TECHNICAL/AGENCY DRAFT

FLORIDA PANTHER RECOVERY PLAN

(*Puma concolor coryi*)

THIRD REVISION

Original Approval: December 17, 1981
First Revision Approved: June 22, 1987
Second Revision Approved: March 13, 1995

Prepared by

The Florida Panther Recovery Team

and

South Florida Ecological Services Office
U.S. Fish and Wildlife Service

for

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

January 31, 2006

DISCLAIMER

Recovery plans delineate actions which the best available science indicates are required to recover and protect listed species. Plans are published by the U.S. Fish and Wildlife Service (FWS), sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the FWS. They represent the official position of the FWS only after they have been signed by the Regional Director. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 2006. Technical/Agency Draft, Florida Panther Recovery Plan (*Puma concolor coryi*), Third Revision. U.S. Fish and Wildlife Service. Atlanta, Georgia. XXXpp.

ADDITIONAL COPIES MAY BE OBTAINED FROM:

U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, FL 32960
772-562-3909

Recovery plans can be downloaded from http://www.fws.gov/endangered or http://www.fws.gov/verobeach

RECOVERY TEAM MEMBERS

Buddy Baker	South Carolina Department of Natural Resources
Sonny Bass	National Park Service/Everglades National Park
Chris Belden*	U.S. Fish and Wildlife Service
Skip Bergmann	U.S. Army Corps of Engineers
Debbie Blanco*	Sarasota County Natural Resources
Dana Bryan*	Florida Department of Environmental Protection
Mary Bryant	The Nature Conservancy
Jimmy Bullock	International Paper Company
Barbara Cintron	U.S. Army Corps of Engineers
Joe Clark*	U.S. Geological Survey, Biological Resources Division
Mark Cunningham*	Florida Fish and Wildlife Conservation Commission
Don Cuozzo	National Association of Home Builders
Kipp Frohlich*	Florida Fish and Wildlife Conservation Commission
Skip Griep*	U.S. Forest Service
Karen Gustin	National Park Service/Big Cypress National Preserve
Dennis Hardin*	Florida Division of Forestry
Deborah Jansen*	National Park Service/Big Cypress National Preserve
Tom Jones	Barron Collier Partnership
F. K. Jones	Miccosukee Tribe of Indians of Florida
Nick Kapustin*	Jacksonville Zoo

* Current members, alternates, and U.S. Fish and Wildlife Service participants who actively contributed by attending meetings.

Robert Lacy	Chicago Zoological Society
Darrell Land*	Florida Fish and Wildlife Conservation Commission
Dwight LeBlanc	U.S. Department of Agriculture, APHIS, Wildlife Services
Gary Lester	Louisiana Department of Wildlife and Fisheries
Laurie Macdonald*	Defenders of Wildlife
Dave Maehr	University of Kentucky
Frank Mazzotti	University of Florida
Roy McBride*	Livestock Protection Company
Brian Murphy	Quality Deer Management Association
Erin Myers*	Natural Resources Conservation Service
Stephen O'Brien	National Cancer Institute
Tim O'Meara*	Florida Fish and Wildlife Conservation Commission
Jim Ozier	Georgia Wildlife Resources Division
Pedro Ramos	National Park Service/Big Cypress National Preserve
Richard Rummel	Mississippi Department of Wildlife, Fisheries & Parks
Mark Sasser	Alabama Division of Wildlife and Freshwater Fisheries
David Shindle*	Conservancy of Southwest Florida
Mel Sunquist	University of Florida
David Thompson	White Oak Conservation Center
Steve Williams*	Florida Panther Society
Ed Woods*	Seminole Tribe of Florida
Wesley Woolf*	National Wildlife Federation

Recovery Team Member Alternates:

Phillip Brouse*	Sarasota County Natural Resources
Monika Dey*	U.S. Army Corps of Engineers
Elizabeth Fleming*	Defenders of Wildlife
Margaret Griep*	U.S. Forest Service
Sarah Grubs*	Seminole Tribe of Florida
Laura Hartt*	National Wildlife Federation
Karen Hill*	Florida Panther Society
Jon Moulding*	U.S. Army Corps of Engineers
Cynthia Ovdenk*	U.S. Army Corps of Engineers
Mike Owen	Florida Department of Environmental Protection
Nancy Payton	Florida Wildlife Federation

U.S. Fish and Wildlife Service Participants:

Paula Halupa*	South Florida Ecological Services Field Office
Layne Hamilton	Florida Panther National Wildlife Refuge
Larry Richardson*	Florida Panther National Wildlife Refuge
Cindy Schulz*	South Florida Ecological Services Field Office
Paul Souza*	South Florida Ecological Services Field Office

Meeting Facilitators – Florida Conflict Resolution Consortium:

Chris Pedersen	Orlando
Tom Taylor	Tallahassee

Previous Recovery Team members that attended meetings were Lincoln Bormann (The Nature Conservancy), Pete David (South Florida Water Management District), Thomas Eason (Florida Fish and Wildlife Conservation Commission), John Kasbohm (U.S. Fish and Wildlife Service), Jeff Norment (Natural Resources Conservation Service), and Jora Young (The Nature Conservancy).

ACKNOWLEDGMENTS

The initial work (2001 - 2004) on this third revision of the Florida Panther Recovery Plan was led by John Kasbohm with the assistance of Dawn Jennings (U.S. Fish and Wildlife Service). Jora Young guided the Team through the threats analysis process and produced the Threats Analysis tables. Building upon that early work, Chris Belden and Cindy Schulz led the team through to completion of this revision.

Many people contributed to this revision, and some spent countless hours working on specific sections. The Overview and much of the Background Sections were initially written by John Kasbohm. Parts of the Background Section were updated and added to by Chris Belden, Mark Cunningham, Elizabeth Fleming, Paula Halupa, Laura Hartt, Karen Hill, Nick Kapustin, Darrell Land, Laurie Macdonald, Roy McBride, Tim O'Meara, Cindy Schulz, and Wes Woolf. The Recovery Strategy was drafted by Laura Hartt and Karen Hill with assistance from Larry Richardson, Wes Woolf, and Steve Williams. The Recovery Action Outline and Narrative Section and Implementation Schedule were a Team effort, but specific parts were provided by

Kipp Frohlich, Margaret Griep, Tim O'Meara, and Karen Hill. Karen Hill provided the majority of the Public Awareness and Education parts of these sections.

The major editing for this revision was done by Cindy Schulz, Chris Belden, and Paula Halupa. Editorial suggestions were also provided by Laura Hartt, Deborah Jansen, Elizabeth Fleming, Karen Hill, Tim O'Meara, Joe Clark, Dana Bryan, Laurie Macdonald, and Mark Cunningham. We want to thank Chris Pederson and Tom Taylor for keeping us focused by facilitating our meetings.

EXECUTIVE SUMMARY

Current Species Status

The Florida panther is the last subspecies of *Puma* still surviving in the eastern United States. Historically occurring throughout the southeastern United States, today the panther is restricted to less than 5% of its historic range in one breeding population of less than 100 animals, located in south Florida. The panther is threatened with extinction and human development in panther habitat negatively impacts recovery. The panther is federally listed as endangered under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) and is on the State endangered lists for Florida, Georgia, Louisiana, and Mississippi.

Habitat Requirements and Limiting Factors

Panthers are wide ranging, secretive, and occur at low densities. They require large contiguous areas to meet their social, reproductive, and energetic needs. Panther habitat selection is related to prey availability (i.e., habitats that make prey vulnerable to stalking and capturing are selected). Dense understory vegetation provides some of the most important feeding, resting, and denning cover for panthers. Although daytime habitat use has been well documented for the panther, the species is predominantly active at night, and therefore a comprehensive understanding of panther habitat relationships has not yet been determined. Telemetry monitoring and ground tracking, however, indicate that panthers use the majority of habitats available to them.

Limiting factors for the Florida panther are habitat availability, prey availability, and lack of human tolerance. Habitat loss, degradation, and fragmentation are among the greatest threats to panther survival, while lack of human tolerance is one of the greatest threats to panther recovery. Problems associated with being a single, small, isolated population and vehicle strikes have continued to keep the panther population at its current low numbers. Potential panther habitat throughout the Southeast continues to be affected by urbanization, residential development, conversion to agriculture and silviculture, mining and mineral exploration, and lack of land use planning that recognizes panther needs. Public opinion is critical to attainment of recovery goals and reintroduction efforts. Political and social issues will be the most difficult aspects of panther recovery and must be resolved before reintroduction efforts are initiated. A lack of public support and tolerance could prevent the reintroduction of panthers anywhere outside of south Florida.

Recovery Strategy

The strategy for Florida panther recovery sets an intermediate goal of downlisting from endangered to threatened with the ultimate goal of delisting. To achieve both the intermediate and ultimate goals, the recovery plan identifies three objectives which, collectively, describe the conditions necessary to achieve recovery. This plan presents objective, measurable criteria that when met would result in a determination that delisting is warranted. These criteria are based on population numbers and number of populations that provide for demographically and genetically viable populations as determined by several population viability analyses to ensure resilience to catastrophic events. The threats to the Florida panther will need to be addressed to attain these criteria.

The recovery strategy for the Florida panther is to maintain, restore, and expand the panther population and its habitat in south Florida, expand this population into south-central Florida if sufficient habitat exists, reintroduce at least two additional viable populations within the historic range outside of south and south-central Florida, and facilitate panther recovery through public awareness and education. The panther depends upon habitat of sufficient quantity, quality, and spatial configuration for long-term persistence, therefore the plan is built upon habitat conservation and reducing habitat-related threats. Range expansion and reintroduction of additional populations are recognized as essential for panther recovery. Similarly, fostering greater public understanding and support is necessary to achieve panther conservation and recovery.

Recovery Goal

The goal of this revised recovery plan is to achieve long-term viability of the Florida panther to a point where it can be reclassified from endangered to threatened, and then removed from the list of endangered / threatened species.

Recovery Objectives

1. To maintain, restore, and expand the Florida panther population and its habitat in south Florida and, if feasible, expand the known occurrence of Florida panthers north of the Caloosahatchee River to maximize the probability of the long-term persistence of this metapopulation.

2. To identify, secure, maintain, and restore habitat in potential reintroduction areas within the panther's historic range, and to establish viable populations of the panther outside south and south-central Florida.

3. To facilitate panther conservation and recovery through public awareness and education.

Recovery Criteria

Downlisting should be considered when:

1. Two viable populations of at least 240 individuals (adults and subadults) each have been established and subsequently maintained for a minimum of fourteen years.

2. Sufficient habitat quality, quantity, and spatial configuration to support these populations is retained / protected or secured in the long-term.

A viable population, for purposes of Florida panther recovery, has been defined as one in which there is a 95% probability of persistence for 100 years. This population may be distributed in a metapopulation structure composed of subpopulations that total 240 individuals. There must be exchange of individuals and gene flow among subpopulations. For downlisting, exchange of individuals and gene flow can be either natural or through management. If managed, a commitment to such management must be formally documented and funded. Habitat should be in relatively unfragmented blocks that provide for food, shelter, and characteristic movements (e.g., hunting, breeding, dispersal, and territorial behavior) and support each metapopulation at a

density of 2 to 3 animals per 100 square miles (259 square kilometers), resulting in a minimum of 8,000 – 12,000 square miles (20,720 – 31,080 square kilometers) per metapopulation of 240 panthers.

Delisting should be considered when:

1. Three viable, self-sustaining populations of at least 240 individuals (adults and subadults) each have been established and subsequently maintained for a minimum of fourteen years.

2. Sufficient habitat quality, quantity, and spatial configuration to support these populations is retained / protected or secured in the long-term.

For delisting, exchange of individuals and gene flow among subpopulations must be natural (i.e., not manipulated or managed).

Actions Needed

1. Maintain, restore, and expand the panther population and its habitat in south Florida.

2. Expand the known occurrence of panthers north of the Caloosahatchee River, if feasible.

3. Identify potential reintroduction areas within the historic range of the panther.

4. Reestablish viable panther populations outside of south and south-central Florida within the historic range.

5. Secure, maintain, and restore habitat in reintroduction areas.

6. Facilitate panther conservation and recovery through public awareness and education.

Total Estimated Cost of Recovery

Cost estimates reflect costs for specific actions needed to achieve Florida panther recovery. Estimates do not include costs that agencies or other entities normally incur as part of their mission or normal operating expenses. The following table provides cost estimates for five years for recovery actions listed in the Implementation Schedule of this document. Costs for some recovery actions were not determinable; therefore, the total cost for recovery during this period is higher than this estimate.

Estimated Cost of Recovery for Five Years by Recovery Action Priority (Dollars x 1,000):

Year	Priority 1 Action	Priority 2 Actions	Priority 3 Actions	Total
1	875	1,981	1,713.5	4,569.5
2	875	1,696	1,506.5	4,077.5
3	835	1,561	1,231.5	3,627.5
4	835	921	981.5	2,737.5
5	835	921	981.5	2,737.5
Total	4,255	7,080	6,414.5	17,750

Date of Recovery

If all actions are fully funded and implemented as outlined, including full cooperation of all partners needed to achieve recovery, criteria for downlisting from endangered to threatened

could be accomplished within 30 years; criteria for delisting could be accomplished within 45 years following reclassification.

TABLE OF CONTENTS

I. BACKGROUND

The Florida panther (*Puma concolor coryi*) was listed as endangered throughout its range in 1967 (32 FR 4001), and received Federal protection under the passage of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). Since the panther was designated as an endangered species prior to enactment of the ESA, there was no formal listing package identifying threats to the species as required by section 4(a)(1) of the ESA. No critical habitat has been designated for the panther.

The ESA establishes policies and procedures for identifying, listing, and protecting species of plants, fish, and wildlife that are endangered or threatened with extinction. The purposes of the ESA are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species…." The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Under the definition of "species" in the ESA, the U.S. Fish and Wildlife Service (FWS) can apply the protections of the ESA to any species or subspecies of fish, wildlife, or plants, or any distinct population segment of any species of vertebrate fish or wildlife that meets the definition of endangered or threatened. The ESA does not attempt to define "species" in biological terms, and thus allows the term to be applied according to the best current biological knowledge and understanding of evolution, speciation, and genetics. So although the Florida

panther is a subspecies, the protection it receives under the ESA is the same as for all other federally listed taxa whether they are species, subspecies, or distinct population segments.

The Secretary of the Department of the Interior is responsible for administering the ESA's provisions as they apply to the Florida panther. Day-to-day management authority for endangered and threatened species under the Department's jurisdiction has been delegated to the FWS. To help identify and guide species recovery needs, section 4(f) of the ESA directs the Secretary to develop and implement recovery plans for listed species or populations. Such plans are to include: (1) a description of site-specific management actions necessary to conserve the species; (2) objective, measurable criteria which, when met, will allow the species or populations to be removed from the endangered and threatened species list; and (3) estimates of the time and funding required to achieve the plan's goals and intermediate steps. Section 4 of the ESA and regulations (50 CFR Part 424) promulgated to implement its listing provisions also set forth the procedures for reclassifying and delisting species on the Federal lists. A species can be delisted if the Secretary of the Interior determines that the species no longer meets the endangered or threatened status based upon these five factors listed in section 4(a)(1) of the ESA: (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or manmade factors affecting its continued existence.

Further, a species may be delisted, according to 50 CFR Part 424.11(d), if the best scientific and commercial data available substantiate that the species or population is neither endangered nor

threatened for one of the following reasons: (1) extinction, (2) recovery, or (3) original data for classification of the species were in error.

The FWS has lead responsibility for conservation and recovery of the Florida panther, but all Federal agencies are responsible for contributing to panther conservation pursuant to section 7(a)(1) of the ESA. In 1981, FWS issued the initial recovery plan, and the plan was revisited in the mid-1980s culminating in the first major revision in 1987. A minor revision to incorporate a task to address genetic restoration and management was approved in 1995. In 1999, the FWS approved the South Florida Multi-species Recovery Plan (MSRP) (FWS 1999) that identified recovery needs of 68 threatened and endangered species in south Florida. The MSRP included recovery actions for the panther, but only for the portion of its range in south Florida. The FWS acknowledges that portions of the MSRP are now outdated and the habitat descriptions need to be clarified to more accurately describe panther habitat.

In 2001, the FWS initiated the process to revise the overall recovery plan for a third time. A new Florida Panther Recovery Team, consisting of representatives of the public, agencies, and groups that have an interest in panther recovery and / or could be affected by proposed actions, was established to assist with this revision.

Since approval of the original recovery plan in 1981 (FWS 1981), significant research has been conducted and important conservation and recovery activities have been accomplished primarily by the Florida Game and Freshwater Fish Commission (now the Florida Fish and Wildlife Conservation Commission [FWC]). This third revision of the recovery plan reflects many of

those accomplishments, addresses current threats and needs, specifically addresses the planning requirements of the ESA, and supersedes previous recovery plans including the Florida panther component of the MSRP.

A. Overview

The Florida panther, a subspecies of *Puma* (also known as mountain lion, cougar, painter, or catamount) is the last subspecies still surviving in the eastern U.S. Historically occurring throughout the southeastern U.S., today the panther is restricted to less than 5% of its historic range in one breeding population of less than 100 animals, located in south Florida (Figure 1).

Persecution and prey decline resulted in a panther population threatened with extinction. Prior to 1949, panthers could be killed in Florida at any time of the year. In 1950, FWC declared the panther a regulated game species due to concerns over declining numbers. The FWC removed panthers from the game animal list in 1958 and gave them complete legal protection. On March 11, 1967, the FWS listed the panther as endangered (32 FR 4001) throughout its historic range. The Florida Panther Act (State Statute 372.671), a 1978 Florida State law, made killing a panther a felony. The Florida panther is listed as endangered by the States of Florida, Georgia, Louisiana, and Mississippi.

FWS uses recovery priority numbers, ranging from a high of 1C to a low of 18, to assign recovery priorities to listed species. The criteria on which the recovery priority number is based are degree of threat, recovery potential, taxonomic distinctiveness, and presence of an actual or imminent conflict between the species and development activities. The FWS has assigned the

panther a recovery priority number of 6C. This priority number identifies the panther as a subspecies with a high degree of threat of extinction, but low recovery potential because recovery is in conflict with construction, other development projects, or other forms of economic activity.

Presently, habitat loss and fragmentation, problems associated with small isolated populations including inbreeding depression and reduced genetic health, and vehicle strikes have continued to keep the panther population at its currently low numbers. Today, survival and recovery of the Florida panther are dependent upon maintaining, restoring, and expanding the panther population and its habitat in south Florida and facilitating panther conservation and recovery through public awareness and education. In addition, recovery also requires expanding the known occurrence of panthers north of the Caloosahatchee River, if feasible, and identifying potential reintroduction areas within the historic range and establishing and maintaining at least two additional viable populations with associated habitats outside of south and south-central Florida.

B. Description

An adult Florida panther is unspotted and typically rusty reddish-brown on the back, tawny on the sides, and pale gray underneath. There has never been a melanistic (black) puma documented in North America (Tinsley 1970, 1987). Adult males can reach a length of seven feet (ft) (2.1 meters [m]) from their nose to the tip of their tail and may exceed 161 pounds (lbs) (73 kilograms [kg]) in weight; but, typically adult males average around 116 lbs (52.6 kg) and stand approximately 24 - 28 inches (in) (60 - 70 centimeters [cm]) at the shoulder (Roelke 1990). Female panthers are smaller with an average weight of 75 lbs (34 kg) and length of 6 ft (1.8 m)

(Roelke 1990). The skull of the Florida panther is unique in that it has a broad, flat, frontal region, and broad, high-arched or upward-expanded nasal bones (Young and Goldman 1946).

Florida panther kittens are gray with dark brown or blackish spots and five bands around the tail. The spots gradually fade as the kittens grow older and are almost unnoticeable by the time they are six months old. At this age, their bright blue eyes slowly turn to the light-brown straw color of the adult (Belden 1988).

Three external characters—a right angle crook at the terminal end of the tail, a whorl of hair or cowlick in the middle of the back, and irregular, white flecking on the head, nape, and shoulders—not found in combination in other subspecies of *Puma* (Belden 1986), were commonly observed in Florida panthers through the mid-1990s. The kinked tail and cowlicks were considered manifestations of inbreeding (Seal 1994a), whereas the white flecking was thought to be a result of scarring from tick bites (Maehr 1992, Wilkins et al. 1997). Four other abnormalities prevalent in the panther population prior to the mid-1990s included cryptorchidism (one or two undescended testicles), low sperm quality, atrial septal (the opening between two atria fails to close normally during fetal development) defects, and immune deficiencies and were also suspected to be the result of low genetic variability (Roelke et al. 1993b).

A plan for genetic restoration and management of the Florida panther was developed in September 1994 (Seal 1994a) and eight non-pregnant adult female Texas panthers (*Puma concolor stanleyana*) were released in five areas of south Florida from March to July 1995. Since this introgression, rates of genetic defects, including crooked tails and cowlicks, have

dramatically decreased (Land et al. 2004). In addition, to date neither atrial septal defects nor cryptorchidism have been found in introgressed panthers (M. Cunningham, FWC, pers. comm. 2005).

C. Taxonomy

The Florida panther was first described by Charles B. Cory in 1896 as *Felis concolor floridana* (Cory 1896). The type specimen was collected in Sebastian, Florida. Bangs (1899), however, believed that the Florida panther was restricted to peninsular Florida and could not intergrade with other *Felis* spp. Therefore, he assigned it full specific status and named it *Felis coryi* since *Felis floridana* had been used previously for a bobcat (*Lynx rufus*).

The taxonomic classification of the *Felis concolor* group was revised and described by Nelson and Goldman (1929) and Young and Goldman (1946). These authors differentiated 30 subspecies using geographic and morphometric (measurement of forms) criteria and reassigned the Florida panther to subspecific status as *Felis concolor coryi*. This designation also incorporated *F. arundivaga* which had been classified by Hollister (1911) from specimens collected in Louisiana into *F. c. coryi*. Nowell and Jackson (1996) reviewed the genus *Felis* and placed mountain lions, including the Florida panther, in the genus *Puma*.

Culver et al. (2000) examined genetic diversity within and among the described subspecies of *Puma concolor* using three groups of genetic markers and proposed a revision of the genus to include only six subspecies, one of which encompassed all Puma in North America including the Florida panther. However, Culver et al. (2000) determined that the Florida panther was one of

several smaller populations that had unique features, the number of polymorphic microsatellite loci and amount of variation were lower, and it was highly inbred (eight fixed loci). The degree to which the scientific community has accepted the results of Culver et al. (2000) and the proposed change in taxonomy is not resolved at this time. The Florida panther remains listed as a subspecies and continues to receive protection pursuant to the ESA.

D. Population Trends and Distribution

The Florida panther once ranged throughout the southeastern U.S. from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida, and parts of South Carolina and Tennessee (Young and Goldman 1946) (Figure 1). Historically, the panther intergraded to the north with *P. c. cougar*, to the west with *P. c. stanleyana*, and to the northwest with *P. c. hippolestes* (Young and Goldman 1946).

Although generally considered unreliable, sightings of panthers regularly occur throughout the Southeast. However, no reproducing populations of panthers have been found outside of south Florida for at least 30 years despite intensive searches to document them (Belden et al. 1991, McBride et al. 1993, Clark et al. 2002). Survey reports and more than 70,000 locations of radio-collared panthers recorded between 1981 and 2004 clearly define the panther's current breeding range (Figure 1). Reproduction is known only in the Big Cypress Swamp / Everglades physiographic region in Collier, Lee, Hendry, Dade, and Monroe Counties south of the Caloosahatchee River (Belden et al. 1991). Although confirmed panther sign, male radio-collared panthers, and uncollared males killed by vehicles have been recorded outside of south Florida in recent years, no female panthers have been documented north of the Caloosahatchee

River since 1973 (Nowak and McBride 1974, Belden et al. 1991, Land and Taylor 1998, Land et al. 1999, Shindle et al. 2000, McBride 2002, Belden and McBride 2005).

Puma are wide ranging, secretive, and occur at low densities. However, their tracks, urine markers, and scats are readily found by trained observers, and resident populations are easily located. Van Dyke (1986b) determined that all resident puma, 78% of transient puma, and 57% of kittens could be detected by track searches in Utah. In south Florida, the Florida panther's limited range and low densities may make the population count derived from track searches more accurate than in Utah. During two month-long investigations – one late in 1972 and early 1973 and another in 1974 – funded by the World Wildlife Fund to determine if panthers still existed in Florida, McBride searched for signs of panthers in portions of south Florida. In 1972, McBride authenticated a road-killed male panther in Glades County and a female captured and released from a bobcat trap in Collier County (R. McBride, Livestock Protection Company, pers. comm. 2005). In 1973, McBride captured one female in Glades County (Nowak and McBride 1974). Based on this preliminary evidence, Nowak and McBride (1974) estimated the "population from the Lake Okeechobee area southward to be about 20 or 30 individuals." In 1974, McBride found evidence of only two additional panthers in the Fakahatchee Strand and suggested that "there could be not more than ten individual panthers in the area around Lake Okeechobee and southward in the state" (Nowak and McBride 1975). This initial survey, while brief in nature, proved that panthers still existed in Florida and delineated areas where a more exhaustive search was warranted. After this initial investigation, more comprehensive surveys on both public and private lands were completed (Reeves 1978; Belden and McBride 1983a, b; Belden et al. 1991).

Thirty individual panthers were identified during a wide-ranging survey in 1985 in south Florida (McBride 1985).

Maehr et al. (1991a) provides the only published population estimate based on a substantial body of field data (Beier et al. 2003). Maehr et al. (1991a) estimated a density of 1 panther / 43 mi^2 [110 square kilometers (km^2)] based on 17 concurrently radiocollared and four uncollared panthers. They extrapolated this density to the area occupied (1,946 mi^2 [5,040 km^2]) by radio-collared panthers during the period 1985 - 1990 to achieve a population estimate of 46 adult panthers for southwest Florida (excluding Everglades National Park [ENP], eastern Big Cypress National Preserve [BCNP], and Glades and Highlands Counties). Beier et al. (2003), however, argued that this estimate of density, although "reasonably rigorous," could not be extrapolated to other areas because it was not known whether densities were comparable in those areas.

More recently, McBride (2000, 2001, 2002, 2003) obtained minimum population counts (i.e., number known alive) based on panthers treed with hounds, physical evidence (e.g., tracks where radio-collared panthers were not known to occur), documentation by trail-camera photos, and sightings of uncollared panthers by a biologist or pilot from a monitoring plane or via ground telemetry. He counted 62, 78, 80, and 87 panthers (which includes adult and subadult panthers but not kittens at the den) in 2000, 2001, 2002, and 2003, respectively. Population counts were not conducted in 2004 and are not yet available for 2005.

McBride (2002) documented an increase in the number of uncollared panthers captured each year between 2000 and 2002 relative to 1981 through 1999, while Shindle et al. (2001) reported

data showing an apparent increase in the number of panthers killed by vehicles since 1999. In neither case, however, was supporting evidence provided that would be necessary to conclude that these increases reflected population trends.

Although the breeding segment of the panther population occurs only in south Florida, panthers have been documented north of the Caloosahatchee River over 125 times since February 1972. This has been confirmed through field sign (e.g., tracks, scrapes, scats), camera-trap photographs, seven highway mortalities, four radio-collared animals, two captured animals (one of which was radiocollared), and one skeleton. From 1972 through 2004, panthers have been confirmed in 11 counties (Flagler, Glades, Highlands, Hillsborough, Indian River, Okeechobee, Orange, Osceola, Polk, Sarasota, Volusia) north of the river (Belden et al. 1991, Belden and McBride 2005). However, no evidence of a female or reproduction has been documented north of the Caloosahatchee River in over 30 years (Belden and McBride 2005).

E. Life History / Ecology

Reproduction--Male Florida panthers are polygynous, maintaining large, overlapping home ranges containing several adult females and their dependent offspring. The first sexual encounters for males normally occur at about three years based on 26 radio-collared panthers of both sexes (Maehr et al. 1991a). Based on genetics work, some males may become breeders as early as 17 months (W. Johnson, National Cancer Institute, pers. comm. 2005). Breeding activity peaks from December to March (Shindle et al. 2003). Litters (n = 82) are produced throughout the year, with 56 - 60% of births occurring between March and June (Jansen et al. 2005, Lotz et al. 2005). The greatest number of births occur in May and June (Jansen et al. 2005,

Lotz et al. 2005). Female panthers have bred as young as 18 months (Maehr et al. 1989a) and successful reproduction has occurred up to 11 years old. Mean age of denning females is 4.6 ± 2.1 (standard deviation [sd]) years (Lotz et al. 2005). Age at first reproduction for 19 known-aged female panthers averaged 2.2 ± 0.246 (sd) years and ranged from 1.8 - 3.2 years. Average litter size is 2.4 ± 0.91 (sd) kittens. Seventy percent of litters are comprised of either two or three kittens. Mean birth intervals (elapsed time between successive litters) are 19.8 ± 9.0 (sd) months for female panthers (n = 56) (range 4.1 - 36.5 months) (Lotz et al. 2005). Females that lose their litters generally produce another more quickly; five of seven females whose kittens were brought into captivity (see Captive Breeding section of F. Conservation Efforts) successfully produced another litter an average of 10.4 months after the removal of the initial litter (Land 1994).

Den sites are usually located in dense, understory vegetation, typically saw palmetto (*Serenoa repens*) (Maehr 1990a, Shindle et al. 2003). Den sites are used for up to two months by female panthers and their litters from birth to weaning. Independence and dispersal of young typically occurs at 18 months, but may occur as early as one year (Maehr 1992).

Survivorship and Causes of Mortality--Intraspecific aggression accounts for 42% of all mortalities among radio-collared panthers (Jansen et al. 2005, Lotz et al. 2005). Unknown causes and collisions with vehicles account for 24 and 19% of mortalities, respectively. From 1990 - 2004, mean annual survivorship of radio-collared adult panthers was greater for females (0.894 ± 0.099 sd) than males (0.779 ± 0.125 sd) (Lotz et al. 2005). Most intraspecific aggression occurs between male panthers; but, aggressive encounters between males and

females, resulting in the death of the female, have occurred. Defense of kittens and / or a kill is suspected in half (5 of 10) of the known instances through 2003 (Shindle et al. 2003).

Female panthers are considered adult residents if they are older than 18 months, have established home ranges and bred (Maehr et al. 1991a). Land et al. (2005) reported that all 24 female panthers first captured as kittens survived to become residents and 19 (79.2%) produced litters. Male panthers are considered adult residents if they are older than three years and have established a home range that overlaps with females. Thirty-one male panthers were captured as kittens and 12 (38.7%) of these cats survived to become residents (Jansen et al. 2005, Lotz et al. 2005). "Successful male recruitment appears to depend on the death or home-range shift of a resident adult male" (Maehr et al. 1991a). Turnover in the breeding population is low with documented mortality in radio-collared panthers being greatest in subadults and non-resident males (Maehr et al. 1991a, Shindle et al. 2003).

Den sites of female Florida panthers and Texas puma females have been visited since 1992 and the number of kittens that survived to six months for 38 of these litters has been documented. Florida and introgressed panther kitten survival to six months were estimated to be 52 and 72%, respectively, but were not significantly different (P = 0.2776) (Lotz et al. 2005). Survival of kittens greater than six months old was determined by following the fates of 55 radio-collared dependent-aged kittens, including 17 introgressed panthers from 1985 - 2004. Only one of these 55 kittens died before reaching independence, resulting in a 98.2% survival rate (Lotz et al. 2005). The FWC and NPS are continuing to compile and analyze existing reproductive and kitten data.

Dispersal--Panther dispersal begins after a juvenile becomes independent from its mother and continues until it establishes a home range. Dispersal distances are greater for males (n = 18) than females (n = 9) (42.5 mi [68.4 km] vs. 12.6 mi [20.3 km], respectively) and the maximum dispersal distance recorded for a young male was 139.2 mi (224.1 km) over a seven-month period followed by a secondary dispersal of 145 mi (233 km) (Maehr et al. 2002a). Males disperse an average distance of 25 mi (40 km); females typically remain in or disperse short distances from their natal ranges (Comiskey et al. 2002). Female dispersers are considered philopatric because they usually establish home ranges less than one average home range width from their natal range (Maehr et al. 2002a). Maehr et al. (2002a) reported that all female dispersers (n = 9) were successful at establishing a home range whereas only 63% of males (n = 18) were successful. Young panthers become independent at 14 months on average for both sexes, but male dispersals are longer in duration than for females (9.6 months and 7.0 months, respectively) (Maehr et al. 2002a). Dispersing males usually go through a period as transient (non-resident) subadults, moving through the fringes of the resident population and often occupying suboptimal habitat until an established range becomes vacant (Maehr 1997a).

Most panther dispersal occurs south of the Caloosahatchee River with only four radio-collared panthers crossing the river and continuing north since 1981 (Land and Taylor 1998, Land et al. 1999, Shindle et al. 2000, Maehr et al. 2002a, Belden and McBride 2005). Western subspecies of *Puma* have been documented crossing wide, swift-flowing rivers up to a mile in width (Seidensticker et al. 1973, Anderson 1983). The Caloosahatchee River, a narrow (295 - 328 ft [90 - 100 m]), channelized river, probably is not a significant barrier to panther movements, but

the combination of the river, State Route (SR) 80, and land uses along the river seems to have restricted panther dispersal northward (Maehr et al. 2002a). Documented physical evidence of at least 15 other uncollared male panthers have been confirmed north of the river since 1972, but no female panthers nor reproduction have been documented in this area since 1973 (Belden and McBride 2005).

Home Range Dynamics and Movements--Panthers require large areas to meet their needs. Numerous factors influence panther home range size including habitat quality, prey density, and landscape configuration (Belden 1988, Comiskey et al. 2002). Home range sizes of 26 radio-collared panthers monitored between 1985 and 1990 averaged 200 mi^2 (519km^2) for resident adult males and 75 mi^2 (193 km^2) for resident adult females; transient males had a home range of 240 mi^2 (623 km^2) (Maehr et al. 1991a). Comiskey et al. (2002) examined the home range size for 50 adult panthers (residents greater than 1.5 years old) monitored in south Florida from 1981 - 2000 and found resident males had a mean home range of 251 mi^2 (650 km^2) and females had a mean home range of 153 mi^2 (396 km^2). Beier et al. (2003) found home range size estimates for panthers reported by Maehr et al. (1991a) and Comiskey et al. (2002) to be reliable.

Annual minimum convex polygon home range sizes of 52 adult radio-collared panthers monitored between 1998 and 2002 ranged from 24 - 459 mi^2 (63 - 1,188 km^2), averaging 140 mi^2 (362 km^2) for 20 resident adult males and 69 mi^2 (179 km^2) for 32 resident adult females (Land et al. 1999, Shindle et al. 2000, Shindle et al. 2001, Land et al. 2002). Home ranges of resident adults tend to be stable unless influenced by the death of other residents, however, several males have shown significant home range shifts that may be related to aging (D. Jansen, National Park

Service [NPS], pers. comm. 2005). Home-range overlap is extensive among resident females and limited among resident males (Maehr et al. 1991a).

Activity levels for Florida panthers are greatest at night with peaks around sunrise and after sunset (Maehr et al. 1990a). The lowest activity levels occur during the middle of the day. Female panthers at natal dens follow a similar pattern with less difference between high and low activity periods.

Telemetry data indicate that panthers typically do not return to the same resting site day after day, with the exception of females with dens or panthers remaining near kill sites for several days. The presence of physical evidence such as tracks, scats, and urine markers confirm that panthers move extensively within home ranges, visiting all parts of the range regularly in the course of hunting, breeding, and other activities (Maehr 1997a, Comiskey et al. 2002). Males travel widely throughout their home ranges to maintain exclusive breeding rights to females. Females without kittens also move extensively within their ranges (Maehr 1997a). Panthers are capable of moving large distances in short periods of time. Nightly panther movements of 12 mi (20 km) are not uncommon (Maehr et al. 1990a).

Intraspecific Interactions--Interactions between panthers occur indirectly through urine markers or directly through contact. Urine markers are made by piling ground litter using a backwards-pushing motion with the hind feet. This pile is then scent-marked with urine and occasionally feces. Both sexes make urine markers, apparently males use them as a way to mark their territory and announce presence while females advertise their reproductive condition.

Adult females and their kittens interact more frequently than any other group of panthers. Interactions between adult male and female panthers last from one to seven days and usually result in pregnancy (Maehr et al. 1991a). Aggressive interactions between males often result in serious injury or death. Independent subadult males have been known to associate with each other for several days and these interactions do not appear to be aggressive in nature. Aggression between males is the most common cause of male mortality and an important determinant of male spatial and recruitment patterns based on radio-collared panthers (Maehr et al. 1991a, Shindle et al. 2003). Aggressive encounters between radio-collared males and females also have been documented (Shindle et al. 2003, Jansen et al. 2005).

Food Habits--Primary panther prey are white-tailed deer (*Odocoileus virginianus*) and feral hog (*Sus scrofa*) (Maehr et al. 1990b, Dalrymple and Bass 1996). Generally, feral hogs constitute the greatest biomass consumed by panthers north of the Alligator Alley section of Interstate 75 (I-75) while white-tailed deer are the greatest biomass consumed to the south (Maehr et al. 1990b). Secondary prey includes raccoons (*Procyon lotor*), nine-banded armadillos (*Dasypus novemcinctus*), marsh rabbits (*Sylvilagus palustris*) (Maehr et al. 1990b) and alligators (*Alligator mississippiensis*) (Dalrymple and Bass 1996). No seasonal variation in diet has been detected. A resident adult male puma generally consumes one deer-sized prey every 8 - 11 days; this frequency would be 14 - 17 days for a resident female; and 3.3 days for a female with three 13-month-old kittens (Ackerman et al. 1986). Maehr et al. (1990b) documented domestic livestock infrequently in scats or kills, although cattle were readily available on their study area.

Infectious Diseases, Parasites, and Environmental Contaminants--

Viral Diseases--Feline leukemia virus (FeLV) is common in domestic cats (*Felis catus*), but is quite rare in non-domestic felids. Routine testing for FeLV antigen (indicating active infection) in captured and necropsied panthers has been negative since testing began in 1978 to the fall of 2002. Between November 2002 and February 2003, however, two panthers tested FeLV antigen positive (Cunningham 2005). The following year, three more cases were diagnosed. All infected panthers had overlapping home ranges in the Okaloacoochee Slough ecosystem. Three panthers died due to suspected FeLV-related diseases (opportunistic bacterial infections and anemia) and the two others died from intraspecific aggression. Testing of serum samples collected from 1990 - 2005 for antibodies (indicating exposure) to FeLV indicated increasing exposure to FeLV beginning in the late 1990s and concentrated north of I-75. There was apparently minimal exposure to FeLV during this period south of I-75. Positive antibody titers in different areas at different times may indicate that multiple introductions of the virus into the panther population may have occurred. These smaller epizootics were apparently self-limiting and did not result in any known mortalities. Positive antibody titers, in the absence of an active infection (antigen positive), indicate that panthers can be exposed and overcome the infection (Cunningham 2005). Management of the disease includes vaccination as well as removal of infected panthers to captivity for quarantine and supportive care. As of June 1, 2005, approximately one-third of the population had received at least one vaccination against FeLV (FWC and NPS, unpublished data). No new positive cases have been diagnosed since July 2004.

Pseudorabies virus (PRV) (Aujeszky's disease) causes respiratory and reproductive disorders in adult hogs and mortality in neonates, but is a rapidly fatal neurologic disease in carnivores. At

least one panther died from PRV infection presumably through consumption of an infected feral hog (Glass et al. 1994). At least one panther has also died of rabies (Taylor et al. 2002). This panther was radiocollared but not vaccinated against the disease.

Feline immunodeficiency virus (FIV) is a retrovirus of felids that is endemic in the panther population. Approximately 28% of Florida panthers were positive for antibodies to the puma lentivirus strain of FIV (Olmstead et al. 1992); however, the prevalence may be increasing. Between November 2004 and April 2005, 13 of 17 (76%) were positive (M. Cunningham, FWC, unpublished data). The cause of this increase is unknown but warrants continued monitoring and investigation. There is also evidence of exposure to Feline panleukopenia virus (PLV) in adult panthers (Roelke et al. 1993a) although no PLV-related mortalities are known to have occurred.

Serological evidence of other viral diseases in the panther population includes feline calicivirus, feline herpes virus, and West Nile virus (WNV). However these diseases are not believed to cause significant morbidity or mortality in the population. All panthers found dead due to unknown causes are tested for alphaviruses, flaviviruses (including WNV), and canine distemper virus. These viruses have not been detected in panthers by viral culture or polymerase chain reaction (FWC, unpublished data).

Other Infectious Diseases--Bacteria have played a role in free-ranging panther morbidity and mortality as opportunistic pathogens, taking advantage of pre-existing trauma or FeLV infections (FWC, unpublished data). Dermatophytosis (ringworm infection) has been diagnosed in several panthers and resulted in severe generalized infection in at least one (Rotstein et al. 1999). Severe

infections may reflect an underlying immunocompromise, possibly resulting from inbreeding depression or immunosuppressive viral infections.

Parasites--The hookworm, *Ancylostoma pluridentatum,* is found in a high prevalence in the panther population. Other parasites identified from live-captured or necropsied panthers include eight arthropod species, eight nematode species, three cestode species, two trematode species, and three protozoa species (Forrester et al. 1985, Forrester 1992, Wehinger et al. 1995, Rotstein et al. 1999, Land et al. 2002). Of these only an arthropod, *Notoedres felis*, caused significant morbidity in at least one panther (Maehr et al. 1995).

Environmental Contaminants--Overall, mercury in south Florida biota has decreased over the last several years (Frederick et al. 2002). However, high mercury concentrations are still found in some panthers. At least one panther is thought to have died of mercury toxicosis and mercury has been implicated in the death of two other panthers in ENP (Roelke 1991). One individual panther had concentrations of 150 parts per million (ppm) mercury in its hair (Land et al. 2004). Elevated levels of p, p'– DDE were also detected in fat from that panther. The role of mercury and / or p, p'– DDE in this panther's death is unknown and no cause of death was determined despite extensive diagnostic testing. Elevated mercury concentrations have also been found in panthers from Florida Panther National Wildlife Refuge (FPNWR). Two sibling neonatal kittens from this area had hair mercury concentrations of 35 and 40 ppm. Although other factors were believed to have been responsible, these kittens did not survive to leave their natal den. Consistently high hair mercury values in ENP and FPNWR and the finding of elevated values in some portions of BCNP warrant continued monitoring (Land et al. 2004). Other environmental

contaminants found in panthers include polychlorinated biphenyls (Arochlor 1260) and organochlorines (p, p'–DDE) (Dunbar 1995, Land et al. 2004).

F. Habitat Characteristics / Ecosystem

Landscape Composition--Noss and Cooperrider (1994) considered the landscape implications of maintaining viable panther populations. Assuming a male home range size of 215 mi^2 (558 km^2) (Maehr 1990a), an adult sex ratio of 50:50 (Anderson 1983), and some margin of safety, they determined that a reserve network as large as 15,625 – 23,438 mi^2 (40,469 - 60,703 km^2) would be needed to support an effective population size of 50 individuals (equating to an actual adult population of 100 - 200 panthers [Ballou et al. 1989]). However, to provide for long-term persistence based on an effective population size of 500 individuals (equating to 1,000 - 2,000 adult panthers [Ballou et al. 1989]), could require as much as 156,251 - 234,376 mi^2 (404,687 - 607,031 km^2). This latter acreage corresponds to roughly 60 - 70% of the Florida panther's historical range. Although it is uncertain whether this much land is needed for panther recovery, it does provide some qualitative insight into the importance of habitat conservation across large landscapes for achieving a viable panther population (Noss and Cooperrider 1994).

Between 1981 and 2003, more than 55,000 locations on more than 100 radio-collared panthers were collected. Belden et al. (1988), Maehr et al. (1991a), Maehr (1997a), Kerkoff et al. (2000), and Comiskey et al. (2002) provide information on habitat use based on various subsets of these data. Since almost all data from radio-collars have been collected during daytime hours (generally 0700 - 1100), and because panthers are most active at night (Maehr et al. 1990a),

daytime radio locations are insufficient to describe the full range of panther habitat use (Beyer and Haufler 1994, Comiskey et al. 2002, Beier et al. 2003, Dickson et al. 2005, Beier et al. in press).

The FWS created the Multi-species/Ecosystem Recovery Implementation Team (MERIT) to assist with implementation of the MSRP after it was signed in 1999. The Florida Panther Subteam of MERIT developed a landscape-level strategy for the conservation of the panther population in south Florida which was not finalized. Many of the Panther Subteam members refined the methodology, further analyzed the data, and better defined the results of this landscape-level strategy into a spatial model (Kautz et al. in press). In developing the model, data from radio-collared panthers collected from 1981 through 2000 were used to evaluate the relative importance of various land cover types as panther habitat, thus identifying landscape components important for panther habitat conservation. Those components were then combined with a least cost path analysis to delineate three panther habitat conservation zones for south Florida: (1) Primary Zone – lands essential to the long-term viability and persistence of the panther in the wild; (2) Secondary Zone - lands which few panthers use contiguous with the Primary Zone, but given sufficient habitat restoration could accommodate expansion of the panther population south of the Caloosahatchee River; and (3) Dispersal Zone - the area which may facilitate future panther expansion north of the Caloosahatchee River (Kautz et al. in press) (Figure 3). The Primary Zone is currently occupied and supports the breeding population of panthers. Although panthers move through the Secondary and Dispersal Zones, they are not permanently occupied. The Secondary Zone could support panthers with sufficient restoration.

These zones vary in size, ownership, and land cover composition. The Primary Zone is 3,548 mi^2 (9,189 km^2) in size, 73% of which is publicly owned (R. Kautz, Dennis, Breedlove, and Associates, pers. comm. 2005), and includes portions of the BCNP, ENP, Fakahatchee Strand Preserve State Park (FSPSP), FPNWR, Okaloacoochee Slough State Forest, and Picayune Strand State Forest. This zone's composition is 45% forest, 41% freshwater marsh, 7.6% agriculture lands, 2.6% prairie and shrub lands, and 0.52% urban lands (Kautz et al. in press).

The Secondary Zone is 1,269 mi^2 (3,287 km^2) in size, 38% of which is public land (R. Kautz, pers. comm. 2005). This zone's composition is 43% freshwater marsh, 36% agriculture, 11% forest, 6.1% prairie and shrub lands, and 2.3% low-density residential areas and open urban lands (Kautz et al. in press).

The Dispersal Zone is 44 mi^2 (113 km^2) in size, all of which is privately owned (R. Kautz, pers. comm. 2005). This zone's composition is 49% agriculture (primarily improved pasture and citrus groves), 29% forest (wetland and upland), 8.8% prairie and shrub land, 7.5% freshwater marsh, and 5.1% barren and urban lands (Kautz et al. in press).

Diurnal Habitat Use--Diurnal panther locations appear to be within or closer to forested cover types, particularly cypress swamp, pinelands, hardwood swamp, and upland hardwood forests (Belden 1986, Belden et al. 1988, Maehr 1990a, Maehr et al. 1991a, Maehr 1992, Smith and Bass 1994, Kerkhoff et al. 2000, Comiskey et al. 2002). Day beds and denning sites are important habitat features that should be considered in panther management. Dense understory

vegetation comprised of saw palmetto provides some of the most important resting and denning cover for panthers (Maehr 1990a). Shindle et al. (2003) show that 73% of panther dens were in palmetto thickets.

Radio-collar data and ground tracking indicate that panthers use the mosaic of habitats available to them as resting and denning sites, hunting grounds, and travel routes. These habitats include cypress swamps, hardwood hammocks, pine flatwoods, seasonally flooded prairies, freshwater marshes, and some agricultural lands. Although radiocollar monitoring indicates that forest is a preferred cover type for daytime rest, it is clear that panthers utilize non-forest cover types, including areas disturbed by humans (e.g., Belden et al. 1988, Maehr et al. 1991a, Comiskey et al. 2002). Compositional analyses by Kautz et al. (in press) confirmed previous findings that forest patches comprise an important component of panther habitat in south Florida, but that other natural and disturbed cover types are also present in the large landscapes that support panthers (Belden et al. 1988, Maehr et al. 1991a, Comiskey et al. 2002). Kautz et al. (in press) found that the smallest class of forest patches (i.e., 9 - 26 ac [3.6 - 10.4 ha]) were the highest ranked forest patch sizes within panther home ranges; this indicates that forest patches of all sizes appear to be important components of the landscapes inhabited by panthers, not just the larger forest patches.

Nocturnal Habitat Use--Maehr et al. (1990a) provide the only descriptions of panther nocturnal activities and represent the available radiocollar data collected during night time hours. Unfortunately, this paper does not provide analyses of nocturnal habitat use. Dickson et al. (2005) examined the movements of 10 female and seven male puma at 15-minute intervals

during 44 nocturnal periods of hunting or traveling in southern California. They found that traveling puma monitored over nocturnal periods used a broader range of habitats than what they appeared to use based on diurnal locations alone. These findings support the argument of Comiskey et al. (2002) that analyses of diurnal locations provide limited information about puma patterns of habitat selection during the time of day when puma are most active (Dickson et al. 2005). The use of Global Positioning System (GPS) radiocollars is now being investigated to determine if this technology will be suitable to answer questions regarding Florida panther nocturnal habitat use.

Prey Habitat Use--Panther habitat selection is related to prey availability (Janis and Clark 1999, Dees et al. 2001) and, consequently, prey habitat use. Adequate cover and the size, distribution, and abundance of available prey species are critical factors to the persistence of panthers in south Florida and often determine the extent of panther use of an area. Duever (1986) calculated a deer population of 1,760 in BCNP, based on Harlow (1959) deer density estimates of 1 / 210 ac (85 ha) in pine forest, 1 / 299 ac (121 ha) in swamps, 1 / 1,280 ac (518 ha) in prairie, 1 / 250 ac (101 ha) in marshes, and 1 / 111 ac (45 ha) in hammocks. Schortemeyer et al (1991) estimated deer densities at 1 / 49 - 247 ac (20 - 100) ha in three management units of BCNP based on track counts and aerial surveys. Labisky et al. (1995) reported 1 / 49 ac (20 ha) in southeastern BCNP. Using track counts alone, McCown (1994) estimated 1 / 183 - 225 ac (74 - 91 ha) on the FPNWR and 1 / 133 - 200 ac (54 - 81 ha) in the FSPSP.

Hardwood hammocks and other forest cover types are important habitat for white-tailed deer and other panther prey (Harlow and Jones 1965, Belden et al. 1988, Maehr 1990a, Maehr et al.

1991a, Maehr 1992, Comiskey et al. 1994, Dees et al. 2001). Periodic understory brushfires (Dees et al. 2001) as well as increased amounts of edge (Miller 1993) may enhance deer use of hardwood hammocks, pine, and other forest cover types.

However, wetland and other vegetation types can support high deer densities. In the Everglades, for example, deer appear to be adapted to a mosaic of intergrading patches comprised of wet prairie, hardwood tree islands, and peripheral wetland habitat (Fleming et al. 1994, Labisky et al. 2003). High-nutrient deer forage, especially preferred by females, includes hydrophytic marsh plants, white waterlily (*Nymphaea odorata*), and swamp lily (*Crinum americana*) (Loveless 1959, Labisky et al. 2003). Wetland willow (*Salix spp.*) thickets provide nutritious browse for deer (Loveless 1959, Labisky et al. 2003).

Marshes, rangeland, and low-intensity agricultural areas support prey populations of deer and hogs. The importance of these habitat types to panthers cannot be dismissed based solely on use or lack of use when daytime telemetry are the only data available (Comiskey et al. 2002, Beier et al. 2003, Comiskey et al. 2004, Beier et al. in press).

Travel and Dispersal Corridors--In the absence of direct field observations / measurements, Harrison (1992) suggested that landscape corridors for wide-ranging predators should be half the width of an average home range size. Following Harrison's (1992) suggestion, corridor widths for Florida panthers would range 6.1 - 10.9 mi (9.8 - 17.6 km) depending on whether the target animal was an adult female or a transient male. Beier (1995) suggested that corridor widths for transient male puma in California could be as small as 30% of the average home range size of an

adult. For Florida panthers, this would translate to a corridor width of 5.5 mi (8.8 km). Without supporting empirical evidence, Noss (1992) suggests that regional corridors connecting larger hubs of habitat should be at least 1.0 mi (1.6 km) wide. Beier (1995) makes specific recommendations for very narrow corridor widths based on short corridor lengths in a California setting of wild lands completely surrounded by urban areas; he recommended that corridors with a length less than 0.5 mi (0.8 km) should be more than 328 ft (100 m) wide, and corridors extending 0.6 - 4 mi (1 - 7 km) should be more than 1,312 ft (400 m) wide. The Dispersal Zone encompasses 44 mi^2 (113 km^2) with a mean width of 3.4 mi (5.4 km). Although it is not adequate to support even one panther, the Dispersal Zone is strategically located and expected to function as a critical landscape linkage to south-central Florida (Kautz et al. in press). Transient male panthers currently utilize this Zone as they disperse northward into south-central Florida.

G. Habitat and Prey Management

Land management agencies in south Florida are implementing fire programs that mimic a natural fire regime through the suppression of human-caused wildfires and the application of prescribed natural fires. Chemical, biological, and mechanical controls of invasive plants are also conducted to maintain and restore native habitat types. Management for panther prey consists of a variety of approaches such as habitat management and regulation of hunting and off-road vehicle (ORV) use.

Eight public land areas within the Primary Zone are managed by five Federal or State agencies and one non-governmental organization (NGO). The annual prescribed fire goals of these public land areas in south Florida total 166 mi^2 (430 km^2). Two-to-five year fire rotations and burn

compartments less than 10 mi^2 (25 km^2) are recommended to increase habitat heterogeneity (Schortemeyer et al. 1991). However, fire prescriptions vary based on fuel conditions, weather conditions, and historic fire frequency. Compartment size will vary based on site conditions, including the use of existing fire breaks or reluctance to establish new fire breaks that would reduce native habitats, fragment native habitats, and serve as vectors for the spread of invasive plants. For example, FPNWR, the only area managed specifically for panthers, uses existing swamp buggy trails and highways as burn compartment boundaries. The Refuge is divided into 54 burn compartments that range in size from 0.47 – 1.72 mi^2 (1.22 – 4.45 km^2). A range of 8 - 12 mi^2 (20 - 32 km^2) is burned annually depending on weather conditions. The fire program at BCNP averages 47 - 62 mi^2 (121 - 162 km^2) burned annually (4 - 5% of the total area) as many habitats are adapted to long fire intervals.

Invasive non-native vegetation has the capacity to replace native plant communities and drastically change the landscape both visually and ecologically. The invasive plants of most concern in south Florida are melaleuca (*Melaleuca quinqueneervia*), Brazilian pepper (*Schinus terebinthifolius*), old-world climbing fern (*Lygodium microphyllum*), cogongrass (*Imperata cylindrica*), and downy rose-myrtle (*Rhodomytrus tomentosus*). The effect of invasive plants on panther habitat utilization, particularly melaleuca, is unknown. However these species may reduce the panther's prey base by disrupting natural processes such as water flow and fire and by significantly reducing available forage. All public lands in south Florida have active invasive plant treatment programs. As of 2002, over 243 mi^2 (630 km^2) of invasive plants had been treated, with an estimated 579 mi^2 (1,500 km^2) yet untreated. No studies have been conducted to determine the effects of invasive plant management on panthers.

Prey management has been accomplished by regulating harvest using a variety of strategies. ENP, FSPSP, and FPNWR are closed to hunting. Corkscrew Regional Ecosystem Watershed, Picayune Strand State Preserve, Okaloacoochee Slough State Forest, and BCNP allow hunting. Only BCNP allows ORV use. It also has the longest deer and hog hunting season (95 days), whereas the other three areas allow hunting for 35 days or less annually. A combination of hunter and vehicle use quotas, restrictions on hunting methods, and harvest limits are used in BCNP to regulate impacts on the panthers' prey base. Over the past 25 years, the annual deer and hog harvest reported at check stations has averaged 210 and 127, respectively, representing a sample of deer and hogs actually harvested. Hunter pressure during that time period has averaged 15,809 "hunter-days" annually (Adams and Bozzo 2002).

H. Response to Management Activities

Few studies have examined the response of panthers to various land / habitat management activities. Dees et al. (2001) investigated panther habitat use in response to prescribed fire and found that panther use of pine habitats was greatest for the first year after the area had been burned and declined thereafter. Prescribed burning is believed to be important to panthers because prey species (e.g., deer and hogs) are attracted to burned habitats to take advantage of changes in vegetation structure and composition, including exploiting hard mast that is exposed and increased quality or quantity of forage (Dees et al. 2001). Responses of puma to logging activities (Van Dyke et al. 1986a) indicate that they generally avoid areas within their home range with intensification of disturbance.

There is the potential for disturbance to panthers from recreational uses on public lands. Maehr (1990a) reported that indirect human disturbance of panthers may include activities associated with hunting and that panther use of Bear Island (part of BCNP) is significantly less during the hunting season. Schortemeyer et al. (1991) examined the effects of deer hunting on panthers at BCNP between 1983 and 1990. They concluded that, based on telemetry data, panthers may be altering their use patterns as a result of hunting.

Janis and Clark (2002) compared the behavior of panthers before, during, and after the recreational deer and hog hunting season (October through December) on areas open (BCNP) and closed (FPNWR, FSPSP) to hunting. Variables examined were: (1) activity rates, (2) movement rates, (3) predation success, (4) home range size, (5) home range shifts, (6) proximity to ORV trails, (7) use of areas with concentrated human activity, and (8) habitat selection. Responses to hunting for variables most directly related to panther energy intake or expenditure (i.e., activity rates, movement rates, predation success of females) were not detected (Janis and Clark 2002). However, panthers reduced their use of Bear Island, an area of concentrated human activity, and were found farther from ORV trails during the hunting season, indicative of a reaction to human disturbance (Janis and Clark 2002). Whereas the reaction to trails was probably minor and could be related to prey behavior, decreased use of Bear Island most likely reflects a direct reaction to human activity and resulted in increased use of adjacent private lands (Janis and Clark 2002).

I. Reasons for Listing / Threats Assessment

The Florida panther was listed as endangered throughout its range in 1967 (32 FR 4001), pursuant to the Endangered Species Preservation Act, and received Federal protection under the passage of the ESA in 1973. The 1967 document did not address the five factor threats analysis. However, we address these factors in the summary below to organize the threats to the panther in a manner consistent with current listing and recovery analyses under the ESA.

Overview of Species Decline / Causes of Decline--Historically, the panther occurred throughout the Southeast (Figure 1). Persecution, prey decline, habitat loss and fragmentation, and problems associated with small population size including inbreeding depression and reduced genetic health, resulted in a population in danger of extinction. Habitat loss, degradation, and fragmentation are the most significant threats to the continued survival of the panther throughout its range. In addition, human-related disturbance and mortality, disease, genetic problems, and contaminants are adversely affecting the panther population.

Threats Assessment--A detailed threats assessment for the panther was conducted by the Florida Panther Recovery Team using The Nature Conservancy's (TNC) planning approach (TNC 2000) (Appendix B). Using this approach, the stresses (the types of degradation and impairment) for each factor were identified and evaluated in terms of severity and scope; sources of stresses were evaluated in terms of contribution and irreversibility. Separate analyses were conducted for the panther population in south Florida and for reintroduction in the Southeast.

Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range--The panther's current occupied range is significantly reduced from its historic range from Louisiana and Arkansas east to South Carolina and southward through Florida. The panther occurs only in south Florida, less than 5% of its historic range (Figure 1). Because of their wide-ranging movements and extensive spatial requirements, panthers are sensitive to habitat fragmentation (Harris 1984).

Land Use Changes in Florida--Habitat loss, fragmentation, and degradation, and associated human disturbance are the greatest threats to panther survival and among the greatest threats to its recovery. These threats are expected to continue in Florida and throughout the Southeast. Throughout Florida, between 1936 and 1987, cropland and rangeland increased 6,609 mi^2 (17,118 km^2) or 30%, urban areas increased by 6,172 mi^2 (15,985 km^2) or 538%, while herbaceous wetlands declined by 6,063 mi^2 (15,702 km^2) or 56% and forests declined by 6,719 mi^2 (17,402 km^2) or 21% (Kautz et al. 1993, Kautz 1994). Assuming that all of the forest lost was panther habitat, Kautz (1994) estimated that the 21% loss of forests was the equivalent of 35 - 70 male panther home ranges and 100 - 200 female panther home ranges. Between 1985 – 1989 and 2003 an additional 5,019 mi^2 (13,000 km^2) (13%) of natural and semi-natural lands (including panther habitat) in the state were converted to urban / developed and agricultural uses (Kautz et al. in draft).

Continued expansion of urban areas on the coasts and the spread of agricultural and urban development in the interior of Florida continue to replace, degrade, and fragment panther habitat, placing the panther at greater risk. Agricultural development continues to replace and fragment

panther habitat. Over 83% of the 2,500 mi^2 (6,475 km^2) of agricultural land in southwest Florida has been categorized as rangeland. Between 1986 and 1990, row crop acreage increased by 14 mi^2 (36 km^2) or 21%; sugarcane increased by 25 mi^2 (65 km^2) or 21%; citrus increased by 84 mi^2 (219 km^2) or 75%; and rangeland, much of it suitable for panther occupation, decreased by 250 mi^2 (647 km^2) or 10% (Townsend 1991). Rangeland losses were about evenly divided between agricultural and urban development (Townsend 1991).

The extent of land use conversions for southwest Florida (Collier, Lee, Hendry, Charlotte, and Glades Counties) between 1986 and 1996 was estimated using a change detection analysis performed by Beth Stys (FWC, unpublished data). The area of disturbed lands increased 31% in these five counties between 1986 and 1996, with the greatest increases in disturbed lands occurring in Hendry and Glades Counties. Most (66%) of the land use change over the 10-year period was due to conversion to agricultural uses. Forest cover types accounted for 42% of land use conversions, dry prairies accounted for 37%, freshwater marsh accounted for 9%, and shrub and brush lands accounted for 8%. Randy Kautz (FWC, pers. comm. 2003) estimated panther habitat loss to be 0.8% per year between 1986 and 1996 using a composite of three different methodologies. These included: (1) review of U.S. Forest Service forest data between 1936 and 1995 using loss of forest as an index of the rate of panther habitat loss, (2) analysis to detect changes in land cover in five south Florida counties (Charlotte, Collier, Glades, Hendry, Lee) between 1986 and 1996 using classified Landsat imagery, and (3) using the Cox et al. (1994) panther habitat model, and based on 1986 Landsat data, 1996 Landsat landcover data was overlaid and then areas originally mapped as panther habitat and subsequently converted to other uses over the 10-year period were tabulated. Kautz (Breedlove, Dennis, and Associates, pers.

comm. 2005) believes the estimated annual habitat loss since 1996 may be 2 to 3 times higher than that calculated for the previous period.

More recently, Stys calculated the extent of semi-natural and natural lands that have been converted to agricultural and urban / developed in Florida between 1985 - 1989 and 2003 (B. Stys, FWC, pers. comm. 2005). Based upon this analysis, approximately 570 mi^2 (1,476 km^2) of natural and semi-natural lands in Glades, Hendry, Lee, Collier, Broward, Monroe, and Miami-Dade Counties were converted during this time period (FWC, unpublished data). Of these, approximately 340 mi^2 (880 km^2) were conversions to agricultural uses and 230 mi^2 (596 km^2) to urban uses. Nearly 42% (142 mi^2 or 369 km^2) of the conversions to agriculture occurred in Hendry County. These conversions have been offset to some degree (19 mi^2 [49 km^2]) by habitat conservation elsewhere in south Florida, particularly in recent years.

Rapid development in southwest Florida has compromised the ability of landscapes to support a self-sustaining panther population (Maehr 1990b, 1992). Maehr (1990b) reported that there were approximately 3,401 mi^2 (8,810 km^2) of occupied panther range in south Florida and that approximately 50% is comprised of landscapes under private ownership. In 2005, Kautz found that approximately 22% of the land in the Primary Zone, 60% of the land in the Secondary Zone, and 100% of the land in the Dispersal Zone is in private ownership (R. Kautz, pers. comm. 2005). Maehr (1990b) indicated that development of private lands may limit panther habitat to landscapes under public stewardship. Given the panther's reliance on public land, the rising cost of land is an impediment to habitat protection and therefore panther conservation and recovery.

Highways in wildlife habitat are known to result in loss and fragmentation of habitat, traffic related mortality, and avoidance of associated human development. As a result, small populations may become isolated, subjecting them to demographic and stochastic factors that reduce their chances for survival and recovery. Two-lane 108 ft (33 m) and four-lane 328 ft (100 m) cleared rights-of-way, respectively, occupy 2.0 and 6.2% of each 640 ac (259 ha) of land through which they pass (Ruediger 1998). Highways can also stimulate land development as far away as 2 mi (3.2 km) on either side (Wolf 1981). Thus, for each 1 mi (1.6 km) a highway is extended, 2,500 ac (1,012 ha) are potentially opened to new development (Wolf 1981).

Belden and Hagedorn (1993) observed that Texas pumas introduced into northern Florida established home ranges in an area with one-half the road density of the region in general, and tended to avoid crossing heavily traveled roads. Of 26 western puma home ranges examined by Van Dyke et al. (1986b), 22 (85%) included unimproved dirt roads, 15 (58%) included improved dirt roads, and only six (23%) included hard-surfaced roads. Female panthers rarely establish home ranges in areas bisected by highways (Maehr 1997b). Because home ranges of resident males typically encompass the ranges of up to six female panthers, males are less likely than females to find sufficiently large areas devoid of major roads. Males tend to cross highways more frequently than females and suffer more vehicle-related injuries and mortalities (see Factor E).

In addition to a direct loss and fragmentation of habitat, constructing new and expanding existing highways may increase traffic volume and impede panther movement within and between frequently used habitat blocks throughout the landscape (Swanson et al. in review). Increases in

traffic volume, increasing size of highways (lanes), and habitat alterations adjacent to key road segments may limit the panther's ability to cross highways and may ultimately isolate some areas of panther habitat (Swanson et al. in review). The addition of wildlife crossings and fencing has ameliorated this threat in the immediate vicinity of these structures. The addition of more wildlife crossings, especially in areas with a history of collisions and where traffic is projected to increase, can help address this significant threat.

Past land use activity, hydrologic alterations, and lack of fire management (Dees et al. 1999) have also affected the quality and quantity of panther habitat. The effect of invasive plants on panther habitat utilization, particularly melaleuca, is unknown. As the remaining forested uplands are lost, sloughs containing cypress, marsh, and shrub wetlands comprise a greater percentage of the remaining habitat available to panthers, relative to habitat historically available to the species.

Human Population Growth--Insight can be gained into expected rates of habitat loss in the future by reviewing human population growth projections for the south Florida region. Smith and Nogle (2001) developed low, medium, and high population growth projections for all Florida counties from 2000 through 2030. Using their medium projections, which they believe provide the most accurate forecasts, Smith and Nogle (2001) estimate that the human population of the 10 counties in south Florida will increase from 6.09 - 9.52 million residents by 2030, an increase of 56%.

Human population in the southeastern U.S. has increased 10-fold since 1850, expanding from 4.7 million to over 48 million in 2000 (cited in Swanson et al. in review). In Florida, the population increased from 87,000 to over 17 million (cited in Swanson et al. in review, U.S. Census Bureau 2004). From 1990 - 2004, the population in Collier County increased from 152,099 to 296,678 (U.S. Census Bureau 2002, 2004). During the same time period, the population in Lee County increased from 335,113 to 514,295 (U.S. Census Bureau 2002, 2004). The population of southwest Florida, particularly Collier and Lee Counties, is projected to increase 21% by 2010 (cited in Swanson et al. in review).

Land Use Changes in Southeastern States--Based on the current trends of urbanization across the southeast, it is likely that forested habitats will continue to be permanently altered, and the amount of available forest habitat will decrease in some areas (Wear and Greis 2002). Compared to earlier periods, land use in the southeast has been fairly stable since 1945, with the most notable exception of Florida, where developed land uses have expanded substantially (Wear and Greis 2002). Two dominant forces strongly influenced recent land use changes: (1) urbanization driven by population and general economic growth and (2) changing relative returns to agriculture and timber production; both of these influences are expected to continue (Wear and Greis 2002). As a result of anticipated population and economic growth, rural land will be converted to urban uses. Forecasts of land uses indicate that the southeast could experience a net loss of from 12,500 - 18,750 mi^2 (32,375 - 48,562 km^2) of forest land (roughly 5 - 8%) between 1992 and 2020 (Wear and Greis 2002).

Potential panther habitat throughout the Southeast continues to be affected by urbanization, residential development, conversion to agriculture and silviculture, mining and mineral exploration, lack of land use planning, and other sources of stress (Appendix B). With human population growth and increased human disturbance, the extent of potentially suitable habitat remaining in the Southeast is expected to decrease. Habitat loss, fragmentation, degradation, and disturbance from human activity throughout the Southeast are expected to remain among the greatest threats to reintroduced panther populations. As development pressure and population growth continues, the opportunity for panther reintroduction in the Southeast could be diminished.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes— There are no commercial or recreational uses of panthers. In rare cases where a panther is unable to survive in the wild, it may be captured and used for educational purposes. However, panthers are routinely captured and monitored for scientific purposes. Risks are associated with capture and monitoring, but the overall threat to the panther is considered low (Appendix B). Capturing and radiocollaring panthers and handling neonate kittens at dens may result in unintentional take relative to three factors. First, mortality or injury may result from the capture event because of capture induced trauma or an adverse reaction to immobilizing chemicals. Routine capture activities include the use of trained hounds to pursue and tree the panther and the subsequent anesthetization of the animal with remotely-injected immobilizing drugs. These activities may result in hyperthermia, hypothermia, dog bite wounds, drowning, fractures, lacerations, seizures, head and spinal trauma, penetration of the abdomen or thorax with dart, vomiting, aspiration, pneumothorax, respiratory depression or arrest, shock, cardiac arrest, or complications associated

with treatment of the above conditions. However, the incidence of these injuries, especially serious injuries and mortalities, has been low over the last 25 years of panther capture work in part because of stringent capture and handling protocols developed by FWC, NPS, and FWS. Since 1981, the FWC has captured and immobilized 133 panthers over 296 times with only one fatality, two panthers suffering broken legs that resulted in their temporary removal to captivity for rehabilitation and the successful return to the wild, and the holding of one other panther for 24 hours to treat an injury involving a needle embedded in bone (D. Land, FWC, pers. comm. 2004). NPS staff in BCNP have been capturing adult panthers and handling kittens at dens since 2003. Between 2003 and 2005, the NPS handled 19 adult or dependent juvenile panthers with no injury or mortality (Jansen et al. 2005).

Second, capture and handling events can result in abandonment of kittens, other disruptions of family structure, or injury to a kitten that requires its removal from the wild for rehabilitation. Further, the injury or death of an adult female with dependent-aged kittens (those less than 1 year of age) could result in the death of the kittens or the need to raise them in captivity. Neonate kittens are handled at den sites when the kittens are older than 2 weeks of age and when the mother is not present. These activities do not require anesthesia of the kittens. Handling activities could result in injury or death to the kitten or the abandonment of one or more of the kittens. From 1986 - 2004, the FWC has captured and radiocollared 59 dependent-aged kittens ranging in age from 4 - 18 months (D. Land, pers. comm. 2004). These captures resulted in the abandonment of two kittens. One was subsequently reared in captivity and released. The other died of an infection in captivity shortly after its capture. Early break-up of family groups may have occurred on a few other occasions. For this reason, dependent-aged kittens less than one

year are no longer captured. Between 1992 and 2005, FWS and NPS handled 195 kittens at 82 dens with no injury, mortality, or den abandonment (Jansen et al. 2005, Lotz et al. 2005).

Third, the loss of contact with or access to young radio-collared panthers whose collars need to be resized to accommodate growth may result in the collar becoming embedded in the panther's neck. If the panther cannot be recaptured to remove (e.g., if a radiocollar prematurely fails) or resize the collar, infection and eventual death could occur. In September 2001, the FWC and NPS began fitting young panthers with break-away radiocollars. This change in protocol has greatly reduced the risks associated with radiocollaring young panthers (D. Land, pers. comm. 2004).

If stringent capture and handling protocols continue to be followed and refined, injury levels are expected to remain low and are not expected to significantly affect important demographic parameters at the population level, including mortality and reproductive rates or recruitment of juveniles. Handling panthers is important for research, management, and monitoring of the population, and overall the risks are low.

Factor C: Disease or Predation-- The Florida panther is susceptible to a number of infectious and parasitic diseases some of which are of population significance while others are important only to the individual. Some diseases have not been diagnosed in panthers but remain a potential threat. As a single contiguous population, there is potential for an infectious disease to have a catastrophic impact on the panther population.

Although FeLV is common in domestic cats (*Felis catus*), it is quite rare in non-domestic felids. The recent outbreak of this disease in the panther population shows the potential of this disease to be of population significance. Another viral disease potentially of population significance is PRV. PRV causes respiratory and reproductive disorders in adult hogs and mortality in neonates, but is a rapidly fatal neurologic disease in carnivores. Approximately 35% of feral hogs are seropositive for PRV in Florida (van der Leek et al. 1993). The virus is actively shed by only a small percentage of infected hogs at any given time; however, stress can increase the percentage that shed the virus (Murphy et al. 1999). Feral hogs are an important prey species for panthers (Maehr et al. 1990b), and there is potential for significant mortality in panthers due to PRV.

Raccoons are a common prey item for panthers (Maehr et al. 1990b) and are the most important reservoir for rabies in the Southeast (Burridge et al. 1986). As panthers are now vaccinated against rabies at capture, only uncollared panthers are at significant risk.

Feline panleukopenia virus (PLV) causes significant mortality in domestic kittens. The virus is also carried by raccoons and is quite stable in the environment. However, kittens are at greatest risk of infection and causes of mortality in this cohort are largely unknown. An epizootic of PLV caused significant mortality among radio-collared bobcats in the late 1970s in south-central Florida (Wassmer et al. 1988), suggesting that the panther population may also be at risk.

Hookworm infections in domestic kittens can cause significant morbidity and mortality resulting from blood loss. The impact of this parasite on panther kittens in the wild is unknown.

Some individual panthers have been shown to be at risk from exposure to mercury in the food chain (Newman et al. 2004). Mercury bioaccumulates through the aquatic food chain reaching high concentrations in higher trophic level carnivores such as raccoons and alligators. Panthers preying on these species are at risk for accumulating high tissue mercury concentrations. Neonates may be more susceptible to the toxic effects of mercury (Berglund and Berlin 1969).

Disease and parasites have not been documented to be a major mortality factor in the panther population (Maehr et al. 1991b, Taylor et al. 2002). However, this observation is largely based on the captured and vaccinated sample of the population. Disease expression and mortality events for the unmarked and unvaccinated segment of the population, including kittens, may be higher, especially for those diseases included in the vaccination regimen. Further, as the panther population density increases there is an increased risk of diseases transmitted by direct contact. The recent outbreak of FeLV demonstrated the potential impact of infectious diseases on the population. Should a virulent pathogen enter the population, such as occurred with FeLV, there is no absolute barrier in south Florida that could prevent such a disease from impacting the entire population (Beier et al. 2003). Consequently, until additional populations of panthers can be established elsewhere in their historic range, infectious diseases and parasites remain a threat to the south Florida population. Finally, infectious diseases, parasites, and environmental contaminants, even of low pathogenicity, may work synergistically to reduce panther fitness and reproduction.

Factor D: The Inadequacy of Existing Regulatory Mechanisms--The panther is federally listed as endangered and is on the State endangered lists for Florida, Georgia, Louisiana, and

Mississippi. The protection provided by Federal (ESA, Clean Water Act [62 Stat. 1155, as amended; 33 U.S.C. 1251-1376] [CWA], National Environmental Policy Act of 1969 [83 Stat. 852, as amended; 42 U.S.C. 4321-4347] [NEPA], Fish and Wildlife Coordination Act [48 Stat. 401, as amended; 16 U.S.C. 661 et seq.] [FWCA]) and State (Florida protective provisions specified in Rules 68A-27.0011 and 68A-27.003) laws help conserve the panther and its habitat.

Section 7(a)(2) of the ESA requires that all Federal agencies consult with the Service to insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. If a project will not jeopardize the continued existence of a species but may result in incidental take of the species, the Service works with the action agency and any applicants to find ways to minimize the effects of the take. Section 7(a)(1) requires all Federal agencies to utilize their authorities in furtherance of the ESA by carrying out programs for the conservation of listed species pursuant to section 4. Section 9 prohibits unlawful acts, including unauthorized take. Section 10(a)(1) allows for the issuance of permits for scientific or enhancement of survival purposes, provided that certain terms and conditions are met. Section 10(a)(2) allows for the issuance of permits, provided that the taking will be incidental to an otherwise lawful action, adequately minimized and mitigated, appropriately funded, and will not appreciably reduce the likelihood of survival and recovery of the species in the wild. Section 4(a)(3) requires the designation of critical habitat for listed species to the maximum extent prudent and determinable.

As discussed previously in Factor A, development pressure in southwest Florida has been high; for example, data for Collier, Lee, and Hendry Counties, a stronghold for the panther population, indicate that from 1985 through 2003 more than 223 mi^2 (578 km^2) of natural and semi-natural lands were converted to agriculture (FWC, unpublished data). In addition, more than 145 mi^2 (375 km^2) of semi-natural and natural lands in this three-county area have also been lost to development (FWC, unpublished data) (see Factor A). While not all of these habitat losses and conversions involved panther habitat, many projects involved wetland impacts, requiring permit review by the U.S. Army Corps of Engineers (COE) pursuant to section 404 of the CWA and / or coordination among regulatory agencies pursuant to the FWCA. For projects with a Federal nexus, consultation pursuant to section 7 of the ESA was needed for actions that may affect the panther and other listed species. Especially in recent years, impacts have been offset by protection and restoration of important panther habitat.

Through 2005, no Habitat Conservation Plans (HCP) have been finalized under section 10(a)(2) of the ESA and no incidental take permits have been issued for the panther. Most panther habitat is interspersed with wetlands, which often require a section 404 permit from the COE and therefore are reviewed under section 7 of the ESA. Section 10, however, provides opportunities for large-scale and regional approaches to panther habitat conservation, and promises to be an especially valuable tool at the county level.

Florida Statute 373.414 requires that activities permitted in wetlands and surface waters of the state are not contrary to the public interest. If it is determined that an activity will adversely effect panthers or panther habitat, the governing board (Water Management District [WMD]) or

the Florida Department of Environmental Protection (FDEP) can consider measures (e.g., on-site mitigation, off-site mitigation, purchase of credits from mitigation banks) that will mitigate the effects of the regulated activity.

In addition to the impacts of individual projects, the FDEP and WMD shall take into account cumulative impacts on water resources and manage those resources in a manner to ensure their sustainability (Chapter 373.016(2) F.S.). Cumulative impacts can be considered unacceptable when they provide significant impacts to functions of wetlands, including the utilization of the wetlands by wildlife species. In practice, evaluating cumulative impacts of development in southwest Florida on panthers has not been sufficient to prevent significant loss of panther habitat.

Since the majority of panther habitat in southwest Florida has significant wetland components, provisions of 373.414 are usually a part of the review of proposed development. However, the state wetlands permitting authorities currently lack comparable regulatory mechanisms to assess impacts to panthers or panther habitat on project sites that do not have a wetland component.

The FWC may exercise the regulatory and executive powers of the State with respect to wild animals, including panthers. The FWC has responsibility for conserving and managing these species and their habitat; however the FWC does not provide regulatory protection for listed species habitat. The FWC provides comments regarding potential impacts to panther habitat to FDEP and WMDs under the authority of Chapter 20.331 Florida Statutes.

Because of the project-specific focus of regulatory programs and other constraints such as high workloads, local, State, and Federal regulatory agencies sometimes find it difficult to complete the cross-government review that would be ideal to thoroughly review and effectively assess all potential impacts to panthers. In addition, local, State, and Federal agencies sometimes have difficulty monitoring permit compliance and tracking the precise impact on species and habitat from authorized actions, as well as tracking the impact from unauthorized actions. Assessing current baseline conditions and accurately predicting future impacts are also challenging because the panther is a wide-ranging species that uses a wide array of habitat types. Furthermore, baseline conditions for the panther are continually changing (e.g., impacts from development, conservation actions). Through consultation under section 7(a)(2) of the ESA, the Service evaluates impacts to panthers from proposed projects against compensation offered to minimize those impacts. Through this process, over 19 mi^2 (49 km^2) were secured in the Primary and Dispersal Zones from September 2003 to May 2005. Rigorous assessments and close coordination and scrutiny of project impacts by local, State, and Federal agencies during the planning phase could help maximize conservation benefits for the panther.

Factor E: Other Natural or Manmade Factors Affecting its Continued Existence--

Mortality, Trauma, and Disturbance--Florida panthers were hunted for bounty during the 1800s and for sport up until the 1950s. Nine illegal shootings were documented in south Florida between 1978 and 2005, three of which were not fatal. Education, self-policing among hunters, and regulation are the tools by which shootings are minimized. All free-ranging puma in Florida are protected by a "similarity of appearance" provision pursuant to the ESA.

Records on documented mortality of uncollared panthers have been kept since February 13, 1972. Records on mortality of radio-collared panthers have been kept since February 10, 1981. Eighty-four radio-collared panthers have died since 1981, and intraspecific aggression was the leading cause, accounting for 42% of these mortalities (Lotz et al. 2005). Unknown causes and collisions with vehicles accounted for 24% and 19% of mortalities, respectively. Other factors (7%), infections (5%), and diseases (4%) caused the remaining mortalities (Land et al. 2004).

One-hundred fifty-three panther mortalities have been documented from February 1972 through June 2004, with at least 58 (41%) of known deaths occurring in the latest four-year period (Land et al. 2004). Overall, documented mortality (n = 105) of radiocollared and uncollared panthers averaged 3.4 per year through June 2001. However, from July 2001 through June 2004, documented mortality (n = 48) increased with an average of 16.0 per year during these years (Land et al. 2004). This increase in panther mortality (e.g., intraspecific aggression, collisions with vehicles) corresponds with increases in the panther population observed in recent years. This increased mortality may indicate a population that is at or approaching carrying capacity (C. Belden, FWS, pers. comm. 2005).

From February 1972 through June 2004, 36 panthers were documented to have died from intraspecific aggression (Land et al. 2004). Although most of these encounters are male-male, from July 2001 through June 2004, at least nine females have been killed in encounters with males (Land et al. 2004). Defense of kittens and / or a kill is suspected in five of these instances that occurred through 2003 (Shindle et al. 2003).

From February 1972 through June 2004, 27 panthers were documented to have died from unknown causes (Land et al. 2004). While a couple of deaths from unknown causes occur each year, five deaths occurred in various areas in 2000 and six deaths occurred in a localized area (Seminole game and safari pens) in 2003 (Land et al. 2004).

Eighty-six panther-vehicle collisions were documented between 1972 and 2005 of which 80 (52%) resulted in panther deaths (Lotz et al. 2005). However, panther-vehicle collisions were identified as the third most important source of mortality among radiocollared panthers (19%), a less biased sample (Land et al. 2004). Fifty-six percent (48) of panther-vehicle collisions have occurred since 2000 with all but two being fatal to the panther (Lotz et al. 2005). Approximately 53% of documented panther roadkills have occurred within the Primary Zone through 2004 (Swanson et al. in review). Panther-vehicle collisions are a significant source of mortality and pose a serious on-going threat to the species. In addition, new and existing roads, expansion of highways, and increases in traffic volume and speed contribute to a loss of panther habitat and impede movement within and between high use habitat blocks throughout the landscape (Swanson et al. in review) (see Factor A). New and expanded highways are likely to increase the threat of panther mortality and injuries due to collisions.

Wildlife crossings and continuous fencing were required during the conversion of two-lane SR 84 (Alligator Alley) into four-lane I-75. To date, no panthers have been killed in these protected areas since completion of I-75 in 1992. Similarly, six wildlife crossings and some fencing were required along SR 29 as a prerequisite to the SR 29 / I-75 interchange. Four of these crossings are now complete and the completed fencing-crossing areas have prevented panther-vehicle

collisions. In addition, a crossing was required on CR 858 (Oil Well Road) to offset projected traffic increases from development. In the absence of crossings and fencing, the remaining stretches of SR 29 and I-75 as well as several other roads continue to pose a serious mortality risk to panthers, including U.S. 41 (Tamiami Trail), SR 82, and County Roads (CR) 850 (Corkscrew Road), 858, 846 (Immokalee Road), 832, and 833. Up through July 2004, 59 of 73 panther roadkills or injuries occurred along these unsecured roads (Swanson et al. in review).

Florida's human population has been steadily growing and as a result, urban / suburban areas now interface with panther habitat. Extensive developments planned within two districts within Collier County's Rural Lands Stewardship Plan have the ability to affect highway infrastructure within the Primary and Secondary Zones (Swanson et al. in review). Extensive developments planned within these districts, such as the Ave Maria University and associated town, will expand local road networks and extend the human / panther interface into primary panther habitat (Swanson et al. in review).

In recent years, there has been an increase in potential for panther-human interactions and disturbance associated with management responses to panthers that have interacted with humans. For example, in 2004, aversive conditioning was used on panthers observed near areas of human habitation in the Pinecrest area within BCNP, and a juvenile dependent male panther was subsequently relocated to Okaloacoochee Slough State Forest. If panther-human interactions increase, the potential for complaints from the public and, in some cases, the need for subsequent management responses could result in take of panthers in the form of harassment through aversive conditioning in an attempt to teach individuals to avoid humans. In extreme cases,

permanent removal from the wild is possible. Currently, the Service, the FWC, and the NPS are working on a document titled *Guidelines for Living with Florida Panthers and Florida Panther Response Plan*. This plan will provide guidance on methods for minimizing the potential for panther-human interactions and help ensure consistency in use of potential management responses.

There is the potential for disturbance to panthers from recreational uses on public lands. Maehr (1990a) and Schortemeyer et al. (1991) reported that panthers may be altering their use patterns as a result of hunting. Janis and Clark (2002) compared the behavior of panthers before, during, and after the recreational deer and hog hunting season on areas open and closed to hunting. Responses to hunting for variables most directly related to panther energy intake or expenditure were not detected (Janis and Clark 2002). However, panthers reduced their use of an area of concentrated human activity, and were found farther from ORV trails during the hunting season, indicative of a reaction to human disturbance (Janis and Clark 2002). Whereas the reaction to ORV trails was probably minor and could be related to prey behavior, decreased use of areas of human activity most likely reflects a direct reaction and resulted in increased use of adjacent private lands. Additional habitat loss on those private lands could exacerbate the negative consequences of this pattern of use (Janis and Clark 2002).

Loss of Genetic Diversity--Natural genetic exchange with other panther populations ceased when the Florida panther became geographically isolated over a century ago (Seal 1994a). Isolation, reduced population size, and inbreeding have resulted in loss of genetic variability and diminished health. Data on polymorphism and heterozygosity, along with records of multiple

physiological abnormalities, suggest that the panther population has experienced inbreeding depression (Roelke et al. 1993b, Barone et al. 1994). Inbreeding has been related to decreased semen quality, lowered fertility, reduced neonatal survival, and congenital heart defects in a variety of domesticated and wild species (Lasley 1978, Ralls and Ballou 1982, O'Brien et al. 1985, Roelke 1991). Genetic problems in the Florida panther included heart murmurs, a high rate of unilateral cryptorchidism, low testicular and semen volumes, diminished sperm motility, and a high percentage of morphologically abnormal sperm.

Geographic isolation, habitat loss, small population size, and associated inbreeding have resulted in the loss of the panther's genetic diversity (Roelke 1990). Measured heterozygosity levels indicate that the Florida panther has lost about 60 - 90% of its genetic diversity (Culver et al. 2000). Measured levels of mDNA variation are the lowest reported for any similarly studied feline population, including leopards, cheetahs, and other puma subspecies. Electrophoretic analyses also indicated that the Florida panther has less genetic variation than any other puma subspecies. Panther DNA fingerprint variation is nearly as low as in the small, isolated population of Asiatic lions of the Gir Forest Sanctuary in India (Roelke et al. 1993b).

To address these threats, a genetic management program was implemented with the release of Texas puma into south Florida in 1995 (see Conservation Efforts Section). The initial results of genetic restoration have been promising (Hedrick 2004), with an increasing population, signs of increased genetic health, recolonization of areas in BCNP and ENP recently unoccupied, and increased dispersal (McBride 2000, 2001, 2002; Maehr et al. 2002a). To date, neither atrial septal defects nor cryptorchidism have been found in introgressed panthers (M. Cunningham,

pers. comm. 2005). Semen examination of a couple of introgressed panthers indicated that sperm volume, motility, and count were higher than for an uncrossed Florida panther. The FWC indicates that representation of Texas puma genes is probably close to the original genetic restoration program goal of 20%, although two of the eight Texas females are overrepresented (Shindle et al. 2001, Land et al. 2004). Genetic introgression is also reducing the occurrence of kinked tails and cowlicks in intercross progeny (Land et al. 2004).

Human Dimension--Previous recovery plans have called for the establishment of additional populations within the historic range of the Florida panther (FWS 1981, 1987, 1995). The FWC studied the possibility of establishing additional populations within the historic range of the panther (Belden and Hagedorn 1993, Belden and McCown 1996). Between 1988 and 1995, 26 Texas puma were released near Okefenokee NWR and Osceola National Forest. Study animals, monitored by radiocollars at least three days per week, established large home ranges, killed large prey at expected frequencies, and generally adapted well to their new environment (Belden and McCown 1996). When these studies were terminated, the remaining panthers were captured and removed from the wild.

Experimental releases of Texas pumas indicated that habitat and prey availability in northern Florida and southern Georgia were sufficient to support a panther population (Belden and McCown 1996). However, although there appeared to be support for reintroduction among the general public in Florida, local landowners tended to oppose having panthers on their property. Political and social issues will be the most difficult aspect of panther reintroduction and must be

resolved before further restoration efforts are initiated (Belden and Hagedorn 1993, Belden and McCown 1996).

Habitat assessment studies have been conducted to identify potential sites for reintroduction of the panther in the Southeast (Thatcher et al. 2003, Thatcher et al. in press). The purpose of these studies was to identify prospective sites for panther reintroduction within the historic range based on quantitative landscape assessments. Nine potential reintroduction sites of sufficient size to support a panther population have been found including: Ozark National Forest region, Ouachita National Forest region, southwest Arkansas, and Felsenthal NWR region in Arkansas; Kisatchie National Forest region in Louisiana; Homochitto National Forest region in Mississippi; southwest Alabama; Apalachicola National Forest region in Florida; and Okefenokee NWR region in Georgia (Thatcher et al. in press). Of the nine areas identified, the Okefenokee NWR, Ozark National Forest, and Felsenthal NWR regions ranked as the best prospective reintroduction sites based on the numerical combination of effective habitat area and expert model scores (Thatcher et al. in press).

Sociopolitical obstacles to large carnivore reintroduction are often more daunting than biological ones (Clark et al. 2002). A lack of public support and tolerance could prevent the reintroduction of panthers anywhere outside of Florida. Public opinion is the most critical impediment to reintroduction efforts and attainment of recovery goals.

Contaminants--Because the panther is a top carnivore, bioaccumulation of environmental contaminants remains a concern (Dunbar 1995, Newman et al. 2004), with the threat of mercury

toxicity considered medium (See Appendix B). However, mercury in the Everglades ecosystem has decreased over the last several years (Frederick et al. 2002).

Other environmental contaminants found in panthers include polychlorinated biphenyls (Arochlor 1260) and organochlorines (e.g., p, p'–DDE) (Dunbar 1995, Land et al. 2004). Continued monitoring for contaminants, especially mercury and organochlorines, in panthers, their prey, and sentinel species is warranted (see E. Life History / Ecology).

Prey availability--The size, distribution, and abundance of available prey species are critical factors to the persistence of panthers in south Florida and often determine the extent of panther use of an area. A resident adult male puma generally consumes one deer-sized prey every 8 - 11 days; this frequency would be 14 - 17 days for a resident female; and 3.3 days for a female with three 13-month-old kittens (Ackerman et al. 1986).

Historically, hunting in the Big Cypress physiographic region has been a major recreational activity with many hunt camps throughout the region. With establishment of national and state parks, the numbers of hunt camps were minimized and additional hunting regulations that reduced hunting pressure on deer were implemented. Although deer densities are difficult to determine, the deer population appears to have steadily increased.

Using aerial surveys, Schemnitz (1974) estimated the deer population in the 3,438 mi^2 (8,903 km^2) in the area south of the Caloosahatchee River and Lake Okeechobee) at 20,000 in 1972, and stated that the deer population had decreased in the Water Conservation Areas (WCA) due to

deeper water levels and submersion of tree islands. Fleming et al. (1994) compared deer density estimates in WCAs 2 and 3 in the 1950s with those from 1985 - 1988 and found a 67% reduction in the deer herd. They surmised that this reduction was due to habitat degradation from impoundment and associated water management.

ENP and portions of the WCAs are within the Primary Zone. If the implementation of the Comprehensive Everglades Restoration Program (CERP) results in higher water levels in the WCAs and ENP, the panthers' prey base could be reduced. Smith and Bass (1994), however, stated that fire and water, which drive the Everglades system, appear to have little effect on the long-term dynamics of the ENP deer population.

Few studies have been done on the hog component of the panthers' prey base (e.g., Maehr et al 1989b). However, the mean checked hog harvest of 29 in BCNP for the past three years (2003 - 2005) has fallen well below the previous 22-year average of 144, probably due to a combination of factors, including high water events and predation by panthers (D. Jansen, pers. comm. 2005).

Although the exact status of prey in different portions of the panther's occupied range is not known at this time, assessment of overall panther health and their success in raising young indicate that the prey base is adequate to support the current panther population. Adequate prey elsewhere within the historic range would be needed to establish populations in other areas.

J. Past and Current Conservation Efforts

Habitat Conservation and Protection--Habitat protection has been identified as being one of the most important elements to achieving panther recovery. While substantial efforts have been made to secure a sufficient habitat base (Figure 4), continued action is needed to obtain additions to and inholdings for public lands, assure linkages are maintained, restore degraded and fragmented habitat, and obtain the support of private landowners for maintaining property in a manner that is compatible with panther use. Conservation lands used by panthers are held and managed by a variety of entities including FWS, NPS, Seminole Tribes of Florida, Miccosukee Tribe of Indians of Florida, FWC, FDEP, Florida Division of Forestry (FDOF), WMDs, NGOs, counties, and private landowners.

Public Lands--Public lands in south Florida that benefit the panther are listed below and shown in Figure 4:

- In 1947, ENP was established with 2,356 mi^2 (6,102 km^2) and in 1989 was expanded with the addition of 163 mi^2 (421 km^2).
- In 1974, Congress approved the purchase and formation of BCNP, protecting 891 mi^2 (2,307 km^2), later 228 mi^2 (591 km^2) were added.
- In 1974, the State of Florida began acquiring land for the FSPSP, which encompasses over 125 mi^2 (324 km^2). Efforts are underway to acquire approximately 26 mi^2 (68 km^2).
- In 1985, acquisition of Picayune Strand State Forest and Wildlife Management Area (WMA) began with the complex Golden Gate Estates subdivision buyouts and now comprises over 119 mi^2 (308 km^2). The Southern Golden Gate Estates buyout through State and Federal funds is complete. The South Belle Meade portion of Picayune Strand

is about 90% purchased and although the State is no longer purchasing in South Belle Meade, Collier County's Transfer of Development Rights program is helping to secure the inholdings.

- In 1989, FPNWR was established and now protects 41 mi^2 (107 km^2).
- In 1989, the Corkscrew Regional Ecosystem Watershed Land and Water Trust, a public / private partnership, was established and to date has coordinated the purchase of 42 mi^2 (109 km^2).
- In 1996, the South Florida WMD, purchased the 50 mi^2 (130 km^2) Okaloacoochee Slough State Forest.
- In 2002 Spirit of the Wild WMA, consisting of over 11 mi^2 (28 km^2), was taken into public ownership by the State of Florida and is managed by FDOF.
- In 2003, Dinner Island Ranch WMA consisting of 34 mi^2 (88 km^2) in southern Hendry County was taken into public ownership by the State of Florida and is managed by FDOF.

Tribal Lands--Lands of the Seminole Tribes of Florida and Miccosukee Tribe of Indians of Florida encompass over 547 mi^2 (1,416 km^2) in south Florida. Of these, 181 mi^2 (469 km^2) are used by panthers, and comprise 5% of the Primary Zone (R. Kautz, pers. comm. 2005). These lands are not specifically managed for the panther and are largely in cultivation.

Private Lands--A variety of Federal, State, and private incentives programs are available to assist private landowners and other individuals to protect and manage wildlife habitat. Voluntary agreements, estate planning, conservation easements, land exchanges, and mitigation banks are

methods that hold untapped potential for conserving private lands. In 1954, the National Audubon Society established the nearly 17 mi^2 (45 km^2) Corkscrew Swamp Sanctuary. However, little additional private land has been protected south of the Caloosahatchee River for panther conservation. A number of properties identified by the State Acquisition and Restoration Council (ARC) for purchase by the Florida Forever Program are used by panthers (e.g., Devil's Garden, Half Circle F Ranch, Pal Mal, Panther Glades). North of the Caloosahatchee River, Fisheating Creek Conservation Easement, 65 mi^2 (168 km^2) in Glades County is a private holding used by panthers.

Habitat Protection Plans--

The Florida Panther Habitat Preservation Plan, South Florida Population--Released in 1993 by the Florida Panther Interagency Committee (Logan et al. 1993) and drafted to guide habitat acquisition, this document contains useful baseline information about lands that constitute important panther habitat.

FWS MSRP--Released by the FWS in 1999, the panther portion of the MSRP outlines how south Florida contributes to the rangewide recovery objective, but does not replace the approved 1995 recovery plan for the panther. While it provides a comprehensive, general overview of panther biology in south Florida, parts that have become outdated will be replaced by this recovery plan.

Landscape Conservation Strategy for the Florida Panther in South Florida-- The FWS created MERIT to assist with implementation of the MSRP after it was signed in 1999. In 2000, the FWS formed a Florida Panther Subteam of MERIT to develop a landscape level conservation

strategy for the panther in south Florida that could be applied in the planning and regulatory context. The Subteam produced a draft report, "Landscape Conservation Strategy for the Florida Panther in South Florida" (Landscape Conservation Strategy) in December 2002. The document includes a panther habitat map of Primary, Secondary, and Dispersal Zones, and outlines recommendations for protection of these areas. Some portions of the science and findings in the Landscape Conservation Strategy have been challenged. As of 2005, the FWS no longer distributes the document as a result of a Data Quality Act (Section 515 of Public Law 106-554) challenge.

Landscape-scale Conservation for the Florida Panther, Kautz et al (in revision)--Many of the MERIT Florida Panther Subteam members refined the methodology, further analyzed the data, and better defined the results of the Landscape Conservation Strategy into a spatial model (Kautz et al. in press). A manuscript describing this analysis and spatial model has been submitted to a scientific journal and we anticipate that it will be published in the near future.

Regulatory Tools--

COE Panther Key--In 2000, FWS issued to the COE its final interim Standard Local Operating Procedures for Endangered Species (SLOPES) for conducting consultations between the FWS and the COE for permit applications that may affect Florida panthers. The COE and FWS also co-developed a number of conservation measures that may, where appropriate and on a case-by-case basis, be incorporated into project designs to facilitate compliance with the requirements of the ESA. The COE and FWS plan to revise the SLOPES and other related documentation as

needed and appropriate to incorporate new science developed in the future to conserve the panther.

FWS Panther Habitat Methodology--In 2002, FWS developed a draft Panther Habitat Assessment methodology to help guide the agency in evaluating permit applications for projects that could affect panther habitat. This draft methodology was a way to assess the level of impacts to panthers expected from a given project, and to evaluate the effect of any proposed compensation offered by the project applicant. The draft methodology evolved over time to incorporate new information, and will continue to evolve in the future as new information is attained. FWS did not finalize an assessment methodology document but instead describes the methodology used to evaluate each project in detail in biological opinions developed under section 7(a)(2) of the ESA. The habitat framework serves one important role in broader conservation efforts to maintain a stable panther population, and is complemented by activities such as fee-title acquisition, easements, and other local, State, and Federal conservation tools. The benefits from each of these conservation tools can be enhanced through coordination. For example, local, State, and Federal land conservation programs could identify and protect areas adjacent to parcels preserved through regulatory review, thereby increasing the size of connected, high-quality habitat for the panther.

Federal and State Project Planning-- Under section 7(a)(2) of the ESA, FWS consults with Federal agencies conducting actions that may affect the panther. In addition, FWC provides comments regarding potential impacts to panther habitat to FDEP and WMDs under the authority of Chapter 20.331 Florida Statutes. Many of the impacts from development have been

compensated through habitat protection of important habitat, especially in recent years. Using the evolving panther habitat methodology described above, for example, FWS helped secure over 19 mi^2 (49 km^2) in the Primary and Dispersal Zones from September 2003 to May 2005. In addition to habitat conservation, regulatory review allows other important compensation strategies to be considered and implemented. For example, new roads can be configured to direct traffic away from panther habitat. In addition, to help offset impacts from increases in traffic within panther habitat, project sponsors can construct crossings that allow panthers to pass safely from habitat on one side of a road to another, thereby minimizing the likelihood of vehicular collisions. New advances in science such as FWC's draft report entitled "Use of Least Cost Pathways to Identify Key Highway Segments for Panther Conservation" (In Review) help identify optimal locations for crossings by depicting where vehicular collisions have occurred in the past. This allows agencies to set priorities and guide project sponsors to offset their impacts by providing crossings in areas with a history of problems

FWS Panther Conservation Banks—Conservation banks provide a unique opportunity to permanently protect important habitat that will help offset impacts from development elsewhere. Although no conservation banks have been finalized to date, FWS has noted a significant increase in interest recently, and is providing technical assistance to evaluate the quality of potential sites and complete related reviews and agreements.

Advisory Councils and Committees--

Florida Panther Technical Advisory Council--Chapter 38-172, Laws of Florida, established the Florida Panther Technical Advisory Council in 1983. The Council members represented State

and Federal agencies and private and professional resource organizations. The Council served in an advisory capacity to FWC on technical matters of relevance to the panther program, provided a forum for technical review and discussion of the status and development of the panther program, and provided a communications liaison between the technical agencies and organizations represented on the Council. Although never officially disbanded, the Council is no longer active.

Florida Panther Interagency Committee (FPIC)--FWS, FWC, NPS, and FDEP established FPIC in May 1986. The FPIC was comprised of the Executive Directors of FWC and FDEP and the Regional Directors of FWS and NPS. The purpose of FPIC was to provide guidance and coordination on panther research and management activities. A Technical Subcommittee, composed of mid-level administrators, was appointed by FPIC to provide proposals and other information to be acted upon. FPIC and the Technical Subcommittee are no longer active.

Transportation Planning and Improvements--

Regional, Landscape Level Transportation Plans--Recent least-cost pathways analyses (e.g., Swanson et al. in review) that identify highway segments crossed by panthers have compiled information that can be used to help avoid and reduce injury and mortality to panthers from collisions with vehicles.

The Florida Department of Transportation (FDOT) is developing a method of early proposal review through the Efficient Transportation Decision Making (ETDM) process that can help assure landscape level protection is addressed, maintain habitat and population connectivity, and

protect wildlife and human safety. The State's Strategic Intermodal System Plan and Florida Transportation Plan 2025 focus on mobility and economic development yet include strengthened habitat and wildlife protection provisions. Federal, State, and local agency coordination, as well as public involvement, is needed in regional transportation planning to so that expanded, extended and new roads, mass transit and ports minimize fragmentation and degradation of habitat.

Reducing Vehicle Mortality--

Wildlife Crossings, Underpasses--FDOT's installation of underpasses and accompanying fencing in 1993 along the section of I-75 (i.e., Alligator Alley) successfully eliminated the roadkill of panthers in that area. Incidents of panther roadkill have also been ameliorated in four additional areas where crossings and fencing have been installed on SR 29 (two north and two south of I-75). FDOT has two additional underpasses planned for completion along SR 29 in 2006.

Wildlife crossings increase initial road costs and require permanent conservation designation of the lands on both sides of the structure. However, the burgeoning human population with accompanying increases in personal and commercial vehicles necessitates many more road improvements to reduce the persistent roadkill problem for panthers, as well as, to help achieve greater human safety.

Reduced Speed Limits--Reduced nighttime speed zones have been in effect along many roads since July 1985 to minimize the likelihood of panther roadkills, however, compliance is a continuing problem. In addition, there are instances in which panthers have been hit despite

drivers following the legal speed limit. An evaluation of the effectiveness of these zones in reducing panther-vehicle collisions could help determine if adjustments to the speed limits are warranted.

Research, Monitoring, and Management--

Research and Monitoring--The FWC began research on the panther with the development of a Florida Panther Clearinghouse in 1976. This was the first step in identifying whether or not this species existed in Florida and where it occurred. A total of 4,620 observations were reported to the Clearinghouse, but only 91 of these were confirmed to be a panther (Belden et al. 1991). The majority of the confirmations came from Collier, Hendry, and Dade Counties.

Capture and radio-collaring work by FWC began in 1981 and by NPS in 2001. Monitoring of radio-collared panthers has been done by NPS in ENP and BCNP since 1986 and 1988, respectively. The objectives of research and monitoring have been directed towards understanding the basic biology and habitat needs of the species. This research included movements, home range size and habitat use, morphological descriptions, food habits, mortality causes, and reproduction. Panther prey studies, including population dynamics, deer herd health and reproduction, and deer mortality have also been accomplished.

Concurrent with these studies, genetics work was being conducted by Dr. Stephen O'Brien of the National Cancer Institute, and collaborations with the Conservation Breeding Specialists Group were begun. Consultations with these experts on small population dynamics and inbreeding depression yielded a strategy to manage the panther population via genetic restoration. A genetic

restoration plan was written in 1994 (Seal 1994a) and implemented in 1995 with the goal of improving the genetic health of the panther population. From 1995 through 2003, most panther capture and monitoring activities were directed towards evaluating genetic restoration. In addition, the goals of the BCNP research and monitoring work include determining the area's potential to support panthers, evaluating the effects of restoration projects and management strategies on the panther population within BCNP, and the extent of connectivity with the subpopulation in ENP.

Capture, handling, and biomedical sample collection by FWC and NPS follow established protocols to ensure safety and thoroughness. Radio-collared panthers are typically monitored by fixed-wing aircraft three times per week to determine location, habitat use, movements, interactions, births, and deaths. Several types of GPS collars are being field-tested by both FWC and NPS in order to obtain data on nocturnal movements and habitat use by panthers.

Since 1990, Florida panther research by FWC has been funded through the Florida Panther Research and Management Trust Fund, which receives its monies from the purchase of Florida panther specialty license plates. Through 2004, nearly 1.4 million panther license plates have been issued, generating nearly $40 million. Eighty-five percent of the proceeds from the extra $25.00 collected annually go into this trust fund. To obtain the money, the FWC must submit a budget request each year to the Florida Legislature for approval. The NPS in ENP and BCNP supports its panther work within its annual budgets or special funding requests.

Captive Breeding--In 1984, John Lukas, Director of Conservation and Curator of Gilman Paper Company's White Oak Plantation, expressed an interest in breeding Florida panthers in captivity. At the time, a male Florida panther was convalescing at the FWC Wildlife Research Laboratory from injuries sustained when he was hit by a vehicle. These events led to the formalization of a plan to captive-breed panthers with the eventual goal of reestablishing them in unoccupied portions of their historic range.

In May 1985, FWC and Gilman Paper Company signed an agreement to breed panthers in captivity and to make suitable animals available for reintroduction. The captive-breeding facilities were constructed at White Oak in 1985 and 1986. The convalescing male panther was the first animal moved to these facilities. Three wild-caught female Texas pumas were brought to Florida in 1986 to be used as surrogates for Florida panthers.

The Florida Panther Viability Analysis and Species Survival Plan Workshop held in 1989 further defined the need to establish a captive Florida panther population as security against extinction and for the long-term preservation of the remaining gene pool (Seal and Lacy 1989). Establishment of a captive population with minimal impacts on the wild population and maximum genetic representation included the removal of selected kittens and adults from the wild over a three- to six-year period, not to exceed six kittens and two adults per year. The goal was to achieve a total panther population of 500 breeding adults (combination of all wild and captive populations) to retain 90% of the current genetic diversity for 100 years or longer (Seal and Lacy 1989).

After an extensive environmental review process, the FWS determined that removal of these animals from the wild was not a major Federal action significantly affecting the quality of the human environment as defined under provisions of NEPA. However, The Fund for Animals, Inc., and Holly Jensen filed a lawsuit against the FWS requesting a court injunction to prevent issuance of the subpermits needed to capture and remove panthers from the wild. An out-of-court settlement reached on February 6, 1991, identified a number of specific elements to be addressed in a Supplemental Environmental Assessment. These elements were to explore and evaluate a genetic enrichment (augmentation) alternative; compare environmental, legal, and regulatory impacts of the proposed action and the genetic enrichment (augmentation) alternative; provide a thorough, expanded analysis on the issue of the feasibility and impact of reintroduction of captive-bred Florida panthers to the wild; and provide a thorough, expanded analysis of the impacts posed to the remaining wild population from the removal of Florida panthers (Jordan 1991).

Once the Supplemental Environmental Assessment had been developed and subpermits issued, six Florida panther kittens were brought into captivity in the spring of 1991 for use in the captive breeding program. Four additional kittens were removed from the wild in 1992. Two of these were taken to Lowry Park Zoological Garden in Tampa and two to the Jacksonville Zoological Gardens. The plan was to pair these panthers for maintaining maximum genetic variability and viability when they matured. However, kitten removal from the wild ceased in 1992. The genetic health of the Florida panther population had deteriorated to a point where continued survival was questionable, even with selective breeding within a captive population, and plans

were being formulated for genetic restoration by simulating natural gene flow by introducing animals from western puma populations (Seal 1994b).

Genetic Restoration--A plan for genetic restoration and management of the panther was developed in September 1994 (Seal 1994a). The level of introgression required to reverse the effects of inbreeding and genetic loss required the release of eight female Texas puma into areas occupied by Florida panthers (Seal 1994a). These eight female Texas puma were released in 1995, five of which produced a total of 20 offspring (Land et al. 2004). None of the original eight Texas pumas remain in the population today (Land et al. 2004). A preliminary assessment of genetic restoration suggested that the desired 20% introgression level had been achieved, but the contributions were primarily from two of the released females (Land and Lacy 2000).

Reestablishment of panther populations in the southeastern U.S.--

Reintroduction Feasibility Studies in North Florida--FWC conducted two reintroduction feasibility studies, from 1988 - 1989 (Belden and Hagedorn 1993) and from 1993 - 1995 (Belden and McCown 1996), to evaluate feasibility of reintroducing panthers into unoccupied areas of their historic range. The studies also identified the need to address social issues surrounding reintroduction.

In 1988, seven pumas captured in west Texas were released in north Florida as surrogates for evaluating the feasibility of translocating Florida panthers. The pumas included three adult males, three adult females, and one yearling female. They were monitored from 1988 - 1989. The pumas established overlapping home ranges, killed large prey at predicted frequencies, and

settled into routine movement and feeding patterns before the hunting season. Three pumas died during the study, the cause of death was unknown for one found floating in the Suwannee River, and shooting was suspected or documented for the other two deaths. Results indicated methods for reducing puma-human interactions, such as placing release pens as far as possible from humans and livestock to reduce puma-human interactions, which occurred most frequently during the immediate post-release period and during subsequent excursions from home ranges (Belden and Hagedorn 1993). Belden and Hagedorn (1993) recommended additional research on the feasibility of panther translocation with a larger initial stocking rate of 10 - 20 pumas to ensure that a social structure can be established even if some of the animals do not survive.

In 1993, 19 pumas were released into north Florida, including 11 females and eight vasectomized males. Six of the pumas were born and raised in captivity, 10 were captured in the wild in western Texas and translocated to Florida, and three were captured in the wild in western Texas and held in captivity in Florida for two to eight years prior to release. The study concluded that reintroduction is biologically feasible, that is, pumas can successfully establish territories and sustain themselves when reintroduced. This study showed that home ranges for females in north Florida were approximately half the size of home ranges for female panthers in south Florida, likely due to more productive habitat in north Florida and southern Georgia (Belden and McCown 1996). The Belden and McCown (1996) study also highlights the need for an effective and comprehensive public education and outreach program that occurs well ahead of releasing panthers into reintroduction sites.

Habitat Assessment to Identify Potential Reintroduction Sites in the Southeastern U.S.-- Jordan (1994) evaluated 24 sites in the southeastern U.S. based on biological and anthropogenic criteria and concluded that 14 sites should be evaluated further as potential panther reintroduction sites. These were assessed and ranked based on four criteria (area size, forest area, human population density, and road density). Jordan (1994) indicated that additional analyses would be needed.

Thatcher et al. (2003) identified and ranked 11 potential reintroduction sites (Figure 5) based on criteria including area of public lands, prey base, livestock density, road density, and human population size. The sites are ranked as high, moderate, or low in suitability for a successful reintroduction effort. No one site was found to be optimal for all the criteria evaluated (Thatcher et al. 2003). The rankings and assessment provide valuable information in weighing the benefits and drawbacks of each potential site. The report also analyzes release procedures and provides management recommendations for reestablishing panther populations. Thatcher et al. (2003) was condensed and refined for publication. Thatcher et al. (in press) identified nine potential sites of sufficient size to support a panther population. Three of these ranked as the best prospective reintroduction sites based on the numerical combination of effective habitat area and expert model scores: Okefenokee NWR (Georgia/Florida), Ozark National Forest (Arkansas), and Felsenthal NWR (Arkansas) regions. The report recommends that the top three sites identified should be considered a starting point for the evaluation of potential reintroduction sites, which should include field surveys and evaluation of sociopolitical information of the chosen reintroduction sites.

Education and Outreach--

Panther Net Website--A multidisciplinary interactive website (www.panther.state.fl.us) was launched and funded by FWC in 1999 with proceeds of the Florida panther license plate. The site includes information for adults and school children on the natural history of the panther, its habitat, threats to its survival, research, management and conservation efforts.

Northeast Florida Panther Education Program (Cramer 1995)--From September 1994 to November 1995 during the Florida Panther Reintroduction Feasibility Study, FWC sponsored this program that reached approximately 1,000 northeast Florida residents through a pamphlet, slide presentations, a county fair display, and a telephone survey. Results revealed a large base of support (75%) for reintroduction of panthers into the Osceola National Forest region. Results also identified specific community concerns, and made suggestions for addressing these through education and outreach. The results from the program can be applied to develop an effective communications program to address community concerns well in advance of subsequent reintroduction efforts.

Statewide Survey (Duda and Young 1995)--FWC sponsored a 1995 statewide attitudinal survey about Florida panthers. The survey revealed that 83% of Floridians surveyed support panther reintroduction efforts.

Public Workshops and Acceptability of Florida Panther Reintroduction--Three years after the 1993 - 1995 Florida Panther Reintroduction Feasibility Study ended, the FWC sponsored a series of workshops in 1998 to address *Public Acceptability of Florida Panther Reintroduction* (Taylor and Pederson 1998). The study focused on residents in Columbia County because of their

experience with earlier reintroduction feasibility studies. The goal was to engage residents in an exploration of concerns and possible ways to address them. However, while the working group was intended to represent a variety of interests, it consisted mostly of local opposition to reintroduction. Several members of the group did not work constructively towards finding solutions, and thus there was not a consensus. The results demonstrated the need to engage a wider variety of interests in the process.

Conservation Organizations--A number of conservation organizations are working to conserve and recover the panther through education, outreach, and advocacy. These include Defenders of Wildlife (www.defenders.org, www.defenders.org/proactive, www.biodiversitypartners.org), Florida Panther Society (www.panthersociety.org), Friends of the FPNWR (www.floridapanther.org), the National Wildlife Federation (www.nwf.org), its state affiliate the Florida Wildlife Federation (www.fwfonline.org), and The Nature Conservancy (www.natureconservancy.org). Programs encompass public education and awareness initiatives, habitat conservation, transportation and land-use planning, compensation for livestock depredation, landowner incentive initiatives, and projects aimed at fostering human-panther coexistence.

Guidelines for Living with Florida Panthers and the Florida Panther Response Plan--The FWC, FWS, and NPS established a Florida Panther Interagency Response Team in June 2004 to manage panther / human interactions while promoting human safety and assuring the continued existence and recovery of the panther. This team, comprised of panther experts and agency representatives, was tasked with developing a panther response plan to provide guidance for the

agencies so that human / panther interactions would be dealt with consistently and quickly while addressing the primary objective of public safety and balancing the needs of recovering an endangered species. Additionally, the plan needed to address public education and outreach concerning panther interactions. The draft plan is currently under review.

Scientific Reviews--

Analysis of Scientific Literature Related to the Florida Panther and Panther Habitat--In 2002, FWC and FWS commissioned an independent Scientific Review Team (SRT) to complete an analysis of scientific literature related to the panther. Completed in 2003, the SRT report (Beier et al. 2003) found that a quarter-century of research strongly supported many published conclusions, including that forests are important as daytime rest sites of panthers, that white-tailed deer and feral hogs are the most important panther prey, that the most important threats to panther persistence include limited habitat area and continued habitat loss and fragmentation, and that recovery of the panther depends most critically on establishing additional populations outside of south Florida. On the other hand, Beier et al. (2003) also found poorly supported inferences regarding panther use of large forest patches, the quality of habitat in Everglades National Park and Big Cypress National Preserve, and some vital rates used in inflexible PVA software.

Information Quality Act Challenge-- The scientific process by design continually advances our collective understanding of the species and its needs for recovery. In 2004, an Information Quality Act challenge identified certain inconsistencies and shortcomings in some panther science. In response, FWS completed a series of tasks to clarify the record and collect,

incorporate, and clearly describe new scientific information in its analyses. FWS remains committed to maximizing the quality, objectivity, utility, and integrity of the information it disseminates to the public. Furthermore, FWS welcomes input from colleagues to improve the quality of scientific information and optimize the conservation benefits achieved through the agency's programs.

K. Population Viability Analysis

Introduction--

Population viability analysis (PVA) estimates the risk of extinction for a given population over a given time period (Shaffer 1981, Gilpin and Soulé 1986, Beissinger and Westphal 1998). In general, PVA models are relatively simple and rarely reflect the exact dynamics of a real population (Fieberg and Ellner 2000). PVA models are dependent upon quality input data (Doak et al. 1994) and how effectively the model itself reflects the life history of the species being modeled. However, PVA models used in conjunction with genetic and other benchmarks may help determine minimum population sizes (Shaffer 1981, Shaffer and Sampson 1985, Morris and Doak 2002) as well as metapopulation structure necessary to offset habitat fragmentation, catastrophes, and other threats (Pulliam et al. 1992, Hanski 2002).

A population is "viable" when it has the "capacity to maintain itself without significant demographic or genetic manipulation for the foreseeable ecological future—usually centuries—with a certain, agreed on, degree of certitude" (Soulé 1987). Shaffer (1981) first defined the "minimum viable population" for a given species in a given habitat as "the smallest isolated population having a 99% chance of remaining extant for 1000 years despite the foreseeable

effects of demographic, environmental and genetic stochasticity and natural catastrophes." As Shaffer, Soulé, and others note, the choice of both the time horizon and the threshold is in fact arbitrary (Shaffer 1981, Soulé 1987, Boyce 1992, Grimm and Wissel 2004). Nonetheless, a literature review of recent empirically derived PVAs suggests that thresholds set at a 95 or a 99% chance of persistence (corresponding to a 5 or 1% chance of true extinction) over a 100-year time horizon are often used (Hamilton and Moller 1995, Horino and Miura 2000, Kelly and Durant 2000, Parysow and Tazik 2002, Kohlmann et al. 2005).

Even populations that persist beyond the stipulated time period may experience a reduction in population size or genetic variation rendering such populations vulnerable to inbreeding depression and / or genetic drift in subsequent generations. Thus, to offset declining mean population fitness as a result of inbreeding depression, Franklin (1980) and Soulé (1980) recommended effective population sizes (N_e) of 50 or more individuals, and Soulé et al. (1986) argued for a genetic threshold of no more than a 10% loss of heterozygosity over 200 years. To offset the erosion of genetic variability due to genetic drift, however, Franklin (1980) and Soulé (1980) recommended an effective population size of at least 500 individuals (see also Lande and Barrowclough 1987, Ewens 1990, Franklin and Frankham 1998). Based on empirical observations that detrimental mutations outnumbered beneficial and neutral ones, Lande (1995) argued for even larger effective population sizes on the order of 5,000 (but see Franklin and Frankham 1998). Finally, effective population sizes of between 10,000 and 100,000 may be necessary to maintain particularly beneficial traits (e.g., single-locus disease resistance factors) (Lande and Barrowclough 1987, Lande 1988). These varied estimates highlight the species-specific nature of the question.

The effective population size is substantially lower than the actual population size because of spatial structure, variance in family size, unequal sex ratios, and temporal fluctuations in population size (Wright 1969, Falconer 1989, Frankham 1995, Waples 2002). "However, one fairly well-substantiated generality is that for many birds and mammals $N_e / N \approx$ one-half to two-thirds, where N is the total population size of *reproductive adults* (Nunney 1993, Nunney and Elam 1994), arguing for a quasi-extinction threshold of at least 100 breeding adults" (Morris and Doak 2002). As Morris and Doak (2002) note, however, "this approach still basically ignores inbreeding problems and will always result in somewhat optimistic answers about population viability." Furthermore, metapopulation substructure is important because the total effective population size is not equal to the sum of the subpopulations and is most likely to be much higher than the sum (Wright 1943, Waples 2002).

Previous Florida Panther PVAs--

There have been at least six PVAs for the Florida panther (Seal and Lacy 1989, Seal and Lacy 1992, Cox et al. 1994, Ellis et al. 1999, Kautz and Cox 2001, Maehr et al. 2002b, Root 2004). The earliest of these, Seal and Lacy (1989) and Seal and Lacy (1992), used the VORTEX program to perform the PVA. The 1989 version predicted that "wholly isolated populations of less than 50 adult panthers (about 80 total adults, subadults, and juveniles) are not demographically stable even if the mean population growth rate, r, is positive." Even assuming that inbreeding has no deleterious effects on viability and reproduction, the predicted probability of extinction within 100 years was more than 14% (Seal and Lacy 1989). If inbreeding depression is assumed, the predicted probability of extinction within 50 years was "virtually

certain" (Seal and Lacy 1989). Largely based on this PVA, the International Union for the Conservation of Nature and Natural Resources Captive Breeding Specialist Group recommended a vigorous captive breeding program.

In 1992, Seal and Lacy revised the VORTEX panther PVA, based on newer data for mortality and reproduction. Like the 1989 version, the 1992 version predicted the panther had a significant chance of extinction in 100 years and reduced genetic viability. For example, simulations of a population of 50 adult panthers with a positive mean population growth rate showed up to a 15% chance of extinction within 100 years in the absence of inbreeding and as much as a 35% chance with inbreeding (Seal and Lacy 1992).

Cox et al. (1994) and Kautz and Cox (2001) performed PVAs for 11 wildlife species, including the panther. Their models build on the earlier work of Shaffer (1987) by including catastrophic events. The Cox et al. (1994) PVA followed adult females only and incorporated a range of fecundity and survival values to simulate "favorable," "moderate," and "harsh" environmental conditions over 200 years. Under the "favorable" environment scenario (high survival and fecundity), 63 panthers had a 90% chance of persistence for 200 years. Under the "moderate" scenario (medium levels of survival and fecundity) 76 panthers and under the "harsh" scenario (low survival and fecundity) 84 panthers had the same chance of persistence.

Kautz and Cox (2001) added a genetic component to the Cox et al. (1994) PVA by using the technique described in Reed et al. (1988). Kautz and Cox estimated the size of a total population needed to obtain an effective population size of 50. The authors acknowledged that effective

populations on the order of 100 - 1,000 times greater than 50 may be needed to ensure genetic variability over the long term; nonetheless, Kautz and Cox (2001) focused on the smallest population sizes likely to persist in the short term. By comparison, Reed et al. (2003) performed PVA in VORTEX for 102 vertebrate species, including the panther, to estimate MVPs. Based on a subset (n = 38) of these species, Reed et al. (2003) determined that 5,800 adult animals were needed for a 95% chance of persistence over 40 generations, 4,700 for a 90% chance of persistence, and 550 for a 50% chance of persistence. Ultimately, Reed et al. (2003) concluded that management programs should conserve habitat capable of supporting approximately 7,000 adult vertebrates to ensure long-term persistence. This number was larger than other MVP estimates cited therein (Franklin 1980 [4,500], Newmark 1987 [greater than 3,250], Thomas 1990 [5,500], Schultz and Lynch 1997 [~2,000], Reed and Bryant 2000 [greater than 2,000], Whitlock 2000 [~2,000]).

Kautz and Cox (2001) assumed that as long as the effective population size does not drop below 50, opportunities will arise later for achieving larger populations and avoiding genetics problems through patch recolonization, translocation of individuals, or removal of environmental constraints on a population through management. Based on these assumptions, Kautz and Cox (2001) estimated that a census population of panthers in the range of 100 - 200 individuals is needed to achieve an effective population size of 50. However, this conclusion is based in part upon equating total metapopulation size with effective population size (see Wright 1943, Waples 2002).

Maehr et al. (2002b) used a "consensus" model, whereby five coauthors each provided initial conditions and parameter values for separate runs in VORTEX. These five "wildly divergent models produced divergent estimates of extinction risk" (Beier et al. 2003). If "discrepancies were more than slight, each author was asked to justify the variable in question" (Maehr et al. 2002b). The "agreement among 4 of 5 estimates of extinction risk was due to drastically differing, but fortuitously offsetting, assumptions between modelers" (Beier et al. 2003). If "a single view did not prevail, compromise was sought by averaging the five versions of the contentious variable" (Maehr et al. 2002b). This consensus model suggested a 98% chance of persistence for 100 years (Maher et al. 2002b). According to Beier et al. (2003), this more "optimistic" outcome was due to some combination of 4 factors: (1) kitten mortality was simulated at 20% compared to 50% in earlier PVAs; (2) initial population size was set as 60 compared to 50 in earlier PVAs; (3) they assumed no loss of habitat compared to 1% annually in earlier PVAs; and (4) they assumed population augmentation in the form of two females per decade compared to none in earlier PVAs.

In 1999, Ellis et al. reviewed the Seal and Lacy (1989), Seal and Lacy (1992), and Maehr et al. (2002b)[1] PVA models. Their review included a comparison of the parameter inputs for the three models as well as additional sensitivity analyses to explore expansion prospects as well as the effects of habitat loss on the south Florida population (Ellis et al. 1999). In general, their analysis demonstrated that these PVA models are fairly sensitive to changes in first-year mortality (i.e., kitten survival) (Ellis et al. 1999). For example, with low carrying capacity (100 - 200 individuals) and low first-year mortality (20 - 40%), the PVA models showed positive

[1] Although the Maehr et al. (2002) was published in 2002, the actual PVA model was first presented in 1999. See Ellis et al. (1999).

population growth, low probabilities of extinction (0 - 3%), and moderate losses of genetic diversity (15 - 27%) (Ellis et al. 1999). However, when first-year mortality is increased (50 - 60%), the probability of extinction rises dramatically (48 - 100%), and loss of genetic diversity is further accelerated (28 - 50%, 100% for the extinction scenario) (Ellis et al. 1999).

Ellis et al. (1999) also determined that in some circumstances, the south Florida population could remain viable given low levels of emigration from the current population (i.e., 1% per year). However, viable expansion required members of the newly established population immigrating back into the current population as well as low first-year mortality (Ellis et al. 1999). Finally, simulations incorporating cumulative habitat losses of 25% and 50% over 25 years yielded significant probabilities of extinction for all but the lowest value of first year mortality, ranging from 10% (assuming 30% first year mortality and 25% habitat loss) to 98% (assuming 50% first year mortality and 50% habitat loss) (Ellis et al. 1999).

Beier et al. (2003) recommended against the use of "canned programs" (e.g., VORTEX, RAMAS) and urged that future models take into account uncertainty in model parameters and functional relationships via sensitivity analyses. With the exception of Cox et al. (1994) and Kautz and Cox (2001), all of the panther PVA models were based on these canned programs. The PVA by Maehr et al. (2002b) did not include a sensitivity analysis. As Beier et al. (in press) note, understanding the sensitivity of PVA models to parameter changes may be more important than a precise estimate of extinction risk. Beier et al. (2003) also recommended that rigorous estimates of reproduction rates, survival rates, and variation in these rates, be incorporated into

future PVAs. Finally, Beier et al. (2003) discouraged against "consensus" approaches (e.g., Maehr et al. 2002b) for inputting values because they lead to a "false sense of reliability."

Recent Florida Panther PVA --

In 2002, Root constructed a PVA model to determine the minimum population size necessary for long-term persistence (100 years). Root's PVA model was constructed using RAMAS GIS, a spatially-explicit PVA software program. Relying on less optimistic fecundity and survival values from Seal and Lacy (1989), Root's PVA model determined that there was no feasible number of panthers that would produce persistence probabilities greater than 75%, even if the initial population size was more than 1,000 females (or 2,000 total panthers, assuming a sex ratio of 1:1). Using more optimistic fecundity and survival values from Seal and Lacy (1989) corresponding to values needed to produce finite population growth rates much greater than 1.05, Root's PVA model determined that 25 females (50 total panthers) would provide a 95% probability of persistence for the next 100 years. Using input parameter estimates needed to produce finite growth rates near 1.05, the population size needed for long-term persistence increased to 51 females (102 total panthers). When the input parameter estimates were modified to reduce the finite growth rate still further to 1.03, Root's PVA model revealed that a panther population comprised of at least 120 females (240 total panthers) was required for long-term persistence.

Some of the PVA work done by Root in 2002 is now published (Root 2004), but the publication does not discuss specific target population sizes necessary for long-term persistence or include a sensitivity analysis. Similar to Cox et al. (1994) and Kautz and Cox (2001), Root's model only

followed females and examined three basic sets of parameters. For the latter, Root (2004) used parameter values similar to those in Seal and Lacy (1989), Seal and Lacy (1992), and Maehr et al. (2002b). Root (2004) ran several variations of each set of parameters, including "different density dependence or none, various levels of habitat loss, intermittent catastrophes or epidemics, or scheduled translocations or reintroductions." In particular, Root (2004) calculated the potential impact on the panther population of a loss of 25% of habitat (1% per year for 25 years), or roughly the amount of private land within the Primary Zone. After 100 years under a moderate scenario with this habitat loss assumption, Root (2004) estimated a decrease in mean final abundance of 26%, and a 1% increase in the likelihood of extinction. However, even under the optimistic scenario she found the 25% habitat loss variation noted above greatly decreased mean final abundance.

Root (2004) also explored emigration (i.e., annual dispersal of female panthers to empty patches north of the Caloosahatchee River), finding that under the Seal and Lacy (1992) set of parameters, the probability of extinction actually increases over what it would have been without emigration. These preliminary results suggest the importance of carefully considering metapopulation structure not only in terms of subpopulation size, but also in terms of dispersal rates, prior to deriving MVPs (see also Sweanor et al. 2000, Frank 2005, Hellgren et al. 2005, McCarthy et al. 2005).

The FWS believes that Root (2004) represents the most current, reliable, and objective PVA model available today. We recognize that any model is only as good as the data / parameters estimates used. We are also aware of the deficiencies of this model (e.g., use of a "canned

program", lack of sensitivity analysis) and realize that while the models included a variation for habitat loss approximating all private lands in the Primary Zone, several of the assumptions in the basic models (e.g., no change in amount, quality, or configuration of habitat; no difficulty finding mates; no catastrophies; no additional human-induced mortality) may be unrealistic. Recognizing these limitations, we believe the PVA analysis by Root (2004) represents the best available science at this time. Therefore, the Root (2004) PVA was used by the Recovery Team and FWS to aid in developing the population numbers for the downlisting and delisting criteria.

Implications--

There is insufficient habitat in south Florida to sustain a viable panther population and the prospects for population expansion into south-central Florida are questionable at this time. Therefore, to achieve a viable population of 240 and to reclassify or de-list the species, additional populations will have to be reintroduced into other areas within the panther's historical range. Unfortunately, the distances from the occupied range to potential reintroduction sites (Thatcher et al. in press) may far exceed long-range panther dispersal capability. In the absence of migration between populations, each panther population will remain isolated and therefore vulnerable to environmental, demographic, and genetic stochasticity as well as catastrophic events (Gilpin and Soulé 1986). These isolated populations will be vulnerable to extinction in the short-term. However, the long-term persistence of the panther will depend on multiple populations that are spatially discrete and able to fluctuate independently from one another in response to catastrophic or other environmental perturbations. If each of these reestablished populations had a moderately low probability of extinction, localized environmental perturbations, and population fluctuations remained asynchronous, all other things

being equal, it is highly improbable that the extinction of the panther would result from a simultaneous extinction of all populations (Seal and Lacy 1989, Carlson and Edenhamn 2000, Kendall et al. 2000, Reed 2004, Li et al. 2005).

In some cases, managed translocation among separate populations may be a cost-effective means of achieving multiple, viable populations (Goodman 1987, Lubow 1996). However, biological concerns such as landscape connectivity (Noss 1987, Root 1998, Beier 1993, Swart and Lawes 1996, Carroll et al. 2004, Kramer-Schadt et al. 2005), disease outbreaks (Hedrick et al. 2003), migration rates among populations (Brown and Kodric-Brown 1977, Mills and Allendorf 1996), demographic impacts on the donor populations (Saenz et al. 2002, Root 2004), population bottlenecks (Ralls and Ballou 2004), Allee effects (Mooring et al. 2004), inbreeding depression (Swinnerton et al. 2004), and random genetic drift (Gautschi et al. 2003) must be carefully considered prior to reintroduction. Furthermore, financial (Margan et al. 1998, van Heezik and Ostrowski 2001, Lindsey et al. 2005), socio-political (Musiani and Paquet 2004) and / or other factors may impose additional constraints on the efficacy of reintroducing multiple populations.

II. RECOVERY STRATEGY

The biological constraints that have to be taken into consideration when planning Florida panther conservation and management actions include the need for large, contiguous landscapes, the need for large prey for successful reproduction, very low population density, and low reproductive and colonization rates. The fact that the panther is a large predator requires human social considerations in its conservation and management.

Panthers are large, solitary carnivores and require large ranges to obtain the necessary prey, white-tailed deer and feral hogs, to meet energy needs required for health and reproduction. Their social and reproductive behavior requires access to large contiguous areas of suitable habitat to maintain viable breeding populations. Social intolerance (mutual avoidance), prey abundance, and specific habitat features are thought to regulate panther density. Females normally have a litter of kittens every other year. When the kittens are 14 - 24 months of age, the family bond is broken and the kittens leave their mother. Subadult males generally disperse and become somewhat nomadic, whereas subadult females generally set up home ranges very close to their natal ranges. For this reason, it can take a considerable amount of time for a population to colonize new areas.

Panthers are sometimes thought of as a wilderness indicator species, not because they require wilderness to live or cannot live in proximity to people, but because people will not usually tolerate panthers living in close proximity to them. People have historically been fearful of panthers due to concern for their livestock as well as their own lives. As humans encroach in panther habitat the likelihood of human-panther interactions increases. People's perceptions and attitudes about panthers will be a major determining factor in the success of panther conservation and recovery.

The recovery strategy for the Florida panther is to maintain, restore, and expand the panther population and its habitat in south Florida, expand this population into south-central Florida if sufficient habitat exists, reintroduce at least two additional viable populations within the historic range outside of south and south-central Florida, and facilitate panther recovery through public

awareness and education. The panther depends upon habitat of sufficient quantity, quality, and spatial configuration for long term persistence, therefore the plan is built upon habitat conservation and reducing habitat-related threats, but also addresses other key issues such as genetic viability. Range expansion and reintroduction of additional populations are recognized as essential for panther recovery. Similarly, fostering greater public understanding and support is necessary to achieve panther conservation and recovery.

Maintain, restore, and expand the panther population and its habitat in south Florida

Before delisting can occur, sufficient habitat quality, quantity, and spatial configuration must be maintained and protected in the long-term to support multiple viable populations. Consequently, habitat conservation will be necessary for recovery. Leading sources of panther mortality (vehicular collisions and intra-specific aggression), impediments to population expansion and subsequent gene flow, and biological constraints on population growth and other life history traits also are habitat-related. Therefore, those actions that maintain, restore, and expand panther habitat generally are critical for conservation and recovery.

The Primary Zone supports the only known breeding panther population. To prevent further loss of population viability, habitat conservation efforts should focus on maintaining the total available area, quality, and spatial extent of habitat within the Primary Zone. The continued loss of habitat functionality through fragmentation and loss of spatial extent pose serious threats to the conservation and recovery of the panther. Therefore, conserving lands within the Primary Zone and securing biological corridors are necessary to help alleviate these threats.

The Secondary Zone consists of lands that have the potential to support an expanding panther population. However, these lands contain lower quality habitat comprised of high intensity agriculture, a patchwork of residential subdivisions, and golf course communities. Restoration would need to occur to allow this area to contribute meaningfully to panther recovery. Because these lands require extensive restoration in some areas and may not contribute to panther recovery for some time, their conservation is considered a lower priority than conservation of the Primary and Dispersal Zones (Kautz et al. in press).

Roads are a significant source of panther mortality and habitat fragmentation in south Florida. Therefore, necessary actions include the identification and prioritization of locations needing crossing and fencing installation, as well as collaborative efforts by transportation agencies, landowners, and local communities to ensure that future roads and road expansion projects are designed and constructed with regard to panther conservation. Several highway segments are particularly problematic for panthers because the adjacent private lands are privately owned. Installation of highway crossings and fencing along sensitive highway segments will require cooperation with private landowners.

Approximately one-fourth of the Primary Zone, two-thirds of the Secondary Zone and all of the Dispersal Zone are in private ownership (R. Kautz, pers. comm. 2005). Therefore, conservation and restoration of Primary, Secondary, and Dispersal Zone habitat will require cooperation with private landowners not only as willing sellers, but also as willing participants in conservation easements or other habitat management programs for the panther. Actions that emphasize

cooperative efforts and landowner incentives, particularly those designed to discourage conversion of land to less suitable habitat are important.

The majority of the Primary Zone is on public lands, and panther survival will depend upon public land managers to ensure that panthers and their prey are considered in management efforts. Important tools for success will include development and implementation of best management practices for panther habitat; formalizing a network of south Florida public land managers; preparation, review, and implementation of State and Federal habitat management plans for public lands; and a tracking system to determine the effects of habitat loss and conversion on panthers.

Although the genetic restoration program initiated in 1995 was successful, the existing population size is not sufficient to offset genetic drift in the long term. At current population levels, the loss of donor individuals to future expansion and / or reintroduction efforts may pose an added risk to the existing population (Root 2004). Therefore, developing and implementing a genetics management program to determine appropriate protocols for translocating or removing panthers as well as gauging the progress of the restoration effort is important. Related to this effort is the need to continue monitoring physical and physiological characteristics correlated with inbreeding and loss of genetic variability. Another priority is to build a PVA model to investigate how we can ensure these management actions do not impair the long-term persistence of existing and future panther populations.

The small size and high degree of isolation of the existing panther population also makes it vulnerable to catastrophic events such as disease or parasite outbreaks. Actions that support continued monitoring and determination of the presence, infection rate, mortality rate, and consequences of known and unknown diseases and parasites are also important.

Provide for the expansion of the breeding population into south-central Florida

As development pressure and human population growth intensify, the opportunity for panther dispersal north of the Caloosahatchee River may be precluded. The Dispersal Zone, all of which is privately owned, requires protection from development to provide a corridor to facilitate dispersal from south Florida to potentially suitable habitat north of the Caloosahatchee River. Maintaining connectivity is important for offsetting the isolating effects of habitat fragmentation in south Florida. Despite the apparent need to preserve and enhance landscape connectivity into south-central Florida, there remains some question whether habitat north of the Caloosahatchee River can contribute to a viable panther population.

Establish viable populations of the panther in potential reintroduction areas

The panther has been restricted to less than 5% of its historic range and the current panther population is not considered viable. Recovery will require reintroduction to establish viable populations in other parts of its historic range. The strategy is to utilize existing studies and computer models along with field surveys to confirm potential reintroduction sites. These potential reintroduction sites will be further refined in coordination with agencies and the public in other southeastern states. This will include conducting preliminary public scoping, conducting field surveys, and using the NEPA process to develop and refine the appropriate

reintroduction alternatives. Once a site is chosen, protocols will need to be developed to determine the number of panthers from each age and sex class that are needed and which individuals are the best candidates for release, methods of release, and monitoring. Education and outreach efforts will be needed to address social concerns before and after panthers are released.

Identify, secure, maintain, and restore habitat in potential reintroduction areas

The strategy for conserving habitat in potential reintroduction areas will need to mirror that for conserving habitat in the currently occupied range. The ability of potential reintroduction sites to support panthers will depend on public land managers to ensure that the needs of both panther and prey are adequately considered. It will be important to develop and implement best management practices for panther habitat; formalize local networks of public land managers; prepare, review, and implement State and Federal habitat management plans for public lands; and develop a tracking system to determine the effects of habitat management on panthers. Those actions that prevent habitat loss, degradation, and fragmentation as well as maximize connectivity and spatial extent in reintroduction areas are important for reintroduction. Actions that involve identification and prioritization of areas for road crossing and fencing installation are essential. Similarly, collaborative transportation planning efforts that ensure future roads and road expansion projects are designed and constructed with regard to panther conservation are high priorities.

Facilitate panther recovery through public awareness and education

Public awareness and support are essential for panther conservation and management activities, as well as for reintroduction efforts. Previous social surveys and biological field research related to panther recovery efforts have identified the importance of public education and outreach programs, including development of a media plan. The strategy is to build support through education and outreach programs that increase public understanding of panther behavior and recovery needs. Social science research will identify public opinion and knowledge levels which are important in developing materials and programs; these will be provided to local planning organizations, decision makers and elected officials, the public, major landowners, residents living in and adjacent to panther habitat, the realtor community, and other audiences. Education and outreach efforts will be evaluated, especially to assess human attitude and behavior changes toward panthers. More importantly, this evaluation will help improve education and outreach.

III. RECOVERY GOAL, OBJECTIVES, AND CRITERIA

Recovery Goal

The goal of this revised recovery plan is to achieve long-term viability of the Florida panther to a point where it can be reclassified from endangered to threatened, and then removed from the list of endangered / threatened species.

Recovery Objectives

1. To maintain, restore, and expand the Florida panther population and its habitat in south Florida and, if feasible, expand the known occurrence of Florida panthers north of the

Caloosahatchee River to maximize the probability of the long-term persistence of this metapopulation.

2. To identify, secure, maintain, and restore habitat in potential reintroduction areas within the panther's historic range, and to establish viable populations of the panther outside south and south-central Florida.

3. To facilitate panther conservation and recovery through public awareness and education.

Recovery Criteria

The quantitative criteria for both reclassification and delisting are based upon threats to the panther, population viability analyses, and the need to address representation, resiliency, and redundancy (Shaffer and Stein 2000 cited in National Marine Fisheries Service 2004). Representation is conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities. Resiliency is ensuring that each population is sufficiently large to withstand stochastic events. Redundancy is ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events.

The most recent population viability analyses (Root 2004) for the panther suggest that populations of greater than 240 have a high probability of persistence, low probability of extinction over 100 years, are able to retain 90% of their heterozygosity (representation), and can tolerate some habitat loss or mild catastrophes. According to Root (2004), these models clearly indicate that unless we are able to safeguard the current condition, amount, and configuration of

the occupied panther habitat, the long-term viability of the panther is not secure. In addition, Kautz et al. (in press) suggests that unavoidable losses in the Primary Zone should be offset by habitat restoration or enhancement of habitat elsewhere in the Primary Zone, thereby increasing the functional value and carrying capacity of the remaining habitat. As a result, it is clear that conservation strategies should be used to maximize protection and restoration, if needed, in the Primary Zone. The south Florida panther population, which verified population counts suggest is roughly 80 individuals, is obviously the foundation for all efforts to expand and/or reintroduce panthers into other parts of the species' historic range.

PVA models are no better than the data upon which they are based, and it cannot be overemphasized that the Root (2004) basic models assume no difficulties in finding mates, no additional human-induced mortality, and no intermittent catastrophic events. In addition, aside from the 25% habitat loss variation that approximates the loss of all privately owned land in the Primary Zone, the Root (2004) models assume that there was no change in amount, quality, or configuration of habitat during 100 years of simulation. Since many of these unrealistic assumptions represent a significant departure from conditions in south Florida and the Southeast, recovery criteria need to include more than one population (resiliency and redundancy) to safeguard against habitat loss (a major threat) and stochastic and catastrophic events. It is difficult to predict the extent to which future catastrophic or stochastic events will impact the panther. However, we believe that two viable populations would be sufficient for reclassification and three viable populations would provide an adequate margin of safety for full recovery. Meeting these criteria would indicate that threats are ameliorated, the panther is

sufficiently genetically represented, and its security is achieved through resiliency and redundancy.

A. Reclassification to Threatened

Downlisting will be considered when:

1. Two viable populations of at least 240 individuals (adults and subadults) each have been established and subsequently maintained for a minimum of fourteen years.

2. Sufficient habitat quality, quantity, and spatial configuration to support these populations is retained / protected or secured in the long-term.

A viable population, for purposes of Florida panther recovery, has been defined as one in which there is a 95% probability of persistence for 100 years. This population may be distributed in a metapopulation structure composed of subpopulations that total 240 individuals. There must be exchange of individuals and gene flow among subpopulations. For downlisting, exchange of individuals and gene flow can be either natural or through management. If managed, a commitment to such management must be formally documented and funded. Habitat should be in relatively unfragmented blocks that provide for food, shelter, and characteristic movements (e.g., hunting, breeding, dispersal, and territorial behavior) and support each metapopulation at a density of 2 to 3 animals per 100 mi^2 (259 km^2), resulting in a minimum of 8,000 -12,000 mi^2 (20,720 km^2 – 31,080 km^2) per metapopulation of 240 panthers.

B. Delisting

Delisting will be considered when:

1. Three viable, self-sustaining populations of at least 240 individuals (adults and subadults) each have been established and subsequently maintained for a minimum of fourteen years.

2. Sufficient habitat quality, quantity, and spatial configuration to support these populations is retained / protected or secured in the long-term.

For delisting, exchange of individuals and gene flow among subpopulations must be natural (i.e., not manipulated or managed).

IV. RECOVERY ACTION OUTLINE AND NARRATIVE

Existing Population

1. To maintain, restore, and expand the Florida panther population and habitat in south Florida and expand the known occurrence of panthers north of the Caloosahatchee River to maximize the probability of the long-term persistence of this metapopulation.

South Florida

1.1. Maintain, restore, and expand the panther population and its habitat in south Florida.

South Florida Habitat

1.1.1. Maintain the ability of the Primary, Secondary, and Dispersal Zones, as identified in Kautz et al. (in press), to contribute to a viable population of panthers. Maintain the quantity and quality of habitat in the Primary Zone, maintain the quantity and improve the quality in the Secondary Zone, and increase the quantity of protected acres and enhance the quality of the Dispersal Zone. The Dispersal Zone needs to provide the connection between south and south-central Florida and provide for expansion of the population. This indicates the need for an accounting of habitat in Primary, Secondary, and Dispersal Zones, tracking acres lost and restored over time. This leads to a need for a mechanism to mitigate impacts.

Non-Regulatory Incentive Programs

1.1.1.1. Use and coordinate all non-regulatory incentive programs to maintain and secure habitat on private lands.

1.1.1.1.1. Develop Safe Harbor Agreements with willing landowners.

1.1.1.1.2. Focus available incentive programs to restore and enhance panther habitat. Coordinate implementation of existing programs (e.g., Farm Bill, Partners for Fish and Wildlife, Landowner Incentive Program, Rural Land Stewardship Program, Stewardship America Program) within and among agencies.

1.1.1.1.3. Explore the creation of new panther conservation incentive programs that compensate, pay, or otherwise provide economic appropriate alternative value for landowners to provide for panthers and panther habitat on their lands.

1.1.1.1.4. Continue to secure lands, both fee simple and conservation easements, through existing and / or new land acquisition programs including Federal, State, county, and non-governmental organization programs. Ensure terms of conservation easements address panther needs and are consistent among agencies.

1.1.1.1.4.1. Revise and implement the preliminary project proposal developed for expansion of FPNWR incorporating the landscape conservation strategy maps (Kautz et al. in press) and the results of Collier County's land use planning efforts.

1.1.1.1.4.2. Modify existing land appraisal procedures to allow government agencies to offer more than the appraised value for private lands that support panthers. Higher acquisition costs may be justifiable on quality habitat because of greater long-term costs of both purchase and restoration of degraded habitat.

1.1.1.1.4.3. Conduct an annual review of Florida Forever projects and rate them with respect to panther conservation values. This report should be sent to the Governor and Cabinet of the State of Florida.

1.1.1.1.5. Identify and support local initiatives to protect panther habitat and purchase development rights. Encourage, assist, and provide resources to local governments to develop and implement land use plans that complement and advance panther recovery.

Regulatory Programs

1.1.1.2. Appropriately use local, State, and Federal regulatory programs to maximize their ability to maintain the overall quality, quantity, and functionality of panther habitat.

1.1.1.2.1. Create a Federal / State working group to coordinate permit review and consultation. The purpose of this group would be to ensure coordination and cooperation between Federal and State programs that provide biological opinions and recommendations to permitting authorities.

1.1.1.2.2. Track permits, especially incidental take and compensation received, issued through Federal and State regulatory programs to determine the impacts on panthers of landscape and land use changes. Modify regulatory procedures and guidance as required to ensure panther survival and promote recovery.

1.1.1.2.3. Develop and implement regulatory procedures and guidance that avoid habitat loss, degradation, and / or fragmentation as a result of federally funded or authorized projects and actions. If incompatible development, conversion of natural habitat types, and / or land use intensification cannot be avoided then such procedures and guidance should ensure that equivalent habitat protection and restoration are provided, especially within the Primary Zone, to compensate for both the quantity and functional value of the lost habitat.

1.1.1.2.3.1. Ensure that panther conservation and protection of panther habitat is included in the State Clearinghouse (SAI) reviews of Federal activities and identify any actions that would be inconsistent with the Federal Coastal Zone Management Plan and NEPA.

1.1.1.2.3.2. Ensure that the section 7 consultation process is utilized and that the best available science is used in development of biological opinions.

1.1.1.2.3.3. Avoid adverse effects to panther habitat (including prey) attributable to CERP and other water management projects. Identify and monitor effects of water management projects; adverse effects should be avoided, then minimized, and then appropriate compensation provided.

1.1.1.2.4. Develop and fully implement regulatory procedures and guidance that avoid habitat loss, degradation, and / or fragmentation as a result of State or locally authorized projects that are not a part of a Federal review process.

1.1.1.2.4.1. FWC will take the lead in providing review and recommendations to FDEP, Department of Community Affairs, WMDs, and other State agencies on permit applications that can potentially impact panther habitat.

1.1.1.2.4.2. FWC and other appropriate State agencies will work with counties and municipalities to modify and amend Comprehensive Plans to include the goal of no net loss of quantity, quality, or functionality of panther habitat in Primary, Secondary, and Dispersal Zones.

1.1.1.2.4.3. Develop a mechanism for providing compensation for projects that affect small acreages (e.g., single family residences) of panther habitat in south Florida. An effective mechanism will address loss of habitat and also cumulative

degradation of habitat and could include panther conservation banks and / or regional off-site mitigation banks.

1.1.1.2.4.4. Initiate and encourage landscape level HCPs where proposed non-Federal actions or projects will impact panthers or their habitat. Explore partnering with counties through their growth management plans to develop HCPs. Priority for conservation should be directed towards the Primary Zone.

Habitat Fragmentation, Connectivity, and Spatial Extent

1.1.1.3. Prevent habitat fragmentation, promote connectivity, and maintain spatial extent within panther habitat.

1.1.1.3.1. Identify, maintain, enhance, and restore habitat corridors to facilitate movements by resident panthers, promote dispersal, and prevent peripheral areas from becoming further isolated from habitat in the Primary Zone.

1.1.1.3.1.1. Secure the Dispersal Zone through fee simple acquisition, compensation, or appropriate conservation easements.

1.1.1.3.1.2. Secure Camp Keais Strand to maintain connectivity from FPNWR to Corkscrew Regional Ecosystem Watershed.

1.1.1.3.1.3. Secure a corridor between BCNP and Okaloacoochee Slough to assure this pathway is not degraded or severed.

1.1.1.3.1.4. Consider panthers in Everglades restoration regarding potential for isolation in ENP. High water levels in Shark River Slough will prevent panthers from moving in and out of ENP, thus separating them from the rest of the population.

1.1.1.3.2. Quantitatively assess factors that constrain or enhance dispersal. Quantify the importance of dispersal as a factor limiting the panther population, particularly those potentially under management control**.**

1.1.1.3.3. Maintain spatial extent and arrangement. Existing panther home ranges and habitat conditions within the Primary Zone should be maintained. According to Root (2004), "Unless the current condition, amount, and configuration of the currently occupied panther habitat are safeguarded, the long-term viability of the panther is not secure." In addition, Kautz et al. (in press) suggests that unavoidable losses in the Primary Zone should be offset by habitat restoration or enhancement of habitat elsewhere in the Primary Zone, thereby increasing the functional value and carrying capacity of the remaining

habitat. Restoration of the Secondary Zone will help maintain spatial extent.

Negative Impacts of Roads on Panther Habitat – South Florida

1.1.1.4. Prevent and minimize the negative impacts of roads to panther habitat. Least cost path analysis, individual based models, and other modeling tools may be used to predict highway stretches that panthers are likely to cross (Swanson et al. in review, Kramer-Schadt et al. 2005, Wikramanayake et al. 2004, Carroll et al. 2004). These same models may characterize habitat use adjacent to dangerous stretches of highway. This information should then be combined with other field observations, home range data, and panther-vehicle collision data to identify and prioritize locations for wildlife crossings, to cluster habitat restoration and mitigation adjacent to these crossing areas, to identify other adjacent habitat used by panthers that needs added protection, and to connect the crossing areas and adjacent habitat with corridors to safer habitat. LCP models also should be used prior to reintroduction to insure that areas selected for reintroduction are secure from highway risks. Finally, because such models may not be able to predict the location of all roadkills, wildlife managers should continue to collect panther roadkill data to facilitate transportation planning (Swanson et al. in review).

1.1.1.4.1. Insure that panther habitat needs are incorporated in the planning of new roads and road expansion projects. Examine future land use projections to assess expected effects of habitat fragmentation from roads. Utilize the Efficient Transportation Decision Making (ETDM) process. Ensure early and continued coordination among agencies and local governments for all road projects in panther habitat. Develop Memorandums of Understanding (MOU) and / or refine pre-coordination procedures with State Department of Transportation and local governments for proactive assessment and pre-planning of road projects.

1.1.1.4.2. Identify current and planned roads that could affect panthers, eliminate roads where possible, and retrofit priority areas with crossings and fencing as appropriate to promote connectivity and dispersal. Develop and distribute recommendations on improvements needed for specific road segments.

1.1.1.4.3. Secure habitat adjacent or contiguous to areas of high risk for panther-vehicle collisions.

1.1.1.4.4. Determine the impacts of roads on range expansion and dispersal.

Habitat Restoration in Primary, Secondary, and Dispersal Zones

1.1.2. Restore habitat in the Primary, Secondary, and Dispersal Zones.

1.1.2.1. Identify and prioritize tracts suitable for restoration.

1.1.2.2. Provide incentives and mechanisms for restoration of agricultural and range lands.

1.1.2.3. Develop / expand funding mechanisms and other incentives for habitat restoration.

1.1.2.4. Develop and disseminate information on cost-effective restoration techniques.

1.1.2.4.1. Facilitate and conduct habitat restoration research.

1.1.2.4.2. Monitor and evaluate restoration projects and report the reasons for successes and failures.

Habitat Management – South Florida

1.1.3. Encourage habitat management that provides for the needs of panthers and their prey.

1.1.3.1. Develop, disseminate, and implement best management practices for managing panther habitat. Develop in coordination with Federal, State, local and private entities.

Public Land Management – South Florida

1.1.3.2. Ensure that panthers and their prey are adequately considered and provided for in management of public lands. Management of public lands should include but is not limited to: restoration and maintenance of natural habitat through prescribed fire, invasive vegetation control, and regulation of ORV use; restoration and maintenance of hydrologic quality and quantity; and regulation of recreational hunting to ensure that it does not negatively impact the panthers' prey base.

1.1.3.2.1. Formalize a network of south Florida public land managers to encourage exchange of panther information and to facilitate the development and implementation of effective land management actions. This group should consider the need for interagency panther habitat management strike teams to capitalize on and share existing resources to implement habitat management priorities on the various public lands in south Florida (e.g., cooperative efforts for prescribed burning and invasive plant control).

1.1.3.2.2. Prepare, review, and implement habitat management plans for public lands to ensure that panthers and their prey are adequately considered and provided for. Plans should include active, state-of-the-art management tools including prescribed fire where appropriate.

1.1.3.2.3. Track habitat management activities and their effects on panthers by developing and distributing annual reports that summarize land management accomplishments and effects.

Private Land Management – South Florida

1.1.3.3. Encourage habitat management on private lands to adequately provide for panthers and their prey.

1.1.3.3.1. Provide incentives and assistance to willing landowners to manage their lands for panthers and their prey using tools such as prescribed fire and invasive plant control. Focus and coordinate existing incentive programs within panther habitat.

1.1.3.3.2. Provide incentives and work with landowners to encourage them not to convert their lands to less suitable habitat.

1.1.3.3.3. Review and comment on county stewardship plans.

Monitoring Habitat – South Florida

1.1.4. Monitor panther habitat quantity and quality, land use changes, and response of the panther population to these changes (e.g., distribution, density, dispersal, reproductive success, mortality). Track land protection and habitat restoration with an emphasis on identifying where habitat is lost and restored.

1.1.4.1. Quantify 24-hour habitat use and movement patterns. More data are needed during hours of peak activity. Obtain and analyze data on nocturnal locations of panthers throughout their range to get a complete picture of panther habitat use.

1.1.4.2. Update Kautz et al. (in press) maps every five years to assess trends in habitat quantity and spatial configuration.

South Florida Population

1.1.5. Achieve and maintain the largest possible healthy panther population in south Florida using management practices that are consistent with ecosystem

conservation. In addition to habitat conservation measures referenced in other sections of the plan the following measures are appropriate.

Demographics

1.1.5.1. Continue to monitor panther population viability.

1.1.5.1.1. Convene a group of agency and independent experts to conduct an appropriate PVA (existing or customized) and corresponding sensitivity analysis. Obtain independent peer-review.

1.1.5.1.2. Continue to determine and monitor demographic variables including age- and sex-specific reproduction and survival rates, litter size, recruitment, age at first reproduction, birth interval, proportion of individuals breeding, age and sex specific causes of mortality (including intraspecific aggression), dispersal, density, and minimum documented population size. Identify, evaluate, and use the least intrusive monitoring techniques or indices as appropriate (e.g., hair / genetics sampling, scats, cameras).

1.1.5.1.3. Develop and implement annual capture and monitoring work plans

Genetic Diversity

1.1.5.2. Maintain and enhance genetic diversity.

1.1.5.2.1. Continue to monitor physical and physiological characteristics correlated with inbreeding and depletion of genetic variability including kinked tails, cowlicks, cryptorchidism, sperm morphology, heart defects, immune function, and reproductive success.

1.1.5.2.2. Develop and implement a genetics management plan. Convene a working group of appropriate geneticists, reproductive physiologists, veterinarians, and population biologists to develop a genetics management plan. Use field observations, existing data, and results from the genetic restoration and management project initiated in 1995. The plan might include protocols and triggers (e.g., specific alleles, physical attributes, percent representation, studbook) for translocating, adding, or removing animals; a protocol for managing / preventing overrepresentation by specific lineages; the disposition of animals that may need to be removed; and specific monitoring needs.

1.1.5.2.3. Develop a panther population model to predict future genetic consequences of management proposals and actions.

Harassment, Injury, and Mortality

1.1.5.3. Monitor and take action to prevent harassment, injury, and mortality of panthers.

Harassment

1.1.5.3.1. Reduce and eliminate illegal harassment of panthers and implement management strategies to prevent future harassment stemming from human activity. Harass is defined by the FWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Harassment is considered a form of "take" as defined in the ESA. This does not include activities permitted by the FWS for panther management. Such permits may be issued by FWS to other Federal land management agencies or State conservation agencies.

1.1.5.3.1.1. Identify harassment activities. These could include, but are not limited to, illegal stalking of panthers, chasing panthers with dogs, pursuing panthers with ORVs, destruction of denning sites in an effort to relocate an animal, intentionally drawing a panther into an area (whether by baiting with live prey, illegal feeding, or other means) for photography or other purpose, excessive noise-making activities (e.g., illegal discharge of firearms, explosive devices such as fireworks and firecrackers, swamp buggy / ORV use).

1.1.5.3.1.2. Implement active management measures designed to inhibit and / or cease illegal harassment activities on public lands. Active management measures that can be implemented on public lands may include:

1.1.5.3.1.2.1. Manage public access to minimize harassment opportunities.

1.1.5.3.1.2.2. Develop ORV management plans where ORVs are allowed. Plans should contain actions that minimize impacts to panthers.

1.1.5.3.1.2.3. Enforce regulations and statutes regarding discharge of firearms, explosive devices, or other loud noise sources.

1.1.5.3.1.3. Increase compliance with existing Federal and State laws and regulations prohibiting harassment.

1.1.5.3.1.3.1. Post and maintain regulatory and informational signs. The effective use of on-site regulatory and informational signs is essential in providing the public with information on prohibited harassment activities (including the legal consequences and fines). This may contribute to better compliance.

1.1.5.3.1.3.2. Enforce existing laws and regulations.

Illegal Killing

1.1.5.3.2. Enforce existing Federal and State laws and regulations to minimize and prevent illegal killing of panthers.

Road Mortalities

1.1.5.3.3. Minimize and prevent panther injuries and mortalities by modifying conditions on existing roads and implement appropriate actions to protect panthers during the planning, permitting, and construction of new roads and highway expansion projects.

1.1.5.3.3.1. Identify and address existing and potential panther / vehicle collision areas to develop recommendations on improvements needed for specific road segments.

1.1.5.3.3.1.1. Convene a working group to prioritize and address actions needed in panther / vehicle collision areas.

1.1.5.3.3.1.2. Secure funding for and install wildlife crossings and fencing in high risk areas.

1.1.5.3.3.1.3. Evaluate and implement other mechanisms to prevent mortalities on roads including installing signs, creating wider shoulders, slower speed limits and speed zones, changing road elevations, using scenic highway designations, and reducing traffic volume with no truck zones or adjusting tolls to encourage alternative routes (e.g., removing tolls on I-75 to reduce traffic on U.S. 41).

1.1.5.3.3.2. Build mechanisms into permits for road projects to provide for adaptive management for panther mortality and / or other unforeseen problems. These could include conditions for when the FWS will reinitiate consultation pursuant to section 7 of the ESA or require additional project alterations to avoid impacts.

1.1.5.3.3.3. Develop new strategies to prevent road mortalities or injuries including alternative technologies and new fencing designs that might be more aesthetically acceptable.

1.1.5.3.3.4. Enforce existing speed zones, monitor effectiveness, and modify as needed.

Research Caused Injuries and Mortality

1.1.5.3.4. Minimize harassment, injury, and mortality of panthers that could result from research, management, and monitoring programs. Ensure that research, management, and monitoring are directed at achieving priority needs of the recovery program and are conducted using the least intrusive and risky methods necessary to meet the objectives of the plan. Allow only highly trained and experienced individuals to capture panthers.

1.1.5.3.4.1. Provide adequate resources and facilities for the rehabilitation of panthers that might be injured or orphaned during capture and monitoring efforts.

1.1.5.3.4.2. Develop, follow, and regularly review and revise research, monitoring, capture, and handling protocols that minimize risks to panthers.

Diseases and Parasites

1.1.5.4. Monitor panther diseases and parasites and develop and implement appropriate management strategies.

1.1.5.4.1. Devise appropriate biomedical strategies to limit population level disease threats.

1.1.5.4.1.1. Continuously evaluate the value of specific vaccinations and review all vaccination protocols annually.

1.1.5.4.1.2. Revise vaccination protocols as appropriate considering new disease threats as they arise.

1.1.5.4.2. Determine and monitor the presence, infection rate, mortality rates, and consequences of diseases and parasites in the panther population.

1.1.5.4.2.1. Collect appropriate tissue and blood samples from all panthers handled, both live and dead, and analyze them for

the presence of priority diseases and parasites, summarize and report results annually.

1.1.5.4.2.2. Evaluate the disease threats presented by other species including bobcats and domestic cats and identify any needed management intervention.

1.1.5.4.2.3. Implement appropriate management strategies.

Environmental Contaminants

1.1.5.5. Identify and minimize the detrimental effects of environmental contaminants to panthers.

1.1.5.5.1. Produce a summary report and database of contaminants in panthers and their environment in south Florida. Identify contaminants and sources of concern and determine management implications.

1.1.5.5.2. Continue to monitor contaminants, especially mercury and endocrine disruptors, in panthers and their prey by collecting and analyzing appropriate tissue samples, summarize and report results.

1.1.5.5.3. Implement actions necessary to remediate contaminants in high risk areas.

Prey Base

1.1.5.6. Ensure an ample, healthy, and diverse prey base. Work with managers of public, private, and Tribal lands.

Deer

1.1.5.6.1. Continue active management of white-tailed deer populations.

1.1.5.6.1.1. Assess and monitor the status of deer populations in panther habitat.

1.1.5.6.1.2. Develop deer harvest regulations that do not compromise the panther prey base and take into consideration food requirements of the panther.

1.1.5.6.1.3. Continue to monitor the impacts on panthers of hunting on public and private lands in panther habitat including BCNP and State lands in south Florida.

Hogs

1.1.5.6.2. Encourage management / control of feral hog populations that does not threaten the panther. Develop a long-term strategy for hog management on public lands given potentially conflicting needs of the panther and agency policy to eradicate exotic species. Continue to assess the role of hogs in the panther prey base as this strategy is implemented.

Prey Diseases

1.1.5.6.3. Monitor prey diseases and attempt to prevent possible spread into south Florida.

1.1.5.6.3.1. Continue statewide monitoring for chronic wasting disease and other emerging wildlife and domestic animal diseases and implement available eradication or control methods.

1.1.5.6.3.2. Identify, map, and appropriately monitor and regulate exotic animal operations that could serve as a source of infection for wild populations.

1.1.5.6.3.3. Coordinate with the southeastern States to review protocols and regulations that require imported ungulates to be disease-free.

Captive Management

1.1.5.7. Establish a program to address issues related to captive panthers and their potential for positively impacting the free-ranging population.

1.1.5.7.1. Develop guidance for the removal of panthers from the wild. This guidance will address removal of individuals for disease containment, survival (e.g., orphaned or abandoned kittens, injured individuals). Appropriate protocols will be generated for the individual reason for removal (e.g., hand-rearing protocols for kittens).

1.1.5.7.2. Evaluate the need for and establish, if necessary, a captive breeding program. This program would be for the maintenance of the captive population (if indicated) and / or for individuals for reintroduction.

1.1.5.7.3. Evaluate the role of alternative breeding strategies including artificial insemination and surrogate mothers that could provide a source of panthers to increase panther numbers or distribution**.**

1.1.5.7.4. Develop and implement a captive management plan for panthers held in captivity.

1.1.5.7.4.1. Form a captive management team. This team should consist of one representative from each participating institution, the panther project veterinarian, a representative of the FWS, FWC, and NPS. Institutional representatives will consist of veterinarians, curators, or other staff involved in panther husbandry. This team can meet annually or as deemed necessary.

1.1.5.7.4.2. Develop a captive management plan. The captive management team should develop a plan as a guide for the placement and maintenance of panthers held in captivity. This plan should include preventative health, husbandry, reproduction, and captive population management.

1.1.5.7.4.3. Implement the captive management plan. Participating institutions will be signators of a MOU relative to adherence to this plan.

1.1.5.7.5. Establish research priorities for captive panthers which can be applied to management of the free-ranging population. Investigations could include such topics as vaccination protocols, baseline reproductive physiology, assisted reproduction technologies, and appropriate diseases.

1.1.5.7.6. Incorporate interpretative education at public facilities where captive panthers are held and prepare public information materials.

Expansion into South-Central Florida

1.2. Provide for the expansion of the breeding population of panthers in south Florida into south-central Florida. The potential for the persistence of the existing population in south Florida could be enhanced by its expansion into south-central Florida.

Feasibility and Habitat Identification

1.2.1. Determine the potential for habitat in south-central Florida to support a breeding population of panthers. Evaluate the quantity and quality of existing panther habitat; likely future habitat trends with respect to human population growth; and patterns of public land ownership, highway expansions, and changing land use practices.

Facilitating Natural Population Expansion

1.2.2. If there is potential for habitat in south-central Florida to support a breeding population of panthers, determine if there are management steps that can be taken to facilitate natural expansion of female panthers into south-central Florida.

Translocation

1.2.3. If natural expansion of female panthers into south-central Florida is not likely, evaluate the feasibility of translocation of panthers to establish a breeding population, including an EA or EIS under the NEPA process if necessary.

1.2.4. If natural expansion is not likely, develop an expansion plan to guide translocation of panthers into south-central Florida. The plan should include education and outreach (implement actions in Section 3), consider the effects of translocations into south-central Florida on potential reintroductions elsewhere in the historic range, and consider the effects of translocations on the south Florida population.

Suitable Habitat

1.2.5. Secure, maintain, and restore suitable habitat for panthers that are dispersing into south-central Florida to support continued dispersal and settlement**.**

1.2.5.1. Secure a dispersal area north of Caloosahatchee River that maintains connection with habitat south of river.

1.2.5.2. Conserve lands buffering the Caloosahatchee River by fostering compatible land uses and riparian habitat protection directly along the river in order to maintain enough characteristics of panther habitat to allow dispersal northward and genetic exchange should female panthers be successfully established north of the river.

1.2.5.3. If establishment of a breeding population of panthers in south-central Florida is feasible, provide for the conservation and enhancement of other lands necessary for persistence of a population in south-central Florida.

1.2.6. Implement appropriate actions in Section 2.

1.2.6.1. If the panther population is expanded into south-central Florida, implement appropriate actions in Section 1.1.

Reintroduction

2. Within the historic range, identify, secure, maintain, and restore habitat in potential reintroduction areas and establish viable populations of the panther outside of south and south-central Florida.

Select Reintroduction Sites

2.1. Select reintroduction areas in coordination with the southeastern States within the historic range of the panther. Use Thatcher et al. (2003, in press).

2.1.1. Develop and conduct preliminary public scoping to allow effective preplanning of the NEPA process. This could include the use of focus / stakeholder meetings and opinion and attitude surveys in the Southeast.

2.1.2. Identify State and Federal laws, regulations, or policies that could conflict with reintroduction and resolve any potential conflicts such as predator control policies that conflict with reintroduction.

2.1.3. Conduct field surveys of selected reintroduction areas. These evaluations should address habitat quality variables including prey density, available habitat types, distribution, connectivity, topography and understory vegetation for stalking and denning cover, hydroperiods and potential for inundation, future trends in land use, accessibility to humans, and recreational uses.

2.1.4. Determine if puma are present in selected reintroduction areas in the Southeast in order to understand any possible conflicts with reintroduction goals. This will be done by checking for sign of existing puma, identifying potential conflicts related to captive puma, collecting and analyzing genetic samples from suspected wild puma encountered to determine their point-of-origin, if needed.

2.1.5. Evaluate possible disease and parasite problems in selected reintroduction areas prior to releasing panthers. Implement actions under 1.1.7.4.

2.1.6. Consider contaminant issues when evaluating selected reintroduction areas. Implement actions under 1.1.7.5.

2.1.7. Use the NEPA process to develop and refine the appropriate reintroduction alternatives and recommend the preferred alternative (e.g., number of sites).

2.1.7.1. Coordinate with the southeastern States, stakeholders, and the public for reintroduction site selection.

2.1.7.2. Collect, compare, and analyze sociopolitical data (including public attitudes / opinions regarding panthers, predators, risks and support) for

identified potential reintroduction areas to help formulate and choose among alternatives.

Reintroduce Panthers into Suitable Sites

2.2. Reestablish viable panther populations outside of south and south-central Florida within the historic range when a suitable reintroduction site is selected.

Source of Panthers for Reintroduction

2.2.1. Determine the number of panthers from each age and sex class that are needed for a reintroduction program. Removal of individuals cannot jeopardize the panther pursuant to section 7 of the ESA. Create a mechanism to expedite genetic analysis of all panthers genetically sampled to provide data for prudent and timely decision-making. Review of this data should occur annually relative to reintroduction decisions. Use a PVA model to evaluate the affect of translocation on the existing population.

2.2.1.1. Select individual panthers that could be removed for reintroduction without negatively affecting the persistence of the existing population.

2.2.1.2. Develop a protocol for the translocation of panthers from the wild.

2.2.1.3. Evaluate the need for and establish, if necessary, a captive breeding program. This program would be to produce individuals for reintroduction.

2.2.1.4. Evaluate the role of alternative breeding strategies and / or source populations, including artificial insemination and surrogate mothers or puma outside of Florida that could provide a source of panthers.

Reintroduction Incentives

2.2.2. Identify and provide incentives and remove disincentives to Federal, State, and local governments and agencies to participate in reintroduction.

2.2.2.1. Address the legal liability issues for State participation in a reintroduction program. Identify the existing State laws and immunities and obtain a solicitor's opinion regarding liability, if needed.

2.2.2.2. Provide resources and funding to assist with panther reintroduction.

Human Dimensions of Reintroduction

2.2.3. Address human dimensions of panther reintroduction (including conflicts between stakeholders and panthers) with education, incentives, compensation, and regulatory mechanisms. Social issues include landowner

rights, safety for pets and livestock, effects on deer populations, and human safety. Implement actions under Section 3.

2.2.3.1. Develop and implement a protocol and response plan for handling human-panther interactions. Use existing protocols, including the draft Florida Panther Response Plan being prepared by FWC, NPS, and FWS.

2.2.3.2. Evaluate the need for and, if appropriate, designate experimental nonessential populations. Under section 10(j) of the ESA, the Secretary can designate reintroduced populations established outside the species' current range but within its historical range as "experimental." Designation of a population as experimental increases flexibility and discretion in managing reintroduced listed species. It must then be determined whether such experimental populations are essential, or nonessential, to the continued existence of the species. Regulatory restrictions may be considerably reduced under a nonessential experimental population designation, which is defined as being nonessential to the survival of the species.

2.2.3.3. Develop a compensation program for the depredation of livestock in reintroduction areas. An effective compensation program should have two components: proactive measures to prevent or reduce conflict between livestock and panthers, and a scheme for compensating livestock owners after a confirmed depredation by a panther. Programs established by other States and entities, such as Defenders of Wildlife, could be referenced for guidelines.

2.2.3.3.1. Develop and distribute a landowner, land manager, and lessees panther handbook. The handbook should include recommendations designed to minimize potential problems.

2.2.3.3.2. Provide assistance to landowners, land managers, and lessees to identify and address potential conflicts on their property.

2.2.3.3.3. Develop, fund, and implement a compensation program. Minimize procedural requirements for compensation when payment is warranted (once depredation by a panther has been determined and landowner protective efforts have been demonstrated). Partner with stakeholders to determine who receives compensation. Ensure that all individuals are adequately trained in confirming panther depredation.

2.2.3.4. Address concerns of hunters in reintroduction areas.

2.2.3.4.1. Understand hunting pressure and methods in potential reintroduction areas to identify possible conflicts. Partner with

hunters and hunting lease holders including timber companies to identify and address panther, hunter, and prey issues.

2.2.3.4.2. Identify and implement habitat management initiatives or other active ways to counter a real or perceived decline in deer populations.

Release of Panthers

2.2.4. Develop a protocol and release panthers into selected reintroduction sites.

Monitoring Reintroduced Panthers

2.2.5. Develop and implement monitoring plans for the selected reintroduction areas.

2.2.6. Minimize and monitor illegal killing of panthers.

2.2.6.1. Enforce existing Federal and State laws and regulations.

2.2.6.2. Extend ESA "similarity of appearance" protection to puma in applicable portions of the historic range prior to reintroduction. Section 4(e) of the ESA and implementing regulations (50 CFR 17.50–17.52), authorize the treatment of an unlisted species as endangered or threatened if the species so closely resembles in appearance a listed endangered or threatened species that law enforcement personnel would have substantial difficulty in attempting to differentiate between the listed and unlisted species.

2.2.6.3. Implement a toll free telephone tip number in reintroduction areas as reintroduction is attempted and provide rewards to those that report the illegal killing of panthers. Coordinate with existing State programs to avoid duplication.

Actions Once Populations Are Established

2.3. As additional populations are established, implement appropriate actions in Section 1.

Public Awareness and Education

3. Facilitate panther conservation and recovery through public awareness and education. Build support for the recovery effort through education and outreach programs that increase public understanding of panther behavior and recovery needs.

Design and Develop Materials and Programs

3.1. Design and develop education and outreach materials and programs.

Education Working Group

3.1.1. Form a working group to design and develop education and outreach materials and programs. The group should include social scientists, environmental educators, university academics, conservation organizations, county extension agents, agencies involved in panther recovery, other local groups and community leaders. Organizations can link together in various ways to bring unified, educational, public relations messages to groups of people concerned with panther conservation and recovery.

Social Science Research

3.1.2. Conduct social science research to identify public attitudes, knowledge levels, and concerns about panthers and panther recovery efforts. Draw on expertise of university academics, environmental educators, and social scientists.

3.1.2.1. Identify target audiences, content, strategic messages, and methods of getting the message out using social science research. Existing social science research on panthers and other carnivores such as wolves and bears can also be used. Audiences can include hunt clubs, hunters, outdoor enthusiasts, area landowners, livestock organizations, area leaders, and groups that attract women and minorities (Cramer 1995).

Production of Materials and Programs

3.1.3. Produce necessary materials and programs for public awareness and education.

Natural History, Recovery, and Reduction of Threats to Panthers

3.1.3.1. Produce information on natural history, place in the ecosystem, panther facts, benefits of panther recovery, and ways to reduce threats to panthers and their habitat. These materials should be produced in English and Spanish**.** This can include concepts such as umbrella species, predator-prey relationships, food web dynamics, cultural importance, only population of pumas remaining in the eastern U.S., historic and current range, persecution that led to original population declines, timeline of events in panther history, biology and behavior.

Habitat Conservation and Management

3.1.3.2. Produce materials and programs regarding panther habitat conservation and management.

3.1.3.2.1. Compile information and produce materials and programs on landowner incentives. See **A**ction 1.1.1.1. for information on incentives and ways to increase economic revenue for private lands.

3.1.3.2.2. Identify ecotourism values and economic incentives related to panthers and develop materials for ecotourism programs.

3.1.3.2.3. Compile information on land management techniques.

3.1.3.2.4. Develop a panther habitat management handbook for public and private land managers based on the best management practices produced under Action 1.1.4.1. Evaluate whether separate handbooks are needed for public and private land managers.

South Florida Population

3.1.3.3. Produce materials and programs regarding the south Florida panther population and its management.

3.1.3.3.1. Develop materials to inform the public and decision makers about methods for reducing panther road mortality, including the success of wildlife crossings, crossing design standards, road placement, and speed and volume of traffic. Use existing materials and programs, such as those produced by conservation organizations, wherever appropriate.

Human / Panther Interactions

3.1.3.4. Produce materials and programs regarding human / panther interactions.

3.1.3.4.1. Develop educational material to address human social issues related to panther conservation and recovery. These could include: human safety, safety for pets and livestock, landowner rights, and effects on deer populations. Identify appropriate individuals to distribute information. This can be a mass media campaign including TV, billboards, mailings, and presentations to homeowner groups similar to the FWC Bear Aware education and outreach program.

3.1.3.4.2. Develop a Living With Panthers outreach program. Inform stakeholders about panthers and ways to reduce potential conflicts. Implement this program statewide, especially where panthers live and disperse. Use the media, hunting license sales, pamphlets, signs, other outlets. Model programs on other successful "living with wildlife" efforts such as the FWC Bear Aware program. Address topics such as

biology and behavior of panthers, panther-human interactions, factors that affect interactions, how to reduce the likelihood of interactions, protecting pets and livestock, tips for recreation in panther country, and what to do if you encounter a panther.

3.1.3.4.3. Develop materials and programs to address hunting concerns, such as a real or perceived decline in the deer population. Draw on organizations experienced with hunting issues, such as the Quality Deer Management Association.

3.1.3.4.4. Include panther conservation issues in ORV educational materials. Materials should include regulations and reasons for staying on designated trails. Utilize U.S. Forest Service education and outreach program for ORV use in National Forests.

Population Expansion and Reintroduction

3.1.3.5. Produce materials and programs regarding panther population expansion and reintroduction.

3.1.3.5.1. Examine sociological information, such as public attitudes in and around reintroduction sites.

3.1.3.5.2. Develop a media plan. This process calls for oversight of logistical, public affairs, and biological aspects of a situation. Public affairs staff will be able to predict what would happen with reintroduction and plan public affairs events, coordinate logistics with other team members, and hold practice sessions of media relations activities. The process also includes regular briefings of staff on key topics and incorporates an assessment of the information needs of mass media news organizations and a media plan for release of panthers (for example see Jacobson 1999:301).

Displays and Programs in Public Environmental Education Centers

3.1.3.6. Design panther education displays and programs for public environmental education centers, such as zoos and natural history museums. Partners can also include the AZA and other affiliated organizations. Use existing programs such as the Panther Glades exhibit at Caribbean Gardens in Naples, Florida, as an example.

Programs and Materials for School Children

3.1.3.7. Develop education programs and materials for school children. This can include curriculum, participation in panther education and recovery actions, and panther awareness events.

3.1.3.8. Develop materials to promote Florida Panther Day.

Provide Materials and Programs

3.2. Provide materials and programs. Provide information to local planning organizations, decision makers and elected officials, the public, major landowners living in and adjacent to panther habitat, potential new residents and the realtor community, and other audiences as identified by social science research. Include positive proactive programs to keep people interested, involved, and a part of conservation and recovery programs. Programs can be also geared toward achieving voluntary behavior changes as an alternative to restrictions.

Communications Teams

3.2.1. Form communication teams to give presentations to audiences in and adjacent to panther habitat and in selected reintroduction sites.

Media / Public Relations Training for Agency Personnel

3.2.2. Provide media / public relations training for agency personnel who will be on-the-ground and interfacing with the public (including private landowners) and media. This includes staff and law enforcement officers. This can be provided in a workshop and a 5 - 10 page manual.

Distribute Materials and Provide Programs

3.2.3. Distribute materials and information to the public, landowners, and stakeholders.

3.2.3.1. Distribute information on landowner incentives.

3.2.3.2. Provide existing ecotourism facilities and the Visit Florida tourism promotion program with updated information on panthers that they can include in their programs. Ecotourism facilities in south Florida include boat tours, swamp buggy rides, and minibus tours.

3.2.3.3. Distribute information on land management techniques and provide technical assistance to public and private land managers regarding techniques to maintain and increase the value of habitat to panthers and their prey.

3.2.3.4. Inform the public, landowners, and decision makers about the needs and benefits of invasive species control / management and prescribed fire. Identify and work with existing programs that address invasive species

control / management and the value of prescribed fire to panthers and their prey.

3.2.3.5. Distribute information on prey management techniques (including exotic game) on public and private lands.

3.2.3.6. Distribute materials to promote Florida Panther Day. This could include the media, schools, environmental education facilities, and others.

South Florida Population

3.2.4. Provide materials and programs regarding the south Florida panther population and its management.

3.2.4.1. Provide information on genetic restoration. This should be directed at clearing up misinformation about genetic restoration as well as informing the public about the benefits and potential needs for genetic restoration. Include historical information on *Puma* subspecies, how the plan was formulated and implemented, and results of the program.

3.2.4.2. Provide information on panther conservation issues in ORV educational materials.

3.2.4.3. Educate sportsmen groups and the public about the legal consequences of illegal harassment. This includes the need for recognizing harassment activities, the detrimental effects that may result from harassment (physical injury, physiological stress, reduced litter size, morbidity) and the importance of preventing actions that constitute harassment.

3.2.4.4. Provide information on panther management, including monitoring.

Human / Panther Interactions

3.2.5. Provide materials and programs regarding human / panther interactions.

3.2.5.1. Provide education and outreach to residents living in and adjacent to panther habitat. Include the realtor community. Include tips for living in panther habitat.

3.2.5.2. Provide tips for recreating in panther habitat.

3.2.5.3. Provide information on protecting livestock and pets. Outreach efforts need to reassure livestock owners that the chance of their livestock being taken by a panther can be minimized, and if it does happen, they may be compensated through a depredation fund.

3.2.5.4. Provide outreach materials to address hunting concerns. Include information regarding the effects of panthers on hunted prey species and hunting success. Provide information to hunters and hunt clubs. Use results from social science research.

Population Expansion and Reintroduction

3.2.6. Provide materials and programs regarding panther population expansion and reintroduction.

3.2.6.1. Engage and provide materials to landowners and the public in south-central Florida to build support for restoring and maintaining habitat and for expansion and reintroduction.

3.2.6.2. Target education at reintroduction sites to address social issues in advance of releasing panthers. Opinion surveys and conservation education should be the cornerstone of reintroduction.

3.2.6.3. Continue education and outreach efforts after panthers are released into a reintroduction site. Include regular contacts with area residents / landowners about the program. Continually reinforce and address panther conservation messages, especially as problems arise.

3.2.6.4. Identify existing ecotourism facilities and State ecotourism boards in or near selected reintroduction sites and provide them with updated panther information. Information can be provided on an on-going basis in a format that is simple for the facilities to include in their programs.

Displays and Programs in Public Environmental Education Centers

3.2.7. Identify and work with existing environmental education facilities to provide or enhance panther education displays and programs. This includes Jacksonville Zoo, Lowry Park Zoo, Tallahassee Museum of History and Natural Science, Caribbean Gardens, and Busch Gardens.

Programs and Materials for School Children

3.2.8. Distribute education programs and materials to school children.

Evaluation

3.3. Evaluate outreach and educational materials and programs. Monitor the programs as they are implemented. Evaluate education and outreach efforts, especially to assess changes in human behavior and attitude. A good example of program evaluation is the FWC Bear Aware *Black Bear Public Education Program.* Evaluation data should be

compared to preliminary social science research (pre-program measurement) to provide a post-program measurement.

3.4. Revise materials where evaluation indicates a need.

V. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program for the Florida panther, as set forth in this recovery plan. It is a guide for meeting the recovery goal and criteria outlined in this plan. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, the parties potentially responsible for actions (either funding or carrying out), and estimated costs. Parties believed to have authority or responsibility for implementing a specific recovery action are identified in the Implementation Schedule. When more than one party has been identified, the proposed lead party is indicated by an asterisk (*). The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

Priority Number

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population / habitat quality or some other significant impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Participants and Other Parties Referenced in the Implementation Schedule

ARC[2]	Acquisition and Restoration Council
COE	U.S. Army Corps of Engineers
counties	South Florida counties
county parks	South Florida county parks
DCA	Department of Community Affairs
FDOF	Florida Division of Forestry
FDOT	Florida Department of Transportation
EPA	Environmental Protection Agency
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FHwA	Federal Highway Administration
FNAI	Florida Natural Areas Inventory
FWC	Florida Fish and Wildlife Conservation Commission
FWS	U.S. Fish and Wildlife Service
IFAS	Institute of Food and Agricultural Science
local governments	City and county agencies
NGO	Non-governmental organization
NPS	National Park Service
NRCS	Natural Resources Conservation Service
private	Private industry, landowners, etc.
State parks	South Florida State parks
Tribes	Miccosukee and Seminole Indian Tribes
universities	Public and private universities
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WMD	Water Management Districts located in south Florida

[2] FDEP's Division of State lands serves as staff to ARC which ranks and recommends for purchase priority lands which are approved by the Governor and Cabinet.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
Existing Population										
South Florida Habitat										
Non-Regulatory Incentive Programs										
3	1.1.1.1.1.	Develop Safe Harbor Agreements	Continuous	FWS*, private						Cost included in standard operating budget of Federal agency.
3	1.1.1.1.2.	Focus available incentive programs to restore and enhance panther habitat	Continuous	FWS*, FWC*, NRCS, NGO, FDOF, IFAS, counties, private	60	60	60	60	60	Cost included in standard operating budgets of agencies.
3	1.1.1.1.3.	Explore the creation of new panther conservation incentive programs	3 years	FDEP, FWC, FWS, NRCS, counties, local governments, NGO, private	10	10	10			
1	1.1.1.1.4.	Continue to secure lands	Continuous	FDEP*, FWC*, FWS, counties, NGO, local governments						Cost dependent upon land prices.
1	1.1.1.1.4.1.	Revise and implement the preliminary project proposal developed for expansion of FPNWR	10 years	FWS*						Cost dependent upon land prices.
3	1.1.1.1.4.2.	Modify existing land appraisal procedures	5 years	Local governments	10	10	10	10	10	
3	1.1.1.1.4.3.	Conduct an annual review of Florida Forever projects and rate them with respect to panther conservation values	Continuous	FWC*, FWS, NPS, NGO	1.5	1.5	1.5	1.5	1.5	
1	1.1.1.1.5.	Identify and support local initiatives to protect panther habitat and purchase development rights	Continuous	FWS, FWC, counties, local governments	10	10	10	10	10	

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
	Regulatory Programs									
2	1.1.1.2.1.	Create a Federal / State working group to coordinate permit review and consultation	< 1 year	FWS, FWC, FDEP, COE, EPA, NRCS, FDOF, WMD, NPS, FDOT, FHwA, USFS, local governments						Cost included in standard operating budgets of agencies.
2	1.1.1.2.2.	Track permits, especially incidental take and compensation received, issued through Federal and State regulatory programs	Continuous	FWS*, FWC, FDEP, COE, EPA, NRCS, FDOF, WMD, NPS, FDOT, FHwA, USFS	5	5	5	5	5	Cost included in standard operating budgets of agencies. Much of the information is available, but needs interagency coordination.
2	1.1.1.2.3.1.	Ensure that panther conservation and protection of panther habitat is included in the State Clearinghouse (SAI) reviews of Federal activities	Continuous	FWC*, FDEP						Cost included in standard operating budgets of agencies.
1	1.1.1.2.3.2.	Ensure that the section 7 consultation process is utilized and that the best available science is used in development of biological opinions	Continuous	FWS*, COE, EPA, NPS, FHwA, NRCS, USFS						Cost included in standard operating budgets of agencies.
2	1.1.1.2.3.3.	Avoid adverse effects to panther habitat (including prey) attributable to CERP and other water management projects	10 years	FWS*, COE, FDEP, FWC, NPS, WMD, FDOF	200	200	200	200	200	Cost for identifying effects is included in standard operating budgets of agencies. Additional funds are

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
										needed for monitoring.
2	1.1.1.2.4.1.	FWC will take the lead in providing review and recommendations to FDEP, Department of Community Affairs, WMDs, and other State agencies on permit applications that can potentially impact panther habitat	Continuous	FWC*, FDEP, WMD						Cost included in standard operating budgets of agencies.
2	1.1.1.2.4.2.	FWC and other appropriate State agencies will work with counties and municipalities to modify and amend Comprehensive Plans to include the goal of no net loss of quantity, quality, or functionality of panther habitat in Primary, Secondary, and Dispersal Zones	Continuous	FWC*, FDEP, counties, local governments						Cost included in standard operating budgets of agencies.
1	1.1.1.2.4.3.	Develop a mechanism for providing compensation for projects that affect small acreages (e.g., single family residences) of panther habitat in south Florida	2 years	FWS*, FWC, COE, local governments	10	10				
2	1.1.1.2.4.4.	Initiate and encourage landscape level HCPs in south Florida where proposed non-Federal actions or projects will impact panthers or their habitat	Continuous	FWS*, FWC, counties, private, local governments, NGO						Cost included in standard operating budgets of agencies.
	Habitat Fragmentation, Connectivity, and Spatial Extent									

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
1	1.1.1.3.1.	Identify, maintain, enhance, and restore habitat corridors	Continuous	FWC*, FWS, FDEP, NPS, NGO, private, FDOF, WMD, DCA						Cost included in standard operating budgets of agencies. Cost dependent upon land prices, number of acres being enhanced and restored.
1	1.1.1.3.1.1.	Secure the Dispersal Zone	Continuous	FWC*, FWS, FDEP*, NGO, private, FDOF, WMD, local government						Cost dependent upon number of willing landowners and land prices.
1	1.1.1.3.1.2.	Secure Camp Keais Strand	Continuous	FWC*, FWS, FDEP*, NGO, private, FDOF, WMD, local government						Cost dependent upon number of willing landowners and land prices.
1	1.1.1.3.1.3.	Secure a corridor between BCNP and Okaloacoochee Slough	Continuous	FWC*, FWS*, FDEP*, NPS, NGO, private, FDOF, WMD, local government						Cost dependent upon number of willing landowners and land prices.
2	1.1.1.3.1.4.	Consider panthers in Everglades restoration regarding potential for isolation in ENP	30 years	FWS*, COE, FDEP, FWC, NPS, WMD	5	5	5	5	5	
3	1.1.1.3.2.	Quantitatively assess factors that constrain or enhance dispersal	2-3 years	FWC*, NPS, FWS, USGS, universities	30	30	30			
1	1.1.1.3.3.	Maintain spatial extent and arrangement	Continuous	FWC*, FWS, NPS, NGO, NRCS, FDEP*, FDOF, WMD,						Cost dependent upon land prices.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
				private, counties, local governments						
Negative Impacts of Roads on Panther Habitat – South Florida										
2	1.1.1.4.1.	Insure that panther habitat needs are incorporated in the planning of new roads and road expansion projects.	Continuous	FWS, FWC, FDOT, FHwA, counties, local government, NGO, COE, FDEP, DCA	10	10	10	10	10	
1	1.1.1.4.2.	Identify current and planned roads that could affect panthers, eliminate roads where possible, and retrofit priority areas with crossings and fencing as appropriate to promote connectivity and dispersal	Continuous	FWS*, FWC, NPS, FDOT, FHwA, counties, local government, NGO, COE, FDEP, DCA	15	15	15	15	15	Cost to retrofit priority areas will be site-specific.
1	1.1.1.4.3.	Secure habitat adjacent or contiguous to areas of high risk for panther-vehicle collisions	Continuous	FDEP*, FWS, FWC*, NPS, FDOT, FHwA, counties, local government, NGO, COE, DCA						Cost will be site-specific.
3	1.1.1.4.4.	Determine the impacts of roads on range expansion and dispersal	3 years	FWC*, NPS, FWS, universities, USGS	50	50	50			
Habitat Restoration in Primary, Secondary, and Dispersal Zones										
1	1.1.2.	Restore habitat in the Primary, Secondary, and Dispersal Zones	Continuous	FWS, FWC, FDEP, FDOF, NPS, NRCS, counties, private						Restoration costs are site-specific.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
3	1.1.2.1.	Identify and prioritize tracts suitable for restoration	3 years	FWC*, NRCS, USGS, FNAI, universities, FWS	50	50	50			
2	1.1.2.2.	Provide incentives and mechanisms for restoration of agricultural and range lands	Continuous	NRCS, FWC, FWS, FDEP, FDACS	30	30	30			Costs to be determined for remaining years.
2	1.1.2.3.	Develop / expand funding mechanisms and other incentives for habitat restoration	Continuous	NRCS, FWC, FWS, FDEP, NGO, private	30	30	10	10	10	
3	1.1.2.4.	Develop and disseminate information on cost-effective restoration techniques	Continuous	NRCS, FWC, FWS, FDEP, NGO	20	5	5	5	5	
3	1.1.2.4.1.	Facilitate and conduct habitat restoration research	10 years	FWC*, NRCS, USGS, FWS, universities, NGO	200	200	200	200	200	
3	1.1.2.4.2.	Monitor and evaluate restoration projects	Continuous	FWC, NRCS, USGS, FWS, universities, NGO	30	30	30	30	30	
Habitat Management – South Florida										
2	1.1.3.1.	Develop, disseminate, and implement best management practices for managing panther habitat	2 years	FWS, FWC, NPS, NRCS, FDEP, FDOF, counties, local governments	25	25				Much of the information needed is available but needs interagency coordination.
Public Land Management – South Florida										
2	1.1.3.2.1.	Formalize a network of south Florida public land managers	< 1 year	FWS*, FWC, NPS, FDEP, FDOF, WMD, counties, local						Cost included in standard operating budgets of agencies.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
				governments						
2	1.1.3.2.2.	Prepare, review, and implement habitat management plans for public lands	Continuous	FWS, FWC, NPS, FDEP, FDOF, WMD, counties, local governments	100	100	100	100	100	
2	1.1.3.2.3.	Track habitat management activities and their effects on panthers	Continuous	FWC*, FWS, NPS, FDEP, FDOF, FNAI, WMD, counties, local governments	30	30	30	30	30	
Private Land Management – South Florida										
2	1.1.3.3.1.	Provide incentives and assistance to willing landowners	Continuous	FWS, FWC, NRCS, FDOF, IFAS, counties, private, NGO	60	60	60	60	60	
1	1.1.3.3.2.	Provide incentives and work with landowners to encourage them not to convert their lands to less suitable habitat	Continuous	FWS, FWC, NRCS, IFAS, FDOF, counties, private, NGO						Costs will be site specific
3	1.1.3.3.3.	Review and comment on county stewardship plans	Periodic	FWS*, FWC, NRCS, FDEP counties, private, NGO						Cost included in standard operating budgets of agencies.
Monitoring Habitat – South Florida										
2	1.1.4.1.	Quantify 24-hour habitat use and movement patterns	3 years	FWC*, NPS	450	450	450			
2	1.1.4.2.	Update Kautz et al. (in press) maps every five years	Periodic	FWS, FWC, USGS, universities	60					
South Florida Population										

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
	Demographics									
2	1.1.5.1.1.	Convene a group of agency and independent experts to conduct an appropriate PVA	2 years	FWS*, FWC, NPS, USGS, universities	30	30				
1	1.1.5.1.2.	Continue to determine and monitor demographic variables	Continuous	FWC*, NPS, FWS	750	750	750	750	750	
2	1.1.5.1.3.	Develop and implement annual capture and monitoring work plans	Continuous	FWC*, NPS, FWS						Costs included in item 1.1.6.1.2.
	Genetic Diversity									
1	1.1.5.2.1.	Continue to monitor physical and physiological characteristics correlated with inbreeding and depletion of genetic variability	Continuous	FWC*, NPS, FWS						Costs included in item 1.1.6.1.2.
1	1.1.5.2.2.	Develop and implement a genetics management plan	Continuous	FWS*, FWC, NPS, universities, private	30	30				Costs for remaining years to be determined.
2	1.1.5.2.3.	Develop a panther population model to predict future genetic consequences of management proposals and actions	3 years	FWS, FWC, NPS, USGS, universities	50	50	50			
	Harassment, Injury, and Mortality									
2	1.1.5.3.1.1.	Identify harassment activities	Continuous	FWS, FWC, NPS	10	10	10	10	10	
2	1.1.5.3.1.2.	Implement active management measures designed to inhibit and / or cease illegal harassment activities on public lands	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments						Cost included in standard operating budgets of agencies.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
2	1.1.5.3.1.2.1.	Manage public access to minimize harassment opportunities	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments	1	1	1	1	1	
3	1.1.5.3.1.2.2.	Develop ORV management plans where ORVs are allowed	Periodic	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments	10	10	10	10	10	
3	1.1.5.3.1.2.3.	Enforce regulations and statutes regarding discharge of firearms, explosive devices, or other loud noise sources	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments	1	1	1	1	1	Cost included in standard operating budgets of agencies.
3	1.1.5.3.1.3.1.	Post and maintain regulatory and informational signs	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments	15	15	15	15	15	
2	1.1.5.3.1.3.2.	Enforce existing laws and regulations	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF, counties, local governments						Cost included in standard operating budgets of agencies.
2	1.1.5.3.2.	Enforce existing Federal and State laws and regulations to minimize and prevent illegal killing of panthers	Continuous	FWS, FWC, NPS, FDEP, WMD, FDOF						Cost included in standard operating budgets of agencies.
2	1.1.5.3.3.1.1.	Convene working group to prioritize and address actions needed in panther / vehicle collision areas	2-3 years	FWS, FWC, NPS, FDOT, counties, NGO, private						Cost included in standard operating budgets of agencies and groups.
2	1.1.5.3.3.1.2.	Secure funding for and	Continuous	FDOT*, FWS,						Site-specific costs

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		install wildlife crossings and fencing in high risk areas		FWC, NPS, counties, NGO, FHwA, private						
2	1.1.5.3.3.1.3.	Evaluate and implement other mechanisms to prevent mortalities on roads	Continuous	FWC*, FDOT, FWS, NPS, FHwA, counties, NGO, private						Cost depends on mechanism and site
2	1.1.5.3.3.2.	Build mechanisms into permits for road projects to provide for adaptive management for panther mortality and / or other unforeseen problems	Continuous	FWC*, FWS, FDOT, COE, FHwA						Cost included in standard operating budgets of agencies.
2	1.1.5.3.3.3.	Develop new strategies to prevent road mortalities or injuries	Continuous	FDOT, FWS, FWC, NPS, counties, NGO, private						Cost depends upon technology.
3	1.1.5.3.3.4.	Enforce existing speed zones, monitor effectiveness, and modify as needed	Continuous	FHP, counties, FWC, FWS, NPS						Cost included in standard operating budgets of agencies.
3	1.1.5.3.4.1.	Provide adequate resources and facilities for the rehabilitation of panthers that might be injured or orphaned during capture and monitoring efforts	Continuous	FWS, FWC, NPS, NGO, private						Cost depends in part upon individual operating costs for each facility.
3	1.1.5.3.4.2.	Develop, follow, and regularly review and revise research, monitoring, capture, and handling protocols that minimize risks to panthers	Continuous	FWC*, NPS, FWS						Cost included in standard operating budgets of agencies.
	Diseases and Parasites									

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
3	1.1.5.4.1.1.	Continuously evaluate the value of specific vaccinations and review all vaccination protocols annually	Continuous	FWC*, NPS, FWS						Cost included in standard operating budgets of agencies.
1	1.1.5.4.1.2.	Revise vaccination protocols as appropriate considering new disease threats as they arise	As needed	FWC*, NPS, FWS						Cost depends on threat, included in standard operating budgets of agencies
1	1.1.5.4.2.1.	Collect appropriate tissue and blood samples from all panthers handled, both live and dead, and analyze them for the presence of priority diseases and parasites	Continuous	FWC*, NPS, FWS	60	60	60	60	60	
2	1.1.5.4.2.2.	Evaluate the disease threats presented by other species including bobcats and domestic cats and identify any needed management intervention	3 years	FWC, NPS, FWS, USGS, universities	60	60	60			
1	1.1.5.4.2.3.	Implement appropriate management strategies	As needed	FWC, NPS, FWS						Case-specific costs.
	Environmental Contaminants									
3	1.1.5.5.1.	Produce a summary report and database of contaminants in panthers and their environment in south Florida	2 years	FWS, FWC, EPA, FDEP, universities	30	30				
2	1.1.5.5.2.	Continue to monitor contaminants, especially mercury and endocrine disruptors, in panthers and their prey	Continuous	FWC, NPS, FWS						Cost included in standard operating budgets of agencies.
2	1.1.5.5.3.	Implement actions	As needed	EPA, FDEP,						Site-specific costs.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		necessary to remediate contaminants in high risk areas		FWS, NPS, COE, FWC, FDAC, FDOF, FDOT, counties, local governments						
	Prey Base									
2	1.1.5.6.1.1.	Assess and monitor the status of deer populations in panther habitat	Continuous	FWC, FWS, NPS, FWS, Tribes, FDOF, FDEP, WMD	70	70	70	70	70	
3	1.1.5.6.1.2.	Develop deer harvest regulations that do not compromise the panther prey base and take into consideration food requirements of the panther	Continuous	FWC, NPS, FWS, Tribes, FDOF, FDEP, WMD	5	5	5	5	5	
2	1.1.5.6.1.3.	Continue to monitor the impacts on panthers of hunting on public and private lands in panther habitat	Continuous	FWC*, NPS, FWS, Tribes, FDOF, FDEP, WMD	5	5	5	5	5	
2	1.1.5.6.2.	Encourage management / control of feral hog populations that does not threaten the panther	Continuous	FWC, NPS, FWS, Tribes, FDOF, WMD	20	20	20			Costs to be determined for remaining years
3	1.1.5.6.3.1.	Continue statewide monitoring for chronic wasting disease and other emerging wildlife and domestic animal diseases and implement available eradication or control methods	Continuous	FWC, FWS, NPS, USDA, FDACS	117	117	117	117	117	
3	1.1.5.6.3.2.	Identify, map, and	Continuous	FWC, USDA,	75	75	75	75	75	

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		appropriately monitor and regulate exotic animal operations that could serve as a source of infection for wild populations		FDACS, FWS						
3	1.1.5.6.3.3.	Coordinate with the southeastern States to review protocols and regulations that require imported ungulates to be disease-free	Continuous	FWS, USDA, State agencies	2	2	2	2	2	
Captive Management										
2	1.1.5.7.1.	Develop guidance for the removal of panthers from the wild	1-2 years	FWC, FWS, NPS, NGO, universities	10	10				
3	1.1.5.7.2.	Evaluate the need for and establish, if necessary, a captive breeding program	As needed / Continuous	FWS, FWC, NPS, private						Costs to be determined.
3	1.1.5.7.3.	Evaluate the role of alternative breeding strategies	As needed / Continuous	FWS, FWC, NPS, private						Cost included in item 1.1.7.7.4.2.
3	1.1.5.7.4.1.	Form a captive management team	< 1 yr	FWS, FWC, NPS, private						Cost included in standard operating budgets of agencies.
3	1.1.5.7.4.2.	Develop a captive management plan	1-2 years	FWS, FWC, NPS, private	10	10				
3	1.1.5.7.4.3.	Implement the captive management plan	As needed / Continuous	FWS, FWC, NPS, private						Costs to be determined.
3	1.1.5.7.5.	Establish research priorities for captive panthers which can be applied to management of the free-ranging population	1 year	FWS, FWC, NPS, private						Cost included in item 1.1.7.7.4.2.
3	1.1.5.7.6.	Incorporate interpretative education at public	2 years	NGO*, Private, FWS, FWC,	30	30				

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		facilities where captive panthers are held and prepare public information materials		NPS, universities						
Expansion into South-Central Florida										
	Feasibility and Habitat Identification									
2	1.2.1.	Determine the potential for habitat in south-central Florida to support a breeding population of panthers	1 year	FWS, USGS, universities	50					
	Facilitating Natural Population Expansion									
2	1.2.2.	If there is potential for habitat in south-central Florida to support a breeding population of panthers, determine if there are management steps that can be taken to facilitate natural expansion of female panthers into south-central Florida	1 year	FWC, FWS						Cost included in standard operating budgets of agencies.
	Translocation									
3	1.2.3.	If natural expansion of female panthers into south-central Florida is not likely, evaluate the feasibility of translocation of panthers to establish a breeding population, including an EA or EIS under the NEPA process if necessary	3-5 years	FWS, FWC, NPS						Cost included in standard operating budgets of agencies.
3	1.2.4.	If natural expansion is not likely, develop an expansion plan to guide	1 year	FWS, FWC, NPS						Cost included in standard operating budgets of agencies.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		translocation of panthers into south-central Florida								
Suitable Habitat										
2	1.2.5.1.	Secure a dispersal area north of Caloosahatchee River that maintains connection with habitat south of river	5 years	FWS, FWC, WMD, FDEP, FDOF, counties, private						Site-specific costs
3	1.2.5.2.	Conserve lands buffering the Caloosahatchee River	Continuous	FWS, FWC, WMD, FDEP, FDOF, NGO, counties, private						Cost included in standard operating budgets of agencies.
3	1.2.5.3.	If establishment of a breeding population of panthers in south-central Florida is feasible, provide for the conservation and enhancement of other lands necessary for persistence of a population in south-central Florida	Continuous	FWS, FWC, WMD, FDEP, FDOF, NGO, counties, private						Site-specific costs.
3	1.2.6.1.	If the panther population is expanded into south-central Florida, implement actions in Section 1.1.	Continuous	FWS, FWC, WMD, FDEP, FDOF, counties, private						Costs dependent upon actions needed.
Reintroduction										
Select Reintroduction Sites										
2	2.1.	Select reintroduction areas in coordination with the southeastern States within the historic range of the panther	1-2 years	FWS, State agencies, USFS						Cost included in standard operating budgets of agencies.
2	2.1.1.	Develop and conduct	1-2 years	FWS, State	50	50				

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		preliminary public scoping to allow effective preplanning of the NEPA process		agencies, USGS, USFS, universities						
3	2.1.2.	Identify State and Federal laws, regulations, or policies that could conflict with reintroduction and resolve any potential conflicts	1-2 years	FWS*, State agencies, USGS, USFS, universities						Cost included in standard operating budgets of agencies.
3	2.1.3.	Conduct field surveys of selected reintroduction areas	3 years	FWS*, State agencies, USGS, USFS, universities	100	100	100			
3	2.1.4.	Determine if puma are present in selected reintroduction areas	1-2 years	FWS*, State agencies, USGS, USFS, universities	40	40				
3	2.1.5.	Evaluate possible disease and parasite problems in selected reintroduction areas prior to releasing panthers	1-2 years	FWS*, State agencies, USGS, USFS, universities	30	30				
3	2.1.6.	Consider contaminant issues when evaluating selected reintroduction areas	1-2 years	FWS*, State agencies, USGS, USFS universities, EPA	30	30				
3	2.1.7.	Use the NEPA process to develop and refine the appropriate reintroduction alternatives and recommend the preferred alternative (e.g., number of sites)	1-2 years	FWS*, State agencies, USFS, NGO						Cost included in standard operating budgets of agencies.
2	2.1.7.1.	Coordinate with the	2 years	FWS*, state						Cost included in standard

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		southeastern States, stakeholders, and the public for reintroduction site selection		and local agencies, USDA, USFS, universities, private, NGO						operating budgets of agencies.
3	2.1.7.2.	Collect, compare, and analyze sociopolitical data	2 years	FWS*, State and local agencies, USGS, USFS, universities, NGO	50	50				
Reintroduce Panthers into Suitable Sites										
Source of Panthers for Reintroduction										
2	2.2.1.	Determine the number of panthers from each age and sex class that are needed for a reintroduction program	1 year	FWS*, FWC, State and local agencies, USGS, NPS universities	30					
2	2.2.1.1.	Select individual panthers that could be removed for reintroduction without negatively affecting the persistence of the existing population	1 year	FWS, FWC, NPS, USGS, universities						Cost included in standard operating budgets of agencies.
3	2.2.1.2.	Develop a protocol for the translocation of panthers from the wild	1 year	FWS*, FWC, NPS, USGS, universities						Cost included in standard operating budgets of agencies.
3	2.2.1.3.	Evaluate the need for and establish, if necessary, a captive breeding program	1-2 years	FWS, FWC, NPS, private						Cost for evaluation included in standard operating budgets of agencies. Costs for establishment to be determined.
3	2.2.1.4.	Evaluate the role of	1 year	FWS, FWC,						Cost included in standard

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		alternative breeding strategies and / or source populations		NPS, private						operating budgets of agencies.
Reintroduction Incentives										
2	2.2.2.	Identify and provide incentives and remove disincentives to Federal, State, and local governments and agencies to participate in reintroduction	1-2 years	FWS, State agencies, local governments, county, USFS						Cost included in standard operating budgets of agencies.
3	2.2.2.1.	Address the legal liability issues for State participation in a reintroduction program	1 year	FWS, State agencies						Cost dependent on solution.
3	2.2.2.2.	Provide resources and funding to assist with panther reintroduction	Continuous	FWS, State agencies, NGO, private						State / site-specific costs.
Human Dimensions of Reintroduction										
2	2.2.3.	Address human dimensions of panther reintroduction (including conflicts between stakeholders and panthers) with education, incentives, compensation, and regulatory mechanisms	Continuous	FWS, State agencies, NGO, private, USFS						State / site-specific costs
3	2.2.3.1.	Develop and implement a protocol and response plan for handling human-panther interactions	Continuous	FWS, State agencies, NGO, USFS, NPS	7	7	7	7	7	
3	2.2.3.2.	Evaluate the need for and, if appropriate, designate experimental nonessential populations	1-2 years	FWS						Cost included in standard operating budget of agency.
3	2.2.3.3.1.	Develop and distribute a	2 years	FWS, State	10	20				

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		landowner, land manager, and lessees panther handbook		agencies, NGO, USDA, private, USFS, NPS						
3	2.2.3.3.2.	Provide assistance to landowners, land managers, and lessees to identify and address potential conflicts on their property	Continuous	FWS, State agencies, NGO, NRCS, private						Cost included in standard operating budgets of agencies.
3	2.2.3.3.3.	Develop, fund, and implement a compensation program	Continuous	FWS, State agencies, NGO, USDA, private						State / site-specific costs
3	2.2.3.4.1.	Understand hunting pressure and methods in potential reintroduction areas to identify possible conflicts	2 years	FWS, State agencies, NGO, private	5	5				
3	2.2.3.4.2.	Identify and implement habitat management initiatives or other active ways to counter a real or perceived decline in deer populations	Continuous	FWS, State agencies, NGO, USDA, private						State / site-specific costs
Release of Panthers										
1	2.2.4.	Develop a protocol and release panthers into selected reintroduction sites	Continuous / As needed	FWS, State agencies, NGO, private, USGS, universities						State / site-specific costs
Monitoring Reintroduced Panthers										
3	2.2.5.	Develop and implement monitoring plans for the selected reintroduction areas	Continuous	FWS, State agencies, USGS, USFS universities	100	100	100	100	100	
3	2.2.6.1.	Enforce existing Federal and State laws and regulations	Continuous	FWS, State agencies, USFS						Cost included in standard operating budgets of agencies.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
3	2.2.6.2.	Extend ESA "similarity of appearance" protection to puma in applicable portions of the historic range prior to reintroduction	2 years	FWS						Cost included in standard operating budget of agency.
3	2.2.6.3.	Implement a toll free telephone tip number in reintroduction areas	Continuous	FWS, State agencies	2	2	2	2	2	
Actions Once Populations Are Established										
3	2.3.	As additional populations are established, implement appropriate actions in Section 1	As needed							Duration, participants, and costs depend on actions as well as State / site selection
Public Awareness and Education										
Design and Develop Materials and Programs										
Education Working Group										
2	3.1.1.	Form a working group to design and develop education and outreach materials and programs	Continuous	FWS*, FWC, NPS, USDA, NRCS, FDEP, FDOF, WMD, State agencies, NGO	10	10	10	10	10	
Social Science Research										
2	3.1.2.1.	Identify target audiences, content, strategic messages, and methods of getting the message out using social science research	1 year	FWS, FWC, NPS, USFS, NRCS, FDOF, WMD, State agencies, NGO	30					
Production of Materials and Programs										
Natural History, Recovery, and Reduction of Threats to Panthers										
3	3.1.3.1.	Produce information on natural history, place in the ecosystem, panther facts, benefits of panther	Continuous	FWS, FWC, FDEP, NPS, NRCS, FDOF, USFS, WMD,	50	50	50	50	50	

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		recovery, and ways to reduce threats to panthers and their habitat		NGO, State agencies, counties, local governments, universities, private						
	Habitat Conservation and Management									
3	3.1.3.2.1.	Compile information and produce materials and programs on landowner incentives	Continuous	FWS, FWC, FDEP, NPS, NRCS, FDOF, USFS, WMD, NGO, State agencies, counties, local governments, universities, private	10	10	10	10	10	
3	3.1.3.2.2.	Identify ecotourism values and economic incentives related to panthers and develop materials for ecotourism programs	1-2 years	FWS, State agencies, NGO, private, universities	25					
3	3.1.3.2.3.	Compile information on land management techniques	1-2 years	FWS, FWC, NRCS, FDEP, FDOF, WMD, NGO	30	30				
3	3.1.3.2.4.	Develop a panther habitat management handbook for public and private land managers based on the best management practices	1-2 years	FWS, FWC, NRCS, FDEP, FDOF, WMD, NGO						Costs included in 3.1.3.2.3.
	South Florida Population									
3	3.1.3.3.1.	Develop materials to inform the public and decision makers about	Continuous	FWS, FWC, NPS, USDA, NRCS, FDOF,						Costs included in 3.1.3.1.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		methods for reducing panther road mortality		WMD, State agencies, NGO						
Human / Panther Interactions										
3	3.1.3.4.1.	Develop educational material to address human social issues related to panther conservation and recovery	Continuous	FWS, FWC, FDEP, NPS, NRCS, FDOF, USFS, WMD, NGO, State agencies, counties, local governments, universities, private	20	20	20	20	20	
2	3.1.3.4.2.	Develop a Living With Panthers outreach program	1 year	FWS, FWC, NPS, Tribes, NRCS, NGO, State agencies	15					
3	3.1.3.4.3.	Develop materials and programs to address hunting concerns, such as a real or perceived decline in the deer population	2-3 years	FWS, FWC, NPS, USGS, universities, State agencies, NGO	10	10	10			
3	3.1.3.4.4.	Include panther conservation issues in ORV educational materials	Continuous	FWS, FWC, NPS, USFS, NRCS, FDOF, WMD, State agencies, NGO	1	1	1	1	1	
Population Expansion and Reintroduction										
2	3.1.3.5.1.	Examine sociological information, such as public attitudes in and around reintroduction sites	2-3 years	FWS, USGS, universities, State agencies, NGO	30	30	30			
2	3.1.3.5.2.	Develop a media plan	1 year	FWS, FWC, NPS, Tribes, NGO, State	100					

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
				agencies						
Displays and Programs in Public Environmental Education Centers										
3	3.1.3.6.	Design panther education displays and programs for public environmental education centers, such as zoos and natural history museums	Continuous	FWS, FWC, NPS, Tribes, NGO, State agencies, private	50	5	5	5	5	
Programs and Materials for School Children										
3	3.1.3.7.	Develop education programs and materials for school children	1 year	FWS, FWC, NPS, Tribes, NGO, State agencies, private	100					
3	3.1.3.8.	Develop materials to promote Florida Panther Day	1 year	FWC*, NPS, FWS, NGO, State agencies, private	30					
Provide Materials and Programs										
Communications Teams										
3	3.2.1.	Form communication teams to give presentations to audiences in and adjacent to panther habitat and in selected reintroduction sites	Continuous	FWS, FWC, NPS, USFS, NRCS, FDEP, FDOF, WMD, State agencies, NGO	5	5	5	5	5	
Media / Public Relations Training for Agency Personnel										
2	3.2.2.	Provide media / public relations training for agency personnel who will be on-the-ground and interfacing with the public (including private landowners) and media	Continuous	NRCS, FWS, FWC, NPS, NRCS, Tribes, NGO, State agencies, private	5	5	5	5	5	
Distribute Materials and Provide Programs										

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
3	3.2.3.1.	Distribute information on landowner incentives	Continuous	FWS, FWC, FDEP, NPS, NRCS, FDOF, USFS, WMD, NGO, State agencies, counties, local governments, universities, private						Costs included in 3.2.3.3.
3	3.2.3.2.	Provide existing ecotourism facilities and the Visit Florida tourism promotion program with updated information on panthers	Continuous	NPS, FWS, FWC, Tribes, private, NGO	7	5	5	5	5	
2	3.2.3.3.	Distribute information on land management techniques and provide technical assistance to public and private land managers regarding techniques to maintain and increase the value of habitat to panthers and their prey	Continuous	FWS, FWC, NRCS, FDEP, FDOF, WMD, NGO	300	300	300	300	300	
3	3.2.3.4.	Inform the public, landowners, and decision makers about the needs and benefits of invasive species control / management and prescribed fire	Continuous	FWS, FWC, NPS, USDA, NRCS, FDEP, counties, NGO, DCA, IFAS, USFS						Costs included in standard operating budgets of agencies.
3	3.2.3.5.	Distribute information on prey management techniques (including exotic game) on public and private lands	Continuous	FWS, FWC, NPS, USDA, NRCS, FDEP, FDOF, WMD, State agencies,						Costs included in standard operating budgets of agencies. Costs included in 3.2.3.3.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
				counties, local governments, NGO						
3	3.2.3.6.	Distribute materials to promote Florida Panther Day	Continuous	FWC*, NPS, FWS, NGO, State agencies	10	10	10	10	10	
South Florida Population										
3	3.2.4.1.	Provide information on genetic restoration	Continuous	FWS, FWC, NPS, NGO, private						Costs included in 3.1.3.1.
3	3.2.4.2.	Provide information on panther conservation issues in ORV educational materials	Continuous	FWS, FWC, NPS, USFS, NRCS, FDOF, WMD, State agencies, NGO						Costs included in 3.1.3.1.
3	3.2.4.3.	Educate sportsmen groups and the public about the legal consequences of illegal harassment	Continuous	FWS, FWC, NPS, USDA, NRCS, FDOF, WMD, State agencies, NGO						Costs included in 3.1.3.1.
3	3.2.4.4.	Provide information on panther management, including monitoring	Continuous	FWC, FWS, NPS, USDA, NRCS, FDOF, State agencies, NGO						Costs included in 3.1.3.1.
Human / Panther Interactions										
2	3.2.5.1.	Provide education and outreach to residents living in and adjacent to panther habitat	Continuous	FWS, FWC, NPS, USDA, NRCS, FDOF, WMD, State agencies, NGO	50	50	50	50	50	
3	3.2.5.2.	Provide tips for recreating in panther habitat	Continuous	FWS, FWC, NPS, USFS, NRCS, FDEP, FDOF, WMD,						Cost included in 3.2.5.1.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
				State agencies, NGO						
3	3.2.5.3.	Provide information on protecting livestock and pets	Continuous	FWS, FWC, NPS, USFS, NRCS, FDOF, WMD, State agencies, NGO						Cost included in 3.2.5.1.
3	3.2.5.4.	Provide outreach materials to address hunting concerns	Continuous	FWS, FWC, NPS, USDA, NRCS, FDOF, WMD, State agencies, NGO						Cost included in 3.2.5.1.
Population Expansion and Reintroduction										
2	3.2.6.1.	Engage and provide materials to landowners and the public in south-central Florida to build support for restoring and maintaining habitat and for expansion and reintroductions	Continuous	FWS, FWC, NRCS, FDOF, WMD, counties, NGO						Costs included in 3.2.3.3.
2	3.2.6.2.	Target education at reintroduction sites to address social issues in advance of releasing panthers	Continuous	FWS, State agencies, NRCS, USFS, NGO, private	50	50	50	50	50	
3	3.2.6.3.	Continue education and outreach efforts after panthers are released into a reintroduction site	Continuous	FWS, State agencies, NRCS, USFS, NGO, private						Cost included in 3.2.6.2.
3	3.2.6.4.	Identify existing ecotourism facilities and State ecotourism boards in or near selected reintroduction sites and provide them with updated panther	Continuous	FWS, State agencies, private, NGO						Costs included in 3.2.3.2.

Priority	Action Number	Recovery Action Description	Action Duration	Participants	Estimated Fiscal Year Costs ($000s)					Comments
					FY1	FY2	FY3	FY4	FY5	
		information								
Displays and Programs in Public Environmental Education Centers										
3	3.2.7.	Identify and work with existing environmental education facilities to provide or enhance panther education displays and programs	Continuous	NPS, FWS, FWC, FDEP, Tribes, private, NGO	50	50	50	50	50	
Programs and Materials for School Children										
3	3.2.8.	Distribute education programs and materials to school children	Continuous	FWS, FWC, NPS, Tribes, NGO, State agencies, private	20	20	20	20	20	
Evaluation										
3	3.3.	Evaluate outreach and educational materials and programs	Continuous	FWS, FWC, NPS, Tribes, NGO, State agencies	15	15	15	15	15	
3	3.4	Revise materials where evaluation indicates a need	Continuous	FWS, FWC, NPS, Tribes, NGO, State agencies	150	150	150	150	150	

VI. LITERATURE CITED

Ackerman, B. B., F. G. Lindzey, and T. P. Hemker. 1986. Predictive energetics model for cougars. Pages 333-352 *in* S. D. Miller and D. D. Everett (eds). Cats of the world: biology, conservation, and management. National Wildlife Federation and Caesar Kleberg Wildlife Research Institute, Washington, D. C. and Kingsville, TX.

Adams, B., and J. A. Bozzo. 2002. Big Cypress National Preserve deer and hog annual report 2001 – 2002. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Anderson, A. E. 1983. A critical review of literature on puma (*Felis concolor*). Special Report No. 54. Colorado Division of Wildlife, Fort Collins, CO.

Ballou, J. D., T. J. Foose, R. C. Lacy, and U. S. Seal. 1989. Florida panther (*Felis concolor coryi*) population viability analysis and recommendations. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Bangs, O. 1899. The Florida puma. Proceedings of the Biological Society of Washington 13:15-17.

Barone, M. A., M. E. Roelke, J. Howard, J. L. Brown, A. E. Anderson, and D. E. Wildt. 1994. Reproductive characteristics of male Florida panthers: comparative studies from Florida, Texas, Colorado, Latin America, and North American Zoos. Journal of Mammalogy 75:150-162.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. Conservation Biology 7:94-108.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59:228-237.

Beier P., M. R. Vaughan, M. J. Conroy, and H. Quigley. 2003. An analysis of scientific literature related to the Florida panther. Final report, Project NG01-105, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Beier P., M. R. Vaughan, M. J. Conroy, and H. Quigley. In press. Evaluating scientific inferences about the Florida panther. Journal of Wildlife Management.

Beissinger, S., and M. I. Westphal. 1998. On the use of demographic models of population viability in endangered species management. Journal of Wildlife Management 62:821-841.

Belden, R. C. 1986. Florida panther recovery plan implementation - a 1983 progress report. Pages 159-172 *in* S. D. Miller and D. D. Everett (eds). Cats of the world: biology, conservation, and management. National Wildlife Federation and Caesar Kleberg Wildlife Research Institute, Washington, D.C. and Kingsville, TX.

Belden, R. C. 1988. The Florida panther. Pages 515-532 *in* Audubon Wildlife Report 1988/1989. National Audubon Society, New York, NY.

Belden, R. C., and B. W. Hagedorn. 1993. Feasibility of translocating panthers into northern Florida. Journal of Wildlife Management 57:388-397.

Belden, R. C., and R. T. McBride. 1983a. Florida panther surveys – Big Cypress National Preserve. Final report to Hughes and Hughes Oil and Gas Company.

Belden, R. C., and R. T. McBride. 1983b. Florida panther surveys – South Florida Indian Reservations. Final report to Natural Resources Management Corporation.

Belden, R. C., and R. T. McBride. 2005. Florida panther peripheral areas survey final report 1998-2004. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Belden, R. C., and J. W. McCown. 1996. Florida panther reintroduction feasibility study. Final Report 7507. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Belden, R. C., W. B. Frankenberger, R. T. McBride, and S. T. Schwikert. 1988. Panther habitat use in southern Florida. Journal of Wildlife Management 52:660-663.

Belden, R. C., W. B. Frankenberger, and J. C. Roof. 1991. Florida panther distribution. Final Report 7501, E-1 II-E-1. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Berglund, F., and M. Berlin. 1969. Risk of methylmercury cumulation in man and mammals and the relation between body burden of methylmercury and toxic effects. *In* M. W. Miller and G. G. Berg (eds). Chemical fallout. Charles C. Thomas, Springfield.

Beyer, D. E., Jr., and J. B. Haufler. 1994. Diurnal versus 24-hour sampling of habitat use. Journal of Wildlife Management 58:178-180.

Boyce, M. S. 1992. Population viability analysis. Annual Review of Ecology and Systematics 23:481-506.

Brown, J. H., and A. Kodric-Brown. 1977. Turnover rates in insular biogeography: effect of immigration on extinction. Ecology 58:445-449.

Burridge, M. J., L. A. Sawyer, and W. J. Bigler. 1986. Rabies in Florida. Florida Department of Health and Rehabilitative Services, Tallahassee, FL.

Carlson, A., and P. Edenhamn. 2000. Extinction dynamics and the regional persistence of a tree frog metapopulation. Proceedings for the Royal Society of London Series B-Biological Sciences 267:1311-1313.

Carroll, C., R. F. Noss, P. C. Paquet, and N. H. Schumaker. 2004. Extinction debt of protected areas in developing landscapes. Conservation Biology 18:1110-1120.

Clark J. D., D. Huber, and C. Servheen. 2002. Bear reintroductions: lessons and challenges. Ursus 13:335-345.

Comiskey, E. J., L. J. Gross, D. M. Fleming, M. A. Huston, O. L. Bass, Jr., H. Luh, and Y. Wu. 1994. A spatially-explicit individual-based simulation model for Florida panther and white-tailed deer in the Everglades and Big Cypress landscapes. Pages 494-503 *in* D. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Comiskey, E. J., O. L. Bass, Jr., L. J. Gross, R. T. McBride, and R. Salinas. 2002. Panthers and forests in south Florida: an ecological perspective. Conservation Ecology 6:18.

Comiskey, E. J., A. C. Eller, Jr., and D. W. Perkins. 2004. Evaluating impacts to Florida panther habitat: how porous is the umbrella? Southeastern Naturalist 3:51-74.

Cory, C. B. 1896. Hunting and fishing in Florida. Estes and Lauriat, Boston, MA.

Cox J., R. Kautz, M. MacLaughlin, and T. Gilbert. 1994. Closing the gaps in Florida's wildlife habitat conservation system. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Cramer P. 1995. The northeast Florida panther education program. Final report to Florida Advisory Council on Environmental Education. University of Florida, Gainesville, FL.

Culver, M., W. E. Johnson, J. Pecon-Slattery, and S. J. O'Brien. 2000. Genomic ancestry of the American puma (*Puma concolor*). Journal of Heredity 91:186-197.

Cunningham, M. W. 2005. Epizootiology of feline leukemia virus in the Florida panther. M.S. Thesis. University of Florida, Gainesville, FL.

Dalrymple, G. H., and O. L. Bass. 1996. The diet of the Florida panther in Everglades National Park, Florida. Bulletin of the Florida Museum of Natural History 39:173-193.

Dees, C. S., J. D. Clark, and F. T. van Manen. 1999. Florida panther habitat use in response to prescribed fire at Florida Panther National Wildlife Refuge and Big Cypress National Preserve. Final report to Florida Panther National Wildlife Refuge. University of Tennessee, Knoxville, TN.

Dees, C. S., J. D. Clark, and F. T. Van Manen. 2001. Florida panther habitat use in response to prescribed fire. Journal of Wildlife Management 65:141-147.

Dickson, B. G., J. S. Jenness, and P. Beier. 2005. Influence of vegetation, topography, and roads on cougar movement in Southern California. Journal of Wildlife Management 69:264-276.

Doak, D. F., P. Kareiva, and B. Klepetka. 1994. Modeling population viability for the desert tortoise in the Western Mojave Desert. Ecological Applications 4:446-460.

Duda, M., and K. Young. 1995. Floridian's knowledge, opinions, and attitudes toward panther habitat and panther-related issues. Florida Advisory Council on Environmental Education.

Duever, M. J., J. E. Carlson, J. F. Meeder, L. C. Duever, L. H. Gunderson, L. A. Riopelle, T. R. Alexander, R. L. Myers, and D. P. Spangler. 1986. The Big Cypress National Preserve. Research Report 8. National Audubon Society, New York, NY.

Dunbar, M. R. 1995. Florida panther biomedical investigations. Annual performance report. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Dunbar, M. R., G. S. McLaughin, D. M. Murphy, and M. W. Cunningham. 1994. Pathogenicity of the hookworm, *Ancylostoma pluridentatum*, in a Florida panther (*Felis concolor coryi*) kitten. Journal of Wildlife Diseases 30:548-551.

Ellis, S., R. C. Lacy, S. Kennedy-Stoskopf, D. E. Wildt, J. Shillcox, O. Byers, and U. S. Seal (eds). 1999. Florida panther population and habitat viability assessment and genetics workshop report. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.

Ewens, W. J. 1990. The minimum viable population size as a genetic and demographic concept. Pages 307-316 *in* J. Adams, D. A. Lam, A. I. Hermalin, and P. E. Smouse (eds). Convergent issues in genetics and demography. Oxford University Press, New York, NY.

Falconer, D. S. 1989. Introduction to quantitative genetics. Third edition. Longman, NY.

Fieberg, J., and S. P. Ellner. 2000. When is it meaningful to estimate an extinction probability? Ecology 81:2040-2047.

Fleming, M., J. Schortemeyer, and J. Ault. 1994. Distribution, abundance, and demography of white-tailed deer in the Everglades. Pages 247-274 *in* D. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Forrester, D. J. 1992. Parasites and diseases of wild mammals in Florida. University Press of Florida, Gainesville, FL.

Forrester, D. J., J. A. Conti, and R. C. Belden. 1985. Parasites of the Florida panther (*Felis concolor coryi*). Proceedings of the Helminthological Society of Washington 52:95-97.

Frank, K. 2005. Metapopulation persistence in heterogeneous landscapes: lessons about the effect of stochasticity. American Naturalist 165:374-388.

Frankham, R. 1995. Effective population size / adult population size ratios in wildlife: a review. Genetical Research 66:95-107.

Franklin, I. R. 1980. Evolutionary change in small populations. Pages 135-149 *in* M. E. Soulé and B. A. Wilcox (eds). Conservation biology: an evolutionary-ecological perspective. Sinauer Associates, Sunderland, MA.

Franklin, I. R., and R. Frankham. 1998. How large must populations be to retain evolutionary potential? Animal Conservation 1:69-70.

Frederick, P. C., M. G. Spalding, and R. Dusek. 2002. Wading birds as bioindicators of mercury contamination in Florida, USA; annual and geographic variation. Environmental Toxicology and Chemistry 21:163-167.

Gautschi, B., J. P. Muller, B. Schmid, and J. A. Shykoff. 2003. Effective number of breeders and maintenance of genetic diversity in the captive bearded vulture population. Heredity 91:9-16.

Gilpin, M. E., and M. E. Soulé. 1986. Minimum viable populations: Processes of species extinction. Pages 19-34 *in* M. E. Soulé (ed). Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Inc., Sunderland, MA.

Glass, C. M., R. G. McLean, J. B. Katz, D. S. Maehr, C. B. Cropp, L. J. Kirk, A. J. McKeirnan, and J. F. Evermann. 1994. Isolation of pseudorabies (Aujeszky's disease) virus from a Florida panther. Journal of Wildlife Diseases 30:180-184.

Goodman, D. 1987. Consideration of stochastic demography in the design and management of biological reserves. Natural Resources Modeling 1:205-234.

Grimm, V., and C. Wissel. 2004. The intrinsic mean time to extinction: a unifying approach to analyzing persistence and viability of populations. Oikos 105:501-511.

Hamilton, S., and H. Moller. 1995. Can PVA models using computer packages offer useful conservation advice? Sooty shearwaters *Puffinus griseus* in New Zealand as a case study. Biological Conservation 73:107-117.

Hanski, I. 2002. Metapopulations of animals in highly fragmented landscapes and population viability analysis. Pages 86-108 *in* S. R. Beissinger and D. R. McCullough (eds). Population Viability Analysis. University of Chicago Press, Chicago, IL.

Harlow, R. F. 1959. An evaluation of white-tailed deer habitat in Florida. Florida Game and Fresh Water Fish Commission Technical Bulletin 5, Tallahassee, FL.

Harlow, R. F., and F. K. Jones. 1965. The white-tailed deer in Florida. Florida Game and Fresh Water Fish Commission Technical Bulletin 9, Tallahassee, FL.

Harris, L. D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago, IL.

Harrison, R. L. 1992. Toward a theory of inter-refuge corridor design. Conservation Biology 6:293-295.

Hedrick, P. W. 2004. Recent developments in conservation genetics. Forest Ecology and Management 197:3-19.

Hedrick, P. W., R. N. Lee, and C. Buchanan. 2003. Canine parvovirus enteritis, canine distemper, and major histocompatibility complex genetic variation in Mexican wolves. Journal of Wildlife Diseases 39:909-913.

Hellgren, E. C., D. P. Onorato, and J. R. Skiles. 2005. Dynamics of a black bear population within a desert metapopulation. Biological Conservation 122:131-140.

Hollister, N. 1911. The Louisiana puma. Proceedings of the Biological Society of Washington 24:175-178.

Horino, S., and S. Miura. 2000. Population viability analysis of a Japanese black bear population. Population Ecology 42:37-44.

Jacobson, S. K. 1999. Case study of public communications for the gray wolf reintroduction to Yellowstone National Park. Appendix *in* Communication Skills for Conservation Professionals. Island Press, Washington, DC.

Janis, M. W., and J. D. Clark. 1999. The effects of recreational deer and hog hunting on the behavior of Florida panthers. Final report to Big Cypress National Preserve, National Park Service, Ochopee, FL.

Janis, M. W., and J. D. Clark. 2002. Responses of Florida panthers to recreational deer and hog hunting. Journal of Wildlife Management 66:839-848.

Jansen, D. K., S. R. Schulze, and A. T. Johnson. 2005. Florida panther (*Puma concolor coryi*) research and monitoring in Big Cypress National Preserve. Annual report 2004-2005. National Park Service, Ochopee, FL.

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.

Jordan, D. B. 1994. Identification and evaluation of candidate Florida panther population reestablishment sites. Pages 106-153 *in* D. B. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Kautz, R. S. 1994. Historical trends within the range of the Florida panther. Pages 285-296 *in* D. B. Jordan (ed). Proceedings of the Florida panther conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Kautz, R. S., and J. A. Cox. 2001. Strategic habitats for biodiversity conservation in Florida. Conservation Biology 15:55-77.

Kautz, R. S., D. T. Gilbert, and G. M. Mauldin. 1993. Vegetative cover in Florida based on 1985-1989 Landsat Thematic Mapper imagery. Florida Scientist 56:135-154.

Kautz, R., R. Kawula, T. Hoctor, J. Comiskey, D. Jansen, D. Jennings, J. Kasbohm, F. Mazzotti, R. McBride, L. Richardson, and K. Root. In press. How much is enough? Landscape-scale conservation for the Florida panther. Biological Conservation.

Kautz, R., B. Stys, and R. Kawula. In draft. Florida vegetation 2003 and land use change between 1985-89 and 2003. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Kelly, M. J., and S. M. Durant. 2000. Viability of the Serengeti cheetah population. Conservation Biology 14:786-797.

Kendall, B. E., O. N. Bjornstad, J. Bascompte, T. H. Keitt, and W. F. Fagan. 2000. Dispersal, environmental correlation, and spatial synchrony in population dynamics. American Naturalist 155:628-636.

Kerkhoff, A. J., B. T. Milne, and D. S. Maehr. 2000. Toward a panther-centered view of the forests of south Florida. Conservation Ecology 4:1.

Kohlmann, S. G., G. A. Schmidt, D. K. Garcelon. 2005. A population viability analysis for the Island Fox on Santa Catalina Island, California. Ecological Modelling 183:77-94.

Kramer-Schadt S., E. Revilla, and T. Wiegand. 2005. Lynx reintroductions in fragmented landscapes of Germany: projects with a future or misunderstood wildlife conservation? Biological Conservation 125:169-182.

Labisky, R. F., M. C. Boulay, K. E. Miller, R. A. Sargent, Jr., and J. M. Zultowskil. 1995. Population ecology of white-tailed deer in Big Cypress National Preserve and Everglades National Park. Final report to National Park Service, Ochopee, FL.

Labisky, R. F., C. C. Hurd, M. K. Oli, and R. S. Barwick. 2003. Foods of white-tailed deer in the Florida Everglades: the significance of *Crinum*. Southeastern Naturalist 2:261-270.

Land, E. D. 1994. Response of the wild Florida panther population to removals for captive breeding. Final Report 7571. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Land, E. D., and R. C. Lacy. 2000. Introgression level achieved through Florida panther genetic restoration. Endangered Species Update 17:99-103.

Land, D., and S. K. Taylor. 1998. Florida panther genetic restoration and management annual report 1997-98. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Land, D., B. Shindle, D. Singler, and S. K. Taylor. 1999. Florida panther genetic restoration annual report 1998-99. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Land, D., M. Cunningham, R. McBride, D. Shindle, and M. Lotz. 2002. Florida panther genetic restoration and management annual report 2001-02. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Land, D., D. Shindle, M. Cunningham, M. Lotz, and B. Ferree. 2004. Florida panther genetic restoration and management annual report 2003-04. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

Lande, R. 1995. Mutation and conservation. Conservation Biology 9:782-791.

Lande, R., and G. F. Barrowclough. 1987. Effective population size, genetic variation, and their use in population management. Pages 87-124 in M.E. Soulé (ed). Viable populations for conservation. Cambridge University Press, MA.

Lasley, M. F. W. 1978. Genetics of livestock improvement. Third edition. Prentice-Hall, Englewood Cliffs, NJ.

Li, Z., M. Gao, C. Hui, X. Han, and H. Shi. 2005. Impact of predator pursuit and prey invasion on synchrony and spatial patterns in metapopulation. Ecological Modelling 185:245-254.

Lindsey, P. A., R. Alexander, J. T. Du Toit, and M. G. L. Mills. 2005. The cost efficiency of wild dog conservation in South Africa. Conservation Biology 19:1205-1214.

Logan, T., A. C. Eller, Jr., R. Morrell, D. Ruffner, and J. Sewell. 1993. Florida panther habitat preservation plan: south Florida population. Florida Panther Interagency Committee, U.S. Fish and Wildlife Service, Gainesville, FL.

Lotz, M., D. Land, M. Cunningham, and B. Ferree. 2005. Florida panther annual report 2004-05. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Loveless, C. M. 1959. The Everglades deer herd life history and management. Florida Game and Fresh Water Fish Commission Technical Bulletin 6, Tallahassee, FL.

Lubow, B. C. 1996. Optimal translocation strategies for enhancing stochastic metapopulation viability. Ecological Applications 6:1268-1280.

Maehr, D. S. 1990a. Florida panther movements, social organization, and habitat utilization. Final Performance Report 7502. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Maehr, D. S. 1990b. The Florida panther and private lands. Conservation Biology 4:167-170.

Maehr, D. S. 1992. Florida panther. Pages 176-189 *in* S.R. Humphrey (ed). Rare and endangered biota of Florida. Volume I: mammals. University Press of Florida, Gainesville, FL.

Maehr, D. S. 1997a. The comparative ecology of bobcat, black bear, and Florida panther in south Florida. Bulletin of the Florida Museum of Natural History 40:1-176.

Maehr, D. S. 1997b. The Florida panther: Life and death of a vanishing carnivore. Island Press, Washington, D.C.

Maehr, D. S., J. C. Roof, E. D. Land, and J. W. McCown. 1989a. First reproduction of a panther (*Felis concolor coryi*) in southwestern Florida, U.S.A. Mammalia 53: 129-131.

Maehr, D. S., J. C. Roof, E. D. Land, J. W. McCown, R. C. Belden, and W. B. Frankenberger. 1989b. Fates of wild hogs released into occupied Florida panther home ranges. Florida Field Naturalist 17:42-43.

Maehr, D. S., E. D. Land, J. C. Roof, and J. W. McCown. 1990a. Day beds, natal dens, and activity of Florida panthers. Proceedings of Annual Conference of Southeastern Fish and Wildlife Agencies 44:310-318.

Maehr, D. S., R. C. Belden, E. D. Land, and L. Wilkins. 1990b. Food habits of panthers in southwest Florida. Journal of Wildlife Management 54:420-423.

Maehr, D. S., E. D. Land, and J. C. Roof. 1991a. Social ecology of Florida panthers. National Geographic Research & Exploration 7:414-431.

Maehr, D. S., E. D. Land, and M. E. Roelke. 1991b. Mortality patterns of panthers in southwest Florida. Proceedings of Annual Conference of Southeastern Fish and Wildlife Agencies 45:201-207.

Maehr, D. S., E. C. Greiner, J. E. Lanier, and D. Murphy. 1995. Notoedric mange in the Florida panther (*Felis concolor coryi*). Journal of Wildlife Diseases 31:251-254.

Maehr, D. S., E. D. Land, D. B. Shindle, O. L. Bass, and T. S. Hoctor. 2002a. Florida panther dispersal and conservation. Biological Conservation 106:187-197.

Maehr, D. S., R. C. Lacy, E. D. Land, O. L. Bass, Jr., and T. S. Hoctor. 2002b. Evolution of population viability assessments for the Florida panther: a multi-perspective approach. Pages 284-311 *in* S. R. Beissinger and D. R. McCullough (eds). Population Viability Analysis. University of Chicago Press, Chicago, IL.

Margan, S. H., R. K. Nurthen, M. E. Montgomery, L. M. Woodworth, E. H. Lowe, D. A. Briscoe, and R. Frankham. 1998. Single large or several small? Population fragmentation in the captive management of endangered species. Zoo Biology 17:467-480.

McBride, R. T. 1985. Population status of the Florida panther in Everglades National Park and Big Cypress National Preserve. Report to National Park Service in fulfillment of Contract #RFP 5280-84 04, Homestead, FL.

McBride, R. T. 2000. Current panther distribution and habitat use: a review of field notes, fall 1999-winter 2000. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2001. Current panther distribution, population trends, and habitat use: report of field work: fall 2000-winter 2001. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2002. Current panther distribution and conservation implications -- highlights of field work: fall 2001 -- winter 2002. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2003. The documented panther population (DPP) and its current distribution from July 1, 2002 to June 30, 2003. Appendix IV *in* D. Shindle, M. Cunningham, D. Land, R. McBride, M. Lotz, and B. Ferree. Florida panther genetic restoration and management. Annual report 93112503002. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

McBride, R. T., R. M. McBride, J. L. Cashman, and D. S. Maehr. 1993. Do mountain lions exist in Arkansas? Proceedings Annual Conference Southeastern Fish and Wildlife Agencies 47:394-402.

McCarthy, M. A., C. J. Thompson, and H. P. Possingham. 2005. Theory for designing nature reserves for single species. American Naturalist 165:250-257.

McCown, J. W. 1994. Big Cypress deer/panther relationships: deer herd health and reproduction. Pages 197-217 *in* D. B. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Miller, K. E. 1993. Habitat use by white-tailed deer in the Everglades: tree islands in a seasonally flooded landscape. M.S. Thesis. University of Florida, Gainesville, FL.

Mills, L. S., and F. W. Allendorf. 1996. The one-migrant-per-generation rule in conservation and management. Conservation Biology 10:1509-1518.

Mooring, M. S., T. A. Fitzpatrick, T. T. Nishihira, and D. D. Reisig. 2004. Vigilance, predation risk, and the Allee effect in desert bighorn sheep. Journal of Wildlife Management 68:519-532.

Morris, W. F., and D. F. Doak. 2002. Quantitative conservation biology: Theory and practice of population viability analysis. Sinauer Associates, Sunderland, MA.

Murphy, F. A., E. P. J. Gibbs, M. C. Horzinek, and M. J. Studdert. 1999. Veterinary virology. Academic Press, New York, NY.

Musiani, M., and P. C. Paquet. 2004. The practice of wolf persecution, protection, and restoration in Canada and the United States. BioScience 54:50-60.

National Marine Fisheries Service. 2004. Interim endangered and threatened species recovery planning guidance. Silver Springs, MD.

Nelson, E. W., and E. A. Goldman. 1929. List of the pumas with three described as new. Journal of Mammalogy 10:345-350.

Newman, J., E. Zillioux, E. Rich, L. Liang, and C. Newman. 2004. Historical and other patterns of monomethyl and inorganic mercury in the Florida panther (*Puma concolor coryi*). Archives of Environmental Contaminants and Toxicology 48:75-80.

Newmark, W. D. 1987. A land-bridge island perspective on mammalian extinctions in western North American parks. Nature 325:430-432.

Noss, R. F. 1987. Corridors in real landscapes: a reply to Simberloff and Cox. Conservation Biology 1:159-164.

Noss, R. F. 1992. The wildlands project land conservation strategy. Wild Earth (Special Issue):10-25.

Noss, R. F., and A.Y. Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D.C.

Nowak, R. M., and R. T. McBride. 1974. Status survey of the Florida panther. Project 973. World Wildlife Fund Yearbook 1973-74:237-242.

Nowak, R. M., and R. T. McBride. 1975. Status of the Florida panther. Project 973. World Wildlife Fund Yearbook 1974-75:245-46.

Nowell, K., and P. Jackson. 1996. Status survey and conservation action plan: Wild cats. International Union for Conservation of Nature and Natural Resources. Burlington Press, Cambridge, U.K.

Nunney, L. 1993. The influence of mating system and overlapping generations on effective population size. Evolution 47:1329-1341.

Nunney, L., and D. R. Elam. 1994. Estimating the effective population size of conserved populations. Conservation Biology 8:175-184.

O'Brien, S. J., M. E. Roelke, L. Marker, A. Newman, C. A. Winkler, D. Meltzer, L. Colly, J. F. Evermann, M. Bush, and D. E. Wildt. 1985. Genetic basis for species vulnerability in the cheetah. Science 227:1428-1434.

Olmstead, R. A., R. Langley, M. E. Roelke, R. M. Goeken, D. Adger-Johnson, J. P. Goff, J. P. Albert, C. Packer, M. K. Laurenson, T. M. Caro, L. Scheepers, D. E. Wildt, M. Bush, J. S. Martenson, and S. J. O'Brien. 1992. Worldwide prevalence of lentivirus infection in wild feline species: epidemiologic and phylogenetic aspects. Journal of Virology 66:6008-6018.

Parysow, P., and D. J. Tazik. 2002. Assessing the effect of estimation error on population viability analysis: an example using the black-capped vireo. Ecological Modelling 155:217-229.

Pulliam, H. R., J. B. Dunning, and J. Liu. 1992. Population dynamics in complex landscapes: a case study. Ecological Applications 2:165-177.

Ralls, K., and J. Ballou. 1982. Effects of inbreeding on infant mortality in captive primates. International Journal of Primatology 3:491-505.

Ralls, K., and J. D. Ballou. 2004. Genetic status and management of California condors. Condor 106:215-228.

Reed, D. H. 2004. Extinction risk in fragmented habitats. Animal Conservation 7:181-191.

Reed, D. H., and E. H. Bryant. 2000. Experimental tests of minimum viable population size. Animal Conservation 3:7-14.

Reed, J. M., P. D. Doerr, and J. R. Walters. 1988. Minimum viable population size of the red-cockaded woodpecker. Journal of Wildlife Management 50:239-247.

Reed, D. H., J. J. O'Grady, B. W. Brook, J. D. Ballou, and R. Frankham. 2003. Estimates of minimum viable population sizes for vertebrates and factors influencing those estimates. Biological Conservation 113:23-34.

Reeves, K. A. 1978. Preliminary investigation of the Florida panther in Big Cypress Swamp. Unpublished report. Everglades National Park, Homestead, FL.

Roelke, M. E. 1990. Florida panther biomedical investigation. Final Performance Report 7506. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Roelke, M. E. 1991. Florida panther biomedical investigation. Annual performance report, Study no. 7506. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Roelke, M. E., D. J. Forrester, E. R. Jacobsen, G. V. Kollias, F. W. Scott, M. C. Barr, J. F. Evermann, and E. C. Pirtle. 1993a. Seroprevalence of infectious disease agents in free-ranging Florida panthers (*Felis concolor coryi*). Journal of Wildlife Diseases 29:36-49.

Roelke, M. E., J. S. Martenson, and S. J. O'Brien. 1993b. The consequences of demographic reduction and genetic depletion in the endangered Florida panther. Current Biology 3:340-350.

Root, K. 1998. Evaluating effects of habitat quality, connectivity, and catastrophes on a threatened species. Ecological Applications 8:854-865.

Root, K. 2004. Florida panther (*Puma concolor coryi*): Using models to guide recovery efforts. Pages 491-504 *in* H. R. Akcakaya, M. Burgman, O. Kindvall, C. C. Wood, P. Sjogren-Gulve, J. Hatfield, and M. McCarthy (eds). Species Conservation and Management, Case Studies. Oxford University Press, New York, NY.

Rotstein, D. S., R. Thomas, K. Helmick, S. B. Citino, S. K. Taylor, and M. R. Dunbar. 1999. Dermatophyte infections in free-ranging Florida panthers (*Felis concolor coryi*). Journal of Zoo and Wildlife Medicine 30:281-284.

Ruediger, B. 1998. Rare carnivores and highways moving into the 21st century. Pages 10-16 *in* Evink, G. L., P. Garrett, and J. Berry (eds). Proceedings of the international conference on wildlife ecology and transportation. FL-ER-69-98, Florida Department of Transportation, Tallahassee, FL.

Saenz D., K. A. Baum, R. N. Conner, D. C. Rudolph, and R. Costa. 2002. Large-scale translocation strategies for reintroducing red-cockaded woodpeckers. Journal of Wildlife Management 66:212-221.

Schemnitz, S. D. 1974. Populations of bear, panther, alligator, and deer in the Florida Everglades. Florida Scientist 37:157-167.

Schortemeyer, J. L., D. S. Maehr, J. W. McCown, E. D. Land, and P. D. Manor. 1991. Prey management for the Florida panther: a unique role for wildlife managers. Transactions of the North American Wildlife and Natural Resources Conference 56:512-526.

Schultz, S. T., and M. Lynch. 1997. Mutation and extinction: the role of variable mutational effects, synergistic epistasis, beneficial mutations, and degree of outcrossing. Evolution 51:1363-1371.

Seal, U. S. (ed). 1994a. A plan for genetic restoration and management of the Florida panther (*Felis concolor coryi*). Report to the Florida Game and Fresh Water Fish Commission, by the Conservation Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seal, U. S. 1994b. Florida panther population viability analysis. Pages 434-439 *in* D. Jordan (ed). Proceedings of the Florida Panther Conference (Fort Myers, Florida, USA). U.S. Fish and Wildlife Service, Gainesville, FL.

Seal, U. S., and R. C. Lacy (eds). 1989. Florida panther (*Felis concolor coryi*) viability analysis and species survival plan. Report to the U. S. Fish and Wildlife Service, by the Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seal, U. S., and R. C. Lacy (eds). 1992. Genetic management strategies and population viability of the Florida panther (*Felis concolor coryi*). Report to the U. S. Fish and Wildlife Service, by the Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seidensticker, J. C., IV, M. G. Hornocker, W. V. Wiles, and J. P. Messick. 1973. Mountain lion social organization in the Idaho primitive area. Wildlife Monographs 35:1-60.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. BioScience 31:131-134.

Shaffer, M. L. 1987. Minimum viable populations: coping with uncertainty. Pages 69-86 *in* M. E. Soulé (ed). Viable populations for conservation. Cambridge University Press, NY.

Shaffer M. L., and F. B. Sampson. 1985. Population size and extinction: a note on determining critical population size. American Naturalist 125:144-152.

Shindle, D., D. Land, K. Charlton, and R. McBride. 2000. Florida panther genetic restoration and management. Annual Report 7500. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Shindle, D., D. Land, M. Cunningham, and M. Lotz. 2001. Florida panther genetic restoration and management. Annual Report 7500. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Shindle D., M. Cunningham, D. Land, R. McBride, M. Lotz, and B. Ferree. 2003. Florida panther genetic restoration and management. Annual Report 93112503002. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Smith, T. R., and O. L. Bass, Jr. 1994. Landscape, white-tailed deer, and the distribution of Florida panthers in the Everglades. Pages 693-708 *in* S. M. Davis and J. C. Ogden (eds). Everglades: the ecosystem and its restoration. Delray Beach, FL.

Smith, S. K., and J. M. Nogle. 2001. Projections of Florida population by county, 2000-2030. Florida Population Studies Bulletin 128. Bureau of Economic and Business Research, University of Florida, Gainesville, FL.

Soulé, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pages 151-160 *in* M. E. Soulé and B. A. Wilcox (eds). Conservation biology: an evolutionary-ecological perspective. Sinauer Associates, Sunderland, MA.

Soulé, M. E. 1987. Introduction. Pages 1-10 *in* M. E. Soulé (ed). Viable populations for conservation. Cambridge University Press, New York, NY.

Soulé, M. E., M. Gilpin, W. Conway, and T. Foose. 1986. The Millennium Ark: How long a voyage, how many staterooms, how many passengers? Zoo Biology 5:101-113.

Swanson, K., D. Land, R. Kautz, and R. Kawula. In review. Use of least cost pathways to identify key highway segments for panther conservation. Unpublished report. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Swart, J., and M. J. Lawes. 1996. The effect of habitat patch connectivity on samango monkey (*Cercopithecus mitis*) metapopulation persistence. Ecological Modelling 93:15-74.

Sweanor, L. L., K. A. Logan, and M. G. Hornocker. 2000. Cougar dispersal patterns, metapopulation dynamics, and conservation. Conservation Biology 14:798-808.

Swinnerton, K. J., J. J. Groombridge, C. G. Jones, R. W. Burns, and Y. Mungroo. 2004. Inbreeding depression and founder diversity among captive and free-living populations of the endangered pink pigeon *Columba mayeri*. Animal Conservation 7:353-364.

Taylor, T. A., and C. Pedersen. 1998. Public acceptability of Florida panther reintroduction, final report based on input from community workshops in Columbia County. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Taylor, S. K., C. D. Buergelt, M. E. Roelke-Parker, B. L. Homer, and D. S. Rotstein. 2002. Causes of mortality of free-ranging Florida panthers. Journal of Wildlife Diseases 38:107-114.

Thatcher, C., F. T. van Manen, and J. D. Clark. 2003. Habitat assessment to identify potential sites for Florida panther reintroduction in the Southeast. University of Tennessee and U.S. Geological Survey, Knoxville, TN. Final report to U.S. Fish and Wildlife Service, Jacksonville, FL.

Thatcher, C., F. T. van Manen, and J. D. Clark. In press. Identifying suitable sites for Florida panther reintroduction. Journal of Wildlife Management.

The Nature Conservancy. 2000. The five-s framework for site conservation: a practitioner's handbook for site conservation planning and measuring conservation success. Volume I, Second Edition.

Thomas, C. D. 1990. What do real population dynamics tell us about minimum viable population sizes? Conservation Biology 4:324-327.

Tinsley, J. B. 1970. The Florida panther. Great Outdoors Publishing Company, St. Petersburg, FL.

Tinsley, J. B. 1987. The puma: legendary lion of the Americas. Texas Western Press, University of Texas, El Paso, TX.

Townsend, D. 1991. An economic overview of the agricultural expansion in southwest Florida. Unpublished report. Hendry County Extension Office, LaBelle, FL.

U.S. Census Bureau. 2002. Table CO-EST2001-12-12 – time series of Florida intercensal population estimates by county: April 1, 1990 to April 1, 2000.

U.S. Census Bureau. 2004. Population estimates, census 2002, 1990 census.

U.S. Fish and Wildlife Service. 1981. Florida panther recovery plan. Atlanta, GA.

U.S. Fish and Wildlife Service. 1987. Florida panther (*Felis concolor coryi*) recovery plan. Atlanta, GA.

U.S. Fish and Wildlife Service. 1995. Second revision Florida panther recovery plan. Atlanta, GA.

U.S. Fish and Wildlife Service. 1999. South Florida multi-species recovery plan. Atlanta, GA.

van der Leek, M. L., H. N. Becker, E. C. Pirtle, P. Humphrey, C. L. Adams, B. P. All, G. A. Erickson, R. C. Belden, W. B. Frankenberger, and E. P. J. Gibbs. 1993. Prevalence of pseudorabies (Aujeszky's disease) virus antibodies in feral swine in Florida. Journal Wildlife Diseases 29:403-409.

Van Dyke, F. G., R. H. Brocke, H. G. Shaw, B. B. Ackerman, T. P. Hemker, and F. G. Lindzey. 1986a. Reactions of mountain lions to logging and human activity. Journal of Wildlife Management 50:95-102.

Van Dyke, F. G., R. H. Brocke, and H. G. Shaw. 1986b. Use of road track counts as indices of mountain lion presence. Journal Wildlife Management 50:102-109.

van Heezik, Y., and S. Ostrowski. 2001. Conservation breeding for reintroductions: assessing survival in a captive flock of houbara bustards. Animal Conservation 4:195-201.

Waples, R. 2002. Definition and estimation of effective population size in the conservation of endangered species. Pages 147-168 *in* S. R. Beissinger and D. R. McCullough (eds). Population Viability Analysis. University of Chicago Press, Chicago, IL.

Wassmer, D. A., D. D. Guenther, and J. N. Layne. 1988. Ecology of the bobcat in south-central Florida. Bulletin of the Florida Museum of Natural History 33:159-228.

Wear, D. N., and J. G. Greis (eds). 2002. Southern forest resources assessment. General Technical Report SRS-53. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC.

Wehinger, K. A., M. E. Roelke, and E. C. Greiner. 1995. Ixodid ticks from Florida panthers and bobcats in Florida. Journal of Wildlife Diseases 31:480-485.

Whitlock, M. C. 2000. Fixation of new alleles and the extinction of small populations: drift load, beneficial alleles, and sexual selection. Evolution 54:1855-1861.

Wikramanayake, E., M. McKnight, E. Dinerstein, A. Joshi, B. Gurung, and D. Smith. 2004. Designing a conservation landscape for tigers in human-dominated environments. Conservation Biology 18:839-844.

Wilkins, L., J. M. Arias-Reveron, B. Stith, M. E. Roelke, and R. C. Belden. 1997. The Florida panther (*Puma concolor coryi*): a morphological investigation of the subspecies with a comparison to other North and South American cougars. Bulletin of the Florida Museum of Natural History 40:221-269.

Wolf, P. 1981. Land in America: its value, use and control. Pantheon Books, New York, NY.

Wright, S. 1943. Isolation by distance. Genetics 28:114-138.

Wright, S. 1969. The theory of gene frequencies. Vol.2, Experimental results and evolutionary deductions. University of Chicago Press, Chicago, IL.

Young, S. P., and E. A. Goldman. 1946. The puma-mysterious American cat. American Wildlife Institute, Washington, D.C.

FIGURES

Figure 1. Historic and current range of the Florida Panther.

Figure 2. Delineation between South and South Central Florida.

Figure 3. Florida Panther Zones in South Florida (Kautz et al. in press).

Figure 4. Conservation areas of south and south-central Florida.

Figure 5. Potential reintroduction sites by priority (Thatcher et al. 2003)

APPENDIX A. DEFINITIONS

CRITICAL HABITAT – Specific geographic areas, whether occupied by listed species or not, that are determined to be essential for the conservation and management of listed species, and that have been formally described in the *Federal Register*.

EFFECTIVE POPULATION SIZE (N_e) – A theoretical population with a 1:1 sex ratio that would result in the same amount of inbreeding or genetic drift as the actual population. Denoted as N_e, the effective population size is usually less than the actual population size.

ENDANGERED – Any species which is in danger of extinction throughout all or a significant portion of its range.

HABITAT – The physical space within which an animal lives. The various factors commonly recognized as components of habitat – cover, food, water, and such – are contained within this area. Panther habitat includes all areas required for the panther to live out its full life-cycle, including areas providing food and shelter and supporting characteristic movement such as hunting, breeding, dispersal, and territorial behavior.

INBREEDING (individual) – The mating of individual related by descent (e.g., brother-sister or cousin matings).

INBREEDING (population) – A population in which matings occur between relatives at a frequency greater than expected by chance.

INBREEDING DEPRESSION – Reduction in reproduction, survival or other fitness characters due to inbreeding.

INTROGRESSION – The incorporation of genes of one species into the gene pool of another.

METAPOPULATION – Two or more partially isolated populations, called subpopulations, which are able to exchange individuals either naturally or through management.

PHILOPATRY – The tendency of an individual to return to or stay in its home area. Female panthers tend to be more philopatric than males.

POLYGYNOUS – A pattern of mating in which a male has more than one female partner.

POPULATION – A group of interbreeding individuals living in the same geographic area at the same time and sharing a common gene pool.

SPATIAL CONFIGURATION – Refers to how patches of habitat are arranged on the landscape with respect to one another as well as their degree of connectivity and relative land cover composition. An extensive arrangement of contiguous tracts of land that incorporates connectivity to support panther life history needs (e.g., appropriate cover, spatial extent, landscape configuration, prey densities, mating access, dispersal routes, and minimizing human disturbance).

SPECIES (ESA definition) – includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife which interbreeds when mature.

SUBPOPULATION – Each distinct population in a metapopulation.

THREATENED – Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

VIABLE – A viable species is one that can reasonably be expected to avoid extinction over a long period of time. Viability is the ability of a population or species to persist over time. A viable panther population is considered to have a 95% probability of persistence for 100 years.

APPENDIX B. THREATS ANALYSIS USING THE FIVE LISTING FACTORS

SOUTH FLORIDA

Factor A: The present or threatened destruction, modification, or curtailment of the Florida panther's habitat or range.

	Stress																				
	Loss of ability for natural expansion of range				Habitat destruction				Habitat fragmentation				Population isolation & lack of connectivity				Habitat degradation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	H	High		V	H	High		H	H	High		H	M	Medium		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor A overall threat rank**
Transportation projects	H	H	H	Very high	L	V	M	Medium	V	V	V	High	M	V	H	High	-	-	-	-	Very high
Lack of suitable habitat	V	H	V	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Water management & conversion to water (includes CERP)	-	-	-	-	M	H	M	Medium	M	V	H	High	M	V	H	High	L	M	L	Low	High
Residential development	-	-	-	-	V	V	V	High	H	V	H	High	-	-	-	-	-	-	-	-	High
Inadequate habitat patch size	-	-	-	-	-	-	-	-	-	-	-	-	M	V	H	High	-	-	-	-	High
Mining and mineral exploration	-	-	-	-	L	V	M	Medium	L	V	M	Medium	-	-	-	-	L	L	L	Low	Medium
Conversion of habitat to agriculture	-	-	-	-	L	H	M	Medium	L	L	L	Low	-	-	-	-	M	H	M	Low	Medium

Factor A continued

	Stress																				
	Loss of ability for natural expansion of range				Habitat destruction				Habitat fragmentation				Population isolation & lack of connectivity				Habitat degradation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	H	High		V	H	High		H	H	High		H	M	Medium		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor A overall threat rank**
Major ditches	-	-	-	-	-	-	-	-	L	V	M	Medium	-	-	-	-	-	-	-	-	Medium
Caloosahatchee River as a barrier	L	M	L	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Intensification of agricultural uses	-	-	-	-	-	-	-	-	L	M	L	Low	-	-	-	-	L	H	M	Low	Low
Invasive exotic plant species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	M	Low	Low
Lack of or poor habitat management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	M	Low	Low

SOUTH FLORIDA

Factor B: Overutilization for commercial, recreational, scientific, or education purposes.

	Stress				
	Overutilization for scientific purposes				
	Severity	Scope	**Stress rank**		
	L	L	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	**Factor B overall threat rank**
Impacts of capture and monitoring	L	L	L	Low	Low

SOUTH FLORIDA

Factor C: Disease and predation.

	Stress				
	Disease				
	Severity	Scope	**Stress rank**		
	L	L	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	**Factor C overall threat rank**
Feline leukemia	M	L	M	Medium	Medium
All diseases	L	M	L	Low	Low

SOUTH FLORIDA

Factor D: The inadequacy of existing regulatory mechanisms.

The Recovery Team believed regulatory mechanisms were more appropriately considered as strategies underlying the other stresses and sources. Therefore, they chose not to evaluate Factor D.

SOUTH FLORIDA

Factor E: Other natural or manmade factors affecting the Florida panther's continued existence.

	Stress																				
	Panther mortality				Loss of genetic diversity				Decline of prey base				Genetic swamping				Loss/lack of support for panther conservation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	H	H	High		M	H	Medium		M	M	Medium		L	V	Low		L	V	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Intraspecific aggression	H	V	H	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Mercury toxicity	L	V	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Road kills	H	M	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Illegal kills	L	H	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Disease	L	H	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Effect of small population size	-	-	-	-	V	M	H	Medium	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Lack of suitable habitat	-	-	-	-	V	V	V	Medium	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Lack of corridors for dispersal	-	-	-	-	M	H	M	Low	-	-	-	-	-	-	-	-	-	-	-	-	Low
Escape of captive pumas	-	-	-	-	-	-	-	-	-	-	-	-	L	H	M	Low	-	-	-	-	Low
Managed releases of pumas	-	-	-	-	-	-	-	-	-	-	-	-	M	M	M	Low	-	-	-	-	Low
Ungulate disease	-	-	-	-	-	-	-	-	L	H	M	Low	-	-	-	-	-	-	-	-	Low

Factor E continued

	Stress																				
	Panther mortality				Loss of genetic diversity				Decline of prey base				Genetic swamping				Loss/lack of support for panther conservation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	H	H	High		M	H	Medium		M	M	Medium		L	V	Low		L	V	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Water management or conversion to water	-	-	-	-	-	-	-	-	M	M	M	Low	-	-	-	-	-	-	-	-	Low
Natural climate or environmental change	-	-	-	-	-	-	-	-	L	V	M	Low	-	-	-	-	-	-	-	-	Low
Lack of or poor prey management (e.g, over hunting)	-	-	-	-	-	-		-	L	L	L	Low	-	-	-	-	-	-	-	-	Low
Prey habitat loss / degradation	-	-	-	-	-	-	-	-	M	H	M	Low	-	-	-	-	-	-	-	-	Low
Exotic prey management	-	-	-	-	-	-	-	-	L	L	L	Low	-	-	-	-	-	-	-	-	Low
Change in the legal description	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V	H	V	Low	Low

Factor E continued

	Stress																				
	Panther mortality				Loss of genetic diversity				Decline of prey base				Genetic swamping				Loss/lack of support for panther conservation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	H	H	High		M	H	Medium		M	M	Medium		L	V	Low		L	V	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Public fear of panthers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	M	L	Low	Low
Landowner fear of regulation, lost property rights, and negative economic consequences	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	M	M	Low	Low

REINTRODUCTION

Factor A: The present or threatened destruction, modification, or curtailment of the Florida panther's habitat or range.

	Stress																				
	Unidentified potential habitat				Habitat fragmentation				Habitat destruction				Incompatible management of private lands				Incompatible management of public lands				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	H	High		M	M	Medium		L	M	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor A overall threat rank**
Urbanization	-	-	-	-	M	V	H	Very high	M	V	H	High	-	-	-	-	-	-	-	-	Very high
Transportation projects	-	-	-	-	V	V	V	Very high	H	H	H	High	-	-	-	-	-	-	-	-	Very high
Low density residential development	-	-	-	-	V	H	V	Very high	V	H	V	High	-	-	-	-	-	-	-	-	Very high
Lack of land use planning	-	-	-	-	H	V	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Inadequate evaluation of potential habitat in historic range	V	L	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Lack of prioritization system among areas	V	L	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Conversion of habitat to agriculture	-	-	-	-	M	M	M	High	M	M	M	Medium	-	-	-	-	-	-	-	-	High
Human recreational uses in panther habitat	-	-	-	-	M	M	M	High	M	M	M	Medium	-	-	-	-	M	M	M	Low	High
Invasive exotic plant species	-	-	-	-	L	H	M	High	L	H	M	Medium	-	-	-	-	-	-	-	-	High
Large public works projects (e.g, dams)	-	-	-	-	L	V	M	High	L	V	M	Medium	-	-	-	-	-	-	-	-	High

Factor A continued

	Stress																				
	Unidentified potential habitat				Habitat fragmentation				Habitat destruction				Incompatible management of private lands				Incompatible management of public lands				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	H	High		M	M	Medium		L	M	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor A overall threat rank**
Lack of incentives to maintain / restore panther habitat	-	-	-	-	H	M	M	High	H	M	M	Medium	H	M	M	Low	-	-	-	-	High
Lack of complete data in historical range	M	M	M	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Right of ways	-	-	-	-	L	V	M	High	-	-	-	-	-	-	-	-	-	-	-	-	High
Conversion of habitat to silviculture	-	-	-	-	L	L	L	Medium	L	L	L	Low	-	-	-	-	-	-	-	-	Medium
Mining and mineral exploration	-	-	-	-	L	M	L	Medium	L	M	L	Low	-	-	-	-	-	-	-	-	Medium
Conflicting mandates	-	-	-	-	-	-	-	-	-	-	-	-	H	H	H	Medium	L	H	M	Low	Medium
Conflicting management of other species	-	-	-	-	-	-	-	-	-	-	-	-	L	L	L	Low	L	L	L	Low	Low
Lack of implementation of management plans	-	-	-	-	-	-	-	-	-	-	-	-	H	M	M	Low	L	M	L	Low	Low

REINTRODUCTION

Factor B: Overutilization for commercial, recreational, scientific, or education purposes.

	Stress				
	Overutilization for scientific purposes				
	Severity	Scope	**Stress rank**		
	L	H	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	**Factor B overall threat rank**
Impacts of capture and monitoring	L	L	L	Low	Low
Impacts of removals for reintroductions to donor populations	L	L	L	Low	Low

REINTRODUCTION

Factor C: Disease and predation.

	Stress												
	Disease				Parasites				Predation				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	L	H	Low		L	H	Low		L	L	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor C overall threat rank**
Feline leukemia	M	L	M	Medium	-	-	-	-	-	-	-	-	Medium
Rabies	M	M	M	Low	-	-	-	-	-	-	-	-	Low
Pseudorabies	H	M	M	Low	-	-	-	-	-	-	-	-	Low
Hookworm	-	-	-	-	H	M	M	Low	-	-	-	-	Low
Manges	-	-	-	-	H	M	M	Low	-	-	-	-	Low
Unknown / other	L	L	L	Low	L	L	L	Low	-	-	-	-	Low
All sources of predation	-	-	-	-	-	-	-	-	V	M	H	Low	Low

REINTRODUCTION

Factor D: The inadequacy of existing regulatory mechanisms.

	Stress												
	Inadequate land use planning or regulation				Lack of agency coordination				Inconsistent state regulation or protection				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		H	V	High		H	L	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor D overall threat rank**
Inadequate development, implementation, and enforcement of comprehensive plans and zoning	V	H	V	Very high	-	-	-	-	-	-	-	-	Very high
Inadequate growth management planning and implementation	V	H	V	Very high	-	-	-	-	-	-	-	-	Very high
Little or no protection of upland habitats	H	H	H	Very high	-	-	-	-	-	-	-	-	Very high
Inadequate development, and implementation of corridor / greenway planning	V	H	V	Very high	-	-	-	-	-	-	-	-	Very high
Lack of cumulative impacts evaluation	H	H	H	Very high	-	-	-	-	-	-	-	-	Very high
Inadequate land conservation of acquisition programs	H	H	H	Very high	-	-	-	-	-	-	-	-	Very high

Factor D continued

	Stress												
	Inadequate land use planning or regulation				Lack of agency coordination				Inconsistent state regulation or protection				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		H	V	High		H	L	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor D overall threat rank**
Lack of public awareness of environmental issues and needs	H	H	H	Very high	-	-	-	-	-	-	-	-	Very high
Conflicting laws, regulations, mandates, or policies	M	M	M	High	-	-	-	-	H	M	M	Low	High
No mechanism for agency communication or coordination	-	-	-	-	H	L	M	Medium	H	L	M	Low	Medium
Lack of a mutually defined common goal	-	-	-	-	H	L	M	Medium	H	L	M	Low	Medium
Interagency distrust and lack of relationships and partnerships	-	-	-	-	M	M	M	Medium	-	-	-	-	Medium

REINTRODUCTION

Factor E: Other natural or manmade factors affecting the Florida panther's continued existence.

	Stress																														
	Public / landowner resistance to reintroduction				Political and agency resistance to reintroduction				Human / panther interactions				Panther mortality				Genetic viability and population connectivity				Conflicting prey management				Conflicts with escaped pumas				Competition with other species			
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**	
	V	V	Very high		V	V	Very high		H	V	High		H	V	High		M	H	Medium		M	H	Medium		L	M	Low		L	H	Low	
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Public perception, misconception, and lack of knowledge	V	M	H	Very high	-	-	-	-	V	M	H	High	-	-	-	-	-	-	-	-	H	M	M	Low	-	-	-	-	-	-	-	-	Very high
Conflicts with livestock (attacks on)	V	M	H	Very high	V	M	H	Very high	M	M	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Public fear of panthers (including fear of attacks / mortality)	V	H	V	Very high	V	H	V	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Distrust of government agencies	H	H	H	Very high	H	H	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Agency funding and resource constraints	-	-	-	-	V	M	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Lack of incentives for states	-	-	-	-	H	H	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high

Factor E continued

	Stress																														
	Public / landowner resistance to reintroduction				Political and agency resistance to reintroduction				Human / panther interactions				Panther mortality				Genetic viability and population connectivity				Conflicting prey management				Conflicts with escaped pumas				Competition with other species				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	V	High		H	V	High		M	H	Medium		M	H	Medium		L	M	Low		L	H	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Agency's fear of liability (political, financial, and professional)	-	-	-	-	V	M	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Public official's fear of losing constituent's support	-	-	-	-	H	H	H	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Influence of opposing special interest groups on public officials	-	-	-	-	V	V	V	Very high	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very high
Conflicts with hunters and hunting	H	M	M	High	H	M	M	High	H	M	M	Medium	-	-	-	-	-	-	-	-	H	M	M	Low	-	-	-	-	-	-	-	-	High
Landowner fear of regulation, lost property rights, and negative economic consequences	H	M	M	High	H	M	M	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High

Factor E continued

	Stress																												
	Public / landowner resistance to reintroduction				Political and agency resistance to reintroduction				Human / panther interactions				Panther mortality				Genetic viability and population connectivity				Conflicting prey management				Conflicts with escaped pumas				Competition with other species				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	V	High		H	V	High		M	H	Medium		M	H	Medium		L	M	Low		L	H	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Media sensationalism and panther myths	M	M	M	High	M	M	M	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Relationships among potential supporting landowners and their neighbors	M	M	M	High	M	M	M	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Lack of panther information dissemination to public officials and agencies	-	-	-	-	H	L	M	High	-	-	-	-	-	-	-	-	-	-	-	-	M	L	L	Low	-	-	-	-	-	-	-	-	High
Road kills	-	-	-	-	-	-	-	-	-	-	-	-	H	H	H	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Illegal kill	-	-	-	-	-	-	-	-	-	-	-	-	H	M	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Accidental death (including contaminants)	-	-	-	-	-	-	-	-	-	-	-	-	L	H	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium

Factor E continued

	Stress																														
	Public / landowner resistance to reintroduction				Political and agency resistance to reintroduction				Human / panther interactions				Panther mortality				Genetic viability and population connectivity				Conflicting prey management				Conflicts with escaped pumas				Competition with other species				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	V	High		H	V	High		M	H	Medium		M	H	Medium		L	M	Low		L	H	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Natural catastrophes	-	-	-	-	-	-	-	-	-	-	-	-	L	V	M	Medium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Small number of founder panthers available	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V	M	H	Medium	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Unidentified or secured pathways for dispersal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	H	H	Medium	-	-	-	-	-	-	-	-	-	-	-	-	Medium
Deer management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V	M	H	Medium	-	-	-	-	-	-	-	-	Medium
Intraspecific aggression or predation	-	-	-	-	-	-	-	-	-	-	-	-	L	M	L	Low	-	-	-	-	-	-	-	-	-	-	-	-	L	M	L	Low	Low
Removal of panthers for management purposes	-	-	-	-	-	-	-	-	-	-	-	-	L	M	L	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Low

Factor E continued

	Stress																														
	Public / landowner resistance to reintroduction				Political and agency resistance to reintroduction				Human / panther interactions				Panther mortality				Genetic viability and population connectivity				Conflicting prey management				Conflicts with escaped pumas				Competition with other species				
	Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		Severity	Scope	**Stress rank**		
	V	V	Very high		V	V	Very high		H	V	High		H	V	High		M	H	Medium		M	H	Medium		L	M	Low		L	H	Low		
Source of stress	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	Contribution	Irreversibility	Rank	**Threat rank**	**Factor E overall threat rank**
Panther visibility to local public	-	-	-	-	-	-	-	-	M	L	L	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Low
Inadequate regulation or understanding of distribution and occurrence of pet puma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	M	M	Low	-	-	-	-	Low
Competition with other large predators	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	L	L	Low	Low
Feral hog management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	M	M	Low	-	-	-	-	-	-	-	-	Low