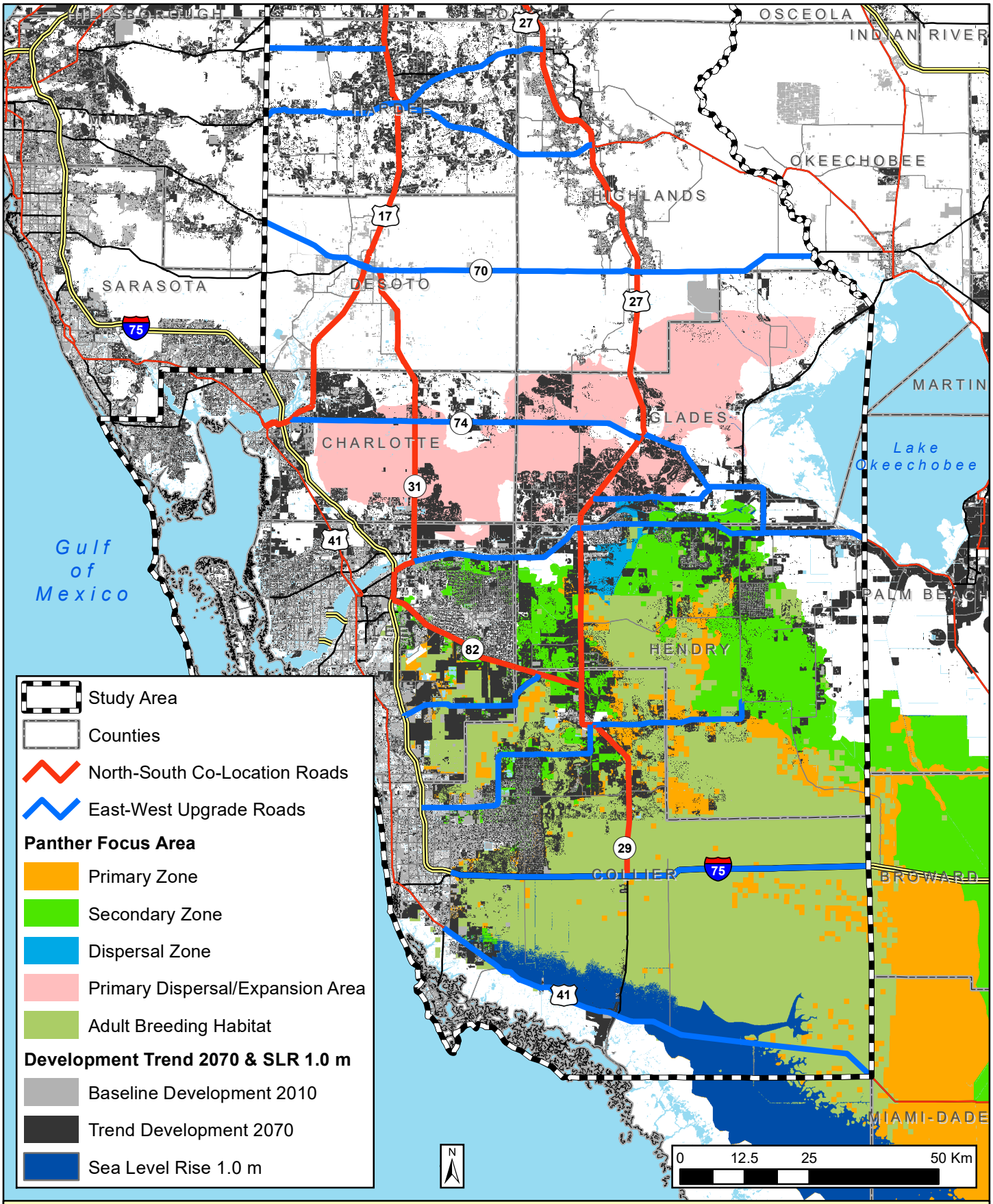

Data Sources: Florida panther occurrence records obtained from FWC. National Geographic World Map obtained online from ESRI.

**Figure 1**. Current range of the Florida panther based on Florida counties containing VHF- and GPS-telemetry records (1981-2018), mortality records (1972-2018), and verified sightings (1900-2018).



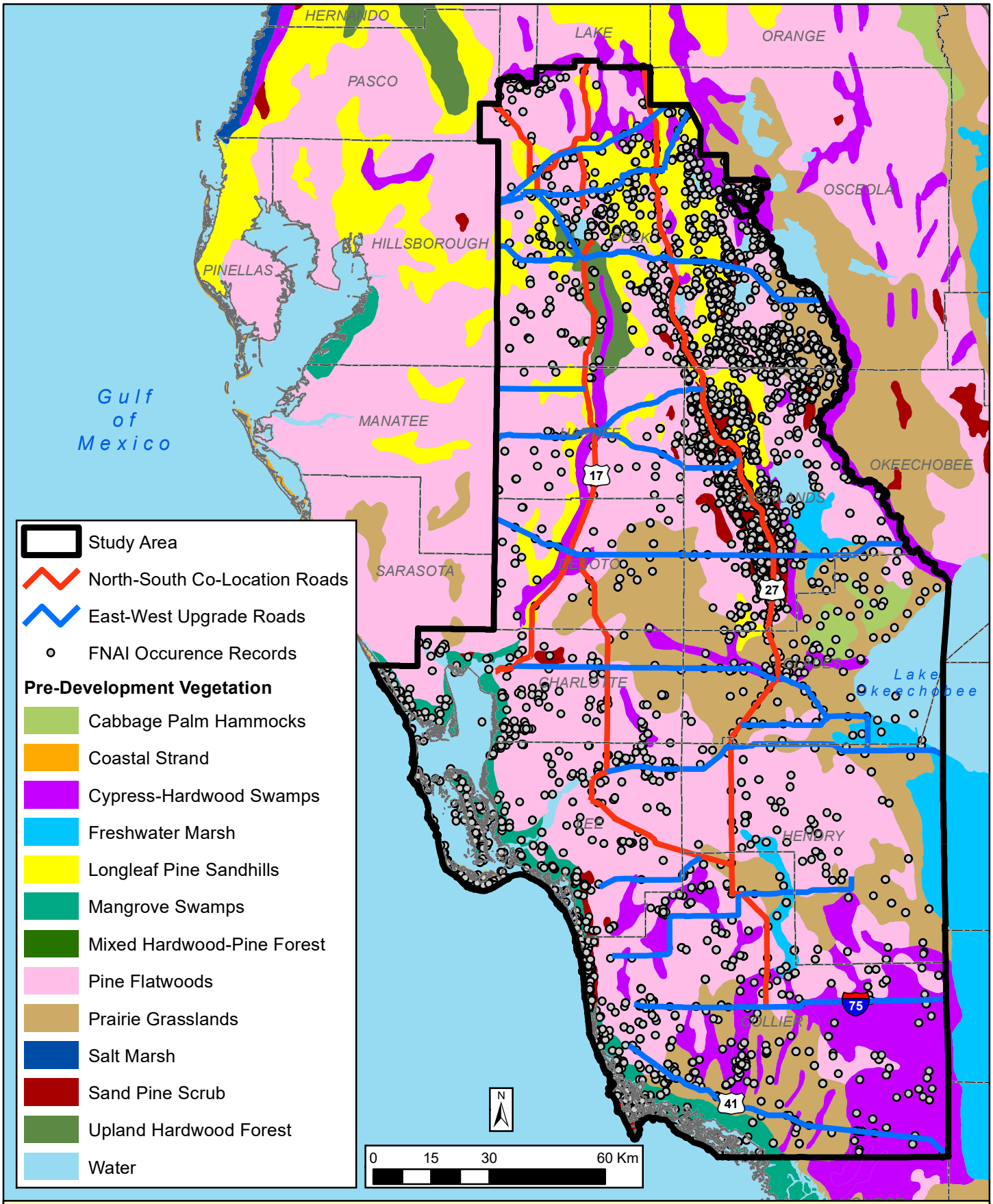

Data Sources: PFA boundaries obtained from USFWS. County boundaries obtained from FGDL. Roads and study area boundary obtained from FDOT.

**Figure 2.** The Panther Focus Area is the consultation area map used to determine which proposed development projects should be referred to USFWS for consultation under the US Endangered Species Act.




Data Sources: PFA boundaries obtained from USFWS. Baseline Development 2010, Development Trend 2070, and county boundaries obtained from FGDL. Roads and study area boundary obtained from FDOT.

**Figure 3**. Areas of habitat within the Panther Focus Area that are likely to be lost to development and sea level rise by 2070.




Data Sources: Davis (1967) map of potential natural vegetation prior to European settlement obtained from FWC. Rare and imperiled species and natural communities records (9/2004 and 10/2012) obtained from FNAI. Roads and study area boundary obtained from FDOT.

**Figure 4**. Point locations of rare and imperiled species and natural communities in relation to major pre-development natural plant communities in the Southwest-Central Connector study area.