FLORIDA PANTHER REINTRODUCTION FEASIBILITY STUDY

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Final Report
Study Number: 7507
Study Period: 1 July 1992 - 30 June 1995

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Abstract: Nineteen mountain lions (*Felis concolor stanleyana*) were released into northern Florida as surrogates for evaluating the feasibility of reintroducing Florida panthers (*F. c. coryi*) into unoccupied areas of their historic range. These included 11 females and 8 vasectomized males. Six of the released mountain lions were born and raised in captivity at Gillman Paper Company's White Oak Plantation near Yulee, Florida, 10 were captured in the wild in western Texas and translocated to Florida, and 3 were captured in the wild in western Texas and held in captivity in Florida 2-8 years prior to release. Animals were monitored using radio-telemetry at least 3 days/week from 22 February 1993 to 30 June 1995. Fifteen lions established one or more home ranges. Nine (60%) home ranges overlapped one or more other home ranges. This population was made up of predominately captive-born and wild-caught/captive-held animals in an area that varied in size from 127 to 418 km^2 (1.5 to 3.1 lions/100 km^2). Mountain lions that established home ranges outside of this population had a higher excursion rate than did animals within it. Excursions were more frequent during the breeding season than during the rest of the year. Captive-raised animals tended to establish home ranges more quickly and were more likely to be in association with other animals than were wild-caught animals. However, captive-raised animals, particularly males, were more likely to be seen and caused most of the human/lion interactions that created negative attitudes toward the program. The mean distance from the release site to the home range center and the mean home range size were significantly greater for wild-caught males. Reestablishment of additional Florida panther populations is biologically feasible. It would require incorporating the advantages and planning around the disadvantages of both captive-raised and wild-caught translocated animals. However, complex social issues were identified that must be satisfactorily addressed, and it must be decided whether the tremendous costs involved (economic, political, social, etc.) in the reestablishment of additional Florida panther populations can be offset by the benefits gained in reducing the risk to the present Florida panther population.

INTRODUCTION

The only documented breeding population of Florida panthers (*Felis concolor coryi*) occurs in southern Florida from Lake Okeechobee southward. This population is found primarily in the Big Cypress Swamp and Everglades physiographic regions. It is estimated that 30 to 50 adult animals remain. This population is being managed to accomplish the objectives of the Florida panther genetic restoration and management plan (Seal 1994), and "Florida panther" in this report refers to animals that meet these plan objectives.

The Florida Game and Fresh Water Fish Commission (FGFWFC), as a member agency of the Florida Panther Interagency Committee, is committed to the recovery of the Florida panther. The recovery objective for the Florida panther, as set forth in the Florida Panther Recovery Plan (U.S. Fish and Wildlife Service 1987), is "to achieve three viable, self-sustaining populations within the historic range of the animal." This will require the reintroducing Florida panthers into at least two other suitable areas in their historic range, if feasible, as well as

managing the existing population. Successfully introducing panthers into such areas would help reduce the risk of extinction for the subspecies. The objectives of this study were to evaluate an initial stocking of at least 10 mountain lions as a means of establishing a mountain lion population in northern Florida, to compare the performance of wild-caught animals with captive-raised animals in the initial release, and to determine the feasibility of adding new animals to an established population.

We acknowledge T. H. Logan and J. R. Brady for constructive criticism, guidance, and support throughout this project. Mountain lions were provided by R. T. and R. M. McBride of Ranchers Supply, Inc., Alpine, Texas, and by J. Lukas of Gillman Paper Company's White Oak Plantation, Yulee, Florida. The first four male lions were vasectomized by staff veterinarian J. Stover of White Oak Plantation and the second four by FGFWFC project veterinarian M. R. Dunbar. D. D. Weiffenbach of Eagle Aviation, Inc., Lake City, Florida, assisted with aerial tracking. We gratefully acknowledge the support and assistance of L. L. Martin, S. K. Stafford, and D. A. Weaver. Law enforcement support was generously provided by L. F. Rossignol and staff in Florida and W. D. Hill and staff in Georgia. A. W. Gaylard, C. T. Lee, and A. W. Stockle gave much needed assistance during all aspects of the study. We also greatly appreciate the cooperation and support provided by the Georgia Department of Natural Resources Game and Fish Division, particularly that of J. C. Kurz, regional supervisors T. Hon, T. Kile, B. Monroe, and D. Marshall and their staffs, and biologists D. Forster and M. Harris. We thank J. R. Brady, S. B. Linda, and P. E. Moler for reviews of the manuscript. S. B. Linda did the majority of statistical analysis, and J. A. Cox, J. M. Hamblen, and E. D. Land generously provided help and guidance with GIS analysis. S. Williams provided field assistance and donated his time and money to initiate a public information campaign. Primary funding for this study was provided by the FGFWFC through the Florida Panther Research and Management Trust Fund. The Barnett Bank of Florida, Inc., agreed to indemnify the Commission against livestock losses caused by introduced mountain lions.

STUDY AREA

The Osceola/Okefenokee area of northern Florida and southern Georgia (Figure 1) was chosen as a study area based on results of a panther habitat evaluation questionnaire sent to wildlife biologists of the FGFWFC (Belden 1987) and a previous study with translocated mountain lions. A brief description of this area can be found in Belden and Hagedorn (1993).

METHODS

Public Support

Certain key community leaders and public officials were contacted in order to obtain support for the panther reintroduction feasibility study and to request their assistance in developing positive public awareness of the proposal. A list of these individuals was developed, and the contacts were timed to be made during 4-6 January 1993 to preclude any premature information which might have resulted in the development of adversarial positions based on a lack of accurate information.

The FGFWFC Office of Informational Services developed an informational brochure for distribution to key contacts and, later, to the media. This brochure briefly described the project and included questions and answers

directed especially to hunters and landowners.

The FGFWFC anticipated landowner concerns over potential loss of livestock to lion predation and decided that the study would not proceed unless mechanisms by which to reimburse any such losses were in place. The Barnett Bank of Florida agreed to indemnify FGFWFC against livestock losses valued up to $10,000.

A press conference was held at the release site on 12 February 1993 to inform the public about the Panther Reintroduction Feasibility Study. A meeting with the invited representatives of 58 hunt clubs was scheduled at the Lake City Community College on 16 March 1993 to present an outline of the study and answer questions. However, < 5 clubs were represented at the meeting.

Study Animals

The animals used in this study were either captured in Texas and released in Florida within 3 months of their capture (wild-caught), captured in Texas and held in captivity for 3-8 years prior to release (wild-caught/captive-held), or born and raised in captivity (captive-raised). Ten mountain lions were released into northern Florida on 22 February 1993 as surrogates for Florida panthers. These included 6 females and 4 males.

One female (T30) had been captured in the wild in Texas and held in captivity in Florida since January 1991. She was 3-4 years old and weighed 33 kg when released. Three of the 10 released mountain lions were born in captivity at Gillman Paper Company's White Oak Plantation near Yulee, Florida. Their mothers (T01 and T08) had been captured in the wild in Texas in 1986 and were bred to a male (T28) that had been captured in the wild in Texas in 1989. Two female siblings (T31 and T32) were born 28 April 1991 and a male (T33) was born 23 August 1991. At release, the females weighed 35 (T31) and 39 (T32) kg, and the male weighed 60 kg.

The remaining 6 mountain lions (3 males and 3 females) were wild-caught in Texas during November and December 1992 and brought to Florida in January 1993. The males were a 1.5 year-old weighing 41 kg (T40), a 3 year-old weighing 54 kg (T35), and a 4 year-old weighing 70 kg (T36). The females were a 1.5 year-old weighing 33 kg (T37), a 3 year-old weighing 35 kg (T38), and a 3 year-old weighing 40 kg (T39).

Nine additional mountain lions were released during the study to determine the feasibility of adding new animals to an established social structure. A 3-year-old female (T41) weighing 40 kg and her 2 yearling male kittens (T42 and T43) weighing 32 and 31 kg were captured in Texas, transported to Florida, and released into the study area on 15 July 1993. A 9 ±-year-old female (T01) weighing 39 kg and her 2 14-month-old offspring (T45_ and T46_) were released into the study area on 25 May 1994. T01 had been captured in Texas and brought to Florida in 1986. Her 2 yearlings were born and raised in captivity at Gillman Paper Company's White Oak Plantation and weighed 39 and 31 kg. Another 9 year-old, wild-caught female (T02), weighing 39 kg, had been brought from Texas to Florida in 1986 and was released into the study area with her 5 month-old, 9 kg, female kitten (T47) on 26 June 1994. A 3 year-old wild-caught Texas male (T48) was released into the study area 12 July 1994.

Male mountain lions were vasectomized to prevent reproduction but to allow normal sexual behavior. All lions were radio-collared and moved to the release site on the western edge of Pinhook Swamp. The release site was selected (Figure 1) on the basis of its remoteness and inaccessibility to the public. Ten adjoining pens (3.1 m x 6.2 m) were erected from panels of chainlink fencing. Nest boxes were placed in each pen. Lions were held in the release pens from 10 to 14 days prior to soft-release.

Monitoring and Data Analysis

Animals were radio-monitored on a daily basis from 22 February 1993 through April 1993 and 3 days/week (M,W,F) thereafter. Additional daily monitoring was conducted during the first 9 days of the general hunting season and occasionally at other times for specific animals when necessary. They were monitored from a Cessna 172 airplane fitted with 2 H-configuration antennas. The latitude and longitude of each lion location were estimated using a loran-C navigation receiver, and each location was plotted on a 1:100,000 scale geological survey map covering a 30 x 60 minute quadrangle.

PROGRAM UTMS (Carlson and Vincenty 1990) was used to convert the latitude and longitude data to Universal Transverse Mercator coordinates. Telemetry data were analyzed using the computer software packages TELEM (Coleman and Jones 1988) and SPANS GIS (INTERA TYDAC Technologies Inc.). Use areas (the area to which an animal restricted most of its movements for periods < 3 months) and home ranges (the area to which an animal restricted most of its movements for ≥ 3 months) were calculated using the minimum area (convex polygon) method (Mohr 1947).

An analysis of variance (ANOVA) was performed on the number of days from release to the establishment of home ranges, the distances of home ranges from the release site, and the sizes of home ranges to test for differences among groups (captive-born females, captive-born males, wild-caught/captive-held females, wild-caught females, and wild-caught males). The data were log transformed to improve homogeneity of variance among groups. All reported *P*-values are for the analysis in the log scale.

Movements out of and back to home ranges were classed as "excursions." The generalized linear model approach (McCullagh and Nelder 1983) was used to determine whether season (peak-breeding - October through April; non-peak-breeding - May through September [Maehr 1990]) or inclusion in a social structure affected the excursion rate for an individual. A Poisson distribution of number of excursions was assumed, and the log link and a log(days on study) offset were used. A random ID effect was included in models, and models were fitted using pseudo-likelihood methodology (Wolfinger and O'Connell 1993). A model with the factors Social Structure, Season, and Social Structure x Season was fitted to the data. If the Social Structure x Season interaction was not significant, then that factor was removed from the model and the reduced model refitted.

Habitat type at each mountain lion location was determined using GIS land cover software. The 15 land cover types used for classifying habitat in the study area were collapsed into 5 types (coniferous forest, forested wetland/swamp, mixed forest, hardwood forest, and other) for purposes of analysis. The proportion of the study area occupied by each of these habitat types was determined from 3,116 points randomly distributed within the study area. The Wilcoxon signed rank test, applied to the within-animal difference between proportion used and proportion available, was used to determine if a given habitat was used more or less than might be expected from its availability.

Friedman's test (Alldredge and Ratti 1986) was used to test the null hypothesis H_O: the ranks of the differences between selection and availability are the same for all habitat types. The difference between proportion used and proportion available for each habitat was computed for each animal. These differences were ranked for each animal (lowest to highest), and ranks were used to compute Friedman's test statistic (habitats were considered as "treatments," and animals as "blocks"). If Friedman's test was significant, then Fisher's least significant difference

(LSD) procedure, applied to the ranks, was used to determine differences among habitats in selection intensity.

A record was kept of reported and verified mountain lion sightings. Sightings were verified when an investigation revealed the presence of physical evidence (tracks, kills, etc.) in the area of the location described in the report or through radio-telemetry location data that corroborated a lion's presence at or near the reported location. Investigations of reported sightings depended upon timeliness of the report and ability of the reporter to provide an accurate location of the event. Corroboration by radio-telemetry locations depended upon the lapse of time between the reported event and the most recent radio-location. Verified sightings were, therefore, a subset of those reported and tended to be biased toward the more serious human/lion interactions.

These sightings were analyzed to determine differences in human/lion interactions among the sex and origin groups to aid in assessing suitability for reintroduction. Mountain lion sightings were assigned to one of 4 categories to describe the nature of the event, and a score was obtained for each animal as follows:

$$\sum_{\text{Categories}} \frac{(\text{Sighting frequency in category} \times \text{weighting factor})}{\text{Lion-days on the study}} \times 1($$

The category weighting factors were: in woods = 1, associated with a deer feeder = 2, next to road = 3, and close to a house = 4. An ANOVA was performed to test for differences among groups, where group was defined by sex-origin combination. The data were log transformed [transformed score = log(score + 1)] to improve homogeneity of variance among groups. All reported *P*-values are for the analysis in the log scale.

Sighting data were quite sparse, so analysis of sighting frequencies was problematic. The differences among groupings in frequencies of sighting by humans and in rates of livestock depredation were analyzed using the generalized linear model approach. A Poisson distribution of number of sightings or frequency of livestock depredation was assumed, and the log link and a log (days on study) offset were used. A separate analysis for each sighting category (in woods, associated with a deer feeder, next to a road, or close to a house) was performed. Sex, Origin, and Sex x Origin effects were tested.

Fisher's exact test of association between group and the binary variable mortality was performed. In addition, the exact 95% confidence interval for mortality probabilities was obtained for each grouping, and Fisher's exact test for pairwise differences between groups for those probabilities was performed for each possible group pair.

Persistence, for the purpose of this analysis, was defined as maintaining a free-ranging status, and failure was defined as death or recapture due to unacceptable behavior or injury. Analysis methods developed for lifetime data were used, where "lifetime" was the length of time from release until failure. T31, T42, T43, and T48 were recaptured the last week in June 1995 due to the termination of the study but prior to failure; thus, the lifetimes for these 4 animals were censored (i.e., the length of time from release to recapture was considered to be a lower limit for the persistence for these animals). Only data from wild caught or captive-born animals were included in the analysis due to small sample size. Estimates of the persistence distribution were obtained using the product-limit (or Kaplan-Meier) method. The Wilcoxon test was used to evaluate a survival difference between wild and captive animals.

RESULTS

Movements and Home Ranges

The 19 mountain lions released into northern Florida were monitored for varying periods between 22 February

1993 and 30 June 1995, and 3,658 locations were recorded in the 859-day period (7,626 lion-days) (Table 1, Figure 2). Fifteen of these lions established one or more home ranges. The four lions that did not establish home ranges included a wild-caught male (T35) and female (T38), a wild-caught/captive-held female (T30), and a captive-born female kitten (T47). T35 was illegally shot and killed 56 days after release, T38 was killed by a vehicle on U.S. Hwy 301 140 days after release, T30 was recaptured 66 days after release because of landowner concerns, and T47 was recaptured 37 days after release because she would not follow her mother and was too young to survive on her own.

The average interval between release and movement into a consistent use area that eventually became a home range was 74 days (range = 0 - 280 days) for the remaining 15 mountain lions (Table 2). The wild-caught/captive-held females (T01 and T02) established home ranges more quickly than other mountain lion groups ($P < 0.0108$)(Table 3). These two females were 9+ years old when released. There was also a tendency for captive-raised animals to establish home ranges more quickly than wild-caught animals, although this difference was not significant ($P = 0.1034$).

Seven of 9 (78%) wild-caught mountain lions that were in the wild ≥ 3 months established one or more use areas before traveling to another use area or home range (Table 4). Only 1 of 2 (50%) wild-caught/captive-held and none of the captive-raised mountain lions established more than one use area or home range. The only animal that had more than one home range was wild-caught male T40, which established 3 use areas and 2 home ranges. He would travel 15 to 73 days (n = 4,$\bar{x}$ = 46, S.D. = 28.21 days), stay in a use area 33 to 69 days (n = 3,$\bar{x}$ = 51, S.D. = 18.01 days) or a home range 164 to 182 days (n = 2,$\bar{x}$ = 173, S.D. = 12.73 days), and then repeat the process. He generally would make 1 to 3 excursions lasting 6 to 44 days (n = 5,$\bar{x}$ = 18, S.D. = 15.60 days) prior to shifting his use area or home range. This same general pattern was followed for wild males T42, T43, and T48. The wild-caught females (T37, T38, T39, and T41) and one wild-caught/captive-held female (T01) stayed in 1 to 2 use areas prior to finally establishing a home range. The captive-raised animals generally established a home range wherever they stopped after leaving the release site.

Mean home range size of wild-caught males was significantly larger than that of each of the other groups ($P < 0.015$ for each pairwise contrast) (Table 3). No significant differences in mean home range size were found among the 4 remaining groups ($P = 0.9623$), excluding wild-caught males. Also, the mean distance from home range center to the release site was greater for the wild-caught males ($P < 0.004$ for each pairwise contrast).

Nine (60%) of 15 mountain lion home ranges overlapped one or more other mountain lion home ranges. All overlapping home ranges were located on the east side of the Suwannee River in northern Columbia County, Florida. This population was made up predominately of captive-born and wild-caught/captive-held animals in an area that varied in size from 127 to 418 km^2 (1.5 to 3.1 lions/100 km^2) (Table 5). Captive-born T33 was the resident adult male in this population until his removal on 7 April 1994 (Figures 3 and 4). Captive-born male T45 was the resident adult male from his release 5 May 1994 until his removal 15 November 1994 (Figure 5). There was not an adult male in the population from the time of T45's removal (Figure 6) until T42 moved back into the area 11 April 1995, where he remained until the end of the study (Figure 7).

Seven of the 9 animals that were added after the study began were assimilated into this established population. An adult female (T41) and her 2 yearling male kittens (T42 and T43) were added to the population when it contained 1 captive-raised male (T33), 2 captive-raised females (T31 and T32) and 1 wild-caught female (T39) (Figure 4). A wild-caught/captive-held female (T01) and her 2 14 month-old yearlings (T45_ and T46_) were

added to the population when it contained 2 captive-raised females (T31 and T32) and 1 wild-caught female (T41) (Figure 5). Another wild-caught/captive-held female (T02) and her 5 month-old female kitten (T47) were added to the population when it contained 1 captive-raised male (T45), 3 captive-raised females (T31, T32, and T46), 1 wild-caught female (T41) and 1 wild-caught/captive-held female (T01) (Figure 5). The 2 animals that were not assimilated into the population were kitten T47, which had to be returned to captivity because she would not follow her mother and, wild-caught male T48, which dispersed from the population.

Mountain lions that established home ranges outside of this social structure had a higher excursion rate than animals in the social structure ($P = 0.0354$) (Table 6). Also, the excursion rate was higher during the October through April peak-breeding season than during the rest of the year ($P = 0.0048$) and tended to begin when the animal reached sexual maturity ($\approx$ 2 years-old).

Two sub-adult males (T42 and T43) dispersed from their mother (T41) during the study. They remained a family group in the northern Columbia County area from their 15 July 1993 release until 1 November 1993, when T41 was located with the resident adult male (T33). T42 dispersed 47 km to an area along the Alapha River east of Valdosta, Georgia, and T43 dispersed 150 km to an area along the Ochlockonee River south of Cairo, Georgia (Appendix A). These males were estimated to be 14 to 18 months-old when they dispersed.

Habitat Use

The differences between the proportion used and the proportion available, computed for each habitat, are shown in Table 7. Use of forested wetlands and coniferous forest habitats was significantly higher than the availabilities of those habitats in the study area ($P < 0.0001$ for Wilcoxon test of zero difference, for each habitat). The use of mixed forest and hardwood forest habitats was lower than the availability of those habitats in the study area ($P < 0.021$). The "other" habitat (urban, agricultural, open water, etc.) was dramatically avoided ($P < 0.0001$) (Figure 8).

Friedman's test statistic (Q) was significant ($Q = 58.520$, df = 4, $P < 0.001$), and the LSD method gave the following ordering of mean ranks (mean ranks in parentheses):

forested wetlands (4.50)
coniferous forest (3.95)
hardwood forest (2.95)
mixed forest (2.60)
other (1.00)
Habitat values not preceded by the vertical line were significantly different at $\alpha = 0.05$.

Mountain Lion/Human Interactions

There were 21 verified mountain lion sightings during the study. Fourteen (67%) were of 5 of the 6 captive-raised animals, 6 (29%) sightings were of 4 of 10 wild-caught lions, and 1 (4%) sighting was of 1 of the 3 wild-caught/captive-held animals. Overall observation scores were highest for the captive-raised mountain lions (Table 8, Figure 9). However, this was due to the sex x origin interaction (disregarding wild-caught/captive-held animals)

(F = 3.30, P = 0.0908). Mean observation score of captive males was significantly higher than that of each of the other groups ($P < 0.05$ for each pairwise contrast). No significant differences in expected observation score were found among the 4 remaining groups (P = 0.8040). The mean observation score of captive males was significantly higher than that of other animals (P = 0.0040).

Sighting rate in woods did not differ among groups ($P > 0.20$). Sighting rate in association with deer feeders was higher for captive-raised than for wild lions (P = 0.0007), and captive-raised lions were the only animals seen around houses. Sighting rate along roads for captive-raised males was higher than for other groups (P = 0.0118), and there was no difference among other groups (P = 0.5089).

Seven mountain lions were involved in 8 depredation incidents. Three incidents involved newborn calves (T02, T32, and T45), 2 involved exotic ungulates (T36, T41, and T49), one involved a horse (T33), one a hog (T33), and one a housecat (T33). The depredation rate for captive-raised males was higher than for each of the other groups ($P < 0.006$ for each pairwise contrast, P = 0.0005 for captive-raised males vs mean of rates of other groups), and there were no significant differences among other groups (P = 0.9396).

Reproduction

Male mountain lion T33 was located with 5 females (T31, T32, T38, T39, and T41) during the time he was in the wild (22 February 1993 - 4 November 1993 and 10 February 1994 - 7 April 1994) (Appendix A). He was located with T32 18-20 March 1993 and 28-30 June 1993, with T38 27 March 1993 - 6 April 1993, with T39 8-9 April 1993, with T31 16-19 April 1993 and 20 August 1993, and with T41 3 November 1993 and 14-16 February 1994. Male mountain lion T45 was located with 4 females (T02, T31, T32, and T46) during the time he was in the wild (25 May 1994 - 15 November 1994). He was located with T46 on 29 July 1994, with T32 3 August and 7 November 1994, with T31 26 October and 7 November 1994 and with T02 on 12 November 1994. Male T42 was located with 2 females after he returned to the Suwannee River population (11 April to 26 June 1995). He was located with T01 6 times between 21 April and 10 May 1995 and 3 times between 14 and 26 June 1995. He was located 3 times with T31 between 22-29 May 1995.

Female T39's movements became confined to a 7 km^2 area during July and August 1993, indicative of having kittens. She was observed with at least one kitten on 4 August 1993. An attempt was made to capture and radio-instrument her kitten (T44) on 3 March 1994. When hit with the tranquilizer dart, the kitten jumped from the tree in which it had been bayed. Although we were able to get to the kitten within 90 seconds, its head was under water when we got to it. We were able to revive the kitten; however, it died 3 days later. A necropsy revealed that the tranquilizer dart had hit a vessel in the kitten's shoulder, causing it to succumb to the drug more quickly than normal (the drug is designed to be absorbed through the muscle, and it normally takes 6 - 10 minutes for the animal to go down).

Female T31's behavior during the first part of August 1993 was consistent with her having kittens. A search of the suspected den site revealed no evidence of kittens. She was located with male T33 again on 20 August 1993. She had a very small home range from October 1993 through June 1994. We were never able to find field sign to verify that she had kittens.

Female T32's behavior during the last part of September 1993 was consistent with her having kittens. However, no kittens nor evidence of kittens were observed in the vicinity of T32 during several close ($\leq$ 10 m)

observations of her.

An uncollared 8-month-old, 31 kg male kitten (T50) was killed on U.S. Hwy 441 on 25 February 1995. Although both T31 and T41 were close to the road when the carcass was recovered, prior hunter observation and subsequent field sign suggested that T41 was the mother and that she had another kitten still with her. That 27 kg female kitten (T49) was captured and radio-collared on 20 March 1995.

A report came into the Wildlife Research Laboratory on 6 March 1995 that panther tracks had been found on the Donaldson Tract, which is 2.1 miles south of Waldo, Alachua County, Florida, off of Hwy 24. This report was investigated the same day, and plaster casts of the tracks were made. This area was surveyed on 5 occasions between 9 March and 23 April 1995. Additional tracks were found on 2 of these occasions. Attempts to capture this animal were delayed until after the spring turkey hunting season at the hunt club's request. Capture efforts began on April 24, and a 54 kg male cougar was captured on 29 April 1995. The lion was taken to the Wildlife Research Laboratory, where blood samples were drawn.

Blood samples from T44, T49, and T50 were sent to Dr. Steve O'Brien at the National Cancer Institute's Laboratory of Viral Carcinogenesis in Frederick, Maryland, for DNA analysis. Short tandem repeat polymorphisms (STRP, also known as microsatillites) were used to determine paternity and maternity. T33 could not be excluded as the father of all 3 of these animals based on this test, T39 could not be excluded as the mother of T44, and T41 could not be excluded as the mother of T49 and T50.

Blood samples from the Waldo cat were also sent to Dr. O'Brian. Allozyme electrophoresis showed a match between the Waldo cat and mountain lions from the western U.S. and a distinction between this cat and Florida panthers (*F. c. coryi*). An additional analysis of 21 STRP's showed that "Waldo" (T51) was the offspring of T33 and T32 ($P \leq 0.01$).

The Georgia Department of Natural Resources' Law Enforcement Office in Blackshear reported on 30 October 1995 that they had recovered the mutilated carcass of a mountain lion. The carcass was brought to the Wildlife Research Laboratory, and tissue samples were sent to Dr. O'Brien. DNA analysis is currently underway in an attempt to determine the origin of this cat.

T38 was killed by a vehicle on U.S. 301 approximately 86 days after being located with T33. No fetuses were evident during necropsy.

Mortality and Persistence

Five (26%) of 19 mountain lions released into northern Florida died during the study. T35 and T36 were illegally shot, T37 and T38 were killed on highways, and T39 died when caught in a snare. Two additional animals born to study animals died during the study. T44 died when captured to fit her with a radio-telemetry collar, and T50 was hit by a tractor-trailer truck on U.S. Hwy 441. Mortality depended on grouping ($P = 0.040$ for the exact test of association between grouping and mortality). Mortality was significantly higher for the wild-caught group than for the captive-raised group ($P = 0.0338$). No other differences in mortality were found among groups ($P > 0.19$ for each of the other pairwise comparisons between groups).

Wild-caught mountain lions tended to persist longer (x = 460.240 days, SE = 90.920) than captive-raised lions (x = 329.667 days, SE = 101.446). The Wilcoxon test for a persistence difference, however, was not significant (chi-square = 0.8179, 1 df, $P = 0.3658$).

DISCUSSION

Stocking Rate, Sources of Stock, and Methods of Release

An initial stocking of at least 10 mountain lions can be used to establish a population. However, the source of the animals to be released must be considered. Advantages and disadvantages of both captive-raised and wild-caught translocated animals can be used to meet specific needs and objectives.

Captive-raised animals tend to establish home ranges close to the release site, with a tendency to become established more quickly than wild-caught animals. They appear to be more social, even grouping at times. Captive-raised males have much smaller home ranges than wild-caught males and do not shift use areas as much. The main disadvantage of captive-raised animals is their lessened fear of humans and greater likelihood to be involved in lion/human encounters that may be perceived by some as negative. There also is evidence to suggest that kittens produced in captivity fail to learn to follow their mothers to kill sites. We suspect this is a learned behavior and is not one easily learned in captivity where the use area is only a few hectares, food is abundant, and adequate nutrition is not dependent on following the mother to food. This effectively precludes releasing females with dependent captive-raised kittens. Non-dependent captive-raised animals, however, began making large kills within a few days of release, suggesting this behavior is instinctive. That one captive-raised female (T31) successfully raised wild-born kittens is evidence that captive-raised animals can be successful.

The main advantage of wild-caught mountain lions is that they do not interact as readily with people and livestock. Wild-caught females with kittens do not move far from the release site when released, and the kittens seem to behave normally. The main disadvantage of wild-caught mountain lions is that males tend to disperse far from the release site and remain transient, moving from one use area or home range to another. The probability of mortality is higher in this group possibly due to the greater movement.

The objective of reintroducing Florida panthers is to reestablish additional populations in unoccupied areas of their historic range to help reduce the risk of extinction for the subspecies. Therefore, reintroduced panthers would need to establish and maintain a social structure once released. Two release plans that take into consideration the advantages and disadvantages of captive-raised and wild-caught translocated mountain lions, based on the results of this study, are proposed.

Wild-caught males tend to disperse greater distances from the release site prior to establishing a use area/home range than any other group of animals. They may then remain in the use area/home range only 3-6 months before moving some distance to another use area/home range. This transient behavior may be continued until females are found. Wild-caught females on the other hand tend to remain relatively close to the release site, particularly those with kittens. Captive-raised animals of both sexes tend to establish home ranges more quickly and are more likely to be in association with other animals than wild-caught animals. However, captive-raised animals, particularly males, are more likely to be involved in human/lion interactions. Therefore, one release plan would be to release 4 to 5 wild-caught, young-adult male panthers and allow them to disperse. Once they established use areas/home ranges for 2 - 3 months, 3 to 4 wild-caught, adult females would be released into each of their ranges. This would, theoretically, stimulate the male to remain in the area and establish a reproducing population. The disadvantages of this method are that specific areas could not be pre-selected because populations will be established where males choose to establish home ranges, and large numbers of translocated Florida panthers

would be required. This method would require 4 to 5 male and up to 12 to 20 female, young-adult Florida panthers, which is likely more than the present population could supply at one time.

Another possible release plan would involve release of 4 to 5 wild-caught female Florida panthers into a target area. Once they had established use areas/home ranges, a captive-raised male could be introduced only long enough to breed with all the females. He could then be recaptured and removed from the wild. This plan has the advantages of requiring fewer Florida panthers from the south Florida population and of allowing more control over where the reestablished population will occur. Wild-caught females with kittens could be used in either of these plans.

Characteristics of Reintroduction Area

Area size.—Home ranges for Florida panthers average 519 km^2 for resident adult males, 193 km^2 for adult females, 623 km^2 for transient males, and 178 km^2 for subadult females (Maehr et al. 1991). Home ranges for wild-caught males in this study (648 km^2) were comparable to those of transient males in southern Florida, which might be expected given the transient behavior of released wild-caught males in northern Florida and southern Georgia. Home ranges for females in this study, however, were only about half the size of home ranges for female Florida panthers. This difference may be due to more productive habitat in northern Florida and southern Georgia and a greater abundance of less-predator-experienced prey. This difference in home range size was also reflected in density differences. The density in southern Florida was 0.91 panthers/100 km^2 (Maehr et al. 1991) compared to an average of 2.14 lions/100 km^2 in northern Florida. The density figure in northern Florida might decrease as the density of less-predator-experienced prey decreases.

Beier (1993) simulated mountain lion population dynamics to predict the minimum areas and levels of immigration needed to avoid population extinction caused by demographic and environmental stochasticity for a period of 100 years. His model predicted very low extinction risk in areas as small as 2,200 km^2 with as few as 1 to 4 animals per decade immigrating into the population. An area this size would contain 20 to 33 animals at a density varying between 0.9 and 1.5 panthers/100 km^2.

The Florida Panther Species Survival Plan (Seal and Lacy 1989) states that "The Florida panther will be considered recovered only when the total number of adult panthers in self-replacing populations of no less than 50 exceeds 500 for the subspecies, and this total number is distributed among at least three independently fluctuating populations." At a density varying between 0.9 and 1.5 panthers/100 km^2, an area containing 50 animals would have to be 3,333 to 5,556 km^2 in size.

Therefore, areas of at least 2,200 km^2 - 5,500 km^2 would be necessary for the initial establishment of a resident breeding population of Florida panthers. However, reintroduction plans should consider expansion, excursions, and dispersal. The 19 mountain lions released in this study covered an area of 84,745 km^2.

Prey density.—Maehr et al. (1990) found that the most common food items of Florida panthers were wild hog (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*) and 9-banded armadillo (*Dasypus novemcinctus*). Belden and Hagedorn (1993) investigated released mountain lion kill sites of large prey in northern Florida and found that 67% were white-tailed deer, 22% wild hogs, and 11% domestic goats. The percentage of deer in the kill dropped from 90% in June to 63% by December. Concurrently, the hog kill percentage increased from 5 to 21%. Replacement of deer by hogs in the lion diet coincided with the winter deer

population decline prior to spring births and the onset of the hog farrowing season, which peaks in late winter.

The theoretical reintroduced population of 50 resident adult Florida panthers at a sex ratio of 1 male:3 females would contain 12 resident adult males and 38 resident adult females, with 19 of these females accompanied by yearling kittens. If males require 1 large prey item/9.5 days, females 1/15.5 days, and females with yearlings 1/3.3 days (Ackerman et al. 1986), this theoretical population would require 3,010 large prey (deer and/or wild hogs) per year. This would translate to 54 - 90 large prey/100 km^2, depending on the size of the area.

An estimate of the deer density in the area where the released mountain lions established a population was 618/100 km^2 (1 deer/40 acres) (J. L. Norment, FGFWFC, unpubl. data). Wild hog, raccoon, and armadillo populations were of unknown density, though abundant. The Georgia wildlife management areas (WMA) where mountain lions established use areas/home ranges contained estimated deer densities ranging from 589/100 km^2 (1/42 acres - Dixon Memorial WMA) to 965/100 km^2 (1/26 acres - Paulk's Pasture and Rayonier WMA's) (Georgia DNR WMA Hunt Maps). Released mountain lions noticeably avoided establishing use areas/home ranges in Osceola WMA in northern Columbia County, Florida, which had an estimated deer density of 178 deer/100 km^2 (1/139 acres) in the still hunt area and 111/100 km^2 (1/223 acres) in the dog hunt area (J. W. Ault, FGFWFC, unpubl. data).

Therefore, deer densities in northern Florida and southern Georgia appear to be sufficient to provide for panther nutritional demands while having minimal impact on a huntable surplus. Furthermore, the availability of wild hogs and other small prey not only add to the panthers diet, they also lessen the number of deer required.

The use of feeding stations by hunters in northern Florida may have aided released mountain lions, particularly the captive-raised lions, in obtaining prey. Feeding stations tend to concentrate the prey animals in their vicinity, thereby increasing prey density and vulnerability in localized areas. We would hypothesize, however, that as naive prey become experienced to the presence of predators, they may alter their behavior around these feeders.

Human population density.—Historically, the decline of panther populations was at least in part due to persecution by man. The areas in which panthers are found today are areas that have been virtually impenetrable to man and development. Ideally, sites for reestablishment of panther populations should have little or no human use and the human population surrounding these sites should be low. Such areas, particularly of the size necessary to support an expanding population of Florida panthers, may be difficult to find. Regardless of the wilderness character of the reestablishment site, however, dispersing animals are more likely to be involved in human/panther interactions. Beier (1995) found that dispersing mountain lions in California showed no aversion to hikers, bicyclists, equestrians, isolated unlit buildings, or parked vehicles. He found that they would readily move through low density housing areas (about 1 dwelling/16 ha [39 ac]) and found dense housing areas (> 20 dwellings/ha [2.5 ac]) impassable.

We estimated housing density to be < 1 dwelling/243 ha (600 ac) in northern Columbia County, Florida, where the population of released mountain lions was established. Housing density in other parts of the study area where lions established use areas/home ranges was much less than this. However, some dispersing cats did travel through relatively dense housing areas and on occasion, as did Beier's (1995) dispersing animals, entered a habitat peninsula (usually a small creek) that dead-ended in an urban area.

Road density.—The density of roads should be as low as possible in potential reintroduction areas. Belden and Hagedorn (1993) found that released mountain lions established home ranges in areas that contained approximately one-half the density of roads found in the entire study area and that the lions tended to avoid

crossing more heavily traveled roads in favor of more lightly traveled roads within these ranges. The density of hard-surface roads in northern Florida and southern Georgia is estimated to be 0.179 km/km^2 (0.288 mi/mi^2) (Belden and Hagedorn 1993). Major highways, including limited-access federal interstate highways did not appear to hinder dispersing males. Two females and an uncollared male kitten, however, were killed on highways during the study.

Public attitudes.—People who live around the reestablishment site also must be supportive of panther recovery. Public attitudes and fears will probably be the major factor affecting success of reintroduction efforts.

The decline of Florida panthers began with early settlers, who attempted to destroy them at every opportunity. The panther was considered a nuisance to livestock and was believed to be equally dangerous as a killer of man. Legends of its ferociousness spread throughout the frontier, and panthers probably accounted for more folk stories in Florida than any other animal (followed by rattlesnakes and bears) (Williams 1976).

Public attitudes today have shifted in favor of preserving Florida panthers rather than persecuting them. However, some of the historic concerns remain. A statewide telephone survey found that 91% of the respondents supported efforts to save the Florida panther from extinction (Duda and Young 1995). A similar survey measured 80.7% support in the northern Florida counties around the release site (Columbia, Hamilton, Baker, Suwannee, and Union) (Cramer 1995).

The majority of respondents statewide (83%) were supportive of reintroduction efforts, 7% opposed, and 11% had no opinion or did not know (Duda and Young 1995). Percentage of respondents that supported reintroduction in the counties around the release site was 75% (Cramer 1995). When asked if they would support the reintroduction of panthers in their own or surrounding counties, 77% of statewide respondents (Duda and Young 1995) and 73% in the region of our study area (Cramer 1995) said that they would support reintroduction efforts. However, it is our opinion that those rural residents that lived in the immediate area where experimental mountain lions were released were strongly opposed to reintroduction efforts. These people became organized in November, 1994, forming "Not In My Backyard" organization to oppose reintroduction efforts. Most of those we heard from said they were not opposed to Florida panthers, they just did not want them in the immediate vicinity.

The major concerns expressed regarding the reintroduction of panthers were human safety, safety for pets and livestock, landowner rights, and effects on deer populations. Thirty percent of statewide respondents that opposed reintroduction efforts gave the reason that panthers are dangerous. Also, 36% of all statewide respondents agreed with the statement that if they saw a panther in the woods, they would be afraid it would attack them (Duda and Young 1995). Feelings that panthers would pose some threat to children was expressed by 47.4% of the respondents in the counties around the release site (Cramer 1995). Beier (1991) examined records of unprovoked attacks on humans by mountain lions in the United States and Canada during the period 1890 - 1990. He found that attacks on humans are rare but have increased markedly during the last 2 decades as mountain lion numbers and human use of mountain lion habitat also increased. The majority (64%) of victims were children.

Twenty-six percent of statewide respondents cited safety of pets and 37% cited safety of livestock as a concern (Duda and Young 1995). Due to anticipated landowner concerns for the potential loss of livestock, FGFWFC determined that mountain lions would not be introduced unless mechanisms were in place by which to recompense any losses due to introduced lions. Livestock owners that lost animals to the introduced mountain lions were reimbursed for their losses. However, we investigated several complaints of livestock depredation during this study where the sign present was more consistent with the depredating animal in question being something other than a

mountain lion, usually a dog or coyote. The "Not In My Backyard" organization in northern Columbia County, Florida, was formed after released captive-raised mountain lions attacked three newborn calves in a 3 week period in late October and early November 1994.

The potential for restrictions to be placed on property in the area of reestablished Florida panther populations was cited as a concern by 31% of respondents in the statewide survey (Duda and Young 1995) and 32.7% in the counties around the study area. However, this issue has been addressed by the U.S. Fish and Wildlife Service, which would classify the reintroduced Florida panthers as an experimental, non-essential population. Reestablished populations would not be covered by many of the restrictive regulations within the Endangered Species Act under this classification. However, landowners are still very concerned about increased government regulation (Cramer 1995).

Seven percent of statewide respondents agreed with the statement that panthers should not be reintroduced because they take away deer that should be left for hunters (Duda and Young 1995), and 32.6% of respondents in the counties around the release site felt that panthers would deplete deer populations in the area (Cramer 1995). Our data and data from a previous study (Belden and Hagedorn 1993) indicate that panthers would not have a significant overall impact on deer populations in reestablishment areas. They could, however, have some local impacts, such as around deer feeding stations and would certainly have an effect on deer behavior (making them more wary). They also could have some local impacts on relatively small, intensively managed areas where deer numbers are maintained higher than on surrounding areas.

Although public attitudes have improved since the early days of panther persecution, approximately a third of the public still considers panthers to be a nuisance to livestock and to be equally dangerous to man. However, both the statewide survey (Duda and Young 1995) and the survey in the counties around the study area (Cramer 1995) found that support for panther preservation and reintroduction increased with increasing level of education and income and decreased with increasing age. Likewise, the amount of concern with regard to human safety, safety of pets and livestock, landowner rights, and effects on deer populations decreased with increasing level of education and income and increased with increasing age. Also, those residents living closest to the reintroduction site are more likely to oppose reintroduction efforts. A strong negative attitude developed among those residing near the established mountain lion population during this study. These attitudes coalesced into organized and vocal opposition.

CONCLUSIONS

Reestablishment of additional Florida panther populations is biologically feasible. It would require incorporating the advantages and planning around the disadvantages of both captive-raised and wild-caught translocated animals. There are enough habitat and prey available in northern Florida and southern Georgia to support a viable, self-sustaining population of Florida panthers. This population would expand in a relatively short period of time and dispersers from this population likely would travel throughout many of the southeastern states.

The presence of this population, however, will create new problems for governmental agencies as well as the general public. These problems will be similar to the problems faced in California and Colorado where the expanding human population is encroaching into mountain lion habitat. The problems associated with a reintroduced population of Florida panthers will result from their encroachment into human habitat, but the

problems will be similar. A segment of the general public will shoot the animals, either maliciously or possibly out of fear. This will require additional law enforcement manpower. Panthers will be killed on highways, particularly dispersing subadults. There will be depredation problems, and most depredations, whether caused by dogs, coyotes, bobcats, or other animals, will be blamed on panthers. This will require an increased amount of manpower to respond to and investigate these complaints, and there will always be some risk, however small it may be, of panther attacks on humans. There will always be a tremendous ongoing need for public information and education because local opponents, if organized and politically astute, may be capable of defeating an otherwise well planned and financed reintroduction effort despite overwhelming but passive statewide support.

The Florida panther faces threat of extinction on 3 fronts. First, there is a continual loss of remaining panther habitat through human development. This continuing decline in amount of available habitat reduces the carrying capacity and, therefore, the numbers of panthers that can survive. Second, genetic variation is probably decaying at a rate that is causing inbreeding depression (reduction of viability and fecundity of offspring of breeding pairs that are closely related genetically) and precluding continued adaptive evolution (Seal and Lacy 1989). Third, panther numbers may already be so low that random fluctuations could lead to extinction. Protection of remaining habitat (Logan et al. 1994) and genetic restoration (Johnson et al. 1995, Seal 1994) are ongoing projects. However, the success of both these projects still leaves the Florida panther population vulnerable to random fluctuations that could lead to extinction. It will only be through the reestablishment of additional populations that this risk can be significantly reduced. It must first be decided, however, whether the tremendous costs involved (economic, political, social, etc.) in the reestablishment of additional Florida panther populations can be offset by the benefits gained in reducing the risk to the present Florida panther population.

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Table 1. Individual characteristics and release chronology for mountain lions released into northern Florida, 22 February 1993 to 30 June 1995.

Lion	Estimated Age at Release	Sex	Origin[a]	Dates in wild		Days in wild	Number of Locations
				From	To		
T30	4.0	F	W/C	02/22/93	04/28/93	66	60
T31	2.0	F	C	02/22/93	06/27/95	856	408
T32	2.0	F	C	02/22/93	11/10/94	627	306
T33	1.5	M	C	02/22/93	11/04/93	256	146
T33[b]				02/10/94	04/07/94	57	32
T35	3.0	M	W	02/22/93	04/18/93	56	51
T36	4.0	M	W	02/22/93	11/24/93	276	159
T37	2.0	F	W	02/22/93	03/07/95	744	361
T38	3.0	F	W	02/22/93	07/11/93	140	95
T39	3.0	F	W	02/22/93	03/30/94	402	218
T40	1.5	M	W	02/22/93	09/29/93	220	133
T40[c]				10/08/93	01/24/95	474	188
T41	3.0	F	W	07/15/93	04/08/95	633	284
T42	0.9	M	W	07/15/93	06/26/95	712	301
T43	0.9	M	W	07/15/93	06/30/95	716	310
T01	9.0	F	W/C	05/25/94	06/26/95	398	174
T45	1.2	M	C	05/25/94	11/15/94	175	75
T46	1.2	F	C	05/25/94	02/10/95	262	116
T02	9.0	F	W/C	06/26/94	11/17/94	145	64
T47	0.5	F	C	06/26/94	08/01/94	37	15
T48	3.0	M	W	07/12/94	06/28/95	352	148

[a]C = Captive-raised, W/C = Wild-caught/Captive-held, W = Wild caught
[b]T33 re-released after being brought into captivity during hunting season due to his lack of fear of humans.
[c]T40 re-released after being held in captivity for treatment of an arrow wound.

Table 2. The number of days from release until mountain lions moved into a consistent use area that eventually became a home range.

Lion	Sex	Origin[a]	Age	Release date	Date home range established	Days
T31	F	C	2.0	02/22/93	03/01/93	7
T32	F	C	2.0	02/22/93	03/28/93	34
T33	M	C	1.5	02/22/93	03/23/93	29
T36	M	W	4.0	02/22/93	04/13/93	50
T37	F	W	2.0	02/22/93	09/08/93	198
T39	F	W	3.0	02/22/93	02/26/93	4
T40	M	W	1.5	02/22/93	11/29/93	280
T41	F	W	3.0	07/15/93	11/01/93	109
T42	M	W	0.9	07/15/93	11/25/93	133
T43	M	W	0.9	07/15/93	01/13/94	182
T01	F	W/C	9.0	05/25/94	05/30/94	5
T45	M	C	1.2	05/25/94	06/17/94	23
T46	F	C	1.2	05/25/94	06/10/94	16
T02	F	W/C	9.0	06/26/94	06/26/94	0
T48	M	W	3.0	07/12/94	08/19/94	38

[a]C = Captive-raised, W/C = Wild-caught/Captive-held, W = Wild caught

Table 3. Home range characteristics for 15 mountain lions released into northern Florida, 22 February 1993 - 30 June 1995.

Lion group	*n*	Days to establish home range x ±SE	Home range center distance from release site (km) x ±SE	Size of home range (km^2) x ±SE
Captive females	3	19.0± 7.94[B]	17.9± 2.62[B]	101.0± 46.65[B]
Captive males	2	26.0± 3.00[B]	19.1± 0.22[B]	92.5± 52.50[B]
Wild/captive females	2	2.5± 2.50[A]	16.9± 7.43[B]	89.5± 53.50[B]
Wild females	3	103.7±56.07[B]	34.7±17.12[B]	102.0± 15.40[B]
Wild males	5	136.6±44.64[B]	123.8±21.50[A]	647.6±249.47[A]

Means with the same letter are not significant.

Table 4. Number of use areas and home ranges established by origin for mountain lions released into northern Florida, 22 February 1993 to 30 June 1995.

Captive-raised			Wild-caught/ Captive-held			Wild-caught		
Lion	Use Area	Home Ranges	Lion	Use Area	Home Ranges	Lion	Use Area	Home Ranges
T31	0	1	T30[a]	--	--	T35[b]	--	--
T32	0	1	T01	2	1	T36	0	1
T33	0	1	T02	0	1	T37	1	1
T45	0	1				T38	2	0
T46	0	1				T39	1	1
T47[c]	--	--				T40	3	2
						T41	2	1
						T42	2	1
						T43[d]	0	1
						T48	1	1

[a] T30 was recaptured prior to having an opportunity to establish a use area. She probably would have established a home range in the recapture area.
[b] T35 was illegally shot and killed prior to having an opportunity to establish a use area.
[c] T47 was recaptured prior to having an opportunity to establish a use area.
[d] T43 was recaptured while he was in the process of shifting to a new use area/home range.

Table 5. Characteristics and density of the mountain lion population in northern Columbia County, Florida, 22 February 1993 to 30 June 1995.

	Population make-up					
Dates	Sex Ratio	%C[a]	%W/C[a]	%W[a]	Area utilized (km^2)	Density (lions/ 100 km^2)
February '93 - June '93	1:3	75	0	25	225	1.8
July '93 - April '94	1:4	60	0	40	190	2.6
May '94 - November '94	1:6	57	29	14	418	1.7
December '94 - March '95	0:4	50	25	25	267	1.5
April '95 - June '95	1:3	25	25	50	127	3.1

[a]C = Captive-born, W/C = Wild-caught/captive-held, W = Wild caught

Table 6. Number of excursions outside of home ranges both in the peak-breeding season and non-peak-breeding season by whether or not the animal was part of a social structure of mountain lions released into northern Florida, 22 February 1993 to 30 June 1995.

Lion	In a social structure	Sex	Origin[a]	Season	Days on study	Number of excursions
T01	Yes	F	W/C	Peak-Breeding	212	0
T01	Yes	F	W/C	Non-Peak	186	0
T02	Yes	F	W/C	Peak-Breeding	48	0
T02	Yes	F	W/C	Non-Peak	97	0
T31	Yes	F	C	Peak-Breeding	492	0
T31	Yes	F	C	Non-Peak	364	0
T32	Yes	F	C	Peak-Breeding	321	0
T32	Yes	F	C	Non-Peak	306	0
T33	Yes	M	C	Peak-Breeding	160	2
T33	Yes	M	C	Non-Peak	153	0
T36	No	M	W	Peak-Breeding	123	0
T36	No	M	W	Non-Peak	153	2
T37	No	F	W	Peak-Breeding	438	12
T37	No	F	W	Non-Peak	306	2
T39	Yes	F	W	Peak-Breeding	249	0
T39	Yes	F	W	Non-Peak	153	0
T40	No	M	W	Peak-Breeding	389	5
T40	No	M	W	Non-Peak	305	0
T41	Yes	F	W	Peak-Breeding	402	1
T41	Yes	F	W	Non-Peak	231	0
T42	No	M	W	Peak-Breeding	424	1
T42	No	M	W	Non-Peak	288	0
T43	No	M	W	Peak-Breeding	424	2
T43	No	M	W	Non-Peak	292	0
T45	Yes	M	C	Peak-Breeding	46	0
T45	Yes	M	C	Non-Peak	129	0
T46	Yes	F	C	Peak-Breeding	133	1
T46	Yes	F	C	Non-Peak	129	0

Table 6. Continued.

Lion	In a social structure	Sex	Origin[a]	Season	Days on study	Number of excursions
T48	No	M	W	Peak-Breeding	212	1
T48	No	M	W	Non-Peak	140	0

[a]C = Captive-Born, W/C = Wild-caught/Captive-born, W = Wild-caught

Table 7. The differences between the proportion used and the proportion available, computed for each habitat, for mountain lions released into northern Florida, 22 February 1993 - 30 June 1995.

Habitat type	*n*	Mean difference	SE	Minimum	Maximum	Wilcoxon *P*-value
Coniferous forest	20	0.16792	0.027479	-0.10603	0.36644	<0.0001
Forested wetland/swamp	20	0.16517	0.019706	-0.02167	0.30690	<0.0001
Mixed forest	20	-0.05730	0.017395	-0.10911	0.12062	0.0063
Hardwood forest	20	-0.03522	0.018038	-0.11489	0.23350	0.0209
Other	20	-0.24057	0.011903	-0.32445	-0.14704	<0.0001

Table 8. Observation scores by category (weighted observation [in woods x 1, associated with deer feeder x 2, next to road x 3, and close to a house x 4]/lion-days x 1000) for mountain lions released into northern Florida and southern Georgia 22 February 1993 to 30 June 1995.

			Frequency of observation				
Origin	Lion	Days in study	In woods	Associated w/ deer feeders	Next to road	Close to house	Total score
Captive Raised	T31	856	0	0	0	0	0.00
	T32	627	1	3	0	0	11.18
	T33	313	0	2	2	3	70.51
	T45	175	1	1	0	0	17.24
	T46	262	0	0	0	1	15.33
	T47	37	0	0	0	0	0.00
	Subtotal	2,270	2	6	2	4	= 19.04
Wild Caught/ Captive Held	T30	66	0	0	0	0	0.00
	T01	398	0	1	0	0	5.04
	T02	145	0	0	0	0	0.00
	Subtotal	609	0	1	0	0	= 1.68
Wild Caught	T35	56	0	0	0	0	0.00
	T36	276	0	1	1	0	18.18
	T37	744	1	0	0	0	1.35
	T38	140	0	0	0	0	0.00

	T39	402	0	0	0	0	0.00
	T40	694	0	0	0	0	0.00
	T41	633	1	0	1	0	6.33
	T42	712	0	0	0	0	0.00
	T43	716	1	0	0	0	1.40
	T48	352	0	0	0	0	0.00
	Subtotal	4,725	3	1	2	0	= 2.73
	Total	7,604	5	8	4	4	= 7.71

Fig. 1. Florida Panther Reintroduction Feasibility Study Area, 22 February 1993 - 30 June 1995.

Fig. 2. Locations of 19 mountain lions released into northern Florida, 22 February - 30 June 1995.

Fig. 3. Overlapping home ranges of released mountain lions in the Suwannee River population, February 1993 - June 1993.

Fig. 4. Overlapping home ranges of released mountain lions in the Suwannee River population, July 1993 - April 1994.

Fig. 5. Overlapping home ranges of released mountain lions in the Suwannee River population, May 1994 - November 1994.

Fig. 6. Overlapping home ranges of released mountain lions in the Suwannee River population December 1994 - March 1995.

Fig. 7. Overlapping home ranges of released mountain lions in the Suwannee River population April 1995 - June 1995.

Fig. 8. Proportion of the study area occupied by each habitat type and the average of within-animal proportion of radio-locations in each habitat.

Fig. 9. Plot of observation scores by grouping. Radius of circle is proportional to number of observations at that value.

Appendix. Summary of individual mountain lion movements and activities.

T30

T30, a wild-caught/captive held (2 years), 4 year-old female, was released 22 February 1993. She moved northeasterly through the Pinhook Swamp after leaving the release site, crossing highway 2 near the Eddy fire tower. She then moved to the northwest, closely following the highway and adjacent railroad tracks, to the Jones Creek watershed north of Fargo, Georgia, where her movements became more restricted and predictable. She was captured on 12 April 1993 after landowner complaints about her presence and released approximately 41 km away in Osceola National Forest. She returned to the vicinity of Jones Creek within 11 days. She was captured and removed from the study 28 April 1993 (Figure A1).

T31

T31, a 2 year-old, captive-born female, was released 22 February 1993. She traveled west to the hardwood forests that lie in the floodplain along the Suwannee River by mid-March 1993. She remained in the vicinity of the river until she was captured 27 June 1995 when the study ended (Figure A2).

T31 was frequently located with male T33 (an unsuccessfully vasectomized male) during the spring and summer of 1993. Her movements became very localized during August 1993, and the area she utilized diminished from 48 km^2 to 29 km^2. A search of her presumptive den site found no kittens or evidence of kittens, and she was soon thereafter located with T33 again, suggesting that her kittens,if any, had died or that she had experienced a false pregnancy.

T33 was removed for the final time on 7 April 1994. T31 then expanded her home range to include the Little Creek area, where she was frequently located with male T45. During this time (1 July 1994 - 27 June 1995) she had a home range of 78 km^2. She was captured on 27 June 1995 as the field portion of the study ended.

T32

T32, a 2 year-old, captive-born female, was released on 22 February 1993. She remained in the vicinity of the release site through March 1993 before gradually expanding her range. She established a home range around Little Suwannee Creek, Little Creek, and the Suwannee River during the next 6 months (Figure A3). She was located with T33 from 18 - 20 March 1993 and from 28 - 30 June 1993. Her locations became restricted by the end of September 1993 to a 4.4 km^2 area north of Little Creek where she apparently had a den. Attempts to document the presence of kittens with her during this time were unsuccessful. Her movements increased to 59.3 km^2 by December 1993 as the kitten(s) began to travel with her, and she shifted her home range southward into commercial pinelands east of Little Creek. Her locations were generally associated with deer feeders within a few miles of Little Creek. She was observed by a hunter unsuccessfully stalking deer at a feeder in December 1993.

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

She was located with male T45 3 August and 7 November 1994. She was also occasionally located with and appeared to travel with females T02 and/or T46, often at the same time. She was found feeding on a new born calf on 9 November 1994 and removed from the study the next day.

A 54 kg male cougar (T51) was captured 29 April 1995, 2.1 km south of Waldo, Florida. Blood from T51 was sent to the National Cancer Institute's Laboratory of Viral Carcinogenesis for DNA analysis. The results indicated a 100% match at 21 "short tandem repeat polymorphism" (STRP) microsatellite chromosomal loci that indicated that T33 and T32 were the parents of T51 ($P \leq 0.01$).

T33

T33, a captive-born, 1.5 year-old male, was released 22 February 1993 and remained around the release site for approximately 3 weeks. He then used the area around Little Suwannee Creek before gradually expanding his home range to 145 km^2 that included the forests along the eastern side of the Suwannee River (Figure A4). After being temporarily removed from the study due to numerous interactions with humans, he was released and eventually utilized a 88 km^2 area that was very similar to the home range he established before his capture (Figure A5).

T33 was responsible for at least 11 interactions with humans that ranged from mere observations of him along forest roads to livestock depredations. A significant portion of these interactions occurred during short periods of time while he was on excursions out of his normal home range. He was temporarily removed from the study from 4 November 1993 - 10 February 1994 after being observed several times and possibly injuring a horse. Shortly after his second release he made an excursion to near Jasper, Florida, and while returning to his home range, killed a house cat near an occupied dwelling. He was captured and removed from the study 7 April 1994.

He was located at various times with females T31, T32, T38, T39, and T41 while a part of this study. Although a vasectomy was performed on all males, including T33, it became apparent that his was not successful. He eventually sired kittens with T32, T39, and T41 as well as with a captive female after he had been removed from the study. He was caught and electroejaculated (23 July 1993) after he sired his first litter with T39 (2 July 1993), but no sperm were evident. This resulted in the erroneous conclusion that T39 had become impregnated with residual sperm left in T33's vas deferens after vasectomy. It was concluded that his vasectomy had not been successful when it became evident that he had sired kittens with 2 other females.

T-35

T35, a 3 year-old, wild-caught male, was released 22 February 1993. He left the release site upon release and traveled west, made a large kill in the swamps near Little Suwannee Creek, and continued to move west. He made regular movements that ranged from the commercial pinelands near Tarver, Georgia to forests on and adjacent to Occidental phosphate mine north of White Springs, Florida (Figure A6).

T35 was last located on 17 April 1993 near Tarver. Radio signals from this animal could not be detected during numerous extensive aerial searches between 18 April 1993 and 30 April 1993. His tracks were found 19

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

April 1993 along a dirt road in Echols County, Georgia, approximately 7 km north of his last known location. Georgia Department of Natural Resources arrested a suspect on 13 July 1993 and charged him with killing T35. The suspect was able to lead investigators to the animal's remains and confessed to killing it with a bow and arrow.

T36

T36, a 4 year-old, wild-caught male, was released 22 February 1993. He made a few exploratory forays westward, crossed the Suwannee River into Georgia, and returned to the vicinity of the release pens. He entered Carter's Pasture, an exotic game hunting preserve on what appeared to be a return trip to the release site. He killed and consumed a male Spanish goat there on 8 March 1993. He was captured the next day and released 42 km away near the east boundary of Osceola National Forest. He traveled northeast following this release and his movements between 10 April 1993 and 27 April 1993 were associated with the St Mary's River. He then made a 185+ km trek from St. George, Georgia, to Levy County, Florida, between 28 March 1993 and 13 April 1993.

T36 spent the remainder of his life, 14 April 1993 - 24 November 1993 within a 421 km^2 home range in Levy County, Florida (Figure A7). We became concerned about the status of this animal when 4 consecutive locations indicated little or no movement between 20 and 24 November. Field observations on 24 November revealed that he was severely injured, able only to drag himself with his front legs. He was captured and euthanized after an examination revealed a single rifle bullet had severed his spine just anterior to the pelvis. Investigation of this incident by FGFWFC law enforcement officers did not result in an arrest.

T37

T37, a 1.5 year-old, wild-caught female, was released on 22 February 1993. She remained around the release site for 5 days before moving to the St Mary's River, where she remained for 2 weeks. She was found to be eating discarded chicken carcasses behind a commercial chicken operation. She then crossed the Okefenokee National Wildlife Refuge and traveled south along the Suwannee River to Occidental WMA, where she spent a few days. She then turned north and spent 2 weeks on Grand Bay Creek near Valdosta, Georgia, before continuing her northward trek during the next month (12 May 1993 - 15 June 1993). She was captured on 16 June 1993 near Sylvania, Georgia, approximately 270 km from the release site. She was transported back to Florida and re-released in Osceola National Forest. She then moved northeast and, for more than 2 months, restricted her movements to the hardwood forests along the St. Mary's River south of Folkston, Georgia. She moved north to the Satilla River north of Folkston in August 1993, where, except for several excursions, she spent the remainder of her life in a 111.3 km^2 home range. She was struck by a vehicle and killed 7 March 1995 on I-95 while on an eastward excursion (Figure A8). As with most of the other animals that occasionally wandered out of their home range for a few days before returning, these excursions seemed to begin when T37 reached sexual maturity, and the majority occurred during the cooler months.

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

T38

T38, a 3 year-old, wild-caught female, was released 22 February 1993. After remaining around the release site for 4 days, she traveled northwest to Little Suwannee Creek (Figure A9), where she was located with T33 on several occasions. The remains of a hog were found at 1 of these sites. She traveled south along the Suwannee River to Deep Creek after 2 months and then southeast to commercial pinelands north of Lake Butler WMA, where she remained until being killed on highway 301 near Maxville, Florida, on 1 July 1993 (Figure A10).

T39

T39, a 3 year-old, wild-caught female, was released 22 February 1993 and for the next 4 months ranged over a 123 km^2 area between Little Suwannee Creek and the junction of Deep Creek and the Suwannee River (Figure A11). She was located with T33 several times during this period. Her movements became restricted to a small area (7 km^2) south of highway 6 near the Suwannee River on 2 July 1993. She displayed aggressive behavior indicative of denning when approached. She moved her kitten north of highway 6 after leaving the den on 30 August 1993 but made only small movements during the next 2 months (Figure A12). Tracks and other sign indicated the presence of a single kitten. She gradually increased her movements to include an area of 47.3 km^2 while traveling with her kitten (Figure A13). An attempt was made to capture and radio-instrument the kitten on 3 March 1994. The male kitten jumped from where it was treed and ran a short distance when darted. Although the kitten (T44) was handled within 90 seconds of jumping, it succumbed to the anesthesia while in a shallow puddle and aspirated water when its head came to rest in 6-8 cm of water. It was revived but died 3 days later. Necropsy revealed that the dart had hit a vein in the kitten's shoulder, which caused the animal to become immobilized within seconds instead of the intended 6-10 minutes, as when the drug is administered intramuscularly.

T39 was found dead 30 March 1994. She had become entangled in a snare which severed her trachea and left jugular vein.

T40

T40, a 1.5 year-old wild-caught male, was released 22 February 1993 and remained around the release site for a week. He then traveled southeast and spent a month in a small (24 km^2) area south of Macclenny, Florida (Figure A14). He then traveled north along the St Mary's River, made a large kill on White Oak Plantation, and continued north, paralleling highway 301 to near Jesup, Georgia. He was recaptured near Statesboro, Georgia on 22 June 1993 more than 240 km from the release site. He was transported back to Osceola National Forest and released. He had traveled northeast into Paulk's Pasture WMA near Brunswick, Georgia by 2 August 1993, where he remained for 2 months. He was shot and wounded in the back with an arrow on 28 September 1993. He was captured and transported to the Gainesville Wildlife Research Lab the next day. A suspect was arrested by Georgia Department of Natural Resources and convicted. T40 was treated and released back into Paulk's Pasture 10 days

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

after being shot and remained there until December 1993. T40 shifted into a 1610 km^2 home range centered around the Canoochee River on Ft. Stewart Military Reservation (Figure A15) after making a few northerly excursions. T40, now more than 2 years old and sexually mature, made numerous excursions away from Ft. Stewart during the next 6 months. Most excursions were westerly along the Altamaha and Ocmulgee rivers and 2 reached as far as Fitzgerald, Georgia, more than 160 km from the center of his Ft. Stewart home range. During June - July 1994, T40 gradually moved north, stopping 1 August 1994 near Louisville, Georgia (Figure A16). He used this area exclusively until November 1994, when he made a southern excursion that stopped just north of Ft. Stewart before returning to the vicinity of Louisville. He left Louisville in January 1995 and traveled north to an area near Washington, Georgia, more than 380 km north of the original release site. This excursion and apparent shift in use areas carried him into areas beyond our ability to respond to potential emergency situations involving this animal, and he was recaptured on 24 January 1995 and removed from the study. T40 never established a home range with the exception of the 6 month period he remained on Ft. Stewart. He had a series of use areas that were utilized for a few weeks to a few months. Abandonment of a use area was generally preceded by a series of lengthy excursions. He was never located with a female during this study.

T41

T41, a 3 year-old, wild-caught female, and her 2 approximately 10 month-old, male kittens (T42 and T43) were released 15 July 1993 and used the area around Little Suwannee Creek until 27 September 1993 (Figure A17). They moved westward and utilized the area along the Suwannee River until 4 November 1993 when T41 was located with T33. T42 and T43 soon left the Suwannee River and were never again located with their mother.

T41 used a 72 km^2 area along the east side of the Suwannee River until 22 June 1994, when her movements became restricted to a very small area (13 km^2), indicative of denning. She appeared to move her kitten(s) south to the area around Deep Creek in September 1994. She restricted her movements to a 11 km^2 area near the junction of Deep Creek and the Suwannee River from 5 September 1994 until 31 January 1995 (Figure A18). An 8 month-old, 31 kg male kitten was killed on highway 441 south of highway 6 on 25 February 1995. T41's presence nearby suggested that she was the mother. Subsequent field searches revealed the presence of another kitten traveling with her. This kitten, a 27 kg female (T49), was caught and radio-collared 20 March 1995. T41 and T49 were located 8 April 1995 inside Carter's Pasture, where they had killed and consumed 2 Sika deer. They were caught and removed from the study.

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

T-42

T42 was a 10 month-old, 32 kg kitten of T41 when he was released on 15 July 1993. He remained with his mother and brother (T43) until 4 November 1993, when his mother was located with male T33 near the Suwannee River. He left the vicinity of the Suwannee River and traveled northwest to the Alapaha River east of Valdosta, Georgia, by 24 November 1993. He occupied a home range of only 77 km^2 centered around the Alapaha River until 9 May 1994. He then gradually expanded his movements to the west to include Grand Bay Creek within the 179 km^2 he used during the next 3 months (Figure A19). He was captured and fitted with a new collar to accommodate growth on 9 August 1994. He had doubled his weight to 63 kg in 13 months. Shortly after capture, he shifted his use area to the east a few kilometers and made excursions to the north along the Alapaha River, eventually reaching the vicinity of Rebecca, Georgia, approximately 140 km away. He left the Alapaha River on 8 April 1995 and within a week returned to the Suwannee River, where he remained until the study ended in June 1995 (Figure A20). He was located with females T01 and T31 after returning to the area around the Suwannee River.

T43

T43, brother of T42 and kitten of T41, weighed 31 kg and was approximately 10 months-old when released 15 July 1993. He remained with his mother and brother until 4 November 1993, when his mother was located with T33. He left the vicinity of the Suwannee River and traveled west, stopping at the Alapaha River near Jasper, Florida, for 2 weeks before continuing westward to an area southwest of Madison, Florida, where he remained for a month. He left this area and traveled northwest to the Ochlockonee River south of Cairo, Georgia, by 8 January 1994. He used a 64 km^2 area around the Ochlockonee River until May 1994, when he expanded his movements to include the Attapulgus Creek and Swamp Creek watersheds southwest of Cairo (Figure A21). He utilized 20+ m deep canyons in clay mines that had ceased operations some 50 years prior while in the Attapulgus Creek area. He was captured at the bottom of 1 of these canyons on 4 August 1994 and recollared. He weighed 63 kg. He continued to use this home range until 19 May 1995, when he left and traveled south to the area around the Econfina River west of Perry, Florida, where he remained until the study ended. He was removed 30 June 1995 (Figure A22).

T01

T01, a 9-10 year-old, wild-caught/captive-held (8 years) female, and her 2 captive-born and raised, 14 month-old kittens (T45_, T46_) were released into the study area 25 May 1994. T01 left after spending a few days with her yearlings in the vicinity of the release pens. Her offspring, possibly as a result of having been in captivity their entire lives, did not follow their mother and were never located with her again.

T01 traveled northeast to the vicinity of Taylor, Florida, where she remained until 25 August 1994, when she

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

left and traveled westward to the Suwannee River, where she remained until December 1994. She was captured inside a fox pen on 16 December 1994 after several flights revealed little movement. She was transported to the original release site and released. She then wandered north into the Okefenokee National Wildlife Refuge before returning by 20 January 1995 to the Suwannee River north of White Springs, where she remained until the study ended (Figure A23). She was located with T42 several times in June 1995.

T45

T45, a 14 month-old, 39 kg, captive-raised male, was released 25 May 1994 with his mother (T01) and sister (T46). When his mother left the release site he did not follow her. He had wandered west to the area around Little Creek that became the center of his home range (Figure A24) by 17 June 1994. He was removed 15 November 1994 for killing and eating a newborn calf. He was found feeding on this calf with T02. He was located with females T46, T32, T31, and T02 during his brief stay. He was occasionally located with more than 1 female at the same time.

T46

T46, a 14 month-old, 25 kg, captive-raised female, was released with her mother (T01) and brother (T45) on 25 May 1994. T46 did not go with her mother when she left the vicinity of the release pens. Instead, she remained near the pens with her brother for 10 days before making any independent movements. She had traveled to the area around Little Creek by mid-June 1994 where she remained until February 1995 (Figure A25). Her casualness around people and dwellings generated several complaints about her presence, and she was captured and removed from the study on 10 February 1995.

T02

T02, a 9 year-old, wild-caught/captive-held (8 years) female and her 5 month-old, 9 kg, female kitten (T47) were released 26 June 1994. They remained together in the vicinity of the pens until 18 July 1994, when T02 was located approximately 3 km west of her kitten. T02 returned briefly to the vicinity of her kitten 20 July 1994 before leaving and making a kill approximately 6 km away. T02 remained in the vicinity of her kill until 29 July 1994. It was becoming apparent by this time that T47 had been abandoned, perhaps due to her refusal or inability to follow her mother. T47 had been alone and in the same location near the pens for two weeks, apparently without food. T47 was captured and removed from the study on 1 August 1994. She was in good health although very thin. It appears that being compelled to follow her mother was not a skill easily taught or learned in captivity, where the use area was only a few hectares, food was abundant, and eating was not dependent upon travel with her mother.

T02 increased her movements, wandering west to the Suwannee River, before settling into an area around the

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.

northern end of Little Creek (Figure A26). She remained there until she was found feeding on a newborn calf with T45 on 14 November 1994 and removed from the study.

T48

T48, a 3 year-old, wild-caught male, was released 12 August 1994. He left the release pen and moved west to the Suwannee River and then south along the river. He then traveled east along I-10 to the vicinity of Macclenny, Florida, and then north along Trail Ridge to the southern end of Okefenokee National Wildlife Refuge. He crossed the Refuge in August 1994 in a northwesterly direction, stopping just south of Waycross, Georgia. He remained in the vicinity of Waycross, where he included the Waycross State Forest within his home range, until March 1995 (Figure A27). T48 made an excursion along the nearby Satilla River from 15 February to 3 March 1995 before returning to his home range for a few days. He left this area for good and traveled to western Georgia between 9 March and 23 April 1995. He traveled along the Chattahoochee River and many of its tributaries between Lumpkin and Blakely, Georgia (Figure A28). He was captured and removed 28 June 1995 when the study ended.

Fig. A28. Locations of wild-caught male T48 along the Chattahoochee River, Seminole, Miller, Clay, Randolf, Quitman, and Stewart counties, Georgia, April - June 1995.