

C-111 Assessment for Florida Panther
(*Felis concolor coryi*)

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Introduction:

It is becoming recognized that understanding and predicting the viability of a population of organisms requires representing the dynamics of the population explicitly in a landscape. In addition, the viability of a small population, such as the Florida panther, may depend on the detailed structure of the population through time; age and size structure, sex ratio, physiological conditions of individuals in the population, and so forth. As a population decreases in size, the effect of random components (demographic stochasticity) increases and becomes quite significant for predicting population size and structure. This becomes particularly significant when population sizes approach 40 individuals or less, and the individuals are distributed among several smaller, spatially separated subpopulations (Pimm 1992). In such small populations, the Florida panther being one example (in which fewer than thirty to fifty individuals may exist at any particular point in time with individuals also being distributed across several subpopulations (U.S.F.W.S., 1987)), this demographic stochasticity can affect a population's persistence. One example of this would be if a highly skewed sex ratio occurred due to sampling phenomena in offspring. The population's persistence would also be affected by a variety of external factors, such as food availability. Changes in these external factors could either magnify or decrease the effects of demographic stochasticity. Thus the relative importance of demographic stochastic effects on predicting the persistence of a local population is in general intertwined with the effects of other factors (food availability, disease prevalence, etc.). Separating out which of these is most significant requires a model capable of evaluating the interconnections between them.

As the only large terrestrial carnivore in the Everglades region, the Florida panther has served as a key species for assessing the health of the ecosystem. Alternative hydrologic scenarios proposed in the C-111 study area could effect the panther population both directly, through restrictions on movement (Smith and Bass, in review), and indirectly through effects on the prey and associated suitable habitat (Dalyrample and Bass, in prep). Assessing the impacts of these alternative scenarios on a small population such as the panther may be best accomplished through the use of an individual-based model; that is, by a model that can simulate the life cycles of all the individuals comprising the population, their interactions, and responses to changing environmental conditions. These models have been described in a number of papers (for references and background information see DeAngelis and Gross, 1992).

Key data necessary to construct such a model have been collected over a number of years in South Florida. There are of course areas in which data are lacking - particularly concerning mortality and fecundity and the spatial rules by which panthers move across the Everglades landscape. However, there is a great deal of behavioral information on panthers derived from studies in other regions, and these data may be utilized as a basis for the assessment to be carried out in the C-111 study area.

Protocol Design:

The specific questions the proposed assessment addresses are:

1. How has the habitat quality of the C - 111 area for Florida panther been impacted by recent water management regulation?

2. How have these habitat changes affected the distribution and abundance of panther in the study area, what would be the effects of alternative water flow scenarios on the likelihood of the region to maintain a viable panther population over several decades?

Thus we shall evaluate the direct and indirect effects of each hydrologic scenario under consideration on the viability of the panther population within the C-111 GDM project area. To do this we shall assess the relative significance of demographic stochastic effects versus other external factors (prey availability) affecting this local population. We will use the Natural System Scenario as the scientific baseline for assessing the relative impacts of alternative hydrologic scenarios. This baseline condition will be used to compare several components of the panther population under alternative water flow schemes. The components to be considered include: mean population size, variance in population size, spatial variation in population abundance, and a risk assessment based upon the probability of persistence of the panther population over time. The time frame for these will be 30 years, and all assessments, including the Natural System Scenario, will utilize current information on the vegetation structure and distribution of habitat types in the study area.

A spatially-explicit, individual-based model of the Florida panther population is being constructed to be coupled with a spatially explicit, white-tailed deer model (SIMDEL) for the Everglades and surrounding wetlands. The deer population is also simulated on an individual-by-individual basis. The panther model will have the following general purposes: (1) synthesis of the population and natural history data that has been collected on the Florida panther: (2) predict the viability of the panther population under a variety of different hydrologic management strategies, and (3) assess potential dangers to the panther population from possible loss of habitat or the benefits from future habitat acquisition, including the specific geographical locations of the lost or acquired (restored) wetland (within the C-111 GDM project area).

SIMDEL, the individual-based model for deer in the Everglades, allows the deer population in the C-111 GDM project area to be simulated as individuals daily, on a landscape divided into 500 meter x 500 meter spatial cells, with varying soil, vegetation, and water depth characteristics. Data from a hydrology model will determine changing water depths in each cell on a daily basis. The ages, sizes, condition factors, group sizes, and spatial locations of each deer will be predicted each day, based on the behavioral and physiological responses of the deer to the changes in water depth, forage quality of vegetation, temperature, and other factors. This spatially explicit model of the Everglades landscape will be extended by adding individual panthers. Each panther will have an initial age, size, sex, physiological status, and a set of behavioral characteristics based on these. A bioenergetics model will be included, individualized for each panther, which predicts its basal (maintenance) and active metabolism. Rules for movement under a variety of circumstances, interactions between panthers (mating, parental care, aggression, territoriality), and ability to capture prey (deer) to meet its energetic requirements for survival and/or growth and reproduction will be attached to each panther. Other prey species of the panther (e.g. lagomorphs and small carnivores) will be included in the model in a non-individual-based manner. In particular, an individual-based model allows us to synthesize the population and natural history data that has been collected on the Florida panther in the form of a predictive model.

The model will then be used to analyze the indirect effects of various hydrological management schemes (C-111 GDM proposed scenarios) on a subpopulation of panthers within the project area, through effects on prey, and taking account of demographic stochastic effects operating on that local

panther population. Alternative runs of the model will first be made to determine the dependence of model behavior on initial conditions (initial numbers and distribution of panthers and their characteristics). To remove effects of initial conditions, the model will be run for an appropriate time period (determined from the above mentioned simulations), and the predicted spatial distribution and abundance of panther from this initial model run will be used to initialize all further simulations, with a single set being used for all alternative hydrologic scenarios.

Since the model contains stochastic components for individual behavior as well as mortality and reproductive factors, a number of simulations will be run for each alternative hydrologic scenario. Output from these will be compared, including: spatially-averaged mean population size over time, spatially-averaged mean population structure over time, the variance of these, and the fraction of model runs in which the population fell below certain threshold values. The latter of these allows for a risk assessment to be done concerning the relative probability under alternative scenarios for the population to remain above some viable level. Also to be considered will be the spatial structure of the population and how this changes over time under alternative scenarios.

Data Gaps and Related Constraints

We believe the limitations associated with the use of this model are due to a general lack of information about particular panther behaviors. Thus, the model will include of necessity a number of assumptions about mating success, fecundity, home range, and movement patterns for which there are not adequate data from the Everglades alone to assess. A key assumption however is that data on panthers from many different locations in the U.S. (not necessarily the Florida panther), studies on single life stage components, and observations of various behaviors, may be reasonably combined to provide a model which covers the entire life cycle.

Model Performance Evaluation

The model described above is currently under construction. Upon its completion, the model will be parametrized and the code verified. The model's performance will then be checked through a sensitivity analysis and tested against empirical data.

Literature Cited

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