Journal of Mammalogy, 90(4):918–925, 2009

A HABITAT ASSESSMENT FOR FLORIDA PANTHER POPULATION EXPANSION INTO CENTRAL FLORIDA

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One of the goals of the Florida panther (*Puma concolor coryi*) recovery plan is to expand panther range north of the Caloosahatchee River in central Florida. Our objective was to evaluate the potential of that region to support panthers. We used a geographic information system and the Mahalanobis distance statistic to develop a habitat model based on landscape characteristics associated with panther home ranges. We used cross-validation and an independent telemetry data set to test the habitat model. We also conducted a least-cost path analysis to identify potential habitat linkages and to provide a relative measure of connectivity among habitat patches. Variables in our model were paved road density, major highways, human population density, percentage of the area permanently or semipermanently flooded, and percentage of the area in natural land cover. Our model clearly identified habitat typical of that found within panther home ranges based on model testing with recent telemetry data. We identified 4 potential translocation sites that may support a total of approximately 36 panthers. Although we identified potential habitat linkages, our least-cost path analyses highlighted the extreme isolation of panther habitat in portions of the study area. Human intervention will likely be required if the goal is to establish female panthers north of the Caloosahatchee in the near term.

Key words: Caloosahatchee River, Florida panther, habitat evaluation, Mahalanobis distance, *Puma concolor*, radiotelemetry

The Florida panther (*Puma concolor coryi*) has been federally listed as endangered since the inception of the United States Endangered Species Preservation Act of 1967 and the subsequent Endangered Species Act of 1973. As the only surviving subspecies of *Puma concolor* in the eastern United States, the Florida panther is limited to a single breeding population of <100 animals (United States Fish and Wildlife Service 2006). Although the historic range of the Florida panther once encompassed the southeastern United States, the population is currently limited to the southern portion of the Florida peninsula. Based on radiotelemetry data, the conterminous breeding population extends as far north as Okaloacoochee Slough in Hendry County, approximately 15 km south of the Caloosahatchee River (Fig. 1).

Unoccupied panther habitat in southern Florida is being converted to agricultural and urban land uses at a rapid rate (Kautz 1998; Kautz et al. 2006). In addition, the small and geographically isolated panther population is vulnerable to stochastic events such as extreme weather, disease, or a sudden loss of its prey base (Clark 2001). Consequently, establishment of panther populations outside southern Florida should be a high priority to improve the likelihood of survival of the subspecies (Maehr et al. 2002). Indeed, one of the objectives of the Florida panther recovery plan is to expand the panther range into central Florida (i.e., north of the Caloosahatchee River) in an effort to increase the probability of long-term persistence of the species (United States Fish and Wildlife Service 2006).

Several male panthers have been documented in central Florida via radiotelemetry, vehicular mortalities, and other confirmed panther sign, suggesting that sufficient prey and cover exist to support the species (Maehr et al. 2002). However, no females have been documented there since 1973 (McBride 2002) and natural population expansion may be inhibited because of habitat fragmentation and barriers to dispersal (Maehr 1997; United States Fish and Wildlife Service 2006). An analysis of potential panther habitat within the southeastern United States was performed by Thatcher et al. (2006), but at a coarse scale (500 × 500-m pixel size) and

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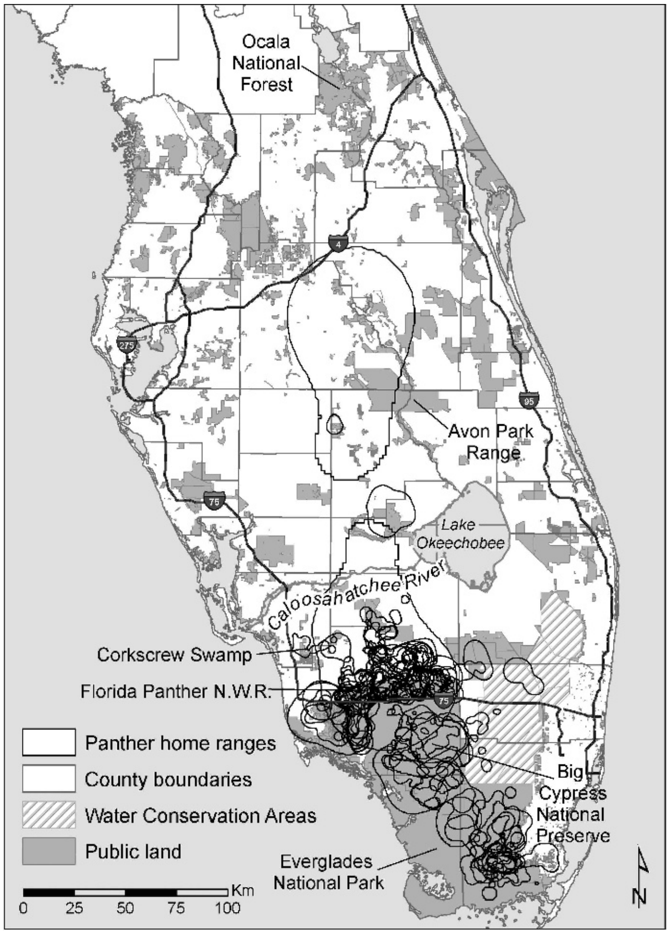

FIG. 1.—Study area and distribution of Florida panther (*Puma concolor coryi*) home ranges in southern Florida, 1981–2005.

with generalized habitat variables. Our objective was to delineate Florida panther habitat north of the Caloosahatchee River at a finer scale and with habitat variables more appropriate for central Florida. We also wished to evaluate factors that may affect habitat connectivity for dispersal and recolonization, which was not performed by Thatcher et al. (2006).

MATERIALS AND METHODS

Study area.—Southern and central Florida is characterized by relatively flat topography and poorly drained soils, resulting in extensive wetlands (Davis 1943). Elevations range from sea level to 95 m. The climate is tropical, with a summer wet season and a winter dry season (Davis 1943). Major vegetation types included pine forests, cypress (*Taxodium*) and mixed hardwood swamps, hardwood hammocks, cabbage palm (*Sabal palmetto*) forests, mangrove (*Avicennia germinans* and *Rhizophora mangle*) forests, saw palmetto (*Serenoa repens*) prairies, and herbaceous wetlands such as sawgrass prairies (*Cladium mariscus* var. *jamaicense*—Florida Fish and Wildlife Conservation Commission 2004). Mean annual rainfall ranged from 114 to 157 cm (United States Department of Agriculture Natural Resources Conservation Service 2006).

The study area contained 31 counties in southern and central Florida encompassing 78,427 km^2 (Fig. 1). Publicly owned land accounted for 29.5% of the study area (Florida Geographic Data Library 2005). The largest public land parcels were Everglades National Park, Big Cypress National Preserve, and several Water Conservation Areas, all located in the southern portion of the Florida peninsula. Approximately 14% of the study area was used for agriculture, including pasture, sugarcane fields, citrus groves, and row crops (Florida Fish and Wildlife Conservation Commission 2004) and about 10% of the study area was characterized by urban land use, particularly along the Atlantic and Gulf coasts and inland along the Interstate 4 corridor.

Telemetry data.—We delineated Florida panther habitat based on a multivariate metric applied to the landscape with a geographic information system. Our approach was to identify landscape conditions north of the Caloosahatchee River that were similar to those associated with home ranges of radiocollared panthers in southern Florida. Panther telemetry data were collected by the Florida Fish and Wildlife Conservation Commission, the National Park Service, and the University of Tennessee beginning in 1981 and totaled >76,000 locations. We chose a subset of the panther telemetry data for analysis that coincided with a time period within 5 years (1988–1998) of the Florida Gap Analysis Program (GAP) land-cover data (1993, see ''*Landscape data*''). Although more recent landscape data were available, the majority of the radiotelemetry data coincided with the 1993 landscape data set. Therefore, we used those home ranges for model development and then applied and tested the model with the more recent landscape and telemetry data (see ''*Model application*''). Mean telemetry error for locations collected by all agencies was estimated to be 176 m, with 95% of locations within 489 m (Janis and Clark 2002). Panthers were monitored year-round, with an average of 3 locations per week. We excluded data for panthers <18 months of age because those animals were usually dependent on their mothers and likely exhibited movement and activity biases (Janis and Clark 2002). Our telemetry data included locations of 8 female Texas mountain lions (*Puma concolor stanleyana*) and their offspring introduced to southern Florida in 1995. Sampling intensity varied among the 3 agencies that collected telemetry data, so we standardized the data to ≤ 3 locations per week for each animal. We excluded panthers with <50 locations to reduce bias in home-range estimation when using the fixed kernel method (Seaman et al. 1999).

Because our goal was to identify habitat areas for range expansion, we used home ranges rather than individual telemetry locations to develop our habitat model. Additionally, telemetry locations were primarily obtained during morning hours and may not adequately describe 24-h habitat use (Beier et al. 2003). However, such temporal bias or telemetry error should not substantially affect home-range estimates. We delineated a home range for each panther by calculating a 95% probability contour using the fixed kernel method (Worton 1989) available in the Animal Movement extension (Hooge and Eichenlaub 1997) to ArcView GIS (ESRI, Redlands, California). Although the telemetry data spanned up to 10 years for some panthers and some exhibited home-range shifts, we calculated a single home range for each animal. Although home ranges of females may better represent food and cover requirements, the larger home ranges of males probably better represent habitat variables that reflect movement and dispersal requirements. Therefore, we used home ranges of both male and female panthers for model development to capture the broad range of habitat requirements.

Landscape data.—To identify habitat characteristics associated with Florida panther home ranges, we used 1993 GAP land-cover data (30-m resolution, 71 land-cover types—Florida Cooperative Fish and Wildlife Research Unit 2000) and other geographic information system data from approximately the same time period. Initial models indicated that individual land-cover classes were too specific. For example, shrub–saw palmetto prairies were common in central Florida but rare in the south. Consequently, shrub–saw palmetto cover in central Florida would have been classified as unsuitable by the model because that type was not available to panthers in the area where most of the telemetry data were collected. To reduce this potential bias, we experimented with different groupings of land-cover types, but eventually chose a binary classification by combining natural land-cover types commonly used by panthers into 1 group (i.e., forests, grasslands, shrublands, and cypress swamps) and the remainder into the other group (i.e., urban, open water, agriculture, and mangrove forests). We used ArcGIS 9.2 (ESRI) to develop variables (30 × 30-m pixel size) that quantified spatial patterns of landscape heterogeneity and fragmentation. Each variable was calculated using overlapping moving windows with a 3,280-m radius, a scale equivalent to the mean daily movement rate of male and female panthers (Janis and Clark 2002).

Spatial data on roads and human population density were included in the habitat model as a measure of anthropogenic influences on the landscape. Human disturbance may increase habitat fragmentation, create impediments to panther movement, and increase the risks to panthers from vehicular mortality and poaching (Comiskey et al. 2002). Human population density was calculated from 1990 United States Census Bureau data at the block group level (Florida Geographic Data Library 2002a). A block group is a polygon representing an area of varying size generally containing between 600 and 3,000 people, with a typical population of 1,500 (United States Census Bureau 2002). We calculated road density from 1992 United States Census Bureau data (Florida Geographic Data Library 2002b) based on the total length of roads within a 3,280-m radius. The road data included all roads except those that were unpaved or accessible only by 4-wheel-drive vehicles. Because wide, heavily traveled roads can act as barriers to panther movement (Dickson et al. 2005; Foster and Humphrey 1995), we developed a 2nd road variable delineating interstate and United States highways only. We represented the width of those highways and adjacent road shoulders by a 90-m distance (3 pixels).

The Water Conservation Areas east of the current panther range were intensively managed by a system of canals and levees to provide flood control and water storage. Areas that were perennially inundated were less able to support white-tailed deer (*Odocoileus virginianus*), an important source of prey for Florida panthers (Comiskey et al. 2002; Fleming 1994; Maehr et al. 1990). Therefore, we included variables related to water regime based on National Wetlands Inventory data (Cowardin et al. 1979). We grouped the wetlands data into 3 categories: permanently flooded or open water, seasonally flooded, and uplands or intermittently flooded. We added areas that were classified as diked or impounded to the permanently flooded and open water category. As with the previous variables, we used moving windows with a 3,280-m radius to calculate the percentage of the area represented by each category.

Mahalanobis distance analysis.—To develop our habitat model, we calculated the Mahalanobis distance (D^2) based on the panther home ranges and geographic information system data layers (Clark et al. 1993):

$$D^2 = (\underline{x} - \underline{\hat{u}})\Sigma^{-1}(\underline{x} - \underline{\hat{u}})',$$

where $\underline{x}$ is a vector of landscape characteristics in the geographic information system grid, $\underline{\hat{u}}$ is the mean vector of landscape characteristics estimated from the set of home ranges, and Σ^{-1} is the inverse of the variance–covariance matrix calculated from the home ranges (Rao 1952). For example, consider a model consisting of 2 variables, percent natural land cover and road density. If the mean percent natural land cover and road densities within all the home ranges were 75% and 440 m/kg^2, respectively ($\underline{\hat{u}}$), and those values within a particular pixel were 70 and 420, respectively ($\underline{x}$), then the difference ($\underline{x} - \underline{\hat{u}}$) would be 5 and 20, respectively. Those numbers would constitute a row vector for that pixel, which would then be multiplied by the inverse of the variance–covariance matrix of those 2 variables based on the home range data (Σ^{-1}). Finally, that resulting row vector would be multiplied by the corresponding column vector ($\underline{x} - \underline{\hat{u}}$)$'$, thus producing a single D^2 value for that geographic information system pixel. The same calculation would be made for every pixel on the landscape map.

The D^2 statistic provides a dimensionless index of similarity to the multivariate landscape conditions associated with the sampled panther home ranges. As an index, units of measure or scaling of model variables do not have to be standardized. Small values of D^2 represent landscape conditions similar to those within panther home ranges, whereas larger distance values represent increasingly different conditions. The Mahalanobis distance technique is well suited for modeling a secretive, wide-ranging animal such as the Florida panther because it requires only presence data for input, rather than both presence and absence data (Clark et al. 1993; Tsoar et al. 2007). We recoded the D^2 scores to probabilities based on the chi-square distribution with $n - 1$ degrees of freedom, where n equals the number of landscape variables in the model (Clark et al. 1993). Assuming multivariate normality, the *P*-value represents the probability of observing a larger D^2 value than that observed when $\underline{x}$ is sampled from a population whose mean is ideal (i.e., equal to the vector of mean predictor variables used to generate the D^2 value). Otherwise, the *P*-values simply represent a rescaling of D^2 values from 0 to 1 with values closer to 1 indicating more favorable landscape conditions as defined by the panther home ranges (Jenness 2003).

Model selection and testing.—We developed several habitat models based on different combinations of landscape variables and used quantitative and qualitative criteria to select the final model. Because the use of species absences is problematic to evaluate presence-only models (Hirzel et al. 2006), we compared model predictions for the actual panther home ranges with what would be expected if home ranges were randomly distributed on the landscape (i.e., 2nd-order habitat selection—Johnson 1980). Although habitat suitability represents a continuum, it was necessary to characterize panther habitat on a binary scale (i.e., habitat, nonhabitat) for model evaluation. To do so, we generated a cumulative frequency distribution of the mean *P*-values observed within the panther home ranges we sampled. We then generated a set of test home ranges, equal in size and number to the average male and female home ranges of our sample, and randomly placed those throughout the study area and created a cumulative frequency distribution based on their mean *P*-values. We chose the *P*-value with the greatest separation between the 2 distributions as a threshold value (Duncan and Dunn 2001) with values less than the threshold representing nonhabitat and the remainder representing panther habitat. We repeated this process 10 times, each time calculating a threshold value and determining the proportion of the random home ranges classified as panther habitat (i.e., mean *P*-values greater than the threshold value). We compared the mean of those proportions with the actual panther home ranges to aid in selecting the best model.

To test model performance and identify panther home ranges that were outliers, we used 10-fold cross-validation. In this resampling procedure, we partitioned the panther home-range data into 10 subsamples containing 6 or 7 home ranges each, excluded 1 subsample, and used the remainder to develop a new habitat model. A *P*-value threshold was determined each time as previously described. We then estimated error by calculating the proportion of home ranges in the excluded subsample that had mean *P*-values below the threshold. We repeated this process 10 times and calculated the mean error rate (Verbyla and Litvaitis 1989).

Finally, we used recent telemetry data (2002–2005) from 25 panthers to perform additional model testing. That data set excluded panthers that were used to develop the original model. We calculated the mean *P*-value for those home ranges and determined the proportion with mean *P*-values greater than the threshold value based on recent landscape data (see ''*Model application*''). Although we minimized subjectivity by using the quantitative criteria we describe, we sometimes chose to add or eliminate a variable based on our visual interpretations of the model. For example, some models performed well in a quantitative sense but predicted panther habitat in selected areas that we knew were not suitable (e.g., inundated areas). Therefore, we added or eliminated variables based on the judicious use of such subjective criteria.

Model application.—Although we developed our model based on telemetry data consistent with the time period when the landscape data were collected, we applied the model using recent landscape data (2003 land cover data [Florida Fish and Wildlife Conservation Commission 2004], 2000 census data [United States Census Bureau 2002], and 2005 road data [United States Census Bureau 2005]) to evaluate current habitat suitability for panthers. Using the threshold *P*-value identified during model testing, we applied our habitat model to create a map layer of panther habitat and nonhabitat. We used the smallest habitat patch that overlapped a substantial portion (>25%) of the home range of a female panther as a subjective minimum area for consideration as a potential translocation site. We used this small size criterion to give consideration to small habitat patches that may be valuable components of a larger habitat matrix.

Habitat connectivity.—We conducted a least-cost path analysis to identify potential habitat linkages and to provide a relative measure of connectivity between habitat patches. Least-cost path models have been used to identify dispersal pathways for Florida panthers (Kautz et al. 2006) and habitat connectivity for other large carnivores such as black bears (*Ursus americanus*—Kindall and van Manen 2006). Our purpose was to identify those patches in central Florida that, if occupied by panthers, would have the greatest potential for connectivity to other habitat patches. We delineated habitat connectivity with a cost-surface grid, which represented relative resistance (i.e., cost) of panther movement through the landscape based on the panther habitat model. Our assumption was that areas with greater D^2 values were less likely to be used by panthers, providing poor habitat connectivity (greater cost). Using D^2 as the measure of resistance to panther movement, we calculated the cost-weighted distances from the habitat patches we identified to each pixel in the study area (Cost Distance function in ArcGIS). The cost-weighted distance represents the lowest cumulative cost of the path back to the source area. Next, we used the weighted distance grids to map habitat connectivity between pairs of neighboring habitat patches using the Corridor function in ArcGIS. That function combines the 2 cumulative cost grids associated with each pair of habitat patches, which we used to delineate habitat connections by mapping the lowest cumulative costs between them. Finally, within each habitat connection we identified the path with the lowest cumulative cost (least-cost path) between each pair of habitat patches (Cost Path function in ArcGIS).

RESULTS

Habitat model.—Sixty-two panthers (30 males and 32 females) met our minimum age and sample size requirements,

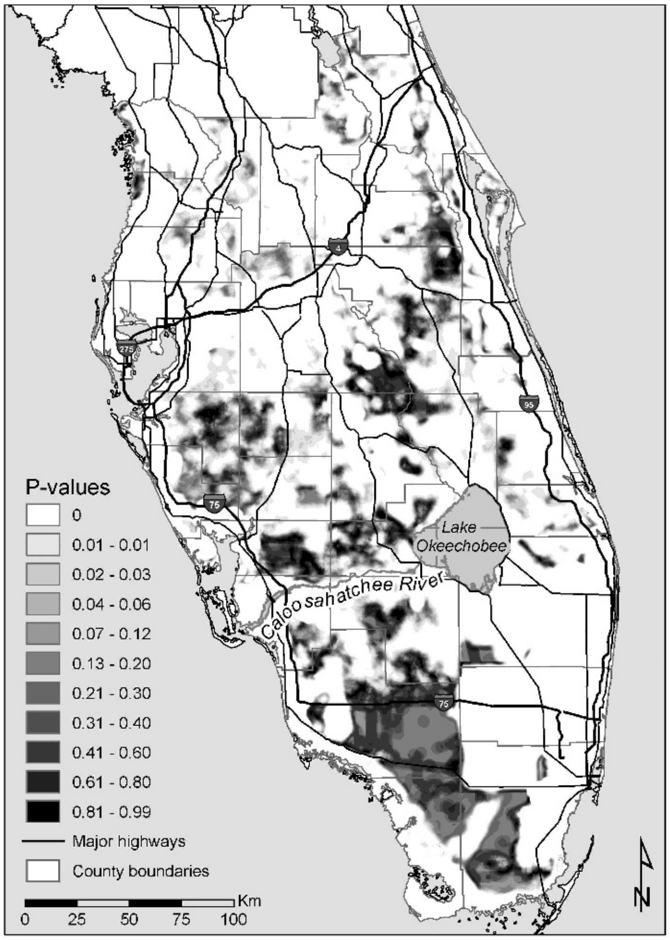

FIG. 2.—The *P*-values used to identify potential Florida panther (*Puma concolor coryi*) habitat north of the Caloosahatchee River in Florida, based on circa 2003 landscape conditions.

with a total of 36,066 telemetry locations (Fig. 1). Mean home-range sizes for males and females were 978 km^2 and 304 km^2, respectively. The final model included paved road density, major highways (United States and interstate highways; categorical variable), human population density, percent permanently or semipermanently flooded, and percent natural land cover. The greatest D^2 values, indicating landscape conditions that were most dissimilar to current panther habitat, corresponded with highly urbanized areas such as the city of Miami and areas with major highways. We applied this model to the more recent (circa 2003) landscape data and rescaled to *P*-values to facilitate model interpretation and assessment (Fig. 2).

Model assessment.—The cumulative frequency graph for the 1993 habitat model indicated that a *P*-value of 0.12 maximized the difference between panther and random home ranges (Fig. 3). At that *P*-value threshold, the false-negative error rate (predicting lack of panther habitat when habitat actually exists) was zero and the false-positive error rate (falsely predicting existence of panther habitat) was 12.9%. The 10-fold cross-validation results indicated that 100% of the panther home ranges had mean *P*-values above the threshold value. Finally, the model correctly classified all 25 panther home ranges estimated from the 2002–2005 telemetry data when we applied the habitat model to the circa 2003 landscape data.

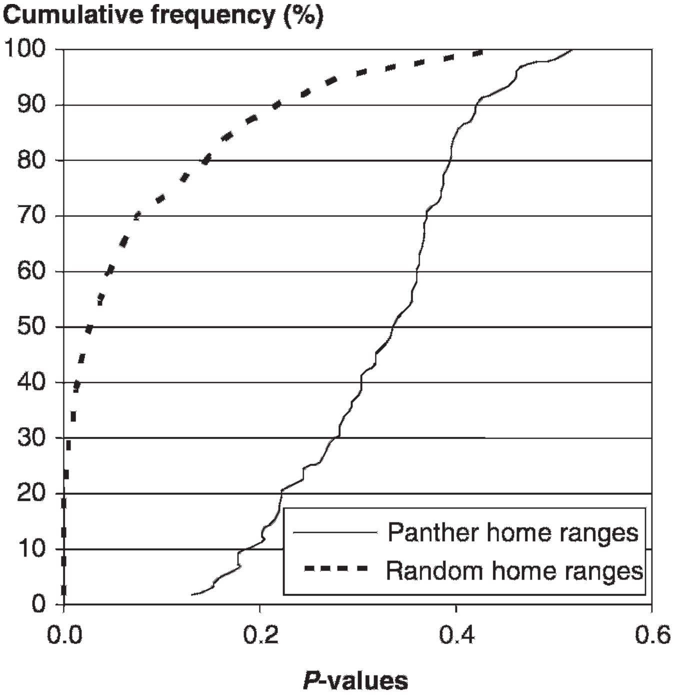

FIG. 3.—Cumulative frequency distribution of *P*-values within Florida panther (*Puma concolor coryi*) home ranges and randomly placed home ranges in southern Florida.

Habitat patch delineation.—The model identified potential habitat patches ranging in size from <1 km^2 to 1,759 km^2 (Fig. 4). The Big Cypress National Preserve area south of Interstate 75 was the largest patch (1,759 km^2) supporting female panthers, whereas the smallest patch (807 km^2) that supported a female panther was in the southern Everglades (Table 1). The average size of all patches that supported panthers was 1,255 km^2.

The smallest patch that overlapped a substantial portion (36%) of a female panther home range in 1993 was 427 km^2, so we used this size as a minimum threshold to identify potential translocation sites. There were 4 unoccupied habitat patches north of the Caloosahatchee River that met that minimum size criterion. The Avon Park site was the largest site (1,558 km^2) and included a large area of public land (Fig. 4, site A). That site was far from the current Florida panther range and major highways isolated it from other unoccupied habitat patches north of the Caloosahatchee River. The Duette Park site was 1,062 km^2 in size and included a number of small public land parcels (Fig. 4, site B). The Babcock-Webb site was relatively large with an area of 1,289 km^2 (Fig. 4, site C) followed by the Fisheating Creek site (478 km^2; Fig. 4, site D); several collared and uncollared male Florida panthers have been documented on these 2 sites in recent years.

Habitat connectivity.—We identified habitat connections among the 4 largest unoccupied patches we delineated (Fig. 4). We also delineated a habitat connection between

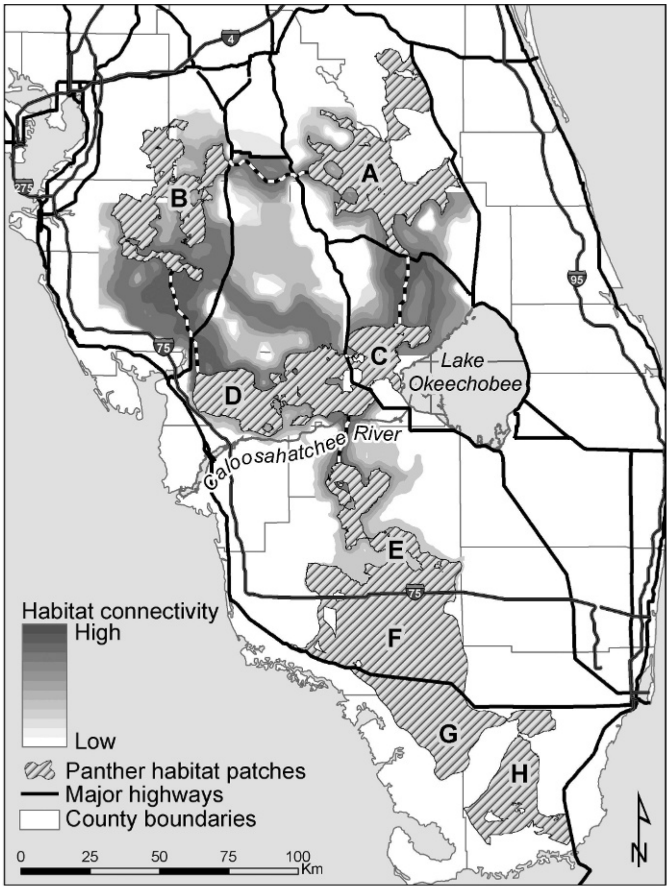

FIG. 4.—Habitat connectivity based on a least-cost path analysis among occupied habitat patches and potential translocation areas for Florida panthers (*Puma concolor coryi*) in southern Florida, circa 2003. Labels correspond to the following areas: A) Avon Park, B) Duette Park, C) Fisheating Creek, D) Babcock-Webb, E) Okaloacoohee Slough, F) Big Cypress, G) Southern Big Cypress, and H) Southern Everglades. The dashed lines represent the least-cost paths between potential translocation areas.

the northernmost portion of the current range (Okaloacoochee Slough) and the nearest potential panther habitat patch north of the Caloosahatchee River (Babcock-Webb site). The route following the best panther habitat connections between Okaloacoochee Slough and the Babcock-Webb site was 19.8 km in length (Fig. 4) and crossed small patches of pine and hardwood forests interspersed between large areas of citrus groves and pasture. The cumulative costs for panthers to travel between habitat patches north of the Caloosahatchee were greater, mostly because of major highways, which strongly influenced the D^2 values and exacted a large cost. The best habitat linkage between the Avon Park site and the Duette Park site was 39.3 km and required traversing patches of hardwood swamp, wet prairie, and citrus groves and crossing United States Highways 17 and 27. The 28.3-km-long habitat connection between the Avon Park site and the Fisheating Creek site traversed citrus groves, pastures, and wet prairies. The best habitat linkage between the Duette Park site and the Babcock-Webb site area was 44.9 km in length. That route traversed a variety of land-cover types, including pastures, prairies, hardwood swamps, and bottomland hardwood forests. In addition to the least-cost pathways, the model also identified alternate pathways for panther movement between patches (Fig. 4).

TABLE 1.—Patches of Florida panther (*Puma concolor coryi*) habitat with areas >427 km^2 based on a Mahalanobis distance model applied to 2003 landscape data in southern Florida.

Site name	Area of patch (km^2)	Within current range?
Big Cypress	1,759	Yes
Avon Park	1,558	No
Babcock-Webb	1,289	No
Southern Big Cypress	1,228	Yes
Okaloacoochee Slough	1,226	Yes
Duette Park	1,062	No
Southern Everglades	807	Yes
Fisheating Creek	478	No

DISCUSSION

Our model clearly identified habitat typical of panther home ranges based on model testing with recent (2002–2005) telemetry data. Our analysis suggests that most panthers, particularly females, do not explore areas north of Okaloacoochee Slough far enough to reach the Caloosahatchee River. Agricultural and urban land use immediately south of the river likely impedes panther movements (Maehr et al. 2002; McBride 2002). Those factors reduce the likelihood that the breeding range of the Florida panther will naturally expand into central Florida. Translocation of female Florida panthers north of the Caloosahatchee River will probably be necessary to reestablish panthers in the near term (Maehr et al. 2002; United States Fish and Wildlife Service 2006).

An important consideration is the number of Florida panthers that might be supported north of the Caloosahatchee River. Using a recent density estimate for panthers in southern Florida as a reference (1 panther/129 km^2—Kautz et al. 2006), we estimate that the Avon Park and the Babcock-Webb sites may support the most panthers (approximately 10–12 each) and the Duette Park site may support 8 panthers. The Fisheating Creek site may support 4 panthers but, because of its small size, would likely have to be part of a larger habitat mosaic. In total, the habitat north of the Caloosahatchee River may support about 36 panthers, with a few more possibly using a matrix of smaller habitat patches. Of course, panther densities in the potential translocation sites may be higher or lower than those in southern Florida, depending on local variation of important factors such as prey density. The goal of the Florida Panther Recovery Plan is to establish and maintain a total population of ≥ 240 animals within historic panther range to avoid extinction due to demographic and genetic processes (United States Fish and Wildlife Service 2006). Although successful population establishment in the study area could help protect the current panther population from extinction caused by stochastic events, it would not be adequate to reach that recovery goal. Thus, the reestablishment of panthers in other areas within historic range will likely be necessary (Thatcher et al. 2006).

Habitat connections are important for dispersing animals and to promote genetic interchange among panthers, thereby increasing panther population viability (Kautz et al. 2006; Maehr et al. 2002). Our analysis suggests that the landscape matrix within which the largest habitat patches exist provides relatively poor habitat connectivity. Indeed, only 7 of 32 females in our sample (1988–1998) crossed major highways, which often formed the boundaries of home ranges of both males and females. Although the effect of major roads on habitat connectivity was substantial, it is not readily apparent from the map (Fig. 2) because the area representing highways and the road shoulders is small. The least-cost path analyses identified potential habitat linkages between the current range and the Babcock-Webb site north of the Caloosahatchee River, which could play an important role in maintaining connectivity with primary panther range to the south, at least for males. That corridor also was identified by other researchers (Kautz et al. 2006; Meegan and Maehr 2002) and was used by at least some of the radiocollared male panthers that crossed the Caloosahatchee River.

As with all models, we view ours as an aid to, rather than as a substitute for, sound decision making. Some variables in the model were simple, especially the binary land-cover classification that we used. Mountain lions have the greatest natural distribution of any mammal in the Western Hemisphere (Nowak and Paradiso 1983), so it is perhaps not surprising that their land-cover requirements could be adequately described with a binary variable. To estimate minimum patch size, it was necessary to use a threshold value to discriminate between habitat and nonhabitat. However, the *P*-values in our model represent a continuum and an absolute threshold value clearly is a simplification. Values higher or lower than the value we chose may be more appropriate depending on the management objectives and associated risks. Additionally, the size criterion to define panther habitat patches should be regarded as a minimum. Field surveys of the potential translocation sites will be important to assess variables we could not measure with the geographic information system, such as vegetation structure and prey density. Finally, the success of any Florida panther translocations would be greatly influenced by public attitudes (Belden and Hagedorn 1993), which should be considered in combination with the biological factors we examined.

Acknowledgments

This study was funded by the United States Fish and Wildlife Service. We thank the Florida Fish and Wildlife Conservation Commission and the National Park Service for providing telemetry data. We thank C. Belden for his help and support throughout the study. He, along with C. Schultz, and B. Rieck of the United States Fish and Wildlife Service and D. Land of the Florida Fish and Wildlife Conservation Commission provided helpful suggestions and comments on earlier versions of the habitat model. Finally, we thank the associate editor and 2 anonymous reviewers for their thoughtful comments on this manuscript.

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Submitted 13 July 2008. Accepted 2 February 2009.

Associate Editor was Roger A. Powell.