Fish and Wildlife Conservation Commission
Determining the Size of the Florida Panther Population

January 2016 DRAFT

Florida panthers (*Puma concolor coryi*) have been listed as Federally-endangered since 1967 because of small population size and geographic isolation (USFWS 2008). References to the panther population size have appeared in scientific literature, agency outreach materials, and popular media for years. Historically, most statements regarding panther population size have resulted from expert opinion informed by field observations of those most closely engaged in panther research

Typically, numbers reported for the Florida panther population size include only adults and sub-adults. Adults are panthers that have established home ranges and are of breeding age. Sub-adults are young panthers that are independent of their mothers but have yet to establish home ranges and have limited opportunities for breeding. Population size numbers do not include newborn kittens or older kittens that are traveling with their mothers (juveniles).

Why do we need to count panthers? The Florida Panther Recovery Plan (USFWS 2008) established recovery criteria for the panther. Reclassification to Threatened will be considered when two populations of 240 adult and subadult panthers have been maintained for 12 years (two panther generations). Delisting will be considered when three populations of 240 are maintained. Counts of panthers are necessary to monitor progress toward these criteria.

This document is intended to:

1) provide background to understanding the challenges in developing a rigorous population estimate with statistical confidence for Florida panthers;
2) present two novel analytical techniques currently being assessed by the Florida Fish and Wildlife Conservation Commission (FWC) in hopes of providing more robust and statistically defensible Florida panther population estimates;
3) describe the current method used by FWC to provide an approximate population size range of adult and subadult Florida panthers;
4) update the lower and upper bound for the approximate Florida panther population size range in south Florida using the most recently available data.

Rigorous capture-mark-recapture methods used to develop population estimates, including DNA hair snares and trail cameras surveys, have been effective for certain species of carnivores in the wild. Unfortunately, preliminary testing has shown that panthers are not consistently attracted to hair snares to make this a dependable method to obtain a robust population estimate. Also it is not possible to reliably identify individual panthers from trail camera photos using their fur (they are not spotted or striped). In addition, capture-mark-recapture sampling techniques can be labor intensive and expensive when implemented for carnivore populations that occupy large areas. This includes panthers, which occupy a breeding range of 3547 square miles (2.2 million acres; Kautz et al. 2006). These issues have similarly affected how managers attempt to estimate puma population sizes in the western United States. Population sizes are determined using a mix of educated guesses, hunter take, or in some cases, they are not enumerated at all (e.g., Wyoming uses trend data to inform management).

The FWC and our collaborators have been proactive in searching for novel techniques that have the potential to determine a true estimate of the panther population size that accounts for sampling effort,

detectability, and provide an associated measure of variance. Two methods currently being assessed are: 1) using data from radiocollared panthers that are recovered as motor vehicle mortalities (MVM) in combination with uncollared MVM recoveries to produce a population estimate for the entire breeding range; 2) using photographic encounter data of marked and unmarked panthers collected within an array of trail cameras to estimate density within a study area.

The MVM technique uses a combination of data from marked and unmarked panthers within what can basically be described as a capture-mark-recapture framework, the foundation of many simple and complex analytical techniques used to calculate true population estimates. Marked panthers serve as the sample from which detection probabilities for MVM are estimated. Essentially, monitoring data collected via aerial telemetry, as well as other variables that are quantified within a marked panthers home range (e.g., road density, traffic volume) help determine the probability of recovery as a MVM. Since we know the proportion of marked panthers that are detected as MVM, we can apply this detection probability to the unmarked panthers documented as MVM. Because these MVM data are collected across the breeding range of panthers, they provide an approximate range-wide estimate of the population size with an associated measure of variance.

A major advantage of the MVM method is that it mainly relies on data that FWC and our partners are already collecting on Florida panthers (e.g., aerial telemetry locations, MVM data). This reduces the cost significantly and makes the method appealing to managers. The protocol describing the MVM method was published in 2015 in the *Journal of Applied Ecology* (McClintock et al. 2015). While the method is promising, one shortcoming was the wide confidence intervals (i.e., uncertainty) associated with the population estimates. This issue will always be a challenge for analytical techniques that are inherently affected by small sample sizes, a common problem for studies focusing on endangered animals. The FWC and our collaborators plan to consider additional data sources that may serve to improve the precision of the MVM estimates in the future. A second shortcoming is that not all panthers are vulnerable to MVM.

The trail camera technique also has its foundation in traditional capture-mark-recapture population estimation techniques (Sollmann et al. 2013). This method involves marking (radiocollars, ear tags) ≥ 5-6 panthers across a 40,000 acre study area. Subsequently, 50 motion activated trail cameras are evenly distributed across the study area for a period of 5 months. During this time period, trail cameras are continuously collecting photographs of marked and unmarked panthers (and all other wildlife) that are using the study area. Photographs from marked panthers, along with their movement data collected via aerial telemetry from VHF radiocollars or GPS collars, are used to derive detection probabilities within the trail camera grid that can then be applied to photographs of unmarked panthers. So, similar to the MVM method, by knowing how often and where marked panthers encounter trail cameras, we can then assign this detection probability to the unmarked sample of panther photographs. In combination, these data provide an estimate of the density of panthers within the study area with an associated measure of variance.

Preliminary results using this technique are promising and precision of the density estimates for a portion of the Big Cypress National Preserve, Florida Panther National Wildlife Refuge and Picayune Strand State Forest are reasonable. Contrary to the MVM method, the trail camera technique is more labor intensive and requires additional field work beyond the routine monitoring of panthers. Furthermore, the population estimates obtained apply only to the study area, not across the breeding range, as with estimates derived using the MVM method. To determine a population estimate for the entire breeding range using the trail camera technique will most likely depend on collecting data across

multiple study areas and then extrapolating those findings. Given that our study design has been proven to be effective at estimating a population estimate for a given area, current research is focusing on collecting additional data sets from different study areas and identifying the best method to extrapolate these values across the breeding range to provide a robust range-wide panther population estimate with measures of variance.

While research by FWC focusing on finding a solution to providing a true population estimate for Florida panthers is ongoing, in the interim, we continue to rely on the historic method of a **Minimum Annual Count (MAC)** that was developed and initiated by Roy McBride in the early 1980s. A detailed description of the methodology for the MAC was published in the *Southeastern Naturalist* (McBride et al. 2008). The method is based on data collected by McBride and a team of trained biologists and includes annual records of verified panther sign, tracks, trail camera photos, panthers treed by dogs, and those outfitted with transmitters. These data, collected from field surveys conducted throughout the calendar year, are then used to tally a minimum number of panthers detected for said calendar year (Figure 1). The MAC includes adult, subadult, and juvenile panthers (i.e., young panthers still traveling with mom) but not kittens documented at dens. This technique does not provide estimates of the numbers of missed or double-counted panthers. Further, it is difficult if not impossible to survey all lands that are potential panther habitat. McBride et al. (2008) acknowledges that about one-quarter of occupied panther range exists on private lands and that they did not have access to most of these lands. There are also portions of public lands that are not surveyed due to logistical constraints. Compared to population estimate techniques, the MAC does not take into account sampling effort or provide a measure of variance for the count. Nevertheless, for the time being, this method continues to be the primary means of assessing Florida panther recovery until more novel techniques have been refined.

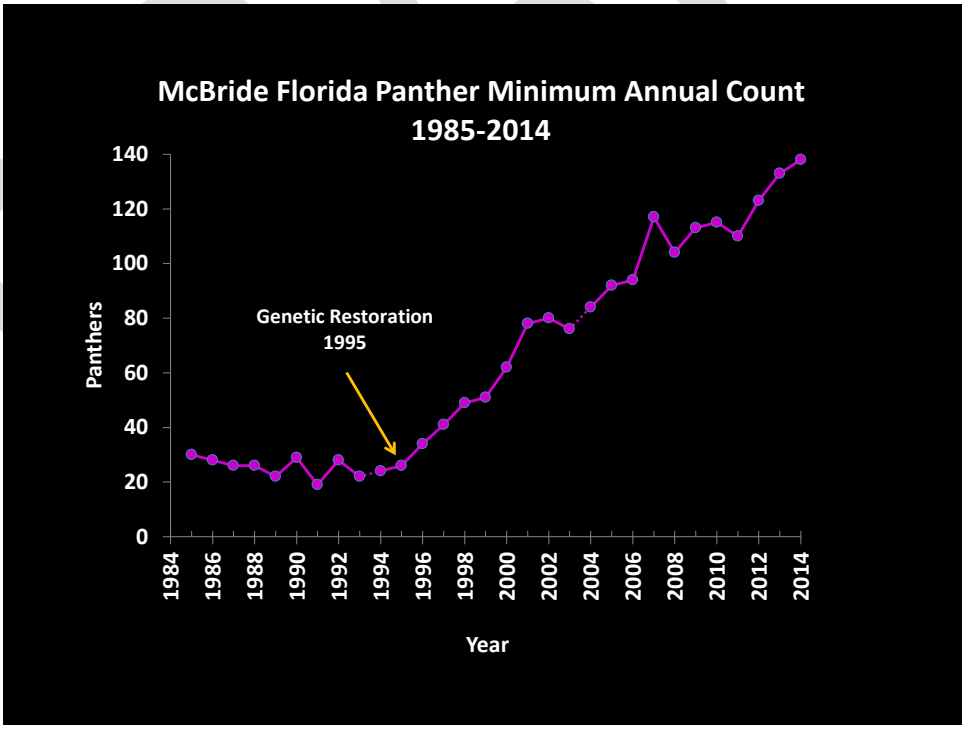

Figure 1. The minimum annual count of adult and juvenile Florida panthers detected from 1985 to 2014, excerpted from McBride et al. 2008, 2015.

The FWC uses the records of adult and subadult panthers documented in the MAC to derive a population size range for Florida panthers across occupied panther breeding habitat (areas in South Florida that are south of the Caloosahatchee River). Data collected for juveniles are not used to derive the population size range due to the significantly lower survival rates for panthers ≤ 1 year old. To obtain the lower bound (minimum) of the population size range, we use the average of the last 5 years (2010-2014) of adult and subadult panthers documented in the MAC (report citations listed below). Those data suggest that we currently have an average minimum of at least 88.8 panthers.

We can then calculate an upper bound for the population size range of panthers by using a combination of data from the last 5 years of the MAC and the total size (i.e. area) of occupied panther breeding habitat. To do this, we started by calculating the total area of four of the nine sampling units utilized in the MAC (McBride et al. 2015): 1) Big Cypress National Preserve (BCNP) south of I-75 and north of US 41; 2) Fakahatchee Strand Preserve State Park and Picayune Strand State Forest; 3) Florida Panther National Wildlife Refuge; and 4) BCNP north of I-75 and the Big Cypress Seminole Indian Reservation. These four units form a large, consolidated block of panther habitat with shared borders. The combined area of these four units was 1267.5 square miles. An average of 66 adult and sub-adult panthers were counted during the MAC within those units from 2010 to-2014 (see report citations below), thereby yielding a density estimate of 0.0521 panthers per square mile, a value within a range of densities reported for pumas in western states by Logan and Sweanor (2001). As stated earlier, the MAC does not provide estimates of the number of missed or double-counted panthers but this count does constitute the best available information on panther numbers. We believe our density estimate for the upper bound may represent a higher value relative to other units in McBride et al. (2015) because it was calculated within units that constitute the core of panther range. Using a higher-than-average density estimate was deemed acceptable because this exercise was intended only to provide an upper bound for the panther population size range.

A paper by Kautz et al. (2006) delineated an area of south Florida, referred to as the Primary Zone, which was supporting the panther population at that time. The Primary Zone includes both public and private lands. Applying the density estimate (0.0521 panthers/square mile) to the Primary Zone (3547 square miles) yields an upper bound value of 184.7 for the population size range of adult and sub-adult panthers. Therefore, (and rounding our numbers to the nearest increment of 10), FWC staff believes that the boundaries of the current adult and sub-adult panther population size is approximately 90-180 within the Primary Zone. It is recognized that there is considerable variability of habitat throughout the range and actual panther density would be dependent upon habitat type and habitat quality. The upper bound of 180 is based on the idealized and unlikely premise that the high panther density found in the core range would be found across the entire variable habitat of the Primary Zone. Nevertheless, this provides reasonable boundaries for a minimum and maximum population to offer insight into the possible magnitude of the adult and sub-adult panther population size in South Florida. We are hopeful that future advances in estimating panther numbers will allow us to provide a rigorous population estimate with statistical confidence and improved precision.

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