Florida Panther Working Group Meeting
Archbold Biological Station
Lake Placid, FL

19 October 2000

Below is a synopsis of the 19 October 2000 Panther Working Group Meeting.

A regular meeting of the Florida Panther Working Group (Group) was held in the auditorium of the Archbold Biological Station, Lake Placid, Florida, on October 19, 2000 and called to order at 10:10 AM by Mr. Brian Millsap, Florida Fish and Wildlife Conservation Commission (FWC) with the following members (acting), including Mr. Millsap, in attendance:

Mr. John Kasbohm, U.S. Fish and Wildlife Service (FWS)
Mr. John Donahue, Big Cypress National Preserve (BCNP)
Mr. Peter David, South Florida Water Management District (SFWMD)

Mr. Dana Bryan, Florida Department of Environmental Protection, and Mr. Don Bethancourt, U.S. Forest Service, were not in attendance.

Introduction

After calling the meeting to order, Mr. Brian Millsap asked all the acting Group members and the 13 persons in attendance to introduce themselves. The Agenda was introduced (Attachment 1). Prior to proceeding with the Agenda, Mr. Millsap discussed his desire to conduct this and future meetings as an open meeting whereby attendees would be permitted to interact fully with the Group.

Merit process: Progress and Anticipated Results

Ms. Dawn Jennings, FWS - Vero Beach, presented background information on the Multi-species Ecosystem Recovery Implementation Team (MERIT) and its Florida panther sub-team (Attachment 2). A South Florida Recovery Team preceded MERIT and was tasked with completing a multi-species recovery plan for South Florida. This Recovery Plan was completed and is available on compact disk (CD). The Recovery Team was disbanded and the MERIT team was assembled to begin implementing the multi-species recovery plan. The first sub-team of MERIT was the Florida panther group and they have been tasked with developing a spatially-explicit model to identify existing occupied and potential panther habitat as well as examining potential consequences of habitat alterations to the panther population.

Ms. Jennings presented an overview of modeling work performed by Mr. Randy Kautz, FWC - Office of Environmental Services, Tallahassee (Attachment 3). The Kautz modeling process involved a change detection analysis, performed by a Geographic Information System

(GIS), in vegetation types from 1986-96 and the creation of a panther potential habitat map based on published data. The GIS was used to delineate 25 large, contiguous blocks of remaining panther habitat and the core panther areas. A least-cost surface was then created through GIS whereby habitats were ranked according to their panther preferences with the lower the numerical rank representing better panther habitat. Linkages among the large blocks of panther habitat are created that reflect the pathways of least resistence (i.e., travel through better panther habitat as indicated by the lower rankings).

Mr. Darrell Land pointed out that the GIS modeling and the distribution of panther telemetry locations were independent of each other, yet there is a good deal of concurrence between the maps.

Ms. Jennings summed up by saying that at the next panther sub-team meeting (7 December 2000, Vero Beach) the model would be refined further. This modeling process is expected to yield discrete maps that will have application as regulatory tools for use by the FWS in their panther recovery efforts.

Mr. John Kasbohm, FWS, asked for clarification on how the various FWS panther activities are being coordinated. Ms. Jennings replied that the MERIT panther sub-team is tasked only with habitat issues pertaining to the South Florida population. Another recovery team is being assembled by Mr. Kasbohm to develop a new panther Recovery Plan and this plan may draw upon the panther portion of the Multi-species Recovery Plan. The new Recovery Plan will take precedence over the South Florida recovery plan.

Update on Memorandum of Agreement

Mr. John Kasbohm, FWS, updated the group on the status of the Memorandum of Agreement (MOA). The MOA has been sent for legal review to the respective agencies that will be represented on the Working Group: the Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, U.S. Forest Service, U.S. Fish and Wildlife Service, South Florida Water Management District, and National Park Service. To date, the MOA’s have not been signed so technically, the Working Group has yet to be formally appointed.

Removal of Female Texas Pumas

Mr. John Kasbohm, FWS, began by stating that eight female Texas puma were released in 1995 and four are still alive today. Two of these female Texas pumas, TX101 and TX107, have produced 4 and 5 offspring respectively. All four of TX101's and two of TX107's offspring have been recruited into the panther population as breeders. The Plan for Genetic Restoration defined a goal of producing two successful recruitments per released Texas puma, therefore both

TX101 and TX107 have met that goal. In order to avoid over-representation by individual Texas puma, the FWC, in consultation with FWS, implanted contraceptives into both females. TX101 died last spring, but TX107 is still occupying portions of Big Cypress National Preserve.

Mr. Kasbohm continued that the FWS would like each Texas puma removed from the wild after they reach their recruited offspring goal, and the FWS has sent a letter to FWC seeking assistance with the capture and removal of TX107. The FWS letter states that FWS will assume full responsibility for the disposition of the pumas and that White Oak Plantation has agreed to house temporarily any removed puma and will seek to place these cats in suitable permanent facilities.

Mr. Brian Millsap informed the Working Group that FWC, in order to stay within their internal policies, made three requests to Texas Parks and Wildlife to allow the return of individual pumas to their former ranges, but all three requests were denied. Mr. Millsap continued by stating that the FWC is reluctant to assume responsibility for the welfare of captive wildlife, so the FWC supported contraception and keeping the pumas in the wild. The FWC did recognize that these Texas puma would be taking space that could be adopted by Florida panthers. After calling FWC headquarters, Dr. Brad Gruver, informed the Working Group that a letter had been sent back to FWC agreeing to assist with the removal of TX107 as recommended.

Ms. Deborah Jansen, Big Cypress National Preserve (BCNP), provided a map and description of TX107's recent movements and in particular her movements 3 months after the contraceptive was implanted (Attachment 4). At the time of TX107's capture and contraception, the cat was known to be with a male panther and sperm was found in vaginal smears. Three months later, the approximate gestation period, TX107 began utilizing a small area of her range, typical to that of a denning panther. To date, there is no evidence that kittens were produced and veterinary opinions suggest that the contraceptive may produce side-effects that could explain such behavior, such as false denning or the mummification of fetuses. Ms. Jansen stated that the possible presence of kittens should be explored prior to removal of TX107.

Mr. John Kasbohm pointed out that the letter from FWS recognized that additional offspring from female Texas pumas who have met reproductive goals were not wanted and they should be removed as well.

Mr. Sumner Matthes, Sarasota Defense of Animals, stated that he had reservations about removing any Texas pumas and that he would like to be kept informed of any decisions to place permanently the removed cats at any wildlife facility.

Mr. John Donahue, Big Cypress National Preserve, asked for a letter from the FWS explaining the need to remove TX107 so that the Preserve can consult with the local Indian Tribes.

Update on Captive Breeding Program

Mr. Jim Krakowski, FWS, reported that a decision at the last Florida Panther Interagency Committee (precursor to the Working Group) authorized a new Florida Panther Captive Breeding Plan (Attachment 4). There are six panthers in captivity, two of each sex at White Oak Plantation, Jacksonville Zoo, and the Lowry Park Zoo in Tampa. The male at Lowry Park Zoo is cryptorchid (no descended testicles) and is effectively sterile and the two cats at Jacksonville are siblings. The two cats at White Oak have been caged together and the female has shown periodic signs of estrous, but to date, no pregnancies have occurred.

Status and Need for Department of Interior's Proposed Second Capture Team

Mr. Jim Krakowski, FWS, reported that the current FWC panther capture team is doing a good job, but that FWS staff in Vero Beach have requested that more panthers be captured in northern Collier and Lee counties so that these potential data could be used in permit reviews. The current FWC team, according to Mr. Krakowski, does not have the time to accomplish these needs and therefore he is proposing forming a second panther capture team within the Department of Interior. Mr. Krakowski ended by saying that there is a poor likelihood of fielding a team for the upcoming 2000-01 capture season due to lack of funding and logistics of forming a team in a short amount of time. However, Mr. Krakowski indicated that a budget proposal has been submitted to the FWS Regional Office to see if new funding can be secured.

Sumner Matthes asked why the Florida Panther Trust Fund couldn't fund a second team. Mr. Brian Millsap responded by informing the Working Group that trust fund dollars are very low and that expenses are exceeding income. Ms. Jerrie Lindsey, FWC, added that 95% of the sale of panther specialty license plates goes to the Trust Fund.

[the meeting was adjourned for lunch at noon and resumed at 1:15 PM]

Panther Occurrence North of the Caloosahatchee River

Dr. Jim Layne, Archbold Biological Station, asked to add this item to the Working Group Agenda. Dr. Layne reviewed a history of panther sightings he has accumulated and presented a map of these sightings as well as a map showing four radiocollared panthers that used areas north of the Caloosahatchee River. Dr. Layne stated that there are panthers in south-central Florida and that in his opinion the people in the area support panthers. He referred to a suggestion from Dr. Dave Maehr that a bridge-type structure might be needed to allow panthers easier access across the Caloosahatchee River. Dr. Layne's recommendations were 1) to ensure continued existence of natural corridors leading to the river from the south and away from it to the north for dispersing cats and 2) to relocate cats north of the Caloosahatchee either to establish (if no resident population exists) or enhance an existing population in south-central Florida. Expansion of the existing population size would not negate the need for reintroduction elsewhere in the panther's former range and it would provide an additional safety margin for population persistence.

Panther Habitat Protection on Private Lands

Mr. Jim Krakowski, FWS, gave an overview of land acquisitions that have benefitted panthers south and north of the Caloosahatchee River. Referring to priority habitats defined in the FWS's Florida Panther Habitat Protection Plan (HPP), Mr. Krakowski stated that 551,400 and 457,700 acres of panther habitat were identified south and north of the Caloosahatchee River. Since 1994, 105,000 and 81,800 acres (19% and 18%) have been publically acquired, respectively south and north of the river. Mr. Krakowski pointed out that many lands identified by the Save our Rivers program overlap with important panther habitat areas.

Genetic Analyses Update

Mr. Darrell Land, FWC, began by informing the Working Group that travel arrangements prevented Dr. Warren Johnson, National Cancer Institute, from presenting an update on the progress of panther genetic analyses underway at Dr. Steven O'Brien's lab in Washington, D.C. Mr. Land handed out a brief report from Dr. Johnson that offered the kind of analyses that are currently underway, plus several previously published articles on panther genetics (Attachment 5). A figure provided by Dr. Johnson showed that genetic analyses could segregate panther samples into distinct groups (panthers, Texas pumas and their offspring, Seminole cats, Everglades cats, and Piper stock). Mr. John Kasbohm asked whether the analyses were performed on nuclear or mitochondrial DNA and Mr. Land replied the analyses were of mitochondrial DNA. Mitochondrial DNA is inherited from maternal lines, thereby explaining why progeny of female Texas pumas aggregate with their mothers and not Florida panthers.

Mr. Land briefed the Working Group that Genetic Restoration was apparently on track to achieving a 20% representation of Texas puma genes in the panther population. Of the eight released female Texas pumas, 5 have produced offspring and there are 36 known descendants, 25 of which are thought to be alive today. There is a concern, however, that most of the descendants originated primarily from two of the pumas, so there has been unequal representation of Texas genetic material in the Florida panther population. A CD was distributed containing the latest FWC Annual Report on Florida Panther Genetic Restoration as well as a host of other documents.

Role of Working Group

Mr. Brian Millsap, FWC, stated that he believes the Working Group should function as coordinating and review body for all panther-related activities. Mr. Millsap advised the Working Group that the FWC is in the process of ending a 6 year Florida Panther Genetic Restoration Study and will be developing new panther-related internal study plans. These plans will be submitted to the group for review. Mr. Millsap would like to see all parties follow the same procedures as they plan future panther work or to identify panther research and management needs. Through general consensus, the Working Group agreed to this role.

Discussion of Proposed Panther Management Plan/Translocating Panthers

Mr. Sonny Bass, Everglades National Park, described the need for an overarching panther management plan. This plan would be useful in decision-making processes such as if or when to translocate panthers within areas occupied by Florida panthers. Mr. Darrell Land agreed with the concept, but expressed that a plan capable of providing guidance for all relevant issues would not be possible. Mr. Millsap suggested that the translocation issue might serve as a good model for developing a component of an overall plan and asked Mr. Bass if he would like to head up that effort. Mr. Bass agreed to pursue acquiring information and begin developing a draft plan. Mr. Darrell Land and Mr. David Shindle, FWC, said they had pertinent literature on the issue and would offer assistance to Mr. Bass. Mr. Jim Krakowski offered the assistance of Mr. Larry Richardson, Biologist, FPNWR with the process as well.

Future Directions for FWC Panther Activities

Mr. Brian Millsap added this item to the Agenda so that he could share with the Working Group the FWC's thinking with regards to new technology development that could be important to panther conservation strategies. The FWC's current panther study plans end this fiscal year and that new plans will have to be developed. The FWC is currently developing proposals to evaluate Global Positioning Systems (GPS) telemetry equipment, use of remote cameras for censusing panthers, remote acquisition of DNA samples through biopsy darts, and the feasability of extracting DNA from panther scats. The FWC will also be resurrecting a Peripheral Range Study to document the occurrence of panthers north of the Caloosahatchee River. Mr. Millsap reiterated an earlier comment that these proposals would be submitted to the Working Group for review when drafts are completed.

Next Meeting Date

The task of planning the next Working Group meeting was passed to Mr. John Kasbohm as per the earlier arrangement to rotate the responsibility between FWC and FWS. The Working Group intended to meet a minimum of twice per year and through general consensus, a meeting around the first of February 2001 was agreed upon. Mr. John Donahue, Big Cypress National Preserve, offered the Preserve Headquarters as a meeting place. The meeting was adjourned at 3:00 PM.

Attachment A

Florida Panther Working Group Meeting
19 October 2000
Acting Working Group Members

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Florida Panther Working Group Meeting
19 October 2000

Attendees

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Mr. Sumner D. Matthes
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Attachment 1

AGENDA

Florida Panther InterAgency Working Group

Archbold Biological Station
Lake Placid, Florida

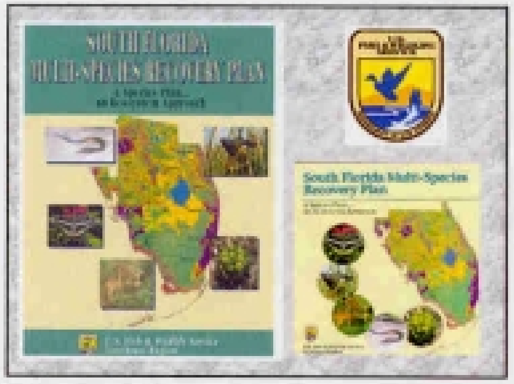
10:00 AM - 3:00 PM

19 October 2000

Update on Memorandum of Agreement	John Kasbohm, USFWS
Removal of female Texas pumas	John Kasbohm, USFWS
Update on Captive Breeding Program	Jim Krakowski, USFWS
Panther Habitat Protection on Private Lands	Jim Krakowski, USFWS
Genetic Analyses Update	Darrell Land, FWC
MERIT process: Progress and Anticipated Results	Dawn Jennings, USFWS
Role of Working Group in Panther Planning	Brian Millsap, FWC
Status and Need for Department of Interior s Proposed Second Capture Team	Jim Krakowski, USFWS
Discussion of Proposed Panther Management Plan	Sonny Bass, ENP
Translocation of Male Panther to ENP	Sonny Bass, ENP

Attachment 2

South Florida Multi-Species Recovery Plan Implementation



Conceived to fulfill the first two objectives and one of the major elements of the South Florida Ecosystem Restoration Initiative:

Recover threatened and endangered species in South Florida

Restore and maintain biodiversity of the natural communities

Finalization Process

Public Review and comment of Technical Agency Draft for total of 8 months (2 separate volumes)

Final recovery plan (~2200 pages)
Approved May 1999

Available on CD-ROM or in printed format from Fish and Wildlife Reference Service (1-800-582-3421)

Available on internet at:
http://southeast.fws.gov/verobeach

An Ecosystem Approach to Recovery Planning

- 23 Ecological Communities
  - restoration actions to enhance biodiversity
- 68 Federally Listed Species
  - updates all recovery plans in one document

Designed to:

Assist with project planning, management actions, and environmental compliance

Provide information for use in interagency consultations and habitat conservation plans (sections 7 and 10 of the ESA)

Geographic Scope

19 counties

3 major watersheds:

- Kissimmee/Okeechobee/Everglades
- Caloosahatchee River
- Peace/Myakka Rivers

South Florida Multi-Species Recovery Plan Implementation

Contents of the MSRP

Introduction

The South Florida Ecosystem

The Ecological *Communities*

The Species

Implementation

IMPLEMENTATION

"Putting the Plan to Work"

Implementation

- Interagency Coordination/Partnerships
- Species Recovery
- Ecosystem Restoration
- Target Management Gaps
- Candidate Conservation, Reclassification and Recovery

MERIT

Multi-species/Ecosystem Recovery Implementation Team

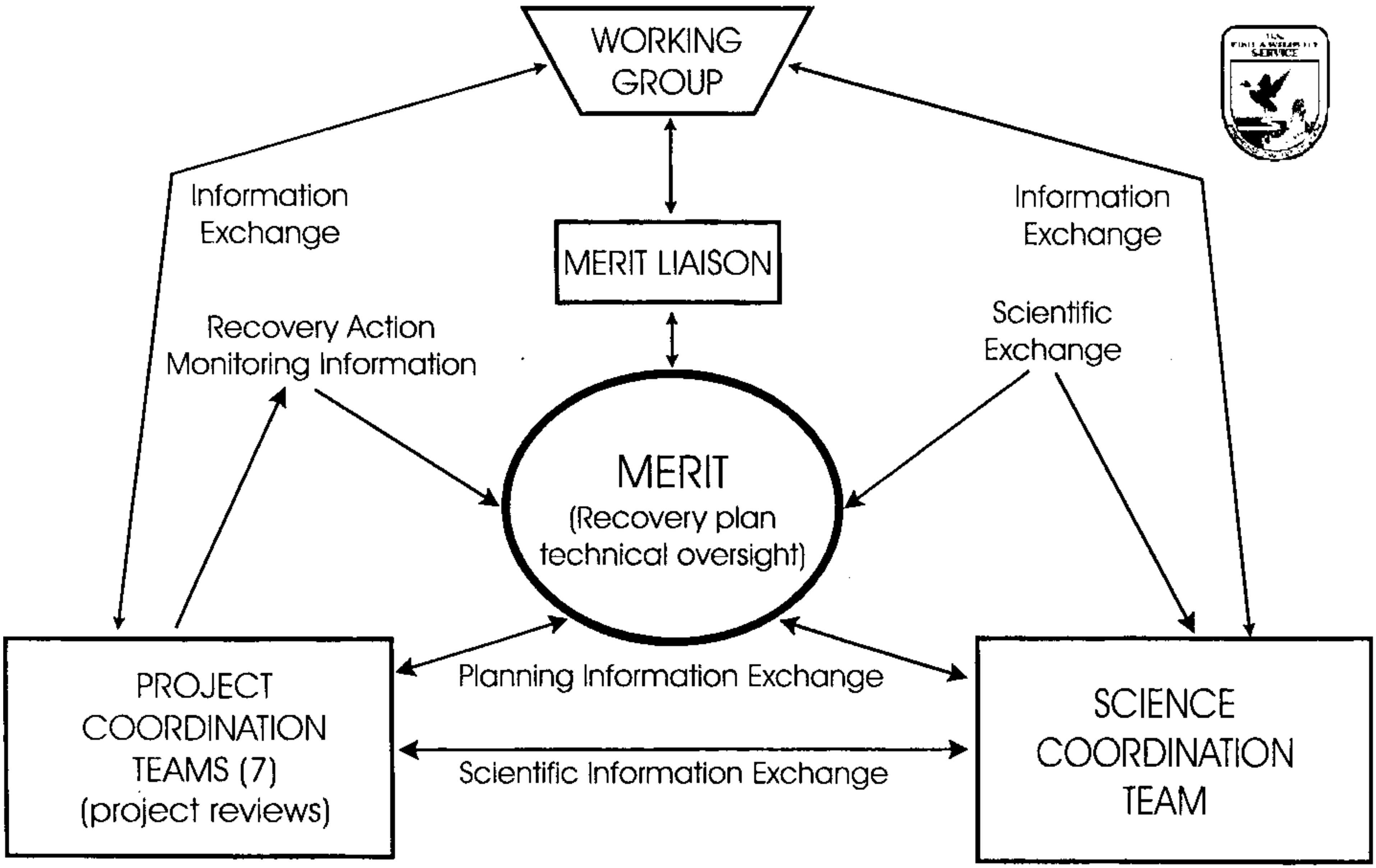
- Prioritize recovery and restoration actions identified in the Recovery plan (develop implementation schedule)
- Recommend on-the-ground recovery and restoration activities at the species and community level

MERIT will also:

- Lead recovery of listed species using an ecosystem approach
- Coordinate governmental, NGO, and private efforts
- Exchange information among Working Group activities
- Promote outreach to involve the public
- Evaluate success with monitoring and adaptive management

Additional Components of the Implementation Plan

- Liaison with Working Group: Interface with Working Group and MERIT on policy/decisional issues
- Project Coordination Teams: FWS representatives from all 7 subregions will coordinate with MERIT to integrate Recovery Plan at project level
- Science Coordination Team: FWS representative will coordinate with MERIT to implement on-the-ground recovery and restoration actions


WORKING GROUP
MERIT LIAISON
MERIT
(Recovery plan technical oversight)
Information Exchange
Recovery Action Monitoring Information
Information Exchange
Scientific Exchange
PROJECT COORDINATION TEAMS (7) (project reviews)
Planning Information Exchange
Scientific Information Exchange
SCIENCE COORDINATION TEAM

Florida Panther MERIT Subteam Activities - Summary

In February 2000, a subteam of the Multi-species/Ecosystem Recovery Implementation Team (MERIT) was appointed with the purpose of developing a spatially-explicit population model for the Florida panther in South Florida. The subteam includes 12 individuals representing academia, Federal and State agencies, and the Seminole Tribe. Eight of the members are also appointed to the overarching MERIT team. In addition, panther biologists from the Florida Fish and Wildlife Conservation Commission (FWC), Florida Panther National Wildlife Refuge and Jacksonville Ecological Services Office are invited to the meetings and sent meeting materials.

The spatially-explicit model for the panther will incorporate all of the data layers considered as panther habitat, as well as the currently available demographic data from the FWC database. To date, four meetings of the subteam have been held. A fifth meeting is scheduled for 16 November, 2000. A habitat map for the model has been selected and updated to reflect recent land use changes. The various community types that comprise the matrix of panther habitat have been scored to produce a "cost suitability surface" on the landscape coverage which the model uses to construct corridors and linkages between large patches of suitable panther habitat.

The product resulting from this effort will enable the Service to determine the extent and configuration of habitat essential to maintaining a viable population of panthers in South Florida. It will include steps necessary for protection of the cats and their habitat in this region. This information will also be useful for the overall recovery of the panther statewide. In addition, the conservation strategy will serve as a tool for regulatory decisions. Knowledge of the amount and configuration of habitat necessary to maintain a viable population of panthers will be useful for effect determinations, and for deciding on specific mitigation/compensation requirements for consultations under sections 7 and 10 of the Endangered Species Act.

MERIT TEAM MEMBERS

Member Name	Affiliation
Dr. Thomas Bancroft	The Wilderness Society
Ms. Gloria Bell	U. S. Fish and Wildlife Service
Mr. Jeff Bielling	Department of Community Affairs
Mr. Robert Bonde	U. S. Geological Survey, Biological Resources Division
Dr. Stephen Bortone	The Conservancy of SW Florida
Dr. Laura Brandt	A.R.M. Loxahatchee National Wildlife Refuge
Mr. David Burr	Southwest Regional Planning Council
Mr. George Dalrymple	Everglades Research Group
Ms. Sheryan Epperly	National Marine Fisheries Service
Mr. David Zeigler	Department of Transportation
Dr. Steve Godley	Biological Research Associates
Mr. Dennis Hardin	Florida Department of Agriculture and Consumer Services
Mr. Greg Hendricks	Natural Resources Conservation Service
Dr. Tom Hoctor	University of Florida
Ms. Mary Huffman	The Nature Conservancy
Ms. Deborah Jansen	National Park Service
Ms. Dawn Jennings[1]	U. S. Fish and Wildlife Service
Mr. F. K. Jones	Miccosukee Tribe of Indians of Florida
Mr. Randy Kautz	Florida Fish and Wildlife Conservation Commission
Mr. Gary Knight	Florida Natural Areas Inventory
Mr. Elmar Kurzbach	Department of the Army Corps of Engineers
Ms. Patty Lodge	Seminole Tribe of Florida
Dr. Thomas Lodge	LawGibb
Mr. Tom Logan	Florida Fish and Wildlife Conservation Commission
Ms. Laurie MacDonald	Defenders of Wildlife
Dr. Frank Mazzotti	University of Florida
Dr. Peter Merritt	Treasure Coast Regional Planning Council
Mr. R. S. Murali	Dames & Moore
Dr. Jim Newman	Pandion Systems, Inc.
Mr. John Ogden	South Florida Water Management District
Ms. Mary Ann Poole	Florida Fish and Wildlife Conservation Commission
Mr. Duncan Powell	U. S. Environmental Protection Agency
Dr. Karen Root	Applied Biomathematics
Mr. Peter Rosendahl	Florida Crystals Corporation
Mr. Jay Slack[2]	U. S. Fish and Wildlife Service
Mr. Skip Snow	National Park Service
Ms. Dawn Zattau	U. S. Fish and Wildlife Service
Mr. Herb Zebuth	Florida Department of Environmental Protection

[1]MERIT Recovery Team Leader
[2]MERIT/Working Group Liaison

FLORIDA PANTHER SUBTEAM OF MERIT

Member Name	Affiliation
Ms. Jane Comiskey	University of Tennessee
Mr. Greg Hendricks	Natural Resources Conservation Service
Mr. Tom Hoctor	University of Florida
Ms. Deborah Jansen	Big Cypress National Preserve
Ms. Dawn Jennings	U.S. Fish and Wildlife Service
Mr. Randy Kautz	Florida Fish and Wildlife Conservation Commission
Ms. Patty Lodge	Seminole Tribe of Florida
Dr. Dave Maehr	University of Kentucky
Dr. Frank Mazzotti	Center for Natural Resources-South Florida
Mr. Roy McBride	Livestock Protection Company, TX
Dr. Karen Root	Applied Biomathematics, NY

Invitees

Mr. Darrell Land	Florida Fish and Wildlife Conservation Commission
Mr. John Kasbohm	U.S. Fish and Wildlife Service
Mr. Jim Krakowski	U. S. Fish and Wildlife Service
Mr. Larry Richardson	U.S. Fish and Wildlife Service
Mr. Jay Slack	U.S. Fish and Wildlife Service

Attachment 3

FLORIDA PANTHER MERIT SUBTEAM

Florida Panther Potential Habitat and Landscape Linkage Modeling

Randy Kautz and Robert Kawula
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September 18, 2000

Model Steps

At the May 2, 2000, meeting, Florida panther MERIT subteam members reached consensus on a set of steps that should be taken to develop a refined model of potential panther habitat. The new model would include not only updated land cover information but would also identify landscape linkages that would be needed to connect isolated but important patches of habitat. The steps identified at the meeting, as drafted by Tom Hoctor, were as follows:

Steps towards identifying Florida panther habitat (Draft 5/4/00)

1. Create preliminary base map using either one accepted methodology or maybe a consensus overlay. Probably the most applicable "single" methodology, as discussed, would be to take the original Florida Fish and Wildlife Conservation Commission (FWC) methods (those found in the Closing the Gaps report) and apply them to an updated version of the FWC landcover map. The landcover map could be updated both through change detection analysis for completed counties and possibly by using 1995 water management district land use data where change detection is not completed. Having change detection for the entire study area would be preferred if possible. The result of step one should be a simple yes/no type map that delineates all areas as either potential panther habitat or non-habitat.

2. Using the potential habitat map created in step one, identify core blocks of panther habitat. Core blocks could be defined based on both size and location. Telemetry data and expert opinion could both be used to identify the core range for panthers and the habitat blocks that support the panther "core".

3. Identify secondary or peripheral blocks of potential panther habitat that may provide additional habitat and or connectivity. Such blocks could be identified based on size, location, and surrounding landscape matrix. Secondary blocks will typically be smaller than core blocks but they must also be "connected" to core blocks through a landscape matrix that will allow panther movement.

4. Consider eliminating blocks of potential habitat that are too small or too isolated to be effective habitat or contribute to connectivity. These blocks of habitat could be identified primarily based on level of isolation. For instance, blocks of habitat separated from core and secondary habitat by intensive land uses could be considered effectively isolated.

5. At this point it would be useful to develop estimates of how many panthers could be supported in the identified core and secondary blocks of panther habitat, both south and north of the Caloosahatchee River.

6. Identify additional lands necessary to support connectivity between core and secondary blocks south of the Caloosahatchee as well as between habitat areas south and north of the river. Although some connectivity will already be incorporated in step 1, especially if lower intensity agricultural land uses are included as potential secondary or supporting "habitat", other, longer landscape linkages such as across the Caloosahatchee River will probably need to be identified. A linkage suitability map and least cost path algorithm could be utilized for this purpose. A linkage suitability map could be based on landscape factors such as habitat block size, roadless area size, density of paved roads, land use type, distance from core panther range, etc.

7. Consider restoration of habitat in or near core habitat areas and critical landscape linkages as well as the inclusion of additional compatible agricultural lands for buffering and optimization of the reserve design.

8. Consider developing a quantitative/qualitative rating system for all identified potential habitat, similar to the methods used by FWC in Closing the Gaps and possibly incorporating elements of the linkage suitability map mentioned in Step 6. Such a rating system could be used, along with identified core habitat blocks and expert opinion, to identify: 1) essential habitat that must be protected; 2) support habitat where habitat loss should be avoided and any loss would require extensive mitigation; 3) peripheral potential habitat where retention should be encouraged and any loss would require mitigation. Mitigation should be a combination of both protecting existing panther habitat (within core habitat blocks first) and restoring areas identified in Step 7.

In order to develop a refined panther habitat model, we used the foregoing set of steps as a guideline. However, we did not follow these steps exactly, nor did we attempt to include all of the steps in our work to date. The results of our work to date, recounted below, were presented at the August 9, 2000, panther MERIT subteam meeting.

Refined Potential Habitat Model

We did not choose the Florida panther potential habitat model created by Cox et al. (1994) as the base model for refinement. Rather, we used the model created by C. Morea (Kautz and Morea 2000), which was derived from the 1993-94 vegetation data produced by the University of Florida Cooperative Fish and Wildlife Research Unit (Coop Unit), as the base model. In our opinion, using this model as the base model for refinement would result in the most up-to-date model possible. Not only was this model based on the most recent vegetation data available throughout the range of the panther, but also we could use the results of our change detection analysis to render the model current as of 1996 in five southwest Florida counties.

As reported at the February 25, 2000, panther MERIT subteam meeting, we have completed a change detection analysis for five southwest Florida counties (i.e., Collier, Lee, Hendry, Charlotte, Glades) (Figure 1). These are the most important areas for habitat conservation within the current range of the Florida panther. The change detection analysis involved (1) classification of 1996 Landsat imagery to identify disturbed lands, (2) overlaying the 1996 disturbed lands coverage on the 1986 vegetation data of Kautz et al. (1993) to identify areas disturbed between 1986 and 1996, and (3) labeling new disturbed lands as agriculture, urban, or other by comparing the results with water management district land use/land cover data and digital ortho quarter quads.

To refine the base panther potential habitat model in the five-county region, the vegetation data of Kautz et al. (1993) was updated by reclassifying recently disturbed lands from natural land cover types to agricultural and urban lands. Next, the techniques used by Cox et al. (1994) to model potential panther habitat were applied to the updated vegetation data in the five-county area. Finally, the new map of potential panther habitat in the five-county area was incorporated into the base map of potential habitat derived from the UF Coop Unit data. The map appearing in Figure 2 became the updated map of potential panther habitat used in subsequent steps.

Identification of Core Blocks of Habitat

We used information in Maehr (1997) to locate “core” blocks of habitat. Maehr (1997) identified lands referred to as core habitat (Figure 3) by drawing a polygon around an area in Collier and Hendry counties that contained most of the radio telemetry locations from years of data collection (Figure 4). The area is north of I-75 and west of SR 29 and straddles Big Cypress National Preserve, Fakahatchee Strand State Park, and adjacent private lands. We assume that contiguous patches of potential habitat contained within or extending beyond the polygon boundary should be treated as core panther habitats in the landscape linkage model. In other words, contiguous patches of panther habitat within the Maehr (1997) polygon were considered to be the source patches from which landscape linkage modeling would originate.

The next step in the linkage model was to identify large contiguous blocks of habitat that should be viewed as possible “destination” patches when running an algorithm designed to detect landscape corridors connecting core habitats to distant patches. This was accomplished by running the ArcView Spatial Analyst “regiongroup” routine on all patches appearing in the revised panther habitat model. This routine groups contiguous pixels of potential habitat into large contiguous patches of habitat. Then, the 25 largest contiguous patches of habitat (Figure 5) were extracted from the set of all contiguous patches. In this case, 25 is an arbitrary number that was assumed to be large enough to identify sizeable distant patches of habitat that could serve as destination patches that should be connected to core patches by a corridor model.

Corridor Modeling: Habitat Suitability Cost Surface

In order to model corridor connections from core to distant patches of habitat, it is necessary to develop a habitat suitability cost surface. A habitat suitability cost surface is a raster file that covers the entire area of interest. Cell values indicate the likelihood that panthers will travel through any given cell. Lower values are assigned to cells more likely to be used by panthers, and higher values are assigned to cells less suitable as habitat. Various methods may be used to assign values to cells. For example, cells may be scored simply in order of probability of use, in proportion to actual use, or arbitrarily on the basis of user perceptions of habitat value.

For the purposes reported here, we created a cost surface that used the Kautz et al. (1993) vegetation data as a starting point. We then updated the vegetation map by applying change detection results to Collier, Lee, Hendry, Charlotte, and Glades counties. Next, we used water management district land use/land cover data from the mid-1990s to subdivide the Kautz et al. (1993) grassland/agriculture and urban/barren classes into urban, row crops, and groves/orchards. Then, we imposed coverages of federal, state, and county roads obtained from the Florida Department of Transportation onto the vegetation data as a single road layer one pixel (30 m) wide. Thus, the original 22-class land cover data set of Kautz et al. (1993) was transformed to a 26-class data set that contained greater land use/land cover detail than the original and that had been updated to 1996 in the five-county region of southwest Florida.

Habitat suitability scores appearing in Table 1 were then assigned to the 26 land cover classes appearing in the refined land cover map. Habitat suitability scores for natural and disturbed land cover types derived from Maehr and Cox (1995) (Table 2). For the most part, the scores reflect the order in which panther radio telemetry points occur in each land cover type in proportion to the occurrence of each type in the landscape (i.e., habitat use versus availability). As shown in Table 3, Morea (2000) obtained similar results when using a slightly different method of analyzing panther radio-telemetry data in relation to land cover distribution using the UF Coop Unit vegetation data from 1993-94. For the cost surface, larger values were arbitrarily assigned to orchards/groves (i.e., citrus), row crops, roads, and urban areas to indicate that these land cover types are less suitable as panther habitat. Assigning higher values to these land cover types tends to steer the model of least cost landscape linkages away from disturbed lands. The fact that each disturbed land cover type has a value (as opposed to a value of “no data”) indicates that panthers do use these cover types under certain circumstances, but they are not highly suitable for use as landscape corridors.

The habitat suitability cost surface was further refined to give high priority to corridors that travel through public lands and especially to potential panther habitat on public lands. To accomplish this, all habitat suitability scores in Table 1 were first multiplied by 10. Taking this step maintained the relative rankings within the cost surface while ensuring that the computer could maintain fast processing speeds by having to work only with cells with integer values (and not floating-point values) during subsequent model runs. Next, public lands were overlaid on the cost surface, and cell values for all land cover types falling within public lands were divided by 2. Finally, the panther potential habitat map was overlaid on the cost surface within public lands, and cell values for all land cover types comprising potential panther habitat and falling within public lands were divided by 10. The resulting habitat suitability cost surface (Figure 6) was used to locate optimum landscape connections for Florida panthers. The cost surface contained a total of 42 habitat suitability scores with cell values as follows: 1-15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 90, 100, 110, 120, 125, 130, 140, 150, 200, 250, 255, 500, 1000, 1275. It is not possible to ascribe a specific landscape situation (e.g., pinelands on public land) to all habitat suitability scores because the method used to calculate scores allowed for more than one combination of conditions to produce the same score. However, the lowest scores generally represent natural land cover types found within the panther potential habitat model on public land.

Corridor Modeling: Identification of Landscape Linkages

Modeling least cost landscape corridors in ArcView Spatial Analyst involves four steps: (1) identification of a source habitat patch and a destination patch, (2) generating a region-wide cost surface from the source to the destination, (3) generating a second region-wide cost surface from the destination to the source, and (4) adding the two cost surfaces together to create a single grid with cell values that are the sum of the source-to-destination and destination-to-source least cost surfaces. The final output is a raster file of the entire region. The file contains a wide range of very large values that can be manipulated to produce a set of corridor scenarios to meet user needs.

To identify the source habitat patch for the corridor model, we overlaid the Maehr (1997) polygon of core population area on the regiongroup model that identified the 25 largest contiguous patches of habitat. The Maehr (1997) polygon intersected two large patches of contiguous habitat (Figure 5). These two patches were treated as a single source patch for the corridor model. The northern-most large patch in central Florida was selected from the set of 25 large contiguous patches as the destination for the corridor model. Based on radio-telemetry data, this is the patch that a dispersing male panther traveled to and remained in for about 1.5 years. The ArcView Spatial Analyst “corridor” function was used to develop accumulative cost surfaces from the source patch to the destination, and from the destination back to the source. The two accumulative cost surfaces were summed to obtain a grid file with cell values ranging from 2,484,402 to 60,978,980.

The power of the accumulative cost surface is that it can be manipulated to depict any number of possible corridor scenarios by simply dropping higher values from the grid. For example, restricting the accumulative cost surface to values <3,000,000 (Figure 7) produces a model of a linked landscape that optimizes connections south to north, includes many patches of habitat depicted in the original panther potential habitat model

(Figure 8), connects many of the 25 largest contiguous blocks of habitat, and contains the majority of available radio-telemetry locations. The model also identifies the area of north central Hendry County where several panthers have crossed the Caloosahatchee River (Figure 9). Restricting the corridor model to accumulative cost surface values <2,750,000 produces a landscape linkage model similar to the one just described, but it is smaller in total area and the landscape connections are narrower. Further restrictions to accumulative cost surface values yield corridor solutions that are even smaller in total area and that have narrower connections. At very low values, some connections actually disappear. In this trial and error manner, the user can manipulate the model to produce a result that can best meet the user's needs. For example, if the amount of habitat needed to support a viable population of panthers is known, the landscape model can be manipulated to identify the optimum placement of habitats in the landscape based on the area needed.

Our preliminary accumulative cost surface models that were restricted to values <3,000,000 produced landscape linkage solutions that appear to match fairly well with what one would expect on the ground. However, several small patches of panther habitat that contain radio-telemetry points in northeastern Hendry County were not connected to the core patches. This is largely because the model was trained to find the most suitable (i.e., least cost) connections between a large patch of core habitat and a large patch of potential habitat a great distance to the north. The smaller patches in Hendry County were a little "off the beaten path" with respect to the core and destination patches chosen for the model. Therefore, we initiated several other model runs to identify optimum landscape connections to patches known to have been used by panthers south of the Caloosahatchee River, the region of greatest importance to the extant population of panthers. This effort identified connections from core habitats to the small patches in northeast Hendry County (Figure 10). While we also tested for possible refinements to connections between core habitats and other large patches just south of the Caloosahatchee River, the results were the same as those produced by the larger model of connectors throughout the entire region.

Habitat Protection Priorities

A preliminary set of habitat protection priorities was developed prior to the August 9 meeting. The terminology and definitions for those categories were recently revised by the U. S. Fish and Wildlife Service to include both recovery and regulatory implications, and are presented here for consideration.

> <u>Foundation area</u>: the central area used by the current panther population based on habitat patch size and location, and known panther use based on telemetry and other information (e.g., tracking); permanent habitat loss through land use conversions and development incompatible with panther use will adversely affect and may result in take of panthers; continued permanent conversion and development threaten survival and recovery of panthers; adverse effects and incidental take of panthers in the foundation area must be minimized, and conservation measures must provide long-term beneficial effects to ensure panther survival and recovery; landscape emphasis

should be to provide panther breeding, feeding, and sheltering; restoration of panther habitat is a high priority.

Collateral areas: large blocks known to be used by panthers but outside of central population area; includes areas needed for connectivity and dispersal; adverse effects and incidental take of panthers in collateral areas must be minimized to ensure panther survival and recovery; landscape emphasis should be to support panther breeding, feeding, sheltering, and movement; restoration of panther habitat is encouraged.

Auxiliary areas: smaller, more isolated patches that are less important as habitat or connectors; patches either include some radio-telemetry locations or are near patches with telemetry locations; landscape could supplement panther breeding, feeding, and sheltering; restoration of panther habitat may be beneficial.

Marginal areas: the potential habitat model indicates that these patches may contain suitable habitat, but use by panthers is not documented by radio-telemetry points nor are the patches near to patches with known telemetry locations; habitat unlikely to be used by panthers (e.g., west of I-75); landscape does not support panther breeding, feeding, and sheltering; restoration for panther habitat is not encouraged.

Several sources of spatially explicit data are available for use in determining the locations of habitats within each category. Once identified, the methodology for determining conservation measures, including minimization and compensation, could be developed. For example, all land cover types within the foundation area need to be considered to ensure the survival and recovery of the Florida panther. Minimization and compensation measures in the foundation area must exceed the amount of the land adversely affected.

One possible source of spatially explicit data that could be used to locate specific areas of habitat meeting the above definitions would be the results of a group of Florida panther experts who made land acquisition recommendations to Florida Natural Areas Inventory biologists working on a needs assessment for the new Florida Forever program (Kautz 2000). This group identified first, second, and third priorities for acquisition of Florida panther habitat with all areas being south of the Caloosahatchee River (Figure 11). Natural land cover types within these areas could be considered as foundation and collateral areas, and disturbed lands (e.g., agriculture, pasture, low density residential) within these areas could be considered as auxiliary areas with less stringent compensation requirements. Compensation resulting from land use conversions within any of the areas should be directed to higher priority areas.

Another possibility would be to use the rankings applied by Kautz (2000) to panther strategic habitat conservation areas (Cox et al. 1994) for the Florida Forever conservation needs assessment (Figure 12). Kautz (2000) borrowed from the results of the panther experts' recommendations and developed a ranking system for strategic habitats that had five levels of priority. Strategic habitats falling within the priority areas identified by the work group were assigned the same priority as recommended by the work group. Strategic habitats falling outside of the areas recommended by the panther experts but south of the Caloosahatchee River were ranked as fourth priority. Strategic habitats north of the Caloosahatchee River in Charlotte, Glades, and DeSoto counties were ranked as fifth priority. Various scenarios of minimization and compensation of adverse effects from land use conversion could be developed based on the prioritized strategic habitats similar to those discussed above.

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Maehr, D. S., and J. A. Cox. 1995. Landscape features and panthers in Florida. Conservation Biology 9(5):1008-1019.

Morea, C. R. 2000. Florida panther potential habitat model. Unpublished report. Office of Environmental Services, Florida Fish and Wildlife Conservation Commission, Tallahassee.

Table 1. Habitat suitability scores used to develop cost surface.

Land cover type	Score	Land cover type	Score
Cypress swamp	1	Sandhill	10
Hardwood forest	2	Xeric oak scrub	10
Tropical hardwood hammock	2	Shrub and brush	10
Hardwood swamp	3	Salt marsh	11
Bottomland hardwood	3	Mixed hardwood-pine forest	12
Pinelands	4	Exotic plants	13
Freshwater marsh	5	Mangrove swamp	14
Grassland and agriculture	6	Water	15
Dry prairie	7	Orchards/groves/vineyards	15
Bay swamp	8	Row crops	20
Shrub swamp	8	Roads	25
Coastal strand	9	Urban	100
Barren	9	Background	255
Sand pine scrub	10		

Table 2. Panther habitat use versus availability based on a comparison of radio-telemetry locations to a randomly generated set of points (Maehr and Cox 1995).

Land cover type	Percent Used	Percent Available
Cypress swamp	31.8	8.1
Hardwood forest	23.2	5.0
Hardwood swamp	17.4	0.7
Pinelands	7.3	8.1
Freshwater marsh	5.8	31.9
Grassland and agriculture	4.5	17.9
Dry prairie	3.3	6.9
Shrub swamp	2.8	3.9
Barren and urban	1.4	6.5
Shrub and brush	0.8	2.4
Salt marsh	0.7	0.0
Mixed hardwood-pine forest	0.7	0.4
Exotic plants	0.1	0.0
Mangrove swamp	0.0	2.8
Water	0.0	3.9

Table 3. Area of 1993-94 UF Coop Unit land cover types within 120 m of Florida panther radio-telemetry locations in comparison to the area of each land cover type within the minimum convex polygon that includes all telemetry locations (Morea 2000).

Land cover type	Acres Used	Acres Available	Percent Used
Swamp Forest Ecological Complex	23,969	103,860	23.1
Cypress Forest Compositional Group	15,854	131,474	12.1
South Florida Slash Pine Wodland	9,152	43,427	21.1
Semi-deciduous Tropical/Subtropical Swamp Forest	7,548	34,580	21.8
Sawgrass Marsh	7,187	371,232	1.9
Dwarf Cypress Prairie	6,120	62,021	9.9
Tropical Hardwood Hammock Formation	5,992	15,032	39.9
Muhly Grass Marsh	5,534	90,277	6.1
South Florida Slash Pine Forest	4,030	30,523	13.2
Graminoid Emergent Marsh Compositional Group	4,653	128,538	3.6
Saturated-Flooded Shrubland Ecological Complex	4,390	124,958	3.5
Pasture/Grassland/Agriculture	3,037	465,242	0.7
Brazilian Pepper Shrubland	2,473	6,892	35.9
Agriculture	1,388	286,858	0.5
Agriculture/Groves/Ornamental	784	151,846	0.5
Mesic-Hydric Pine Forest Compositional Group	590	136,481	0.4
Open water	361	170,830	0.2
Spikerush Marsh	319	18,265	1.7
Urban	275	43,238	0.6
Live Oak/Sabal Palm Ecological Complex	270	2,212	12.2
Bare soil/Clearcut	266	13,582	2.0
Forb Emergent Marsh	251	24,138	1.0
Cajeput Forest Compositional Group	205	2,187	9.4
Pavement, Roadside	178	8,198	2.2
Dwarf Mangrove Ecological Complex	169	21,272	0.8
Cattail Marsh Compositional Group	138	16,988	0.8
Cloud	96	4,796	2.0
Dry Prairie (Xeric-Mesic) Ecological Complex	82	67,943	0.1
Mixed Mangrove Forest Formation	77	41,755	0.2
Water Lily or Floating Leaved Vegetation	78	21,152	0.4
Flooded Shrubland Compositional Group	76	21,612	0.4
Graminiod Dry Prairie Ecological Complex	71	11,847	0.6
Xeric Scrubland	65	12,725	0.5
Bay/Gum/Cypress Ecological Complex	64	20,453	0.3
Sparsely Wooded Wet Prairie Compositional Group	51	4,305	1.2
Xeric-Mesic Live Oak Ecological Complex	47	16,496	0.3
Sandhill Ecological Complex	38	4,734	0.8
Gallberry/Saw Palmetto Shrubland Group	28	42,644	0.1
Saltwort/ Glaswort Ecological Complex	23	2,862	0.8

Table 3. Continued.

Land cover type	Acres Used	Acres Available	Percent Used
Sand Pine Forest	27	5,605	0.5
Red Mangrove Forest	18	6,296	0.3
Urban Open/Others	18	28,406	0.1
Urban Residential	16	57,960	0.0
Buttonwood Woodland	15	3,095	0.5
Sand Cordgrass Grassland	14	6,546	0.2
Evergreen and Mixed Shrubland Compositional Group	13	5,107	0.3
Black Needle Rush Marsh	11	5,203	0.2
Salt Marsh Ecological Complex	8	2,558	0.3
Sand, Beach	7	369	1.9
Mixed Mangrove Woodland	5	662	0.8
Red Mangrove Woodland	4	1,207	0.3
St. Johns Wort Shrubland Compositional Group	3	6,730	0.0
Black Mangrove Woodland	2	679	0.3
Temperate Wet Prairie	2	3,742	0.1
Black Mangrove Forest	1	1,203	0.1
Extractive	1	1,837	0.1
Maidencane Marsh	1	7,397	0.0
Recreation	0	2,013	0.0

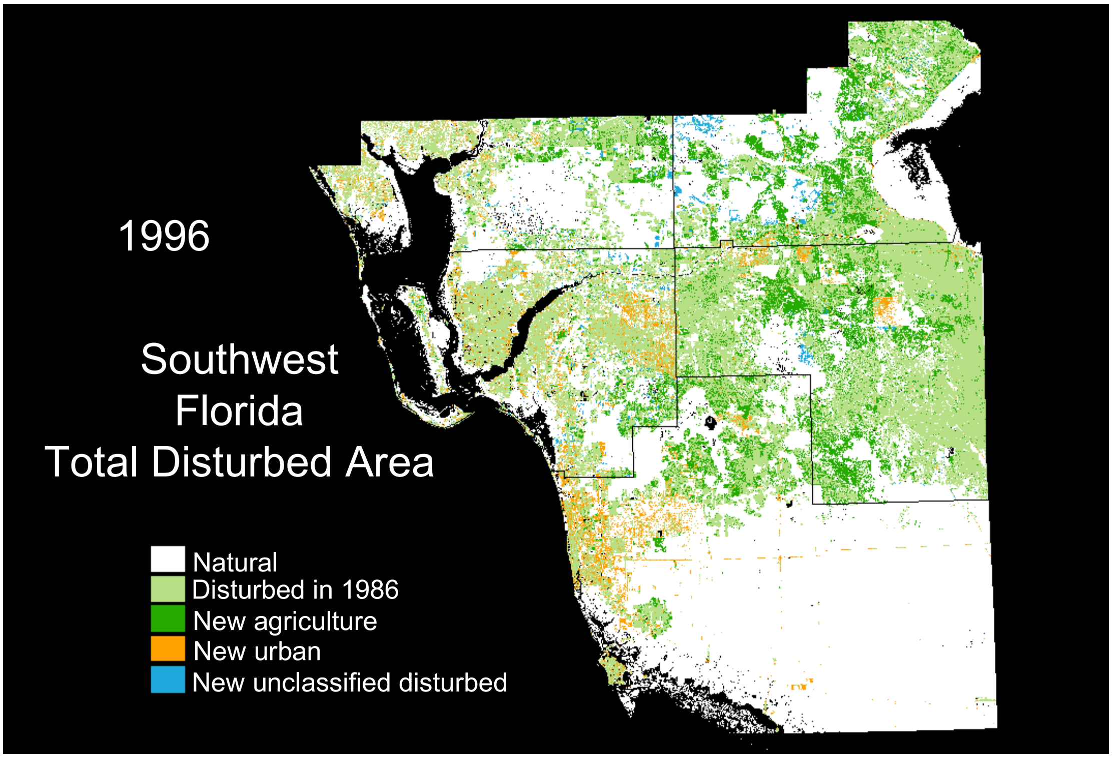


Figure 1. 1986-96 change detection analysis results for Charlotte, Glades, Lee, Hendry, and Collier counties, Florida.

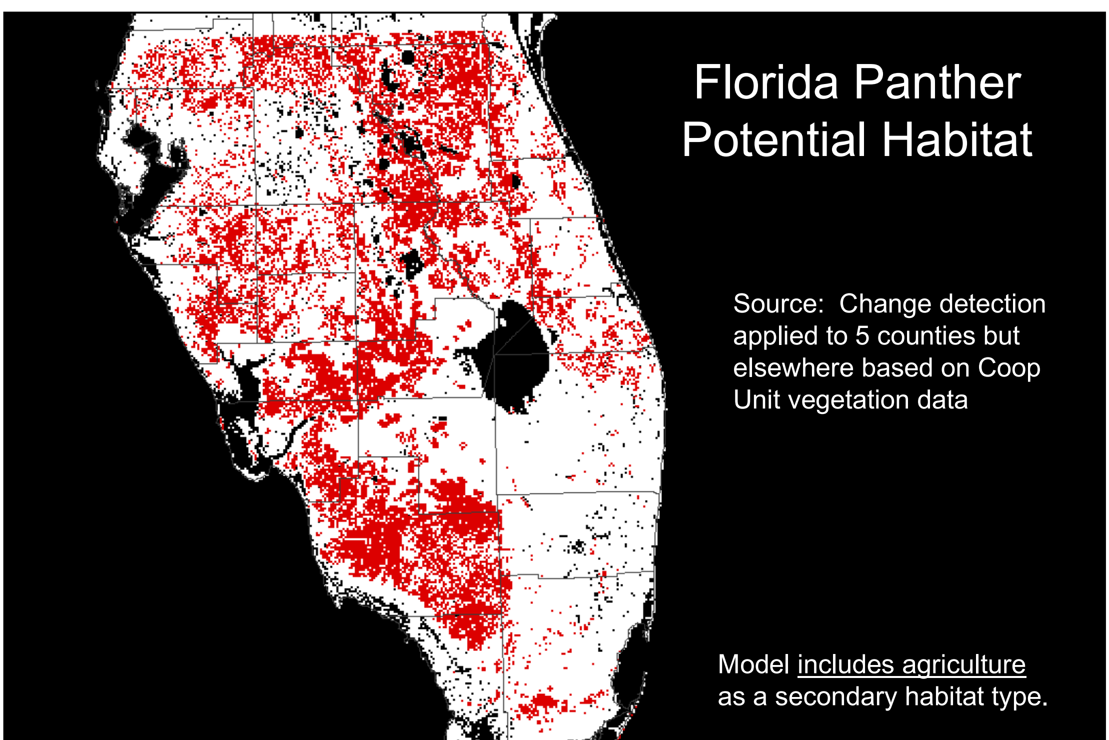


Figure 2. Revised Florida panther potential habitat map. Base map derived from University of Florida Coop Unit vegetation data, but with change detection results applied to five southwest Florida counties.

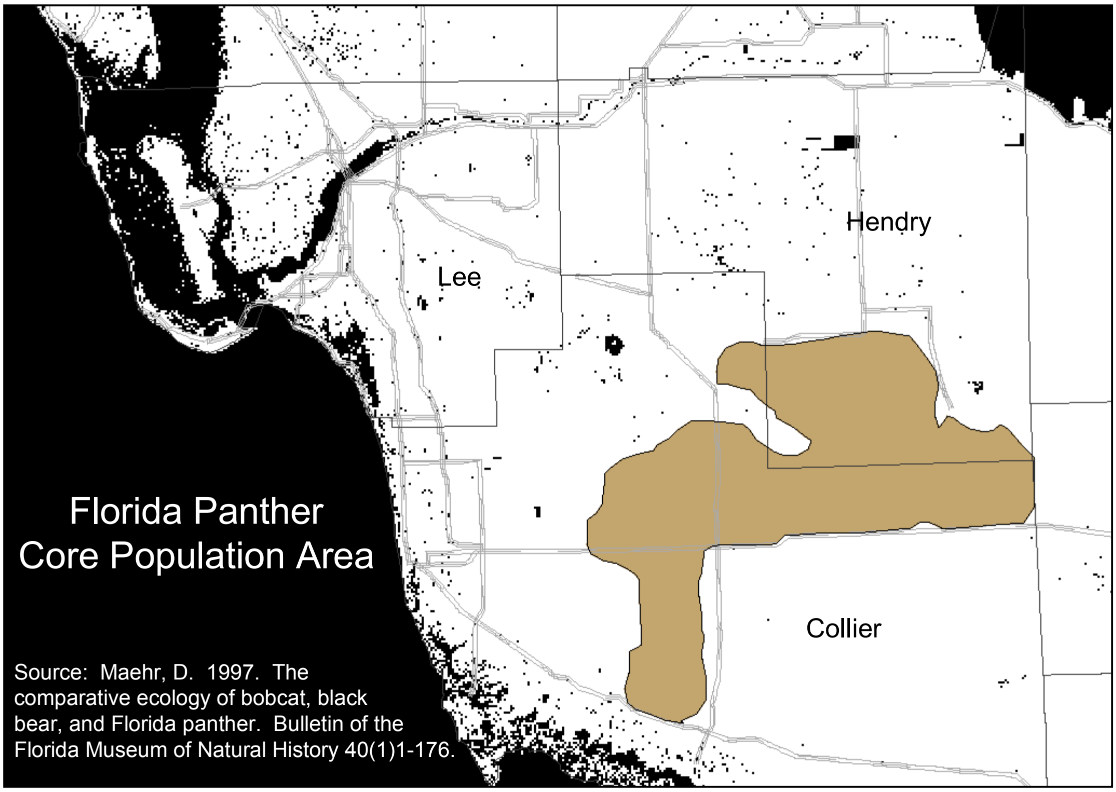


Figure 3. Florida panther core population area as defined by Maehr (1997).

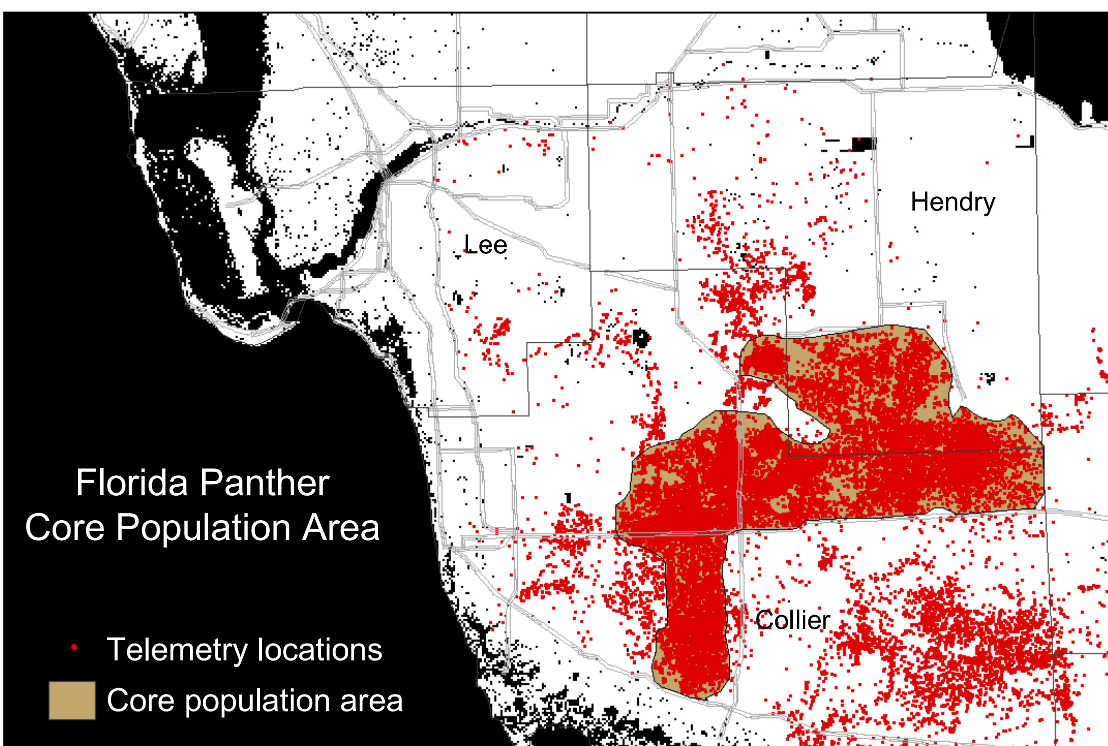


Figure 4. Florida panther core population area (Maehr 1997) in relation to current radio-telemetry locations.

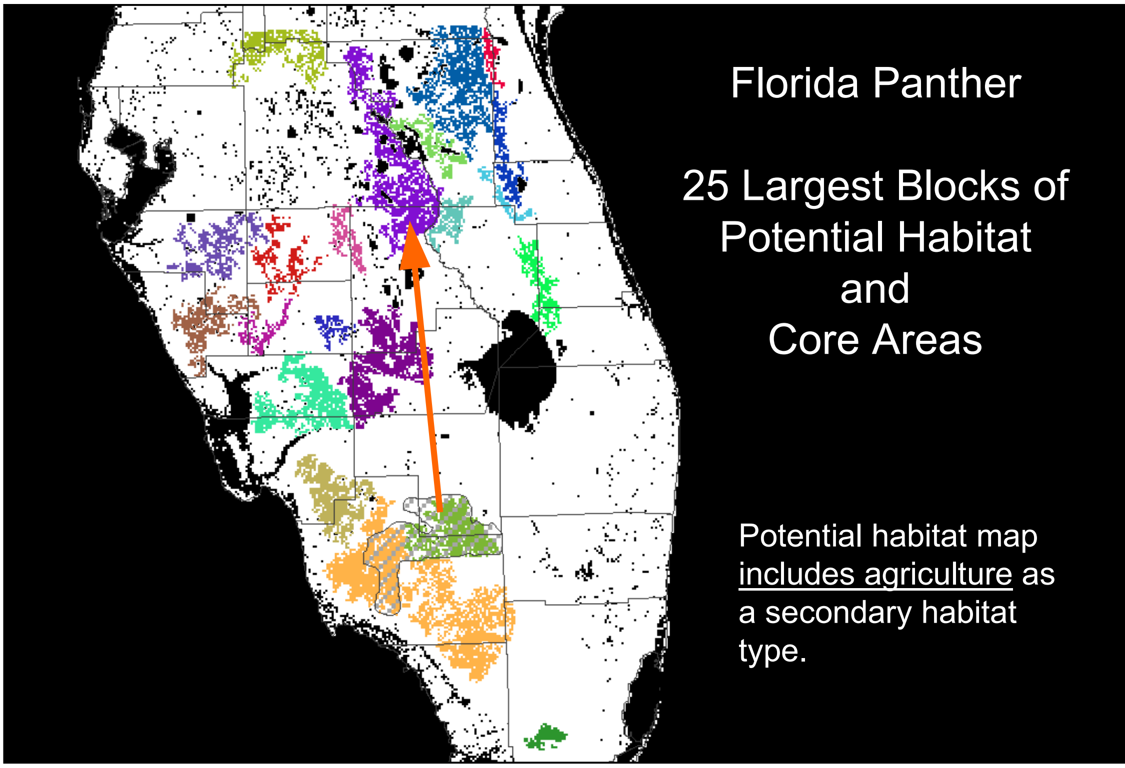


Figure 5. 25 largest contiguous blocks of Florida panther habitat, core population area (Maehr 1997), and source and destination patches for corridor modeling.

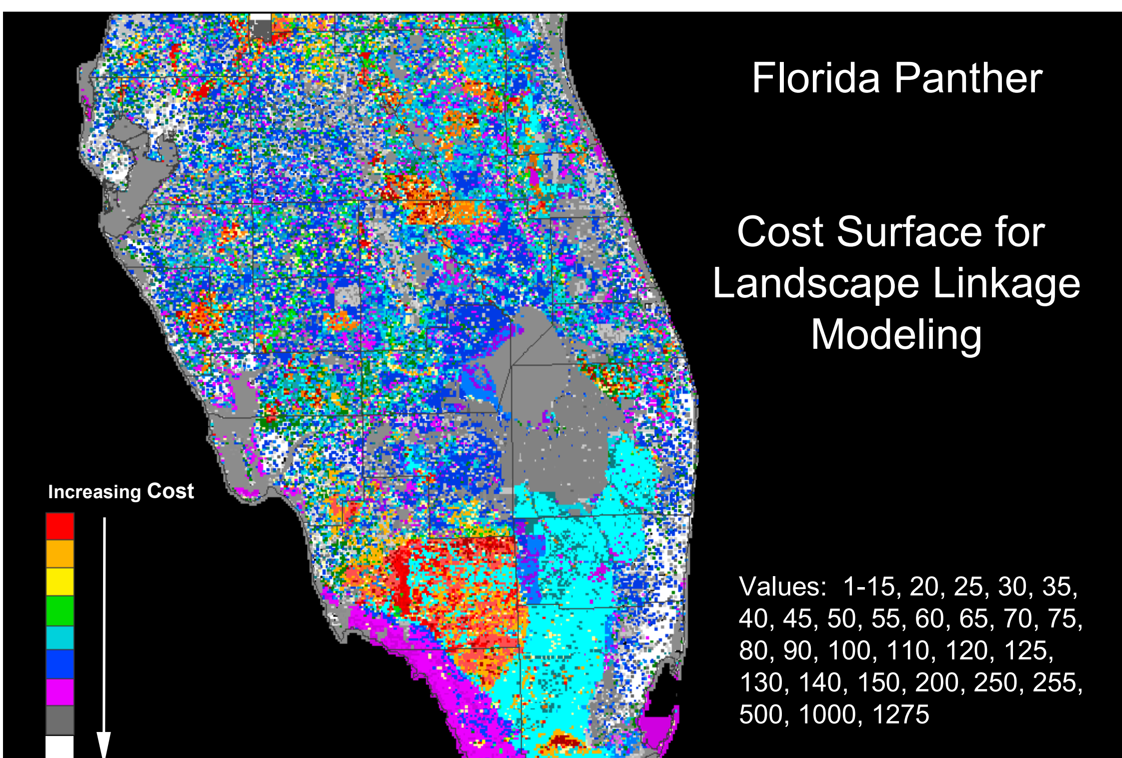


Figure 6. Generalized rendering of the cost surface used for landscape linkage modeling.

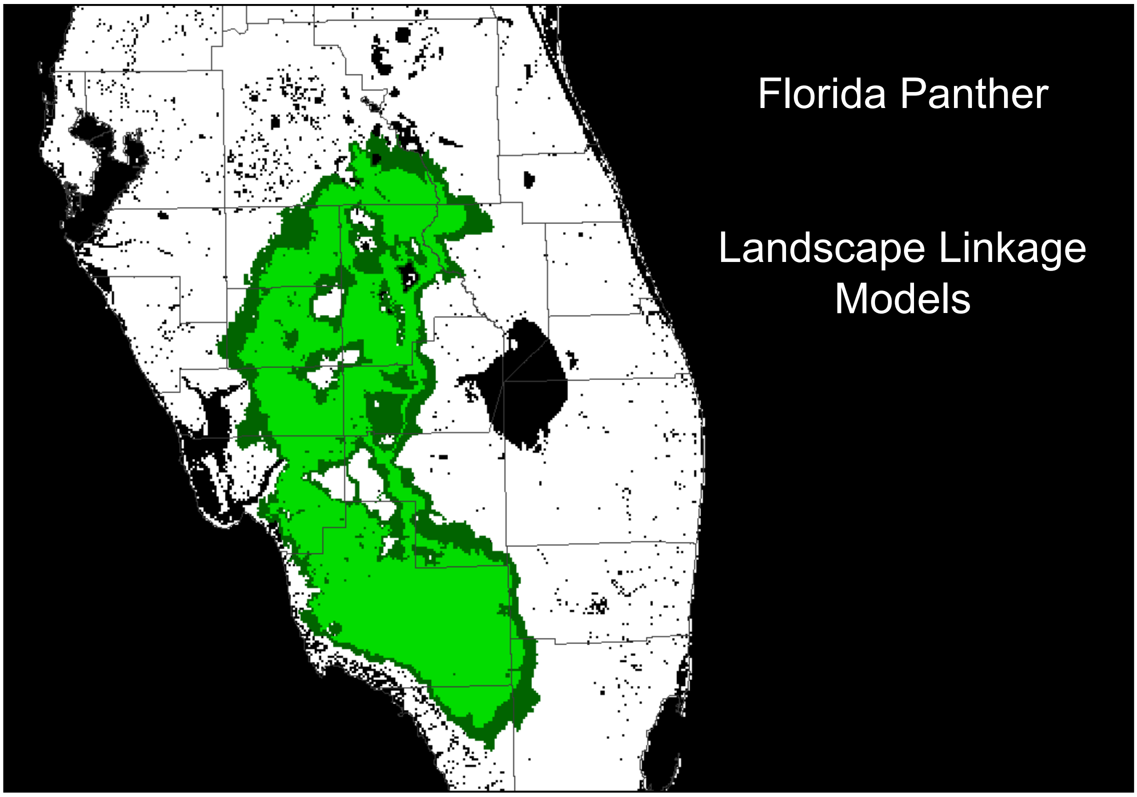


Figure 7. Two versions of a landscape linkage model. The dark green area includes cost surface values <3 million; the light green area includes values <2.75 million.

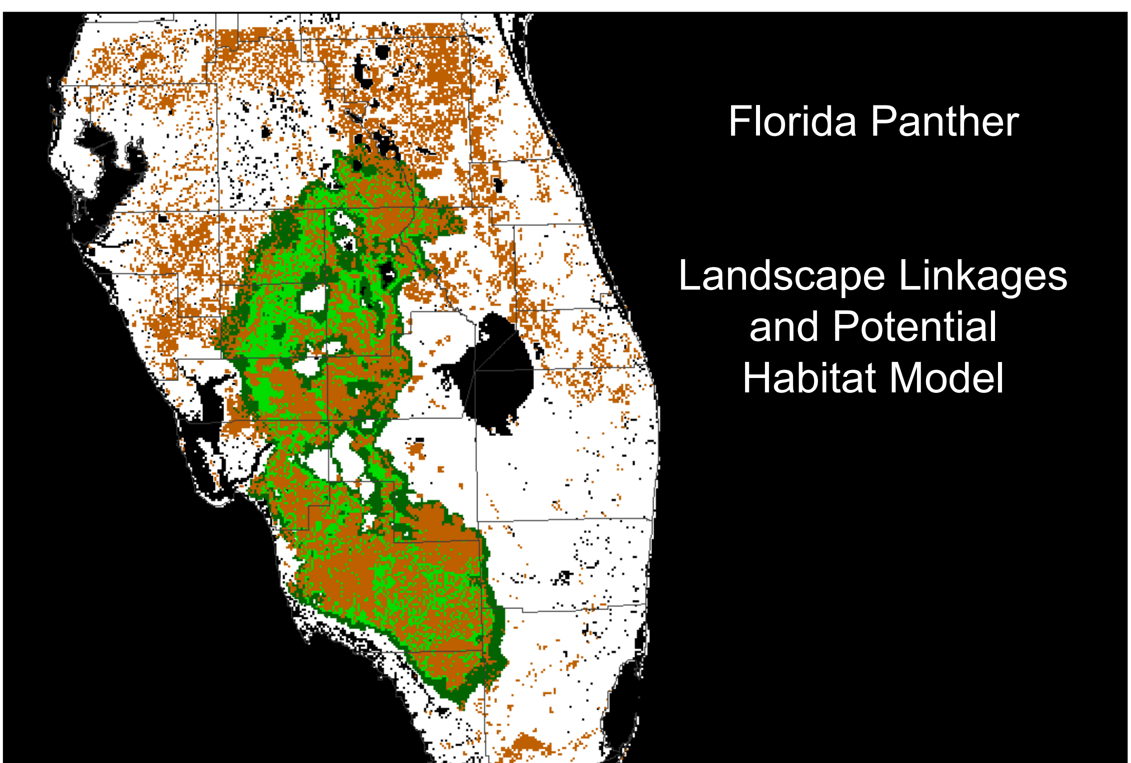


Figure 8. Landscape linkage models include significant portions of the Florida panther potential habitat model.

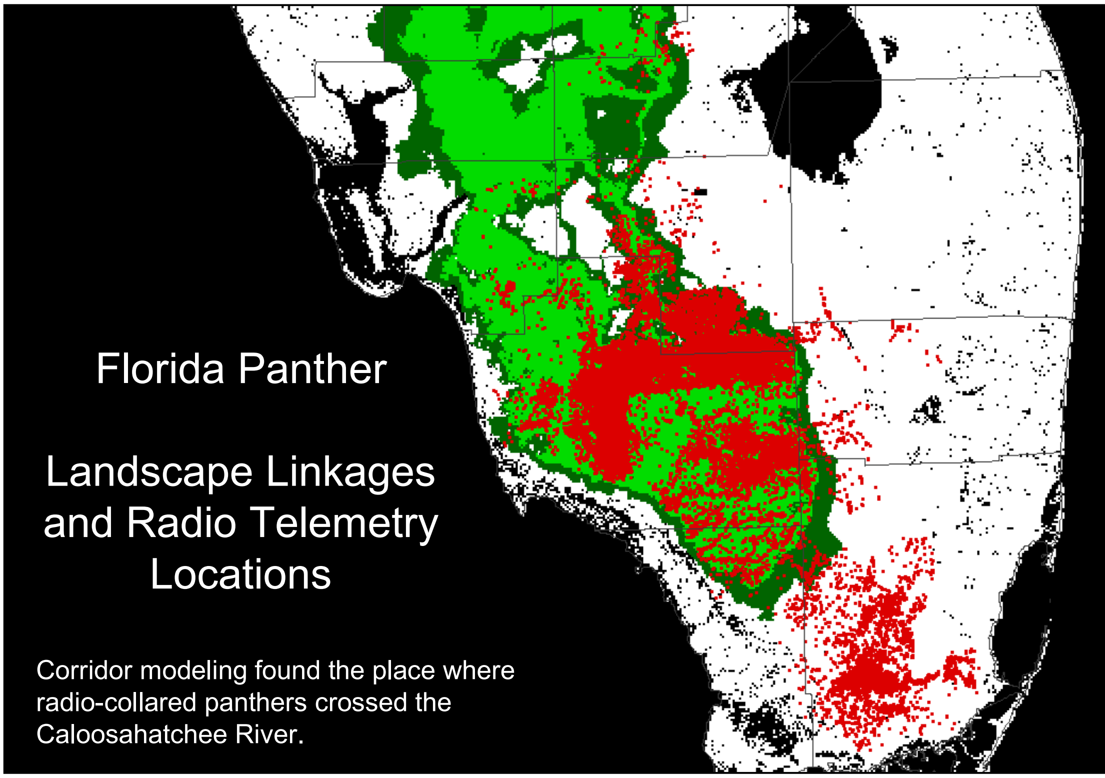


Figure 9. Landscape linkage models successfully identified the corridor used by radio-collared panthers that crossed the Caloosahatchee River.

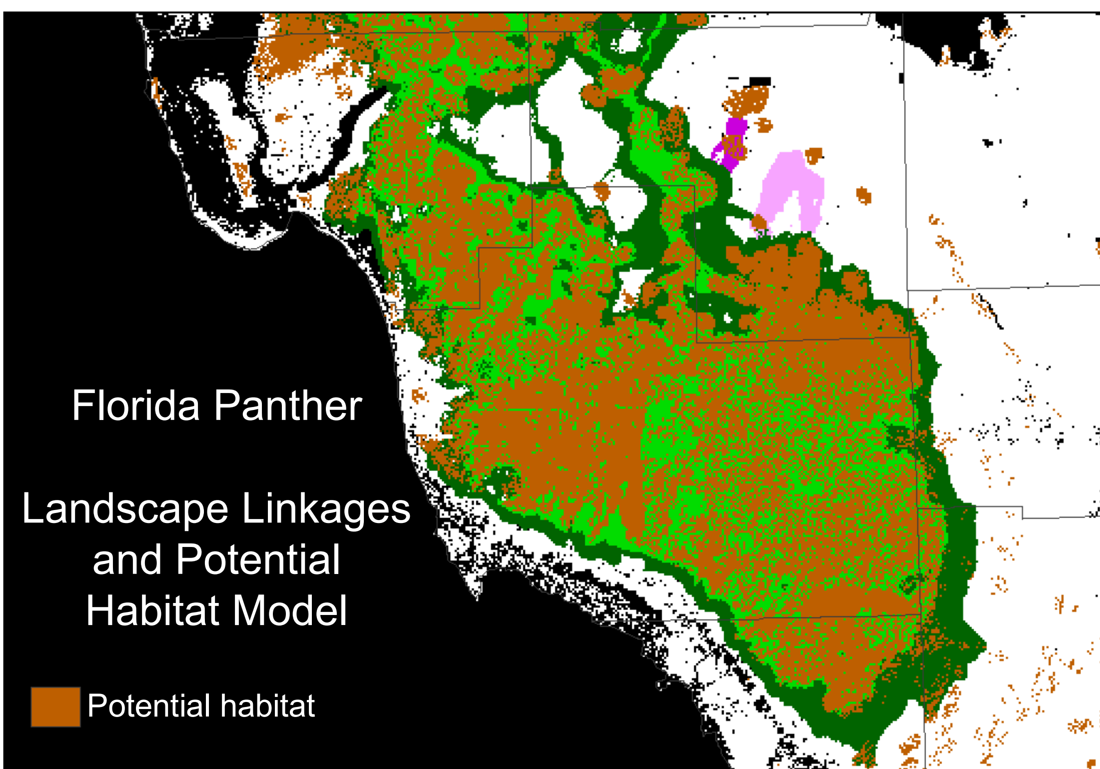


Figure 10. Least cost corridors that link the core population area with isolated patches of currently used habitat in northeastern Hendry County.

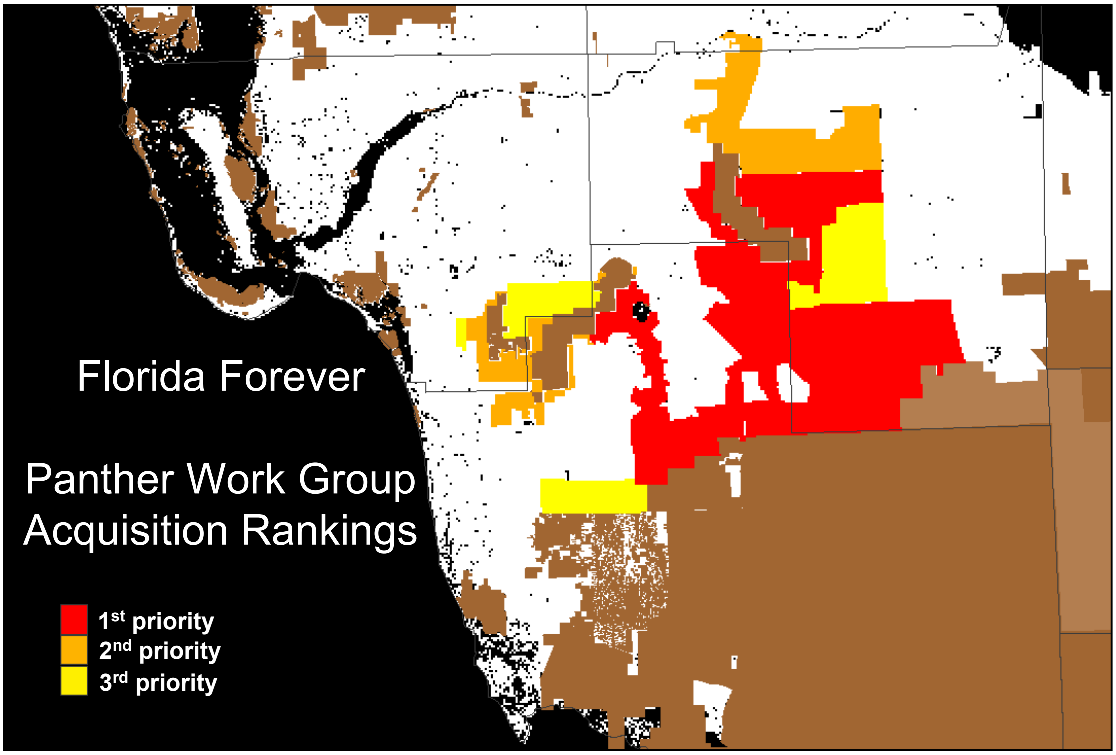


Figure 11. Land acquisition priorities for the Florida panther as developed by a group of panther experts for application to the Florida Forever program.

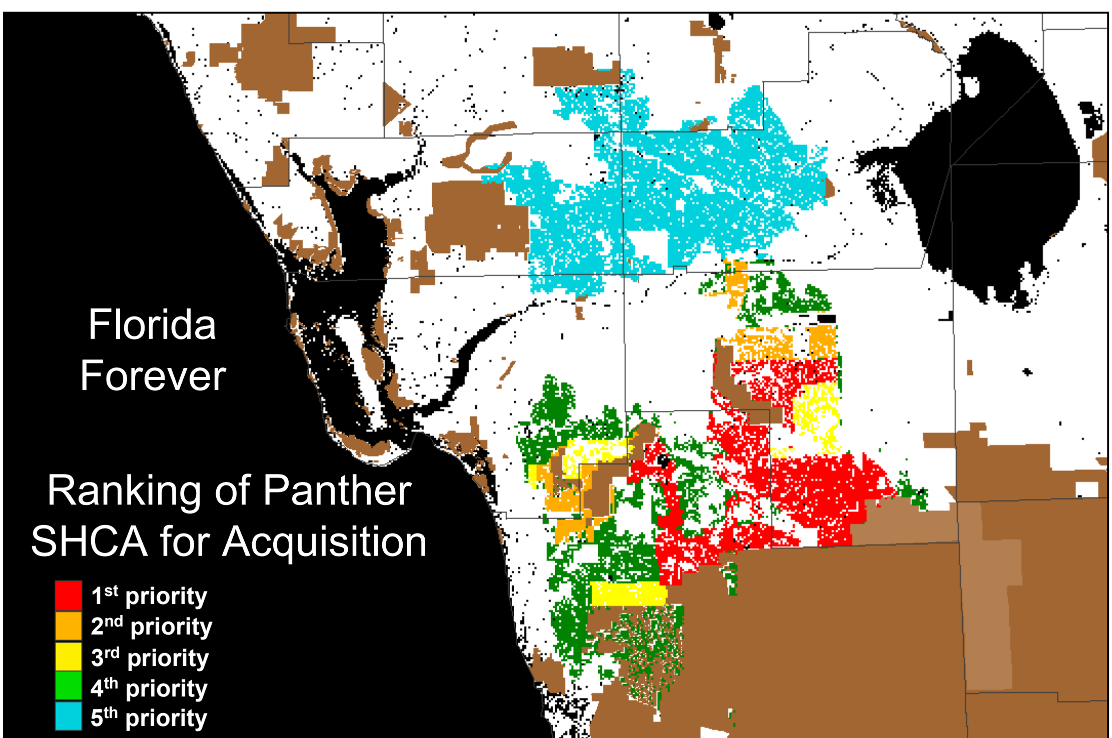


Figure 12 Ranking of Florida panther strategic habitat conservation areas (Cox et al. 1994, Kautz 2000) for possible acquisition under the Florida Forever program.

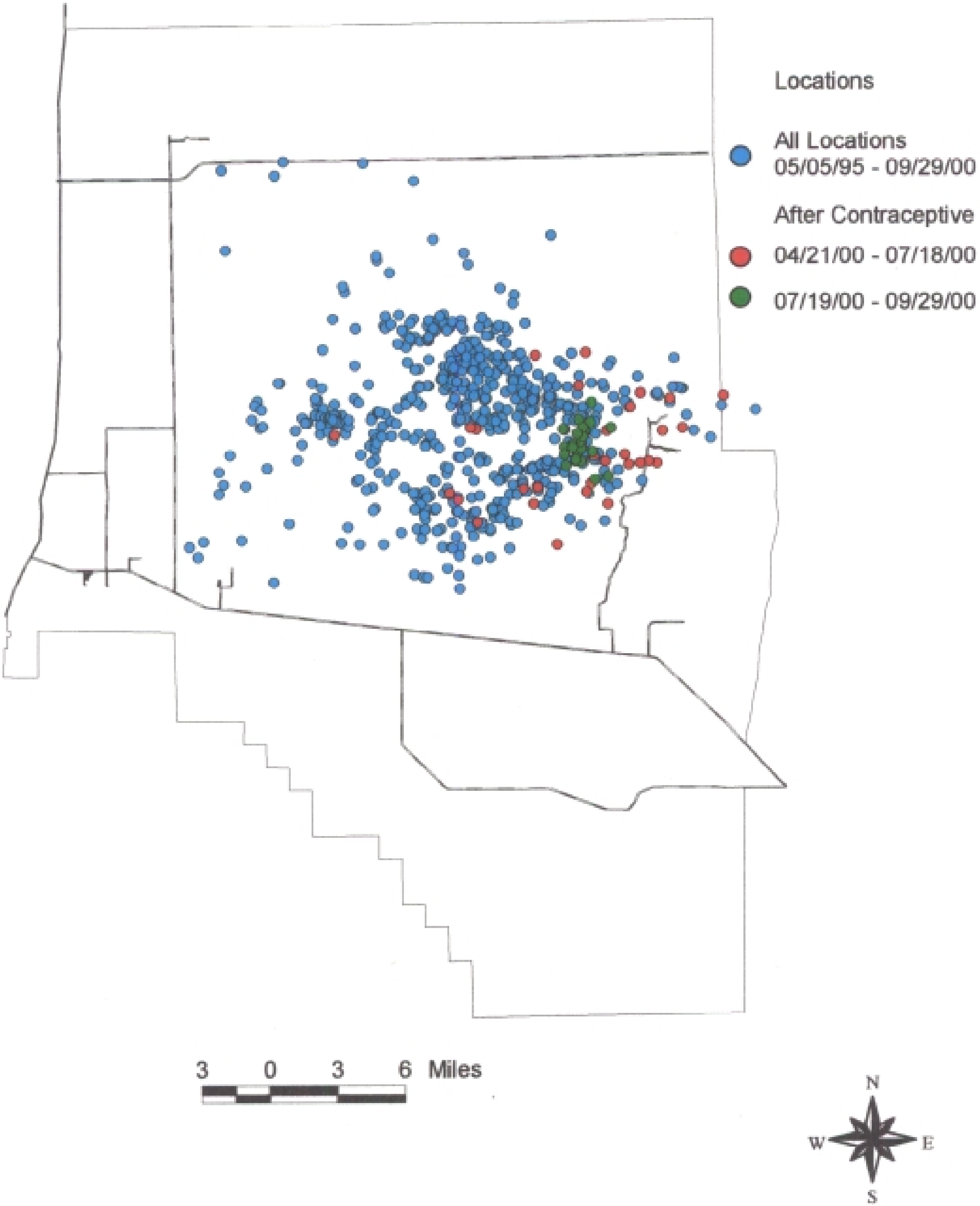
Attachment 4

POSSIBLE DENNING BEHAVIOR BY TX 107

(D. Jansen; Oct. 18, 2000)

April 19, 2000	replaced collar that malfunctioned on October 27, 1999; was with male #79 and had semen in vagina; not with or in vicinity of #79 since then
June 21, 23, 26, 28	same small area northwest of Popenhager's airstrip
August 2	first day documented at den??? site on east side of marsh
August 4	same site
August 7	same site
August 9	same site
August 11	same site
August 14, 15	2 1/2 miles southeast of site; probable had a kill (vultures); checked den?? site but found nothing (4.5 man-hours)
August 16	200 meters east of site, but in same pineland
August 17	~1 mile southeast of site
August 18	1+ mile southeast of site
August 21	100 meters south of site on south side of marsh
August 22	1/2 mile north of site
August 24	2 miles north of site
August 28	at site
August 30	1/2 mile southwest of site
Sept 2	1 1/2 miles northeast of site
Sept 5	north side of pineland with site (vultures seen here next day)
Sept 6	1/2 mile north of site
Sept 8	2 1/2 miles north of site
Sept 11	3/4 miles north of site
Sept 13	1 1/2 miles north of site
Sept 15	1 mile north of site

Locations for Panther Tx107



Attachment 5

PLAN FOR MANAGEMENT OF CAPTIVE HELD FLORIDA PANTHERS

Approved By
Florida Panther Interagency Committee
October 14, 1999

Allan L. Egbert, Ph.D.
Executive Director
Florida Fish and Wildlife Conservation Commission

for Sam Hamilton
Regional Director, Southeast Region
U.S. Fish and Wildlife Service

David B. Struhs
Secretary
Florida Department of Environmental Protection

Jerry Belson
Regional Director, Southeast Region
U.S. National Park Service

PLAN FOR MANAGEMENT OF CAPTIVE HELD FLORIDA PANTHERS

A program for the establishment of a captive Florida panther *(Puma concolor coryi)* population was developed and implemented through the Florida Panther Interagency Committee (FPIC) in 1991. Specifics on the captive program are contained in the U.S. Fish and Wildlife Service's "*Final Supplemental Environmental Assessment - A Proposal to Establish a Captive Breeding Population of Florida Panthers*"[1]. The proposed action underwent extensive environmental review and comment by other organizations and the public. The action resulted in a litigation process that extended over a 21 month period and included six public meetings and the analysis of over 600 written comments.

The purposes for establishing a captive population were to "provide immediate security against extinction of the Florida panther and provide for the long-term preservation of the remaining panther gene pool." The target for the captive population was to achieve in captivity, to the extent possible, a complete representation of the wild population's genetic composition. This goal was to be obtained through a capture regime that will provide for the removal of up to six panther kittens from select adults in the wild population each year over a three to six year period.

Selective breeding within the captive population, something not obtainable in the wild, was to be utilized to minimize inbreeding and help preserve remaining genetic diversity within the population. Population viability modeling at that time indicated that a total panther population of 500 breeding adults (combination of all wild and captive populations) would be needed in order to retain 90% of the current genetic diversity for 100 years or longer. Because of limited growth potential within habitats occupied by the existing wild population and the absence of proven techniques and technology for successfully reestablishing panther populations elsewhere, a large percentage of these 500 breeding adults would have to be maintained within the captive segment of the total population.

The U.S. Fish and Wildlife Service (USFWS) issued the necessary permits and subpermits required under provisions of the Endangered Species Act for the capture and holding of panthers for the captive population. Establishment of the captive population was initiated in 1991. A total of 10 kittens were removed from the wild population during 1991 and 1992. However, the removal of kittens from the wild was placed on hold in 1992 because of heightened concerns that the genetic health of the wild population had possibly deteriorated to a point where continued survival of the Florida panther was questionable, even under enhanced genetic protection and management opportunities offered through captive breeding.

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[1] Jordan, D.B. 1991. Final Supplemental Environmental Assessment - A proposal to establish a captive breeding population of Florida panthers. U.S. Fish and Wildlife Service, Atlanta, GA. 65pp.

The U.S. Fish and Wildlife Service, White Oak Conservation Center and the Conservation Breeding Specialist Group sponsored a workshop in October 1992, to revisit population viability projections and evaluate other possible genetic management strategies for the Florida panther. This workshop resulted in FPIC's adoption of a genetic management program for the Florida panther built around the restoration of historic gene flow into the population. This strategy involved the translocation of eight females from the Texas population (*Puma concolor stanleyana*) into south Florida. The goal was for these females to become breeders in the south Florida population. This program was initiated in 1995 and at this point appears to be functioning as designed.

KEY PROVISIONS OF THE CAPTIVE PROGRAM APPROVED IN 1991

- The approved action was to establish and maintain a captive breeding population of Florida panthers (Final Supplemental Environmental Assessment [FSEA] p. 3).
- Should the captive program be terminated for any reason, the goal would be to, if at all possible, successfully place all captive animals in the wild as soon as possible (FSEA p. 14).
- Captive animals are to be maintained within human contact and exposure levels necessary and appropriate to achieve overall success of the recovery program (FSEA p. 16).
- Animals targeted for release into the wild would be exposed to minimal human contact (FSEA p. 16).
- Captive breeding programs would selectively mate panthers to achieve and maintain maximum genetic variability and viability (FSEA p. 19).
- Captive institutions will follow provisions contained in the Florida Panther Captive Management and Health Protocol (Endangered Species Permits p. 2).
- All felids in receiving facilities will be tested for specific disease agents as identified in the Florida Panther Captive Management and Health Protocol (Endangered Species Permit p. 2).
- Panthers may not be transferred unless the receiver has first been issued written authorization by the Regional Director, USFWS (Endangered Species Permit p. 2).
- Holding facilities for Category I panthers (those panthers projected to be maintained in captivity for life) will include outside enclosures containing a minimum of 1,600 sq. ft., as prescribed in the Florida Panther Captive Management and Health Protocol (Protocol).

- Holding facilities for Category II panthers (those panthers with potential release into the wild) will include outside enclosures containing a minimum of 3,200 sq. ft. (Protocol).

CURRENT STATUS AND MANAGEMENT OPTIONS FOR THE CAPTIVE POPULATION

Two of the ten panthers originally brought into captivity during 1991-92, have died while in captivity (females 205 & 206). Two were returned to the wild (males 201 & 203) and have since died. Six remain in captivity (male 202, female 204, male 207, female 208, female 209, and male 210) (Table 1); one of these (207) is bilaterally cryptorchid (sterile). Panthers 202 and 204 are currently housed at White Oak Conservation Center. Panthers 207 and 208 are currently housed at Lowry Park Zoological Garden in Tampa. Panthers 209 and 210, who are litter-mates, are currently housed at Jacksonville Zoological Gardens. Panthers 202, 204 and 207 were between seven and nine months of age when brought into captivity. The remaining three were between 12-14 days of age when brought into captivity. There have been no attempts to breed any of the captive panthers.

Table 1. Captive Florida Panther Population (September 1999).

Institution	Present Holdings	Committed Capacity (within 12 Months)
Lowry Park Zoological Gardens	Male 207 - 3/92[1] (non-reproductive) Female 208 - 6/92	3
Jacksonville Zoological Gardens	Male 210 - 8/92 Female 209 - 8/92	3
White Oak Conservation Center	Male 202 - 2/91 Female 204 - 2/91	6
Totals:	**3 Males & 3 Females (3.3)**	**12 (+6)**

[1] Dates kittens were removed from wild population.

Preliminary results of the genetic restoration program now appear to have removed the need to achieve and maintain a large captive population of Florida panthers as originally projected. However, this does not negate the fact that individuals presently in captivity represent important genetic material which should be preserved and utilized in the recovery program. In fact, four captive individuals likely represent the only remaining reservoirs of particular genetic lineages.

Potential management options for the individuals that remain in captivity are to either maintain them in captivity or return them to the wild. A careful analysis of each captive individual regarding its potential for a successful return to the wild (successful meaning contributing its genetic makeup to the wild population), coupled with the results of the effort to return 201 and 203 to the wild, support a conclusion that individuals in captivity can best serve the panther recovery program by being maintained and utilized through captive processes. Therefore, the surviving six individuals should be mated, as soon as possible, to produce offspring that will preserve and maintain the unique genetic representation of the captive population. The individuals currently remaining in the population, including kittens that will result from planned matings, should be maintained, transferred among and placed at participating zoological parks to best serve recovery needs, as described in Management Strategies, page 5.

Key factors in this conclusion included: (1) 208, 209 and 210 were brought into captivity as neonate kittens; were hand raised, have been closely associated with humans for six years and are considered too acclimated to humans to be valid candidates for a successful return to the wild; (2) 207 is sterile and would have no value in the wild population; (3) 204 has only one lung and medical personal have concluded that her prospects for withstanding the rigors of survival in the wild and being successful in contributing to the breeding population are doubtful; and (4) 202 was carefully evaluated along with 201 and 203 earlier when the need arose to return two males to the wild for genetic restoration needs. This evaluation resulted in 202 being ranked last of the three candidate males by the technical staff at White Oak Conservation Center. This ranking was based on physical condition, behavior, captive history and genetic makeup. The fact that the two higher ranked males did not survive beyond a month-and-a-half after return to the wild does not speak well for 202's prospects for a successful return. However, perhaps the most compelling factor regarding 202 is the fact that he represents the sole known remaining source of genetic lineage for both his parents. This makes his genetic makeup extremely valuable. Survival and successful breeding probabilities are considered much greater for this individual in captivity than in the wild.

PURPOSE

The purpose of this document is to provide revised guidance in the continued implementation of the captive breeding program which was approved in 1991 by providing appropriate guidelines, protocols and breeding/placement schedules for management of captive-held Florida panthers.

MANAGEMENT STRATEGIES

This management plan follows the basic provisions of the original captive program that was approved in 1991. It is designed to facilitate a captive breeding and placement schedule to assure the maintenance of key genetic materials contained in the present captive stock and to fully utilize the captive population in all applicable aspects of the recovery program. The plan does not propose to reinitiate the original removal regime guiding the establishment of the captive population. The present captive population has the potential to contribute to many key aspects of the recovery program, including: genetic restoration and management, meeting specific demographic needs within the wild population, stock for possible future population reestablishment programs, medical and reproductive research and public education and outreach. It should be noted that all captive breeding actions will be "need oriented" i.e. undertaken to meet a specific recovery need or goal.

Individuals in the captive population range from approximately 7½ to 9½ years of age, which are considered older breeding ages. Therefore, actions to produce offspring should be initiated immediately.

It is important to note that the captive program approved in 1991 will continue to provide the overall guidance for the management of captive held Florida panthers. The implementation and management of this revised plan will be further guided by additional provisions which include; a breeding/placement schedule to guide matings (reviewed annually and refined as needed); a revised captive management/health protocol; a commitment of participation from holding facilities, the U.S. Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission (conditions of State and Federal Permits, as may be required) and guidelines for public education and outreach.

The following strategies are those that will be necessary for implementation of this revised management plan:

1. State and Federal permits, permit renewals and/or amendments should be issued to approved, participating zoological parks (AZA Certified) for their possession, maintenance, breeding, display, disposition and transportation of captive Florida panthers. (by November 30, 1999)

2. The initial plan for pairings and placements of captive Florida panthers should be implemented, immediately as follows:

Table 2. Pairings[1] and placements through June 2001.

M	F	Location	Projected Date
202	204	(Both at White Oak Conservation Center) - Breed there	November 1999
207		(At Lowry Park Zoological Gardens) - Move to Tallahassee Museum of History and Natural Science	February 2000
210		(At Jacksonville Zoological Gardens) - Move to Lowry Park Zoo	March 2000
210	208	Breed at Lowry Park Zoological Gardens	June 2000
202		(At White Oak Conservation Center) - Move to Jacksonville Zoological Gardens	June 2000
202	209	Breed at Jacksonville Zoological Gardens	September 2000

[1] Kittens produced from the pairings that exceed the capacity of other participating zoological parks shall be maintained at White Oak Conservation Center.

3. A multi-year plan for Florida panther pairing and placements should be designed that maximizes preservation of the genetic material that is currently represented in the captive population, and includes management, research and outreach objectives for each participating zoological park. (by December 31, 2000)

4. A public education/outreach plan should be developed for each participating zoological park. The opportunity is unlimited in terms of enhancing the public's understanding and appreciation of the Florida panther and increasing its awareness of biodiversity and ecosystem conservation issues. The magnitude and extent that the captive population can play in other key panther recovery programs, such as genetic restoration and management, population establishment, demographic management in the wild population, health, medical and reproductive issues, etc., may be unlimited as well. Additional management/use programs and protocols will be developed and implemented as specific needs and opportunities are identified.

5. The "Florida Panther Captive Management and Health Protocol" should be revised. (by December 31,1999)

6. Research protocols should be developed for approval/permitting as may be required. (as needed)

SCHEDULE

This plan will be in effect through the 1999-2000 and 2000-2001 breeding seasons.

THL/thl
ESC 6-2
Panther Captive Management Plan.wpd

Attachment 6

Darrell Land

From: "Warren Johnson" <johnsonw@ncifcrf.gov>
To: "Darrell Land" <landd@fwc.state.fl.us>
Sent: 06 October, 2000 12:41 PM
Attach: Florida Panther draft report.doc; report table2.xls; Florida Panther Report.TIF; Florida Panther Report.jpg; Florida Panther Report.ppt; Florida Panther Report.gif
Subject: Florida panther report

Dear Darrell,

I have attached a copy of the draft report, one excel spreadsheet with two tables, and a figure (in various formats). It is meant only to be a place for us to continue our discussions and nothing in it is final. In fact, for example, I am sure that due to ignorance and outright mistakes that I have clustered individuals incorrectly. I have not even begun most of the most appropriate analyses since it was premature before having a complete "clean" data set. However, I am actually very encouraged by the results of the superficial analyses that I have done thus far. It is clear that the microsatellite loci have a lot of resolving power (i.e. variability) and will allow us to answer most of our questions, once the data is cleaned up. The shear size and complexity of the data set make this a complex task, that will have to be undertaken at many levels. But, as you can appreciate already from the phylogenetic tree built from the individual genotypes, the data appears to group individuals so that they are most closely related to animals from the same genetic lineages, and that they are distinguishable from others.

My plans are more or less the following.

1. Continue to proof the data collected to date for accuracy, and do additional lab work as necessary to fill out the data set.

2. Build a pedigree from the available individuals, assign most-likely parents and estimating degree of relatedness among unknown individuals. Compare suspected relationships with projected ones.

3. Follow the expression of morphological traits through the pedigree.

4. Assign unknown individuals to certain populations based on their composite genotypes.

5. Compare patterns of molecular genetic variation of current Florida panther populations with historic populations and levels of molecular genetic introgression from "non-Florida" animals. This will be complicated in part because a large portion of the existing population are not represented in our data set.

6. Compare patterns of molecular genetic variation of current population with estimates of future populations with or without future contributions from the remaining introduced Texas females.

This should all be well within our reach to have most if not all of this done by Thanksgiving and perhaps have a formal paper ready by the end of the year.

I'll talk to you when I get back from Asia.

Sincerely,

Warren Johnson

p.s. Please let me know if any of this did not make it or if you would prefer that I FAX it to you.

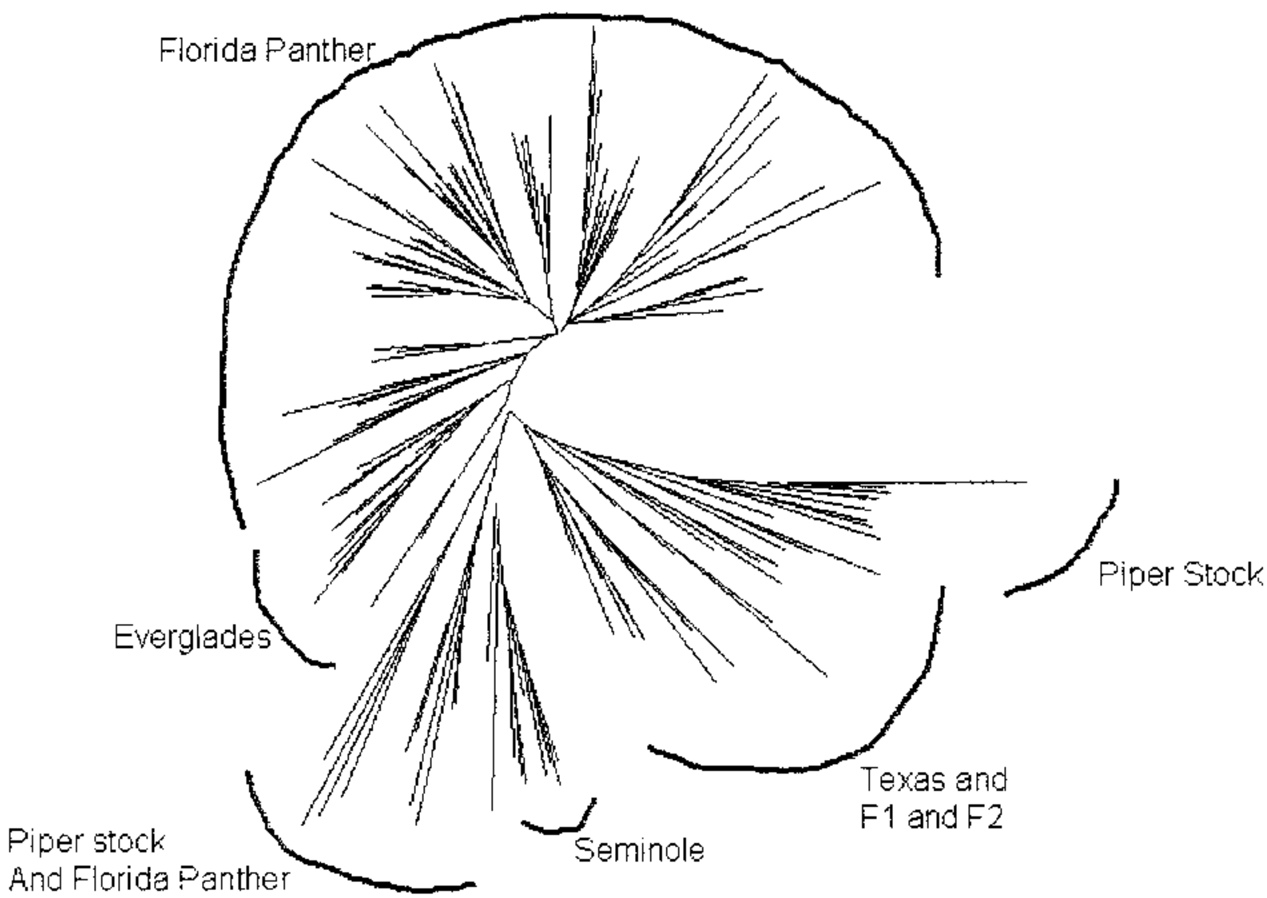
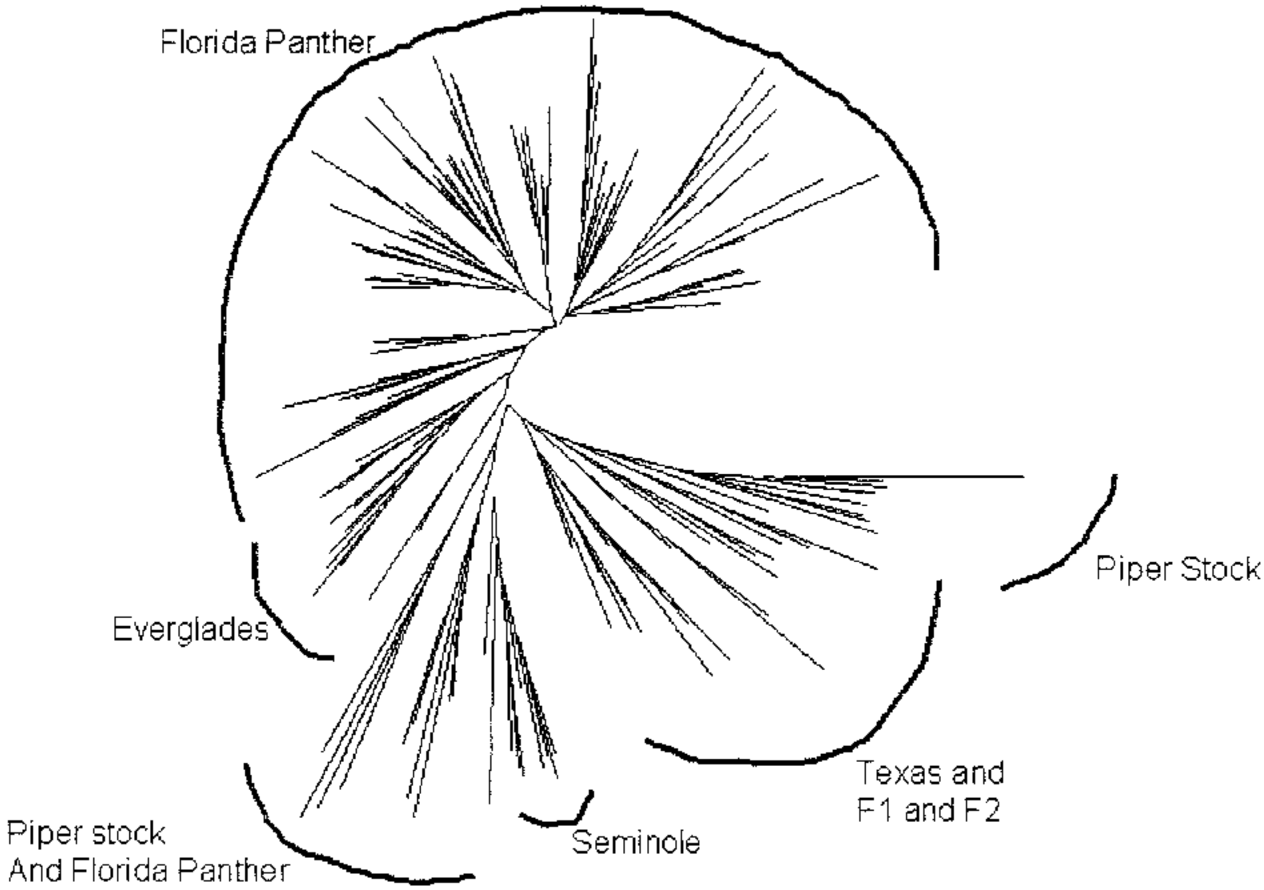


Figure 1. Phylogenetic tree of composite genotypes from 15 microsatellites constructed using the neighbor-joining algorithm from a distance matrix estimated by the proportion of shared alleles.



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Genetic Introgression within the Florida Panther *Felis concolor coryi*

STEPHEN J. O'BRIEN, MELODY E. ROELKE, NAOYA YUHKI, KAREN W. RICHARDS, WARREN E. JOHNSON, WILLIAM L. FRANKLIN, ALLEN E. ANDERSON, ORON L. BASS JR., ROBERT C. BELDEN, AND JANICE S. MARTENSON

*The Florida panther (*Felis concolor coryi*) is a severely threatened relict population of puma or mountain lion whose historic range has included much of the southeastern United States. The population now consists of 30 to 50 animals living in the Big Cypress Swamp–Everglades ecosystems in southern Florida. Field observations indicated the presence of two distinct morphological phenotypes that are stratified between the two adjacent areas despite the occurrence of periodic migration between them. A comprehensive molecular genetic analysis using mitochondrial DNA and nuclear markers indicates the existence of two distinct genetic stocks concordant with the morphological phenotypes. One stock confined to Big Cypress is derived from the ancestors of *F. c. coryi*. A second stock, found largely in the Everglades, is descended primarily from pumas that evolved in South or Central America, but were introduced (probably by man) in the Florida habitat very recently. The precarious genetic disposition of the few remaining authentic Florida panthers may be benefiting from the introgression of genetic materials into the wild population.*

The Florida panther (*Felis concolor coryi*) is one of 27 described subspecies of puma (also called cougar or mountain lion) that inhabit the western hemisphere (Goldman 1946). The Florida panther has always ranged throughout the southeastern United States; however, the pressure of human development has reduced the present subspecies to a relict population of <50 individuals living in the Big Cypress Swamp and Everglades National Park ecosystems in southern Florida (Belden 1986; Goldman 1946). In March 1967, the U.S. Fish and Wildlife Service listed the species as endangered. Portions of panther habitat in the two regions have received state and federal protection and four government agencies (U.S. Fish and Wildlife Service; Florida Game and Fresh Water Fish Commission; National Park Service; and Florida Department of Natural Resources) have combined resources to sustain this fragile population (Florida Panther Interagency Committee 1987). By many standards the Florida panther has emerged as a flagship species for national and international efforts to preserve endangered species and their associated ecosystems.

The Florida panther was first described by Cory (1896) and named as a distinct subspecies by Bangs (1889). The original taxonomic

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The consequences of demographic reduction and genetic depletion in the endangered Florida panther

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The Florida panther has recently suffered severe range and demographic contraction, leaving a remarkably low level of genetic diversity. This exerts a severe fitness cost, manifested by spermatozoal defects, cryptorchidism, cardiac abnormalities and infectious diseases that threaten the survival of the subspecies.

Introduction

The recent expansive development and spread of human populations has precipitated the highest rate of species extinction since the demise of the dinosaurs [1–4]. Recognizing these events, national and international conventions have been established to identify and conserve endangered species [5–8]. Dwindling populations of endangered species have been suspected to suffer primarily from stochastic demographic factors (such as altered sex ratios and accidental mortalities), reproductive decline and disease outbreaks [9–13]. In addition, small populations often undergo inbreeding, despite instinctive avoidance of matings with close relatives. This can result in the expression of rare, normally cryptic deleterious alleles that contribute to developmental, reproductive and immunological impairments [14–22]. Close observation of the extinction process in lost species has been rare, and evidence for the various causal components has been inferential or correlative, so that conclusions as to the causes of species extinction could only be tentative. In this review we summarize previously published and new data about the population genetic variability, reproductive function and physiological fitness of populations of the Florida panther (*Felis concolor coryi*), a subspecies in imminent danger of extinction, and argue for the relevance of these observations to attempts to conserve the subspecies.

The Florida panther (Fig. 1) exists as a small relict population of approximately 30 individuals that resides in southern Florida, primarily in the Big Cypress Swamp (BCS) and adjoining Everglades National Park (ENP) ecosystems [23–30]. Before the immigration of European settlers, the panther's range included the entire southeastern portion of the United States, while populations of other *F. concolor* subspecies — called panthers, pumas, cougars or mountain lions — were spread throughout North and South America

Fig. 1. The Florida panther, *Felis concolor coryi.*

(Fig. 2). Human depredation, spurred principally by fear, legends of ferociousness toward livestock and humankind, and imposition of bounties, reduced the subspecies' range to hardwood swamps and cypress prairies of south and central Florida by the 1920s

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Introgression Level Achieved through Florida Panther Genetic Restoration

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Abstract
Florida panthers (Puma concolor coryi) exist today as a small isolated population of 60-70 individuals in southern Florida after two centuries of habitat loss and persecution eliminated them from much of the southeastern United States. Many observed phenotypic traits such as cryptorchidism, kinked tails, cowlicks, and atrial septal defects are assumed to be manifestations of inbreeding. Dispersal mechanisms can no longer function to maintain genetic diversity within the small population. A plan to restore genetic diversity within the panther population to levels comparable to western puma was initiated with the release of 8 Texas puma (P. c. stanleyana) in 1995. The goal was to achieve a 20% representation of Texas puma genes in the panther population. To date, 4 of the 8 Texas pumas are still alive and have produced a minimum of 36 descendants, 25 of which are thought to still be alive. Based on our pedigree knowledge, we calculate that the panther population has 18% to 22% representation of Texas puma genes as the result of genetic restoration.

Introduction

Florida panthers (*Puma concolor coryi*) are endangered by a combination of population and habitat factors (USFWS 1987). Loss and fragmentation of habitat and unregulated killing over the past two centuries have reduced and isolated *Puma* populations in the eastern United States to the point where only one population estimated to number between 60-70 individuals exists on approximately 8810 km^2 (2.2 million acres) of habitat in south Florida (Maehr 1990). Small population size and geographic isolation increase the chance for extinction of Florida panthers due to demographic instability inherent in small numbers and erosion of genetic diversity from restricted gene flow and inbreeding. Maintaining genetic diversity is key for production of fit individuals as well as providing population elasticity in order to respond to changing environmental and habitat conditions.

Genetic diversity within the panther population would have been maintained at higher levels when the population was greater in size. Furthermore, natural exchange of genetic material occurred historically among the Florida panther population in the southeastern United States and contiguous populations of *P. c. cougar* to the north, *P. c. hippolestes* to the northwest and *P. c. stanleyana* to the west (Young & Goldman 1946). Gene flow occurred as individuals dispersed widely and bred, however, human settlement of the eastern United States resulted in local extirpations of *Puma*, thereby eliminating this exchange. With limits to dispersal and decreasing population size, breeding among close relatives occurs and can lead to inbreeding depression, loss of genetic variation, declining health, reduced survivability, and eventual extinction (Gilpin & Soulé 1986). Even with adequate habitat protection, these genetic concerns could lead to panther extinction.

Florida panthers exhibit reduced genetic variability when compared to western pumas (Roelke et al. 1993), and panther traits such as kinked tails, cowlicks, atrial septal defects, cryptorchidism, and poor sperm characteristics may be manifestations of inbreeding. Concern that the predicted downward trend in panther population viability may have begun led to the development and implementation of a "Plan for Genetic Restoration and Management of Florida Panthers" (Seal 1994). This plan called for the release of 8 female Texas pumas into areas occupied by Florida panthers to mimic the former natural exchange of individuals among these populations. The resultant *Puma* population in Florida after several generations of intercrossed offspring have been assimilated was expected to trace

20% of its genome to material from the Texas population. This level of genetic restoration was deemed adequate to forestall negative impacts of inbreeding and to raise the panther population genetic diversity to levels documented in western North American *Puma* populations. Periodic releases of *Puma* into Florida would be necessary to maintain the desired levels of genetic variation within the panther population over time.

The objectives of this study are to document the productivity of the Texas pumas that were released in 1995 and their subsequent offspring and to calculate the percentage of the panther population's genome that originated from these translocated Texas (TX) cats.

Methods

The study area encompassed most of interior Florida south of Orlando (28.3°N), extending to southern Everglades National Park. Approximately 50% of panther habitat is in public ownership and includes areas such as Big Cypress National Preserve, Florida Panther National Wildlife Refuge, Fakahatchee Strand State Preserve, and Everglades National Park. Major vegetation communities are pine forests and savannas, cypress and mixed hardwood swamps, hardwood hammocks, and open marshlands (Davis 1943). Climate is sub-tropical with average annual temperature and precipitation of 74° F (23 C) and 137 cm respectively (Henry et al. 1994). The Texas pumas used for genetic restoration originated from west Texas, primarily in Pecos, Presidio, and Brewster counties.

Florida panthers (FP) and Texas pumas were captured using trained hounds, anesthetized following McCown et. al (1990), and fitted with radiocollars. Vital signs were monitored during anesthesia and all animals underwent a complete physical examination to assess general health condition. Samples taken included whole blood and skin biopsies, and *Puma* greater than 4 months of age were vaccinated for feline viral rhinotracheitis, feline calicivirus, feline panleukopenia, and rabies. All animals were ear tattooed and had subcutaneous transponder chips implanted between the shoulder blades. Neonate kittens were handled following Land et al. (1998).

Criteria for selecting appropriate Texas pumas for release in Florida were identified by Seal (1994). The 8 pumas were quarantined for a minimum of 30 days to screen for possible pathogens and were released at five sites throughout areas occupied by Florida panthers (Johnson et al. 1998).

All radiocollared *Puma* were monitored from fixed-winged aircraft 3 times weekly and locations plotted on 1:24000 USGS Topological Maps. Associations among radiocollared cats were noted during each flight. Universal Transverse Mercator coordinates were obtained from the maps and stored in electronic databases. Radiocollars were equipped with mortality sensors and all carcasses detected were recovered and subjected to full necropsies by Board-certified pathologists typically within 24 hours.

Panther population size was estimated at 60-70 individuals based on the sum of all extant radio-collared panthers (35) plus their known offspring (12) and all known uncollared panthers detected through intensive capture and survey efforts over the past year (9) (D. Land, unpublished data). In addition to these known animals, we added 5-10 individuals to our estimate to reflect the percentage of the population that remains undetected. Each year we encounter previously unknown individuals that are discovered through collisions with motor vehicles or are captured during routine surveys.

Results

Thirty-six intercross animals are known to have been produced, and 25 of these may still survive in the south Florida population (see Appendix). Two were recovered after colliding with vehicles, one died of unknown causes, and eight are strongly suspected of dying based either on tracking evidence or their dams' behavior. Evidence of the fates of another three intercross offspring has not been found subsequent to independence from their dams. Thus, probably 22 to 25 intercross cats exist presently within a total population of about 70 *Puma concolor*.

Table 1 shows the known contributions of each TX female to the south Florida population of *Puma concolor* as of August 2000. The numbers of descendants of each TX female are tallied by the type of intercross, with a dashed line separating each female's own offspring from her grand-offspring. The genetic contribution of a TX female is expressed as the number of copies of her genome that are represented in her descendants. Thus, each offspring contributes 0.5, and each grand-offspring contributes 0.25. The contributions of each female are given first for all descendants not known to have died. Subsequent columns show the reduced contributions obtained after omitting all animals that are likely to have died ('d' status animals in the Appendix), and then after omitting also the animals whose status presently unknown ('?' status animals in the Appendix). The last column shows additional contributions that may be likely if the TX females are allowed to continue breeding. TX101 was contracepted with melanogesterol acetate for two years prior to her death in March 2000 and TX107 was contracepted in April 2000. The other TX females are all 8 or 9 years old, and each may be expected to produce about one more litter. The last column of the table assumes that each of three TX females

Table 1. Known contributions of Texas pumas to the population of *Puma concolor* in south Florida as of May 2000.

Identification	Maximum Descendants[a]	Contribution, less known deaths	Contribution, less likely deaths	Contribution, less unknown fates	Potential future contribution
TX101 (deceased)	4 F_1 (-0)[b] 10 B-FP (-6)[b] 3 B-TX (-1)[b] 7 F_2 (-1)[b]	6.25	5.00	4.75	+0.0
TX105	2 F_1 (-0)[b]	1.00	1.00	0.50	+1.0[d]
TX106	4 F_1 (-2)[b]	2.00	1.00	0.50	+1.0
TX107	2 F_1 (-0)[b] 3 B-TX (-1)[b] 7 F_2 (-1)[b]	4.25	3.50	3.50	+0.0
TX108	3 F_1 (-1)[b] 1 B-FP (-0)[b]	1.75	1.25	1.25	+1.0[c,d]
Total	36 (-11)[b]	15.25	11.75	10.50	+3.0
% of living population	37.1%	21.8%	16.8%	15.0%	+4.3%

Notes:
[a] Some descendants show up under two TX females from which they descend
[b] Known or suspected deaths
[c] Has recently shown denning behavior, but no litter has been found
[d] No males known to be in area currently

Generations:
TX = female translocated from Texas
F_1 = intercross between TX female and FP male
F_2 = progeny of F_1 x F_1 mating
B-TX = progeny of F_1 male x TX backcross
B-FP = progeny of F_1 x FP backcross

will produce two more offspring. At the bottom of the table are the total contributions of the TX lineages to the south Florida population and the percent contributions out of an assumed population of 70 animals, for the subset of intercross descendants defined for each column.

It is possible that there were some undocumented intercross animals in addition to those listed in the Appendix and tallied in Table 1. FP74 and FP84 were discovered as presumed offspring of F_1 female FP73 at ages that allow for the possibility that unobserved littermates could already have dispersed. TX105 exhibited denning behavior in August 1999, but no litter was found. In May 2000, we captured a female kitten from this litter (FP94) and found no sign of other littermates. The two male F_1 cats that are old enough to reproduce may have mated with unknown females: FP79 is suspected of siring four litters and other uncollared females are known to occur in his home range; FP65 was not the most mature, resident male in the vicinity of any known breeding females, but he too may have sired unobserved litters. F_1 females K23 and K34 have not been observed since they would have become independent from their dams, but they may be alive and would be old enough to be breeding. One of TX108's litter of K45 and K46 is believed to have lived to at least the time of independence from its dam. If it is still alive, it would be old enough that it could have recently produced a litter. Other than these cases, it is unlikely that any undocumented intercross litters survive. The other TX and intercross cats have all been monitored sufficiently closely so that rearing of an unobserved litter would be unlikely, have had known litters at intervals that make it unlikely that additional litters could have been produced, or are still too young to have reared a litter.

Recognizing the above possibilities of undocumented intercross cats, it is likely that at least a few additional intercross cats exist. However, it would be unlikely that more than about four F_1 cats and perhaps four second-generation intercross cats evaded detection.

Discussion

The number of *Puma concolor* in

Florida containing some Texas puma ancestry is not precisely known. However, the tabulation presented here is probably fairly complete, with perhaps several F_1, F_2, or backcross litters having been undetected. Similarly, it is not known precisely how many total *Puma concolor* are presently in the population. Assuming that most of the population is collared or otherwise known (such as kittens observed recently), it is likely that the total population size is approximately 70 cats.

The likely representation of Texas puma genes in the south Florida population is about 15% to 16.8% if the aging Texas puma females are excluded, or about 19.6% to 21.3% if those TX females are included. With a projection of three more F_1 litters to be produced in the next few years before all the TX females become post-reproductive, we estimate that the ultimate representation of TX genes in the population would be 19.3% (15.0% now, plus 4.3% in future progeny of TX cats). This is perhaps fortuitously close to the original genetic restoration program goal of 20% representation.

It is possible that an additional one or two F_1 litters and perhaps up to 6 backcross (B-FP) litters were undetected. If these litters do exist, and each produced two surviving kittens, the TX contribution could be as much as 5.0 higher, increasing representation by up to 7.1%. Thus, accounting for these possible intercross litters, the plausible range of current representation of Texas puma genes in the population is from 15.0% to 28.9%.

If there are no further genetic manipulations, and if future breeding success is unrelated to the ancestry of cats, then the expectation is that the percent of TX genes in the population would remain near the current level. If animals containing more TX ancestry are more successful as breeders, then the representation of TX genes will gradually increase. The reverse will occur if natural selection favors the ancestral FP genes in the population. Most likely, however, change in the frequency of TX genes will occur primarily due to chance, at least during the early generations of intercrossing. After a few more generations, almost all animals will likely contain representation from both ancestral sources, and the range of TX representation among animals will narrow.

Although the average representation of Texas puma genes is probably close to the 20% goal of genetic restoration, most of the TX genes are derived from only a few of the Texas cats. More than 40% of the TX genes are derived from TX101, and much of the remaining TX genes come from TX107. The unequal representations of the Texas pumas in the intercross descendants reduce the genetic diversity inserted into the population. Although five Texas pumas have contributed some descendants, the diversity contributed by those five is the equivalent of about three "effective founders" (founders that have contributed equally to the population: Lacy 1989). As a result, while the genetic restoration will have considerably reversed prior inbreeding, that may be a relatively short-term benefit.

The population of *Puma concolor* in south Florida is still so small that inbreeding will likely become common again among the intercrossed descendants within the next few generations. Already, one intercross animal (FP85) is thought be an inbred offspring of a mating of an F_1 female to her FP father. Although there are an estimated 70 animals in the population, perhaps only half are breeders of the current generation. (Many are still kittens, and some females and many males may not be successful breeders.) The genetically effective population size would be still smaller. To counter a resumption of inbreeding and loss of genetic diversity, further releases of non-local cats may be considered as part of ongoing management of the genetic restoration. The effects of any future releases on the representation of TX ancestry achieved in this initial genetic restoration will need to be assessed.

Our analysis of the representation of Texas puma genes that has been achieved in the genetic restoration program for the Florida panther has been based on the pedigree as it is known from field observations through August 2000, about 5 years after the release of 8 Texas females. This pedigree analysis will need to be regularly updated and refined as field monitoring continues. In addition, molecular genetic analyses are underway that will likely provide confirmation and/or refinement of the pedigree, as well as information about the likely ancestry of previously unknown cats. These data on the ancestry of the cats in the population will then allow analysis of the effects of the genetic restoration on the morphological traits (including cowlicks, kinked tails, cryptorchidism, and atrial-septal defects), reproductive performance, survivorship, and population viability.

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Figure 2. Texas pumas and known intercross Puma concolor in the south Florida population.

ID	Sex	Dam	Sire[1]	Birth	Gen.	Status[2]	Notes
TX101	F			1991±2y	TX	D	contracepted 11/97
FP65	M	TX101	FP45	12/96	F_1	A	
FP66	F	TX101	FP45	12/96	F_1	A	With 2 kittens
K52	M	FP66	FP54	9/98	B-FP	d	Not oberved after handled at den,
K53	F	FP66	FP54	9/98	B-FP	d	dam re-bred early
K54	M	FP66	FP54	9/98	B-FP	d	
K76	M	FP66	FP60	12/99	B-FP	D	Roadkill (2/00)
K77	F	FP66	FP60	12/99	B-FP	a	Still with dam
K78	F	FP66	FP60	12/99	B-FP	a	
FP73	F	TX101	FPX	9/95	F_1	A	Litters in 98 and 99
FP74	M	FP73	FPX	6/97	B-FP	D	Roadkill (9/99). May have lttermates.
FP84	M	FP73	FPX	2/99	B-FP	D	Death by unknown causes (4/00). May have littermates
FP79[3]	M	TX101	FPX	9/95	F_1	A	Sired 12 known offspring
FP87	F	FP55	FP79	4/99	B-FP	A	Independent from dam
K61	M	FP55	FP79	4/99	B-FP	?	Not observed after independence
TX102	F			1991±2y	TX	D	Pregnant when hit by car (9/95)
TX103	F			1991±2y	TX	D	Pregnant when died (8/99)
TX104	F			1991±2y	TX	D	Not known to have bred. Died 4/98
TX105	F			1991±2y	TX	A	May have a recent unrecorded litter
K34	F	TX105	FP16	9/96	F1	?	Not observed after independence
FP94	F	TX105	FP16	9/96	F1	A	May have had littermates
TX106	F			1991±2y	TX	A	With 1 kitten
K23	F	TX106	FP51	11/95	F_1	?	Not observed after independence
K47	M	TX106	FP51	2/98	F_1	d	Disappeared after male entered area
K62	F	TX106	FP54	6/99	F_1	d	No longer with dam
FP83	F	TX106	FP54	6/99	F_1	A	Still with dam
TX107	F			1991±2y	TX	A	Contracepted 4/00
FP70	F	TX107	FPX	5/97	F_1	A	With 3 kittens
FP88	F	FP70	FP79	6/99	F_2	A	Wtill with dam
FP91	F	FP70	FP79	3/99	F_2	A	
FP92	M	FP70	FP79	3/99	F_2	A	
FP71	F	TX107	FPX	5/97	F_1	A	With 3 kittens
K69	M	FP71	FP79	6/99	F_2	a/d	Still with dam, either k69 or k70 presumed dead
K70	F	FP71	FP79	6/99	F_2	a/d	based on field sign
FP86	F	FP71	FP79	6/99	F_2	A	
FP90	M	FP71	FP79	6/99	F_2	A	
K56	F	TX107	FP79	2/99	B-TX	d	Monitoring hampered by failure of dam's collar; FP93
K57	M	TX107	FP79	2/99	B-TX	a	captured 4/00
FP93	F	TX107	FP79	2/99	B-TX	A	
TX108	F			1992±2y	TX	A	
FP61	F	TX108	FP16	7/96	F_1	A	With 1 kitten
FP85	M	FP61	FP16	3/99	B-FP	A	Inbred
K45	F	TX108	FP16	1/98	F_1	a/d	One of K45 and K46 with dam prior to independence;
K46	M	TX108	FP16	1/98	F_1	a/d	other likely dead

Notes

[1]FP_x indicates that the sire was unknown, but temporal and/or spatial circumstances make it likely that it was a FP male, rather than F_1 or other intercross.

[2]Status codes:

- **A = radio-collared; monitored regularly**
- **a = presumed alive; observed recently or signs of continued presence with dam**
- **? = fate unknown; not collared and not recently observed**
- **d = presumed dead; disappeared under circumstances that suggest mortality is likely**
- **D = known to be dead**

[3]Also has offspring listed under dams FP70, FP71, and TX107