Florida Panther Demography and Population Viability

Jeffrey A. Hostetler, Ph.D.

April 25, 2016
Scientific Review Team (SRT, 2003)

- Rigorous estimates of survival and reproductive parameters not currently available
- Previous population viability analyses unreliable
- Genetic restoration
  - Important management experiment
  - Potentially wide-ranging consequences
  - Critical to measure effects
Outline

• Demography
• Population dynamics and viability
• Genetic restoration
• Thoughts on current and future work
Survival and Reproduction of Florida Panthers
Data

- Radio-tracking
- Cause of death
- Den checks
- PIT tagging
  - Recaptures
  - Recoveries
- Litter failures
- Genetic ancestry and heterozygosity
- Abundance index
Statistical Methods

- Adult survival: Cox proportional-hazard
- Kitten survival: mark-recapture-recovery
- Probability of reproduction: binomial regression
- Litter size: cumulative logit regression
- Information-theoretic
Sub-Adult and Adult Survival

- Sex and age
  - Females survive better, fewer intraspecific aggression deaths
  - Female survival peaks early, male later
- No evidence of effect of abundance

Density-Dependent Kitten Survival

Kitten Survival Summary

• Kitten survival estimated lower than expected (0.32)
• Panther abundance reduces kitten survival
Survival Results Update

Very similar results with data through 2013
van de Kerk et al. in revision. *Conservation Biology.*
van de Kerk et al. in revision. *Conservation Biology.*
Inverse Density-Dependent Probability of Breeding

Litter Size by Age

Age Class

Sub-Adult

Average Litter Size

0.0
0.5
1.0
1.5
2.0
2.5
3.0

Adult

Reproduction Summary

• Age
  – Older-adults lower probability of breeding
  – Sub-adults higher litter sizes

• Panther abundance increases probability of breeding but not litter size

Population Dynamics and Viability of Florida Panthers
Population Modeling

• Data
  – Survival and reproductive estimates from previous section

• Growth analyses
  – Population projection matrices
  – Female or two-sex, age-structured, birth-flow
  – Estimated deterministic and stochastic
    • Growth rates ($\lambda$ and $\lambda_s$)
    • Elasticities

\[ n(t + 1) = A(t)n(t) \]
Population Viability Analysis

- Environmental and demographic stochasticity
- Density-dependence
- Uncertainty
- Estimated
  - Probabilities of extinction
  - Probabilities of quasi-extinction
Growth Rates and What Affects Them

• $\lambda = 1.04$ (90% CI: 0.95 – 1.14)
• Suggestive of growing population
• $\lambda$ has highest elasticity to female prime-adult survival
• $\lambda_s = 1.03$ (95% CI: 0.95 – 1.11)

Cumulative Probability of N<10

Stochastic Elasticities

Preliminary Updated Probability of N<10

van de Kerk et al. in prep.
Did Genetic Restoration Save the Florida Panther?

Background

Demography

PVA

Genetics

Discussion
Florida Panther Genetic Restoration

- Evidence of inbreeding depression
- 8 adult female Texas pumas released in 1995
- 5 of these reproduced
- Produced 12 litters; ≥ 20 admixed kittens
- Dramatic changes in the population

Background Demography PVA Genetics Discussion
Objectives

• How genetic restoration affected
  – Demographic parameters
  – Population growth rate
  – Probability of quasi-extinction
Restoration Increased Survival


No Positive Effect of Restoration on Female Reproduction

Restoration Led to Population Growth

• $\lambda = 1.04$ (90% CI: 0.95 – 1.14)
  • Suggestive of growing population
• Ran deterministic matrix model for canonical panthers
  • $\lambda = 0.95$ (90% CI: 0.83 – 1.08)
  • Suggestive of shrinking population
• Main difference due to kitten survival

Restoration Reduced Risk of N < 10

van de Kerk et al. in revision. *Conservation Biology.*
Introgression Survival Update

Background
Demography
PVA
Genetics
Discussion
Was the Genetic Restoration a Success?

- Increased genetic diversity, decline in inbreeding traits
- Increased fitness, notably kitten survival
  - Apparently persistent benefits so far
- Increased population size
  - Other factors probably also contributed
- Pretty strong evidence that genetic restoration CAN help save populations
Our PVAs

Caveats

• No catastrophes
• Most data collected during period of population increase
• Assumes no habitat changes
• No genetic stochasticity

Strengths

• Incorporates rigorous estimates of vital rates and their variation
• Environmental and demographic stochasticity
• More realistic birth-flow modeling
• Density dependence
• Uncertainty
• “What might have been” scenario
Management Implications

• Florida panthers still exist in small, isolated population
• Future genetic restorations may be required
• New model could be used to address this and other future management scenarios
  – Reintroduction
  – Changes in roadkill mortality
• Assessing other threats may require other approaches
Thank You!

Collaborators

- Madan Oli
- Dave Onorato
- Madelon van de Kerk
- Ben Bolker
- Jim Nichols
- John Benson
- Warren Johnson
- Melody Roelke
- Stephen O’Brien
- Deborah Jansen
- Darrell Land
- Mark Cunningham
- Robert Belden
- Roy McBride
- Mark Lotz
- Dave Shindle
- And more!