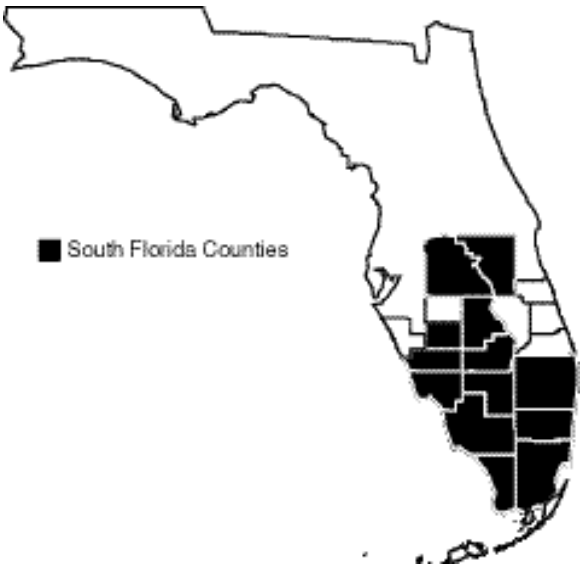
Florida Panther

Puma concolor coryi

Federal Status:	**Endangered (March 11, 1967)**
Critical Habitat:	**None Designated**
Florida Status:	**Endangered**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. County distribution of the Florida panther since 1981, based on radiotelemetry data.



The Florida panther, a subspecies of mountain lion, is one of the most endangered large mammals in the world. It is also Florida's state animal. A small population in South Florida,estimated to number between 30 and 50 adults (30 to 80 total individuals), represents the only known remaining wild population of an animal that once ranged throughout most of the southeastern United States from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida and parts of South Carolina and Tennessee. The panther presently occupies one of the least developed areas in the eastern United States; a contiguous system of large private ranches and public conservation lands in Broward, Collier, Glades, Hendry, Lee, Miami-Dade, Monroe, and Palm Beach counties totaling more than 809,400 ha.

Geographic isolation, habitat loss, population decline, and associated inbreeding have resulted in a significant loss of genetic variability and overall health of the Florida panther population. Natural gene exchange ceased when the panther became geographically isolated from other subspecies of *Puma concolor* about a century ago. Population viability projections have concluded that, under current demographic and genetic conditions, the panther would probably become extinct within two to four decades.

A genetic management program was implemented with the release of eight female Texas cougars (*Puma concolor stanleyana*) into South Florida in 1995 (refer to the Management section for a discussion of this program).

The survival and recovery of the Florida panther is dependent upon: (1) protection and enhancement of the extant population, associated habitats, and prey resources; (2) improving genetic health and population viability; and (3) re-establishing at least two additional populations within the historic range.

This account represents South Florida's contribution to the range-wide recovery plan for the Florida panther (FWS 1995); the range-wide recovery plan is currently under revision.

Description

The Florida panther is a medium-sized puma or mountain lion that is described as being relatively dark tawny in color, with short, stiff hair (Bangs 1899), and having longer legs and smaller feet (Cory 1896) than other subspecies. Adult male panthers reach a length of 2.15 m from their nose to the tip of their tail and may reach or exceed 68 kg in weight, but typically average around 54.5 kg. They stand approximately 60 to 70 cm at the shoulder. Female panthers are considerably smaller with an average weight of 34 kg and length of 1.85 m. The skull of the Florida panther has been described as having a broad, flat, frontal region, and broad, high-arched or upward-expanded nasals (Young and Goldman 1946).

The coat of an adult Florida panther is unspotted and typically rusty reddish-brown on the back, tawny on the sides, and pale gray underneath. The long cylindrical tail is relatively slender compared to some of the other subspecies of *Puma concolor* (Belden 1988).

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 are often observed in Florida panthers which are not found in combination in other subspecies of *Puma concolor.* These characters are: 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, light flecking on the head, nape, and shoulders (Belden 1986). The light flecking may be a result of scarring from tick bites (Maehr 1992a, Wilkins 1994). The kinked tail and cowlicks are considered manifestations of inbreeding (Seal *et al*. 1994).

Taxonomy

The Florida panther was first described by Charles B. Cory in 1896 as *Felis concolor floridana*. The type specimen was collected by Cory in Sebastian, then considered a part of Brevard County (Hall and Kelson 1959). Bangs (1899), however, noted that *Felis floridana* had previously been used for a bobcat and, believing that the panther was restricted to peninsular Florida and could not intergrade with any other form, assigned it full specific status as *Felis coryi*. The taxonomic classification of the *Felis concolor* group was revised by Nelson and Goldman (1929), wherein the panther was reassigned subspecific status as *Felis concolor coryi.* This designation also incorporated *Felis arundivaga*, which had been classified by Hollister (1911) from specimens collected in Louisiana. Detailed descriptions of each of the subspecies are provided in Young and Goldman (1946) [30 subspecies], and Hall (1981) [27 subspecies]. The genus *Felis* was recently revised so all mountain lions, including the Florida panther, were placed in the genus *Puma* (Nowell and Jackson 1996).

Distribution

The only known, reproducing panther population is located in the Big Cypress Swamp/Everglades physiographic region of South Florida. The core of the breeding population is centered in Collier, Hendry and Miami-Dade counties.

Florida panther.
Original photograph by David Maehr.

Radio-collared panthers have also been documented in Broward, DeSoto, Glades, Highlands, Lee, Monroe, Osceola, Palm Beach, and Polk counties (Figure 1). There are still large areas of privately owned land in Charlotte, Collier, Hendry, Lee, and Glades counties where uncollared individuals may reside (Maehr 1992b). Private lands account for approximately half the occupied panther range in South Florida (Maehr 1990b, Logan *et al*. 1993). This region is extremely reduced from the species' former range. The Florida panther once ranged from eastern Texas or western Louisiana and the lower Mississippi River valley east

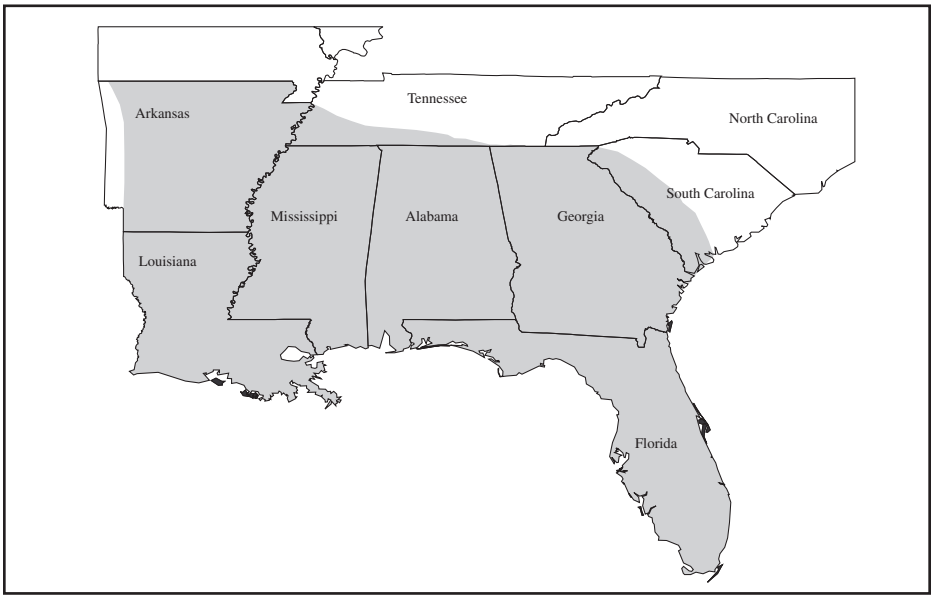


Figure 2. Historic distribution of the Florida panther (Young and Goldman 1946).

through the southeastern states (Figure 2), intergrading to the north with *F. c. couguar*, to the west with *F. c. stanleyana,* and to the northwest with *F. c. hippolestes* (Young and Goldman 1946).

Habitat

Early radiotelemetry investigations indicated that panther (n=6) use of mixed swamp forests and hammock forests was greater than expected in relation to the availability of these vegetative communities within the panthers' home range area (Belden *et al*. 1988). As investigations expanded onto private lands between 1985 and 1990, it was determined that panthers (n=26) preferred native, upland forests, especially hardwood hammocks and pine flatwoods, over wetlands and disturbed habitats (Maehr *et al.* 1991a). For pine flatwoods, which comprised about 12 percent of the habitat available to male Florida panthers (n=5) and female Florida panthers (n=5), mean habitat use between 1986 and 1994 averaged 33 and 32 percent respectively. For hardwood hammocks, which comprised about 13 percent of the habitat available, mean habitat use averaged 38 and 31 percent respectively (Maehr 1996). Hardwood hammocks provide important habitat for white-tailed deer (*Odocoileus virginianus*), an important panther prey species (Harlow 1959, Belden *et al.* 1988, Maehr 1990a, 1992a, Maehr *et al.* 1991a). Understory thickets of tall, almost impenetrable, saw palmetto (*Serenoa repens*) have been identified as the most important resting and denning cover for panthers (Maehr 1990a).

Agricultural and other disturbed habitats, freshwater marsh, thicket swamp, and mixed swamp are not preferred, and are either used in proportion to their availability or are avoided (Maehr 1990a). Panthers have not been found in pastures during daytime radiotelemetry flights but may travel through them at night (Maehr *et al.* 1991a, Maehr 1992a).

Male and female panther home range size is inversely related to habitat quality; the greater the extent of agricultural land and wetland habitats the larger the home range, and the greater the extent of mixed hardwood forests and dry pine forests the smaller the home range. High-quality habitat produces abundant prey and influences female panther reproductive success (Maehr 1992b, Maehr *et al.* 1989b).

The largest contiguous tract of panther habitat is in the Big Cypress Swamp/Everglades physiographic regions. Big Cypress National Preserve, Everglades NP, and Florida Panther NWR together comprise about 927,793 ha of native habitats--46 percent of which is forested. However upland forests, *e.g.* pine forests and hardwood hammocks, comprise only 8 percent of the total land area (Duever *et al*. 1986, FWS 1996, NPS 1998).

Behavior

Interactions between Florida panthers are infrequent. Most interactions occur between adult females and their kittens. Interactions between adult male and female panthers, lasting from 1 to 7 days, were second in frequency and usually resulted in pregnancy. Interactions between males were rare but often resulted in serious injury or death. Aggressive encounters between females have not

been documented. "In the absence of unnatural mortality (*i.e.* road kills, illegal shooting, research accidents), aggression between males may be the most common form of male mortality and an important determinant of male spatial and recruitment patterns" (Maehr *et al.* 1991a).

Reproduction and Demography

The pattern of Florida panther distribution involves several males maintaining large, mutually exclusive home ranges containing several adult females and their dependent offspring. This spatial arrangement seems to be a prerequisite for successful reproduction (Maehr 1993).

Male Florida panthers are polygynous. Breeding activity peaks in fall and winter (Maehr 1992a). Parturition is distributed throughout the year with 81 percent of births occurring between March and July (July having the greatest number of births). Litter sizes range from one to four kittens, with a mean of 2.2 kittens surviving to at least 6 months. Intervals between litters range from 16 to 37 months (Land 1994).

Den sites are usually located in dense, understory vegetation, typically saw palmetto (Maehr 1990a) at distances greater than 1 km away from roads (Maehr 1996). Den sites are used for up to 2 months by female panthers and their litters from parturition to weaning. Female panthers losing their litters generally produce replacement litters. Five of seven females whose kittens were brought into the captive breeding program successfully reproduced an average of 10.4 months after the removal of the litter (Land 1994).

Female Florida panthers have bred as young as 18 months of age (Maehr *et al.* 1989a) and as late as 11 years of age. The mean age of denning females was 5.8 years (Land and Taylor 1998). The first sexual encounters for males occur at about 3 years of age (Maehr *et al.* 1991a) although a male in Everglades NP bred at 18 months (O. Bass, NPS, personal communication 1997). Dispersal of young typically occurs around 1.5 to 2 years of age, but may occur as early as one year of age (Maehr 1992a).

Infant mortality is thought to be relatively high with fewer than half of all pregnancies resulting in offspring that survive beyond 6 months of age (Roelke *et al.* 1993). The kitten survival rate between age 6 months and 1 year has been estimated at 0.895 (Land 1994). This is based on a sample of 15 radio-collared kittens monitored from 6 months to 1 year of age. Young panthers are considered recruited into the population when they have successfully reproduced (D. Jordan, FWS, personal communication 1997). Of 21 dependent kittens radio-collared and followed beyond independence, 71 percent of females (5 of 7) and 29 percent of males (4 of 14) have been recruited into the population. Females are readily recruited into the population as soon as they are capable of breeding (Maehr *et al.* 1991a). Males appear to have more difficulty being recruited. Without large areas of suitable habitat to accommodate dispersal, young males have few opportunities for recruitment as residents. As a result, the panthers' ability to increase and outbreed has been severely restricted. 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 Florida panthers being greatest in subadult and non-resident males (Maehr *et al.* 1991b).

Florida panther mortality (n=67) averaged 3.5 deaths per year from 1978 through June 30, 1998. Male panthers accounted for 57.6 percent of mortality. Sub-adult panthers (0 to 3 years) of both sexes accounted for 45.5 percent of mortality. Specific causes of panther mortality include road kill (37.9 percent), intraspecific aggression (21.2 percent), disease and old age (18.2 percent), causes unknown (12.1 percent), shootings (9.1 percent), and research related (1.5 percent) (Land and Taylor 1998).These mortality figures only include panthers endemic to South Florida, and not the introduced Texas cougars.

Foraging

Food habit studies of Florida panthers indicate that feral hog (*Sus scrofa*) was the most commonly taken prey followed by white-tailed deer, raccoon (*Procyon lotor*), and nine-banded armadillo (*Dasypus novemcinctus*). Deer and hogs accounted for 85.7 percent of consumed biomass north of Interstate 75, and 66.1 percent south of Interstate 75 (Maehr *et al*. 1990a). No seasonal variation in diet was detected; however, panthers inhabiting an area of better soils north of Interstate 75 consumed more large prey. In addition, deer abundance was up to eight-fold greater north of Interstate 75 (McCown 1991). The estimated number of deer consumed per panther did not differ between the areas north and south of Interstate 75. Hog numbers were lower south of Interstate 75. Fewer large prey may, in part, explain the poorer physical condition, larger home ranges, and lower reproductive output of panthers residing south of Interstate 75. Hogs dominated the diet of panthers in the north in terms of both estimated biomass and numbers. In the south, deer accounted for the greatest estimated biomass consumed, whereas raccoons were the highest estimated number of consumed prey. Domestic livestock were found infrequently in scats or kills, although cattle were readily available (Maehr *et al.* 1990a).

Movements and Dispersal

Adult Florida panthers space themselves throughout available habitat in southwest Florida in a pattern similar to that of western cougars (Land 1994). The home range size of 26 radio-collared panthers monitored between 1985 and 1990 varied from 53 to 1,183 km^2, averaging 519 km^2 for resident males and 193 km^2 for resident females. Home ranges of resident adults were stable unless influenced by the death of other residents. Home-range overlap was extensive among resident females and limited among resident males (Maehr *et al.* 1991a).

There are no known differences in seasonal movements, wet and dry season habitat use, or effects of season on road crossing. There may be a response to fluctuations in water levels; however, the response is believed to be undetectable (Maehr 1989; Maehr *et al.* 1990b, 1991a).

A female panther was killed by automobile on S.R. 84 in 1986. Prior to, and during the early phases of, conversion from two-lane S.R. 84 to four-lane Interstate 75 only male panthers were detected crossing this roadway. The highway may have been a deterrent to female movements (Maehr *et al.*

1991a). Since the completion of Interstate 75 and associated wildlife crossings, numerous male panthers and a female panther have regularly crossed underneath the roadway (Lotz *et al.* 1996).

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, channelized, blackwater river, should not be a significant barrier to panther movements, but the combination of the river, S.R. 80, and land uses along the river seems to have restricted panther dispersal northward (Maehr 1996). In 18 years of research only one radio-collared panther crossed the Caloosahatchee River. This dispersing subadult male crossed the river in April of 1998 enroute to Osceola County setting a dispersal record of 220 km in the process (Land and Taylor 1998). Dispersal distances average 58.7 km for subadult males and 16 km for a single subadult female. Mean dispersal age was 17.9 months (Maehr 1992a).

Activity levels for Florida panthers peak around sunrise and sunset (Maehr *et al.* 1990b). 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.

Relationship to Other Species

The Florida panther requires extensive, biotically diverse landscapes to survive. Large carnivores are considered critical in maintaining ecological integrity in many large forest systems (Terborgh 1988). Landscapes through which the panther ranges support a vast array of South Florida's rich faunal and floral diversity including the Florida black bear (*Ursus americanus*), Big Cypress fox squirrel (*Sciurus niger avicennia*), American swallow-tailed kite (*Elanoides forficatus*), hawks and owls, neotropical migratory birds, and endemic orchids and epiphytes (K. Dryden, GFC, personal communication 1996).

Deer, hog, and raccoon have already been mentioned as the most important prey species taken in terms of biomass and numbers (Maehr *et al*. 1990a). As a result of human-induced changes in habitat quantity and quality, it is possible that competition between key members of a faunal community may develop. However, comparisons of food habits, habitat use, and movements among bobcat (*Lynx rufus*), panther, and black bear revealed a low probability for competitive interactions (Maehr 1996).

Status and Trends

The State of Florida declared the panther a game species in 1950 and an endangered species in 1958. The FWS listed the panther as endangered in 1967 (32 FR 4001). Activities in the 1800s and early 1900s contributed to its need for listing.

The first bounty on Florida panthers was passed in 1832. Another Florida law passed in 1887 authorized a payment of $5.00 for panther scalps (Tinsley 1970). Agricultural land clearing in the southeast between 1850 and 1909 totaled 12.8 million ha. Lumbering reduced the original southern forest nearly 40

percent from 121.4 million ha to 72.0 million ha by 1919. A staggering 36.4 million ha of pine forests were considered cut-over by 1920 with one-third classified as restocked with sawable timber, one-third restocked with scrubby cordwood only, while one-third remained barren (Williams 1990). Meanwhile the white-tailed deer, primary prey of the panther, was reduced from a range-wide population of about 13 million in 1850, to under 1 million by 1900 (Halls 1984). Over a 100-year period, bounty hunting, land clearing, lumbering, and market hunting of deer contributed to the range-wide decline of the panther.

Of the 27 *Puma concolor* subspecies described in Hall (1981), the Florida panther is the only one remaining in the eastern U.S. The panther population in Florida numbered about 500 at the turn of the century (Seal *et al.* 1989). Kautz (1994) estimated that a loss of 1.74 million ha of forests in Florida between 1936 and 1987 was the equivalent of 35 to 70 male panther home ranges and 100 to 200 female panther home ranges. The Big Cypress population was estimated at 125 in 1969 (DOI 1969) and a South Florida population at 92 in 1972 (Schemnitz 1972). The Florida Panther Act, a State law enacted in 1978, made killing the panther a felony.

The uncertain status of the panther led to the establishment of a GFC Florida Panther Record Clearinghouse in the 1970s. Records were compiled prior to extensive field surveys and radiotelemetry research of remaining animals (Belden 1977). The first field surveys began in 1972. Radiotelemetry research began in 1981 and through 1983 was limited to Fakahatchee Strand State Preserve and Big Cypress National Preserve (Belden *et al.* 1988). The research program gradually expanded to include Everglades NP, Florida Panther NWR, Picayune Strand State Forest, Okaloacoochee Slough State Forest, the Corkscrew Regional Ecosystem Watershed, and private lands in Collier, Hendry, and Lee counties. A total of 72 panthers (41 male, 31 female) have been radio-collared since telemetry research began in 1981. As of June 30, 1998 there were 30 panthers (14 male, 16 female) being monitored.

Ten Florida panther kittens, five male and five female, were removed from the wild between February 1991 and August 1992 for captive breeding purposes. The kittens ranged in age from 10 days to 8 months and represented progeny of 11 different adult panthers. Two females died in captivity in 1992. One died after heart surgery in an attempt to correct an atrial septal heart defect and one died of unknown causes. Two males died of severe respiratory distress after being released to the wild in southern Big Cypress National Preserve in 1997. Six panthers remain in permanent captivity, one male and one female each, at White Oak Conservation Center in Yulee, FL, Lowry Park Zoo in Tampa, and at the Jacksonville Zoo (Land and Taylor 1998).

Threats

The Florida panther's existence is threatened by extinction processes. Population viability analysis projections indicate that under existing demographic and genetic conditions the panther will likely be extinct in 24 to 63 years (Seal *et al.* 1992). Environmental factors affecting the panther include: habitat loss and fragmentation, contaminants, prey availability, human-related disturbance and mortality, disease, and genetic erosion (Dunbar 1993). Any reference to

mortalities associated with these threats refers only to the endemic South Florida population and not to the introduced western cougars.

Genetic and Physiological: Natural gene exchange between the Florida panther and three other subspecies ceased when the panther became geographically isolated, probably over a century ago (Seal *et al*. 1994). Isolation from *F. c. cougar*, *F. c. hippolestes*, and *F. c. stanleyana*, habitat loss, reduced population size, and inbreeding have resulted in loss of genetic variability and diminished health. Data on polymorphism and heterozygosity, when combined with multiple physiological abnormalities, suggest that the panther is experiencing inbreeding depression (Roelke *et al*. 1993, Barone *et al*. 1994). Inbreeding depression has been related to decreased semen quality, lowered fertility and neonatal survival, and congenital heart defects in a variety of domesticated and wild species (Lasley 1978, Ralls and Ballou 1982, Wildt *et al*. 1982, O'Brien *et al*. 1985, Roelke 1991). The panther exhibits many of these traits.

Congenital heart defects were documented in 11 Florida panthers in 1990 and 1991 (Roelke 1991). Some of these heart defects were severe enough to result in death. All eight panther kittens examined that year had heart murmurs, as well as 30 percent of the adults examined. Congenital heart defects are believed to result from inbreeding, and may interfere with survival and reproduction (Roelke 1991, Dunbar 1993, Barone *et al*. 1994).

The Florida panther exhibits poorer male reproductive characteristics than other populations of mountain lions in North America or Latin America (Barone *et al*. 1994). Of 16 panthers, more were unilaterally cryptorchid (43.8 percent vs. 3.9 percent), had lower testicular and semen volumes, poorer sperm progressive motility, and more morphologically abnormal sperm than did 51 individuals from other *Puma concolor* populations in Texas, Colorado, Latin America, and North American zoos (Wildt 1994).

Research indicates the extant Florida panther population is comprised of two genetic stocks. Panthers in Big Cypress Swamp descended from *F. c. coryi*. Panthers in the Everglades also descended from *F. c. coryi* but contain additional Latin American genetic markers (O'Brien *et al*. 1990) that probably originated from captive "Piper" stock released into the Everglades between 1956 and 1966 (Vanas 1976, Mounger 1991). The presence of Latin American genes may explain the lack of congenital heart defects in Everglades panthers. None of the Everglades panthers tested in one study were cryptorchid, whereas 64 percent of the Big Cypress panthers tested were cryptorchid (Barone *et al*. 1994).

Low heterozygosity levels indicate that the Florida panther has lost approximately half of its genetic diversity (Roelke 1990). The level of mDNA variation in the panther is the lowest reported in any similarly studied feline population, including leopards, cheetahs, and other *puma* subspecies. Electrophoretic analyses also indicate the panther has less variation than any other *puma* subspecies and is nearly as low as the level of allozyme variation reported in the two cheetah subspecies. Panther DNA fingerprint variation is nearly as low as the genetic variation in Asiatic lions from the Gir Forest Sanctuary in India (Roelke *et al*. 1993).

Disease: Disease is a threat to small, inbred populations (Roelke 1991, Barone *et al*. 1994, Seal *et al*. 1989). All Florida panthers undergo an examination to assess general health and physical condition at the time of capture. Panthers

greater than 8 weeks of age are dewormed and vaccinated for feline viral rhinotracheitis (FVR), feline calicivirus (FCV), feline panleukopenia (FPV), and rabies. Biomedical samples collected include whole blood, skin biopsy, hair, and feces. Bacterial cultures are taken as needed. Panther kittens less than 6 weeks of age are also given injections of iron, vitamin B, and penicillin (Taylor 1997).

Six of 20 free-ranging Florida panthers (30 percent) captured from Everglades NP, Big Cypress National Preserve, and adjacent lands between 1986 and 1988 tested positive for feline immunodeficiency virus (FIV) (Barr *et al*. 1989). Five out of 19 panthers (26.3 percent) examined in 1992 (Roelke and Glass 1992) and one of 23 examined between July 1, 1996 and June 30, 1997 (Taylor 1997) tested postive for FIV. FIV has a long incubation period but leads to non-specific immunosuppression and death in domestic cats (Roelke 1991). Its significance to the panther is not known.

Other diseases, such as feline infectious peritonitis (FIP), feline leukemia virus (FeLV), *Cytauxzoon felis*, and *Bartonella henselae*, are present in varying degrees (Roelke 1991, Roelke and Glass 1992, Dunbar 1993).

Parasites found on 12 panthers examined between 1978 and 1983 included one protozoan, two trematodes, three cestodes, seven nematodes, six ticks, and one flea. The trematode *Alaria marcianae* and a hookworm *Ancylostoma pluridentatum* were the most prevalent and abundant (Forrester *et al.* 1985).

Mortality from shooting: Six Florida panther shootings, five fatal and one non-fatal, occurred between 1978 and 1986--an average of one every 2 years. These data do not include the more recent shootings of introduced Texas cougars; however, it should be noted that all subspecies of *Puma concolor* that occur in Florida are protected by a "similarity of appearance" provision in the Endangered Species Act.

Highways: Construction of highways in wildlife habitat may result in habitat fragmentation, direct mortality, direct habitat loss, displacement and avoidance, and associated human development (Ruediger 1998).

Rare carnivores are generally present only in locations with the lowest highway densities. Highways, and other human developments, tend to create boundaries for individuals and populations. Habitat fragmentation isolates small populations, subjecting them to demographic and stochastic factors (Ruediger 1998) that reduce their chances for survival and recovery.

Panthers consistently use large areas with few major highways (Maehr and Cox 1995). Belden and Hagedorn (1993) observed that Texas cougars, used in a population reintroduction study, established home ranges in an area with one-half the road density of the region in which the study was conducted. In particular, the study animals tended to avoid crossing more heavily traveled roads (*e.g.* primary and secondary hard-surface highways, and light-duty roads) in favor of more lightly traveled roads. Of 26 *puma* home ranges examined by Van Dyke *et al*. (1986), 22 (85 percent) included unimproved dirt roads, 15 (58 percent), included improved dirt roads, but only 6 (23 percent) included hard-surfaced roads. Female panthers rarely establish home ranges bisected by highways and maternal dens are located at distances one kilometer or greater away from highways (Maehr 1996).

Florida panther road mortality (n=24) between 1978 and June 30, 1998 averaged 1.2 panthers per year and was almost evenly divided between males

(n=13) and females (n=11). Vehicle collisions resulting in the death of subadult panthers (0 to 3 years) of both sexes exceeds subadult mortality due to intraspecific aggression (23.4 versus 10.9 percent) and equals all other forms of subadult mortality combined (Land and Taylor 1998). Although the relative significance of highway deaths to other sources of mortality is not entirely known, it has been the most often documented source of mortality (Maehr 1989, Maehr *et al.* 1991b).

Florida panther road mortality and injury (n=30) between 1978 and June 30, 1998 was greatest in Collier County (76.7 percent), followed by Hendry County (10.0 percent), and Lee County (10.0 percent). During the same period panther mortality and injury was greatest on S.R. 29 (33.3 percent) and Alligator Alley (16.7 percent) in Collier County (Land and Taylor 1998). Nighttime speed limits were reduced on S.R. 29 and Alligator Alley in 1984 in an effort to minimize panther/vehicle collisions. Wildlife underpasses, first used by panthers in 1989 (Maehr 1992a), have greatly reduced risks in these problem areas (Foster and Humphrey 1995).

A 33 m (2 lane) and 100 m (4 lane) cleared right-of-way would consume, respectively, 1.9 and 5.7 percent of each section of land through which it passes (Ruediger 1998). Highways stimulate more land development than is generally recognized. Change occurs as far away as 3.2 km on either side of the highway. Thus for each kilometer a highway is extended, 644 ha are opened to new development (Wolf 1981).

Urbanization: The rapid and extensive loss of panther habitat is a result of Florida's flourishing human population, which has doubled nearly every 20 years since 1830. Only five percent of the state's residents lived in South Florida in 1900. Today 50 percent live there. Florida's population, fourth largest in the U.S., is expected to reach 17.8 million (127 persons per km^2) by 2010 (Floyd 1996).

The population of South Florida passed one million (130 persons per km^2) in 1950, three million (391 persons per km^2) in 1970, and six million (780 persons per km^2) in 1990. The population density of South Florida has exceeded the statewide average since 1960. South Florida's population is projected to reach 8.2 million (1,070 persons per km^2) by 2010 (Floyd 1996).

South Florida accounted for 49 percent of Florida's residential construction starts in 1995. Ft. Lauderdale, Miami, West Palm Beach-Boca Raton, Sarasota-Bradenton, Ft. Myers-Cape Coral, Ft. Pierce-Port St. Lucie, Lakeland-Winter Haven, Punta Gorda, and Naples, in descending order, accounted for 39 percent of Florida home sales in 1996. Ft. Lauderdale ranked third and Miami fourth statewide in total numbers of houses sold. Naples ranked second statewide in the percentage increase of houses sold (Floyd 1996).

Population growth and agricultural expansion in South Florida are compromising the ability of natural habitats to support a self-sustaining panther population. Continued expansion of the urbanized east coast, increasing growth on the west coast, and the spread of agricultural development in the interior have placed increasing pressures on forested tracts in Collier, Glades, Hendry, and Highlands counties (Maehr 1990b, Maehr 1992a, Maehr *et al.* 1991a).

Agriculture: Statewide between 1936 and 1987, cropland and rangeland increased 1.72 million ha or 30 percent, urban areas increased by 1.60 million ha or 538 percent, while herbaceous wetlands declined by 1.57 million ha or 56 percent and forests declined by 1.74 million ha or 21 percent.

Agricultural and urban development continues to replace and fragment panther habitat. Over 83 percent of the 648,000 ha of agricultural land in southwest Florida; *i.e.* Charlotte, Collier, Glades, Hendry, Lee and Sarasota counties, is categorized as rangeland. Between 1986 and 1990, row crop acreage increased by 3,640 ha or 21 percent, sugarcane increased by 6,475 ha or 21 percent, citrus increased by ha or 75 percent, and rangeland--much of it suitable for panther occupation - decreased by 64,750 ha or 10 percent. Rangeland losses were about evenly divided between agricultural development (citrus, row crops, sugarcane) and urban development (Townsend 1991).

Occupied panther habitat is about evenly divided between public and private lands. If private land habitats are lost the existing public lands in South Florida are judged capable of supporting only 9 to 22 (Maehr 1990b) of the minimum 50 adult panthers needed to sustain a genetically viable population. Where current uses on private lands are compatible with panthers, owners should be economically encouraged to continue those practices (Maehr 1992a, 1992b).

Management

Early conservation efforts benefitting the Florida panther involved land protection and natural areas management. After nearly a decade of planning, Everglades NP was established in 1947. Corkscrew Swamp Sanctuary was established in 1954, when the National Audubon Society and The Nature Conservancy purchased remnant stands of old growth cypress from the Lee Tidewater Cypress Company and Collier Enterprises.

The Florida Legislature passed the Big Cypress Conservation Act of 1973, thus designating 347,228 ha of the 634,561 ha Big Cypress Watershed as an "Area of Critical State Concern (ACSC)." The Fakahatchee Strand State Preserve, established in 1974; the Big Cypress National Preserve, established in 1974 (P.L. 93-440); and the Florida Panther NWR, established in 1989 (the only public land established specifically to protect the panther), all lie within the Big Cypress ACSC. Today 24,282 ha remain in private ownership. Site alteration within the Big Cypress ACSC is limited to 10 percent of the land parcel. Impervious surfaces are limited to one-half of the site altered. Agricultural activities are exempt from these restrictions (Chapter 28-25, F.A.C.).

The Florida Panther Research and Management Trust Fund and the Florida Panther Technical Advisory Council were established by the Florida Legislature in 1983. Money from the trust fund is used to manage and protect the extant panther population and panther prey; to inform the public of panther recovery activities, and to reintroduce panthers into areas where habitat is suitable. These funds are obtained through donations and a portion of the severance tax on oil extracted in Collier County.

The Technical Advisory Council is comprised of two members that represent State or Federal agencies responsible for endangered species management, two members with academic expertise in the research and management of felines or large mammals, and one member from the public at large. Membership was expanded in 1997 to include two members representing landowners from that part of South Florida where panthers inhabit private lands. The purpose of the Technical Advisory Council is to advise the GFC on

technical matters relevant to panther recovery, review and comment on research and management activities, and provide a public forum for technical review and the status of recovery efforts.

The Florida Panther Interagency Committee (FPIC), comprised of the FWS, NPS, GFC, and DEP, was established in 1986 to coordinate recovery of the Florida panther. A Habitat Preservation Plan (HPP), prepared in 1993 for the FPIC, identified 374,868 ha of occupied and potential habitat considered essential to maintaining a minimum viable population of 50 breeding adult panthers in South Florida. The HPP also identified habitat threats, and the means by which the habitat could be protected; *e.g.,* land acquisition, conservation easements, exchanges, donations, voluntary management agreements, landowner incentives, and landowner disincentives. Figure 3 shows the relationship of existing and proposed state land acquisition and conservation easement projects to nine of the ecological units identified in the HPP (Logan *et al.* 1993).

Present-day conservation efforts include accelerating state acquisition of Picayune Strand SF with matching Federal funds. Okaloacoochee Slough SF, the first publicly owned conservation land in Hendry County, was purchased by the SFWMD in 1996. Lands were added to the Big Cypress National

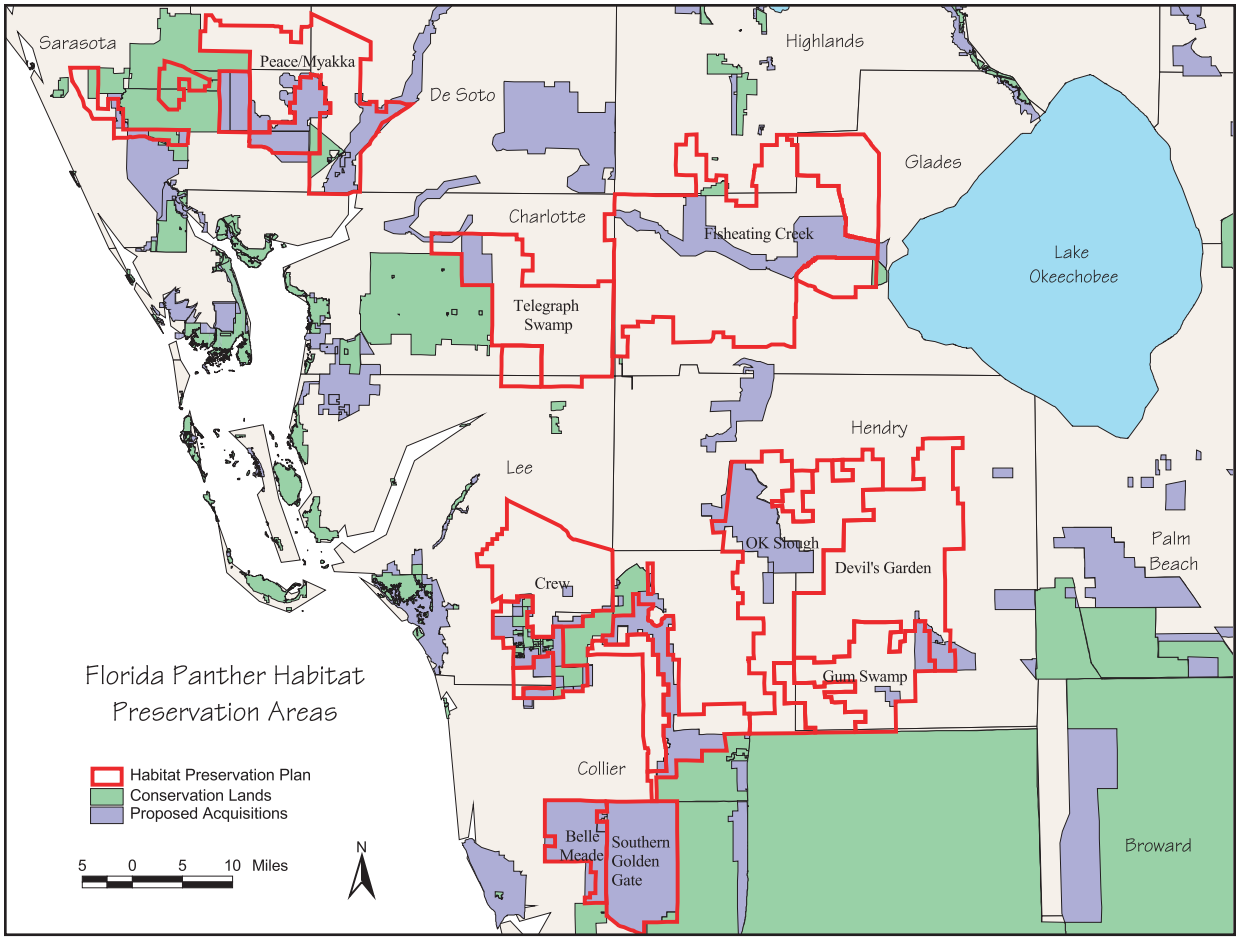


Figure 3. Florida panther habitat preservation areas.

Preserve and Florida Panther NWR when the Arizona-Florida land exchange (P.L. 100-696) was finalized late in 1996. Caloosahatchee Ecoscape, a landscape corridor connecting panther habitat in Glades and Hendry counties, was added to the Conservation and Recreation Lands acquisition list in 1998. USDA/NRCS and FWS landowner incentive programs are suited to panther habitat protection and their full potential has yet to be realized. The State of Florida is promoting the use of conservation easements to protect panther habitat and easements are expected to play a larger role in Florida's land conservation efforts after 2000. Private landowners in South Florida have initiated a grassroots effort to link Federal estate tax reform with protection of endangered species habitat.

* * * * *

The survival and recovery of the Florida panther is dependent on: (1) protection and enhancement of the extant population, associated habitats, and prey resources; (2) improving genetic health and population viability; and (3) reestablishing at least two additional populations within the panther's historic range.

The first area of emphasis in Florida panther recovery is protection and enhancement of the extant population, its associated habitat, and its prey resources. Several State and Federal agencies manage within existing financial, legal, philosophical, and ecological constraints, public lands inhabited by the panther and its prey.

Panther habitat management on public lands consists primarily of prescribed fire and wildfire suppression in fire-adapted vegetation communities. Chemical, biological, and mechanical control of invasive exotic plants helps maintain and perpetuate preferred panther habitat types. In addition to prescribed fire and exotic plant control, management for panther prey, *e.g.* white-tailed deer and feral hog, consists of hunting restrictions and vehicle access restrictions.

Two-to-five year fire rotations and burn compartments less than 2,500 ha are recommended to increase habitat heterogeneity (Schortemeyer *et al.* 1991). However, fire prescriptions will 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 exotic plants. For example, Florida Panther NWR uses existing swamp buggy trails and highways as burn compartment boundaries. The refuge is divided into 54 burn compartments that range in size from 121 to 445 ha. A range of 2,023 to 3,238 ha is burned annually depending on weather conditions. Best results have been obtained by burning 3 to 5 days following a light rain shower (<12.7 cm) and when dead fuel moistures (1 and 10 hour fuels) are 8 to 12 percent and live fuel moistures (1 and 10 hour fuels) are 134 to 168 percent (FWS 1996).

Food plots, clearings and feeders can be effective in local situations. Disturbed sites, particularly those invaded by willows, can produce good forage for deer. Establishment of oaks and palms on disturbed sites can significantly increase mast production in select areas (Schortemeyer *et al.* 1991).

Prey management has also been accomplished by regulating harvest. A variety of strategies have been used. Everglades NP, Fakahatchee Strand State Preserve, and Florida Panther NWR are closed to hunting. Portions of Big Cypress National Preserve are closed to hunting, open only for archery hunting, or open for a limited general gun season. Use of hunting quotas and off road vehicle (ORV) access permits have reduced or redistributed hunting pressures. Use of dogs for hunting is prohibited. A five-inch antler rule reduced the harvest of does and fawns. Big Cypress National Preserve and all private lands south of Interstate 75 are excluded from the doe season (Schortemeyer *et al.* 1991).

Overall, management activities directly benefitting the panther and panther prey are limited to upland habitats which comprise only 8 percent of the total land area in Big Cypress National Preserve, Everglades NP, and Florida Panther NWR.

Private landowners should be encouraged to continue or initiate land management practices beneficial to the Florida panther. Landowner incentive programs can be used to provide technical and financial assistance for prescribed fire, exotic vegetation control, rotational grazing, fencing, tree planting, *etc*. Given that 60 to 80 percent of panther radio-locations occur in pine flatwoods and hardwood hammocks (Maehr 1996) landowners should be encouraged to restore pine flatwoods and protect hardwood hammocks from over-grazing.

The Immokalee Rise physiographic region includes all of Hendry County and parts of Collier, Glades, and Lee counties, *i.e.* the core of occupied panther habitat. Pine flatwoods in this area declined 88 percent from 153,928 ha in 1900 to 17,970 ha in 1989. Pine flatwoods have also been severely fragmented and today are comprised of thousands of patches less than 50 ha in size (Mazzotti *et al.* 1992). Pine flatwoods have been replaced by pasture, row crops, and citrus.

Restoration of pine flatwoods will not be easy. Few landowners in South Florida are located within the critical radius of a railhead in Palmdale, Florida--the only route by which timber from South Florida can be hauled to North Florida mills for processing and distribution. Consequently there is little incentive to replant timber in South Florida once it matures and is harvested. One possible long-term solution is development of local outlets for "value-added" pine timber products. An alternative, short-term solution is to pay landowners to replant and maintain sufficient stands of pine flatwoods to increase panther distribution and densities.

Hardwood hammocks have increased (probably due to land drainage) from 6,703 ha in 1900 to 9,516 ha in 1989 but have never comprised more than 2 percent of the vegetative cover in the Immokalee Rise physiographic region (Mazzotti *et al.* 1992). Given the high level of panther use and scarcity as a cover type it is important that hardwood hammocks be maintained in conditions attractive to panthers and panther prey. Hardwood hammocks are sometimes manipulated by landowners to increase understory browse for cattle. In extreme cases over-grazing has reduced the hammock understory to bare dirt. Landowner incentive programs should be used to establish rotational grazing programs to reduce grazing pressure on the hammocks and to fence cattle from the hammocks where appropriate.

The second area of emphasis in Florida panther recovery is genetic health and population viability.

A program to address these concerns through the restoration of gene flow was initiated in 1995. The rationale and details for the program, as well as morphological and genetic criteria used to monitor and measure success, are found in the FWS document entitled "Final Environmental Assessment - Genetic Restoration of the Florida Panther" and the associated genetic restoration and management plan (FWS 1994).

The level of introgression required to reverse the deleterious effects of inbreeding is estimated at 20 percent, or 6 to 10 Texas cougars (*F. c. stanleyana*), based on the current population estimate of 30 to 50 breeding adult panthers. Each of the Texas cougars released needs to produce at least two offspring that survive and are recruited as breeders. One additional Texas cougar will be translocated into South Florida every 6 years thereafter. This should restore genetic variability in the panther without significant alteration to its basic genetic makeup which may be adapted to local environmental conditions (Seal *et al.* 1994).

Unrelated animals were selected from various locations throughout Texas, screened in the field for cowlicks and kinked tails, and screened in quarantine for atrial septal heart defects and disease. Females 2 to 4 years of age were selected because they were considered more likely to remain near release sites, less likely to be adversely affected, and could be more easily assimilated into the extant panther population (Seal *et al.* 1992).

The extent of introgression will be assessed by several factors: pedigree analysis based on Florida and Texas founder contributions, analysis of molecular genetic markers, and analysis of morphological characters that differentiate the two subspecies (Seal *et al.* 1992).

Genetic management began with the release of eight female Texas cougars in 1995. Two each were released in Fakahatchee Strand State Preserve, northern Big Cypress National Preserve, southern Big Cypress National Preserve (Figure 4), and Everglades NP.

As of July 1, 1998 six of the eight female Texas cougars remained alive. One was killed in a vehicle collision in Hendry County September 1, 1995. The second was found shot in a Collier County citrus grove April 18, 1998. Five of the six female Texas cougars remaining alive have produced eight litters of first generation (F_1) intercross kittens--eight female and four male (Land and Taylor 1998). An F_1 female produced the first litter of F_2 kittens (one female, two male) in September 1998. A population viability analysis workshop will assess the progress of the genetic management program.

The third area of emphasis in Florida panther recovery is to establish two additional populations within the historic range of the panther (FWS 1987, FWS 1995). Population establishment involves site selection and use of surrogate animals for site evaluation (Jordan 1994, Belden and Hagedorn 1993, Belden and McCown 1994). Between 1988 and 1995, 26 Texas cougars were released near Okefenokee NWR and Osceola NF. Six animals were born and raised in captivity. Twenty were captured in western Texas and translocated to Florida, 17 of which were released into the wild shortly after arrival. The remaining three

were part of a study to develop captive breeding techniques and were held in captivity for 2 to 8 years prior to release (Belden *et al*. 1989, Belden and McCown 1996).

The study animals, monitored by radiotelemetry at least 3 days per week, established overlapping home ranges, made kills of large prey at predicted frequencies, and generally adapted well to their new environment (Belden *et al*. 1989). Captive-raised animals tended to establish home ranges more quickly, and were more likely to associate with other study animals than were wild-caught animals. Captive-raised animals, particularly males, were more likely to be seen by humans and were the primary cause of negative attitudes toward the study. The mean distance from the release site to the home range center and the mean home range size were significantly greater for the wild-caught males than captive-held males, and captive or wild-caught females (Belden and McCown 1996).

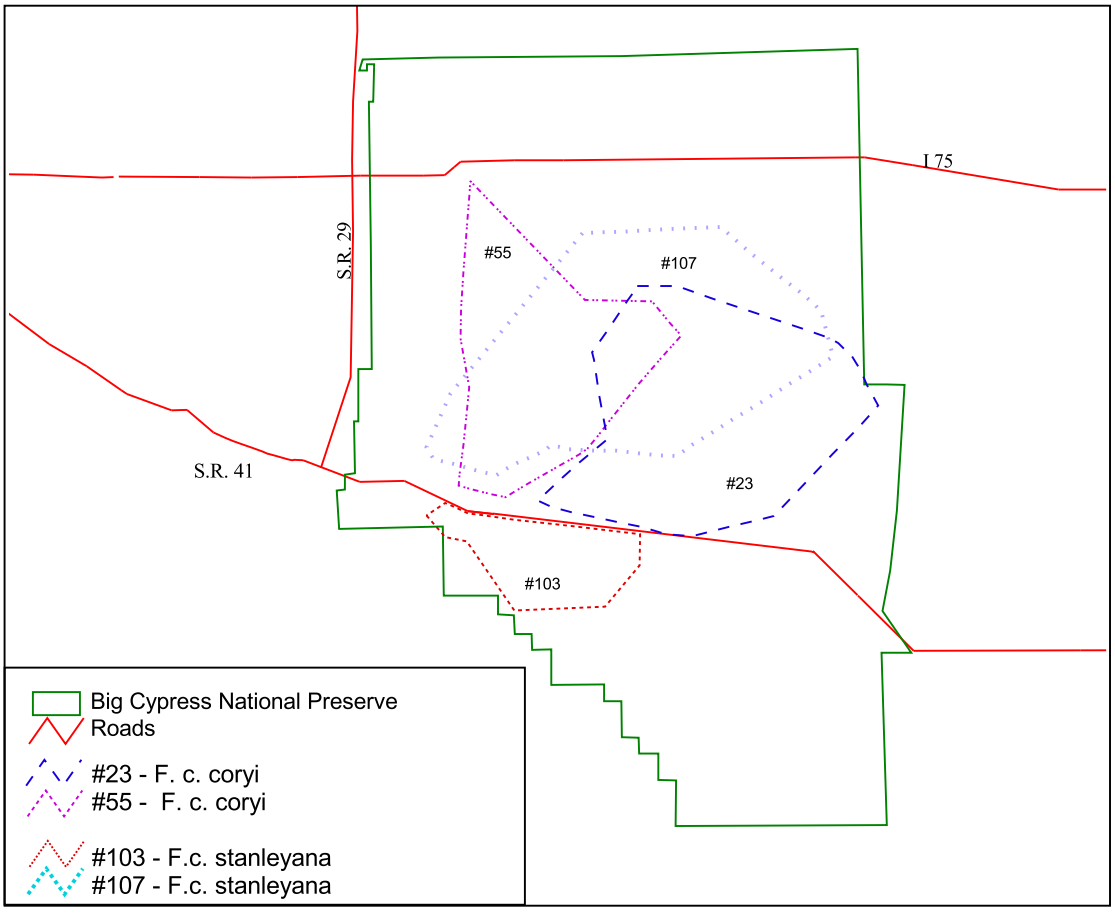


Figure 4. Home ranges of collared *F. concolor* in portions of Big Cypress National Preserve.

One of two plans for population re-establishment discussed by Belden and McCown (1996) involves the release of four to five wild-caught female Florida panthers into a select area. Once they established home ranges a captive-raised male would be introduced only long enough to breed the females. This plan has the advantages of requiring fewer panthers from the South Florida population and of allowing more control over where re-establishment occurs. Wild-caught females with kittens could also be used.

Studies have concluded that Florida panther reintroduction is biologically feasible (Belden and Hagedorn 1993, Belden and McCown 1996). Habitat and prey available in north Florida and south Georgia are sufficient to support a viable panther population. However, complex social issues must be addressed prior to population reestablishment (Belden and McCown 1996). A study is currently underway to identify these issues and ways to manage them.

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Recovery for the Florida Panther

Felis concolor coryi

Recovery Objective: Establish three viable populations within the historic range**.**

South Florida Contribution: The narrative in this multi-species recovery plan is being prepared in advance of the range-wide Florida panther recovery plan revision which will be undergoing complete revision beginning in late 1997. Therefore, recovery tasks identified in this plan should be considered tentative and subject to change based on the results of the range-wide recovery plan revision. The multi-species plan will focus on the South Florida population, while recognizing that full recovery of this species is dependent upon the establishment of additional populations within the historic range of the species. The FWS will ensure the two plans complement one another in effecting recovery of the Florida panther.

Recovery Criteria

The present range-wide recovery objective for the Florida panther is to achieve three viable, self-sustaining populations within the historic range of the animal. First priority will be to secure the population in South Florida. A viable population level will be determined when enough data are available to develop a panther population model. An essential criteria for recovery of the panther needs to ensure 95 percent probability of persistence of the South Florida population over a minimum of 100 years. Re-established populations may require separate population goals. Population objectives will generally be based on the size of the respective areas, prey base, and other ecological factors important to panthers.

This narrative will only address the existing population in South Florida. The range-wide recovery plan revision will incorporate the needs in South Florida with population re-establishment and the many other tasks deemed necessary to recover the panther.

Species-level Recovery Actions

S1. **Refine the current distribution of the South Florida panther population**. Delineate areas inhabited or frequented by panthers. Radio-collared panthers have been documented in 12 of 19 counties in South Florida. The breeding population is centered in Collier, Hendry, and Miami-Dade counties. Uncollared panthers may still reside on private lands in Charlotte, Collier, Hendry, Lee, and Glades counties.

S1.1. **Conduct field surveys on all newly acquired public lands.** As State or Federal conservation lands are added to the public trust field surveys should be conducted to determine the presence or absence of Florida panthers. Uncollared panthers encountered should be added to the research population.

S1.2. **Conduct field surveys on private lands to document panther presence**. Potential sites would include areas identified in the HPP, other areas comprising panther habitat, and areas associated with reliable reports of panther observation/sign. Special emphasis should be placed on developing cooperative partnerships with private landowners for access. Private

landowners currently involved in telemetry research studies should be commended for their participation. As in **S1.1**, uncollared panthers encountered should be added to the research population.

S2. Protect and enhance the South Florida panther population.

S2.1. Enhance the panther population through genetic and demographic management. Plans for genetic and demographic management should anticipate the circumstance under which translocation would be appropriate, and should distinguish the advantages and disadvantages of using males, females, pregnant females, animals of various ages, soft- and hard-release techniques, *etc*.

S2.1.1. Translocate animals for genetic management. Eight female western cougars (*F. c. stanleyana*) were translocated from Texas to Florida for genetic introgression in 1995. The approved genetics management plan calls for the translocation of one female western cougar about every 6 years thereafter. Animals selected for translocation must be screened in the field for cowlicks and kinked tails and screened in quarantine for atrial septal heart defects or disease using established protocols.

S2.1.2. Formulate plan for humane disposition of surplus animals. Female western cougars may need to be removed once F1 kitten recruitment goals (two per female) are met. A female western cougar/male F1 kitten pairing (backcross) is undesirable. Contraception, translocation, and removal are techniques by which undesirable pairings can be prevented. Develop a protocol for removal of these surplus animals from the population and attach it to the recovery plan as an appendix.

S2.2. Translocate animals for demographic management. It may be necessary, on occasion, to translocate panthers or intercross progeny to minimize or prevent undesirable pairings, to balance gender representation, and to fill home range vacancies in marginal habitat (*i.e*. southern Big Cypress).

S2.3. Reformulate plan for captive propagation of Florida panthers. Ten kittens, representing 11 adult panthers, were removed from South Florida during 1991 and 1992. Two died in captivity in 1992. Two died after being released to the wild in 1997. The other six panthers remain in permanent captivity. A population re-establishment study showed that there were advantages to using wild-caught versus captive-raised animals. Wild-caught western cougars are being used for genetic management rather than captive-raised animals. Consequently, the role of captive propagation in panther recovery would seem diminished. However, the fate of panthers remaining in captivity, and the role of captive propagation for education, genetic management, demographic management, or population re-establishment has not been determined. These issues need to be addressed.

S2.4. Identify causes of injury and mortality. Florida panther mortality (n=67) averaged 3.5 deaths per year from 1978 through June 30, 1998. Specific causes of panther mortality include: road kill (37.9 percent), intraspecific aggression (21.2 percent), disease and old age (18.2 percent), causes unknown (12.1 percent), shootings (9.1 percent), and capture related (1.5 percent). Other than disease, only those causes of panther injury or mortality attributable to humans can be minimized.

S2.4.1. Continue to minimize injury and mortality from panther/vehicle collisions. Florida panther injury and mortality (n=30) from vehicle collisions averaged 1.5 per year between 1978 and June 30, 1998. Panther/vehicle collisions were greatest in Collier County (76.7 percent), Hendry County (10 percent), and Lee County (10 percent); and on S.R. 29 (33.3 percent) and Alligator Alley (16.7 percent) in Collier County. Reduced nighttime speed limits are in effect, and enforced, on S.R. 29. Underpasses and fencing have eliminated panther mortality on Alligator Alley and certain stretches of S.R. 29. Panther/vehicle collisions continue on other rural roads.

S2.4.1.1. Complete installation of underpasses on S.R. 29. Four of six underpasses have been installed concurrent with the widening and realignment of S.R. 29. Two underpasses remain to be constructed in the Sunniland, Florida vicinity.

S2.4.1.2. Establish an underpass on S.R. 80 east of LaBelle, Florida. The Caloosahatchee Ecoscape was added to the Conservation and Recreation Lands acquisition list in 1998 and serves as the last remaining link between panther habitat in Glades County and Hendry County. S.R. 80, which runs from Ft. Myers to West Palm Beach, bisects the project, is heavily traveled, and likely to be four-laned. An underpass or underpassses will be required to maintain this important landscape link.

S2.4.1.3. Identify and prioritize other underpass needs in South Florida. Panther/vehicle collisions continue on rural two-lane roads in eastern Collier County, Hendry County, and in rapidly developing eastern Lee County. Underpass needs should be identified prior to future road maintenance or improvement projects on appropriate roads in South Florida counties. It is more efficient to construct wildlife underpasses concurrent with road improvements.

S2.4.2. Minimize the risk of disease outbreaks. Disease is a threat to small, inbred populations. All Florida panthers undergo an examination to assess general health and physical condition at the time of capture. Panthers greater than 8 weeks of age are dewormed and vaccinated for feline viral rhinotracheitis (FVR), feline calicivirus (FCV), feline panleukopenia (FPV), and rabies. Biomedical samples collected include whole blood, skin biopsy, hair, and feces. Bacterial cultures are taken as needed. Panther kittens less than 6 weeks of age are also given injections of iron, vitamin B, and penicillin. This protocol should continue--subject to periodic review, and amendment as needed.

S2.4.3. Minimize the risk of shootings. Education, self-policing among hunters, and regulation are the tools by which shootings are minimized. All free-ranging puma in the southeastern U.S. are protected by a "similarity of appearance" provision in the ESA.

S2.4.4. Minimize the risk of capture-related mortality. The only capture-related panther mortality occurred in 1983. Captures are confined to

cooler months (November through March) to minimize heat stress. Crash bags and safety nets are used to cushion the impact of panthers that fall from the tree after immobilization. Anesthetic drugs have been changed and doses reduced through experience to minimize adverse reactions to the drugs. Advances in pharmacology have also made anesthesia safer.

S2.5. Enforce available protective measures. Implement local, State and Federal regulations and guidelines to protect Florida panthers and their habitat.

S2.5.1. Initiate section 7 consultation when applicable. All Federal agencies must consult with the FWS on any of their activities (authorized, funded, or carried out) that might adversely affect Florida panther populations. Such activities include (among others) land clearing, road construction, and military training exercises.

S2.5.2. Implement on-site minimization, habitat compensation, and mitigation on private lands through section 10 when needed. Where adverse effects cannot be avoided, measures must be taken to minimize on-site disturbance, and compensate or mitigate for the impacts that remain. The FWS generally recommends that areas used as habitat compensation be located in the vicinity of the affected habitat, where appropriate, and avoid further fragmentation and isolation of existing habitat.

S3. Continue Florida panther life history and ecology research.

S3.1. Conduct research on biology, ecology, and population demographics. Although considerable work has been done on the biology and ecology of the Florida panther, biological studies should continue to increase information on population viability, and relationship of demographic factors to habitat quality and availability.

S3.2. Conduct risk assessment and population viability analyses to determine the probability of persistence of panthers in South Florida, using current demographic data. Conduct periodic workshops to update population viability projections.

S3.3. Continue research on effects of mortality on the Florida panther.

S3.3.1. Assess the current state of knowledge of the effects of environmental contaminants on the Florida panther. Compile the latest available information from published and unpublished literature, and from scientists, to determine the direction for future research.

S3.3.2. Continue to research effects of environmental contaminants that could be affecting the Florida panther. Other environmental contaminants, such as endocrine disruptive chemicals, should be researched to assess any possible effects to the Florida panther.

S3.3.3. Continue to gather and evaluate data on feline-associated viruses, parasites and other potentially debilitating agents. Management recommendations should follow guidelines resulting from these data.

S3.3.4. Develop health indicator matrix. Presence or absence of disease and contaminants (estrogen mimics, mercury) for each animal would be indicated in the matrix. An index of health would be established by noting the number of animals affected by disease or contaminants, the extent to which the animal is affected, the age, sex, and breeding condition of the

animal, and comparing that to a desired index.

S3.3.6. Conduct research to determine the effects of road density and development (human density) on white-tailed deer and feral hog distribution and abundance.

S4. Monitor the South Florida panther population.

4.1. Continue and expand the radio-telemetry/monitoring program. The radiotelemetry/monitoring program within the core population area has been underway since 1981. Continue to track locations of collared panthers, and maintain all data on a GIS database. Expand the program by radio-instrumenting individuals in under-studied segments of the population and monitoring outside of the core area (*i.e.* CREW, Okaloacoochee Slough area, areas north of the Caloosahatchee River, *etc.*).

4.2. Continue to monitor translocated animals and offspring. All western cougars used for genetic introgression are radio-collared and monitored. All intercross kittens will be implanted with transponder identification chips, radio-collared prior to dispersal, and monitored. Four F1 kittens implanted with transponder identification chips have dispersed without being radio-collared. These animals, now old enough to breed, will be collared when encountered. DNA analysis will be required to establish the identity of F2 kittens sired or reared by the four uncollared F1 kittens.

S5. Refine statewide education and outreach programs for Florida panther. A 1995 public opinion survey indicates that Floridians are remarkably positive in their opinions and attitudes toward panther conservation (92 percent support, 2 percent oppose). The challenge now is to turn this support into tangible conservation efforts. Educators need to identify specific ways Floridians can become involved in panther protection. The action items should be simple and need to be effectively and constantly communicated to the public.

S5.1. Emphasize basic facts about the Florida panther in outreach materials. Awareness of the panther among respondents of the 1995 survey was high (90 percent) but knowledge levels were limited. Surprisingly, only 44 percent of the people aware of panthers in Florida knew that the panthers were confined to South Florida and only 14 percent knew that there were less than 50 remaining. Public relations efforts and materials must continue to reflect these basic facts.

S5.2. Tailor outreach efforts and materials to non-residents. Tourism, which brings about 40 million people to Florida annually, was not a focus of the 1995 survey. Agencies are only now beginning to understand the relationship between tourism, development, and wildlife conservation. Another way to increase panther awareness levels and support is to tailor outreach efforts and materials to tourists.

S5.3. Publicize Florida panther website. A website has been developed by Florida State University and the Florida Advisory Council on Environmental Education with funding derived from the sale of panther license plates. Education and outreach materials should include the web address (www.panther.state.fl.us).

S5.4. Establish South Florida education and outreach programs for Florida panther. Informing the public about the life history of the panther, land management practices that benefit the panther, and interagency efforts to prevent the extinction of the panther are important components of the panther recovery program. Listed below are tasks specific to South Florida as identified in the Florida Panther National Wildlife Refuge

Comprehensive Conservation Plan.

S5.4.1. Develop multi-agency visitor center. Use high-quality, conventional exhibits and progressive interactive media displays to inform public. The center will serve as an outdoor classroom in the Big Cypress Watershed for students in Collier County, Hendry County, Lee County, and all of South Florida.

S5.4.2. Hire three new personnel at Florida Panther National Wildlife Refuge. A media specialist is needed to coordinate news events, press releases, and information transfer to local, State, and national news outlets. A public use specialist is needed to coordinate visitor center activities, refuge interpretive displays, school outreach, and refuge volunteer activities. An administrative assistant is needed to support the media specialist and public use specialist.

S5.4.3. Increase membership of "Friends of the Panther Refuge" support group. The target is to have 100 members. The group will assist with education programs on and off the refuge. Quarterly evaluations will assess the effectiveness of the group's support efforts.

S5.4.4. Collaborate with partners to support outreach activities. Partners include but are not limited to local, State, and national non-profit organizations, and State and Federal agencies. Participate with partners in at least two events per year (National Wildlife Refuge Week, International Migratory Bird Day, Earth Day, *etc*.).

S5.4.5. Develop lesson plans for local school teachers and community organizations. The lesson plans should focus on the panther, public land management, South Florida ecosystem issues and restoration efforts. An annual workshop will be held for teachers from school districts in Collier County, Hendry County, Lee County, and all of South Florida.

S6. Continue to participate in the Florida Panther Recovery Program. .

S6.1. Reconstitute the Florida Panther Interagency Committee. The Florida Panther Interagency Committee (FPIC), established in 1986 to coordinate panther recovery efforts, is comprised of the FWS, NPS, GFC, and DEP. However, other State and Federal agencies and tribal governments have much to contribute to panther recovery. Consideration should be given to expanding FPIC membership.

S6.2. Convene periodic meetings of the Florida Panther Recovery Team. The Florida Panther Recovery Team should convene periodically to discuss interagency relations, ongoing research, research results, new literature relevant to panther recovery, and to assess panther recovery program accomplishments and needs.

S6.3. Convene periodic meetings of the Florida panther Technical Advisory Council. The Florida Panther Technical Advisory Council should continue to convene biannually.

S6.4. Update and revise the range-wide Florida panther recovery plan. The range-wide recovery plan, first approved in 1981, then revised in 1987 and 1995, is currently undergoing its third revision, which should be complete in 2000. The range-wide plan details the status of the recovery program and the myriad of tasks necessary for panther

recovery. The plan should be updated and revised every 5 years. Progress reports on recovery plan implementation should be published annually.

S6.5. Convene periodic conferences for recovery program partners and general public. The Florida Audubon Society sponsored the first Florida Panther Conference in Orlando, Florida in 1978. A second conference sponsored by Florida Defenders of the Environment was held in Gainesville, Florida in 1986. A third conference sponsored by the Florida Panther Interagency Committee was held in Ft. Myers, Florida in 1994. The conferences have all focused on the issues of, and progress towards, panther recovery. Conferences held about once a decade for recovery program partners and the general public seem appropriate.

Habitat-level Recovery Actions

H1. Preserve and protect Florida panther habitat. The Florida Panther Habitat Preservation Plan (HPP) identified 374,868 ha of occupied and potential habitat considered essential to maintaining a minimum viable population of 50 breeding adult panthers in South Florida. Fifty-seven percent of these lands are classified as Priority 1 (highest quality and/or most frequently used) and 43 percent as Priority 2 (lower quality and/or less frequently used). The HPP also identified habitat threats, and the means by which habitat could be protected: land acquisition, conservation easements, exchanges, donations, voluntary management agreements, landowner incentives, and landowner disincentives.

H1.1. Complete acquisition projects comprised of Priority 1 and Priority 2 habitat. Nearly 190,000 ha of priority panther habitat have been proposed for State (75 percent) or Federal (25 percent) acquisition. Thirty-three percent of these lands have been preserved using fee-simple acquisition and conservation easements. The remainder should be preserved in a timely manner.

H1.2. Initiate new acquisition projects comprised of Priority 1 and Priority 2 habitat. The FWS has initiated a proposal to expand the Florida Panther NWR in Collier County and Hendry County by about 150,000 ha. Other proposals are being developed. Appropriate agencies should continue to identify landowners interested in panther recovery from whom land and conservation easements may be purchased.

H1.3. Complete public protection of Big Cypress Area of Critical State Concern. The Big Cypress Conservation Act of 1973 designated 347,228 ha of the 634,561 ha Big Cypress Watershed as an Area of Critical State Concern (ACSC). Today, 93 percent of the ACSC is in public ownership. The 7 percent remaining in private ownership, all Priority 1 habitat, extends from Florida Panther NWR north to Okaloacoochee Slough SF, serves as a large mammal corridor between Collier County and Hendry County, and should be protected.

H1.4. Establish, restore, and maintain important corridors. Corridors are necessary for population expansion and for facilitating gene flow between subpopulations. The Caloosahatchee Ecoscape, added to the CARL acquisition list in 1998, is a 4,047 ha corridor connecting panther habitat in Glades County and Hendry County. Camp Keais strand links Florida Panther NWR with the CREW. A recent 20,695 ha conservation easement acquired by the SWFWMD could link panther habitat in DeSoto County and Glades County. The Florida Greenways Coordinating Council

adopted in 1998 a five-year implementation plan for a statewide system of greenways and trails that could benefit the panther long-term.

H2. Use landowner incentive programs to conserve, restore, and manage panther habitat. The USDA-NRCS and FWS administer several landowner incentive programs capable of preserving Priority 1 and Priority 2 panther habitat on farms and ranches in South Florida. Each of the programs is briefly discussed below. Some examples of how the program can be used for panther recovery are given.

H2.1. Environmental Conservation Acreage Reserve Program. The Environmental Conservation Acreage Reserve Program (ECARP) encompasses the Conservation Reserve Program, Wetlands Reserve Program, and the Environmental Quality Incentives Program. The purpose of these programs is to help farmers and ranchers conserve and enhance soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat. Program objectives are achieved primarily through short-term or perpetual retirement of marginal agricultural land and changes in land management practices.

H2.1.1. Conservation Reserve Program. The Conservation Reserve Program (CRP) makes annual rental payments and pays 50 percent of the cost of eligible conservation practices implemented by the landowner. Two types of CRP are recognized.

The **Traditional CRP** allows irregular, periodic enrollment of large acreages and can quickly provide measurable benefits to wildlife species requiring expanses of contiguous habitat. For example, traditional CRP should be used to establish tracts of pine flatwoods 250 ha or greater to reverse a historic pine flatwoods decline of 88 percent in central South Florida. Forest tracts 250 ha or larger are a constituent element of occupied panther range and pine flatwoods can account for about 30 percent of individual panther radio-locations.

The **Continuous CRP** allows year-round enrollment of small acreages with an emphasis on strip-type water quality practices. The continuous CRP should be used to plant pine or hardwood buffers around isolated cypress domes or along cypress strands to provide cover for panthers, cover for panther prey, and to increase average forest patch size in a given area, thus reversing fragmentation. Trees planted in strips of sufficient width along ditches, canals, interior access roads or similar landscape features could serve as cover for panther prey and provide nominal travel corridors for the panther.

H2.1.2. Wetlands Reserve Program. The Wetlands Reserve Program (WRP) pays farmers and ranchers to restore former and degraded wetlands. Restoration of forested wetlands would reverse forest declines and would be somewhat beneficial to the panther given its preference for forested habitats. Wetland restoration would also benefit panther prey, which can be found feeding in, or around the edge of, herbaceous wetlands. The options available include the following: (1) permanent easements, where the easement payment is generally 100 percent of the agricultural value or a predetermined area cap, and NRCS pays 100 percent of the

restoration costs; (2) 30-year easements, where the easement payment is generally 75 percent of the agricultural value or a predetermined area cap, and NRCS pays 75 percent of the restoration costs; and (3) restoration cost-share agreements, where there is no easement payment but NRCS pays 75 percent of the restoration costs. The minimum duration for the agreement is 10 years.

H2.1.3. Environmental Quality Incentives Program. The Environmental Quality Incentives Program (EQIP) provides educational, technical, and financial assistance to help farmers and ranchers comply with State and Federal environmental laws. Fifty percent of the annual appropriation is allocated to livestock-related natural resource concerns and cattlemen owning land inhabited by the panther are ideal applicants. This program can be used to fence hardwood hammocks that have been degraded by mechanical manipulation or overgrazing. Hardwood hammocks can account for 30 to 40 percent of individual panther radio-locations and are the most productive white-tailed deer habitat.

H2.2. Wildlife Habitat Incentives Program. The Wildlife Habitat Incentives Program (WHIP) helps farmers and ranchers to plan and pay for improvements that benefit threatened and endangered upland and wetland species. NRCS will pay up to 75 percent of the cost of implementing the conservation practice. A minimum 10-year contract is required. Annual food plots are not eligible. The program was designed to promote habitat management compatible with active agricultural operations and can be used to develop, restore, or enhance many habitat types. All of the examples given above could be accomplished using this program. Use of prescribed fire to manage pine flatwoods and to stimulate the growth of understory browse for deer is also possible.

H2.3. FWS Partners for Fish and Wildlife program. The Partners for Fish and Wildlife (PFW) program provides technical and financial assistance to private landowners to restore and enhance fish and wildlife habitat on their property. The FWS will pay up to 100 percent of the cost of habitat restoration projects and up to 50 percent of habitat improvement projects. The funding is limited to $10,000 per landowner per year and the minimum duration of a PFW contract is 10 years. The PFW program can work in conjunction with any of the USDA-NRCS programs to help implement the conservation practices discussed above.

H3. Optimize habitat management techniques for panther and prey. Optimal management of habitat suitable for panther and prey on public and private lands is second only to habitat preservation. Prescribed fire should be used to maintain fire-adapted vegetation communities and provide browse for white-tailed deer. Chemical, biological, and mechanical control methods can eradicate invasive exotic plants. Hunting and access restrictions can be used to manage prey and minimize human activities that might disturb panthers. Research and education are key to optimizing habitat management for panther and prey.

H3.1. Continue research on panther, panther prey, and habitat relationships. The USGS-BRD, University of Tennessee is conducting a study on the response of panthers to prescribed fire and a study on panther movements in response to recreational hunting. The University of Florida, Institute of Food and Agricultural Sciences, Southwest Florida Research Center is conducting a deer forage study. Staff at Florida Panther NWR are conducting experiments on food plots for white-tailed

deer. Other studies are underway or being planned. Land management programs will be refined as research results dictate.

H3.1.1. Determine properties best suited for habitat restoration using landowner incentive programs. Using most recent low-level aerial photography and land ownership data available, determine which ownerships best fit the ideal for panther habitat.

H3.1.2. Host annual seminar for South Florida land managers. The seminar will provide an interactive forum for farmers, ranchers, and public land managers to discuss management techniques, current research, research needs, public/private partnerships, and other topics pertinent to panther habitat management and panther recovery.

H4. Develop and implement a habitat monitoring program. Data exist for habitat changes in the Immokalee Rise physiographic region from 1900 through 1989. Low-level aerial photography should be acquired every 10 years to ascertain positive and negative changes in habitat quantity. The analysis should focus on upland and wetland forest fragmentation, *i.e.* gaps between forest patches, forest patch size and abundance per patch size, *etc*.

H5. Publicize habitat management techniques and research results to increase public awareness. Publish a periodic newsletter, via print and the internet, on panther habitat management issues and relevant research results. The newsletter should be sent via direct mail to all South Florida land managers (public and private) and distributed through local county extension and USDA-NRCS offices to landowners.