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POPULATION DYNAMICS AND MOVEMENTS OF PROBLEM BLACK BEARS IN GREAT SMOKY MOUNTAINS NATIONAL PARK

A Thesis

Presented for the

Master of Science

Degree

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William Henry Stiver

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ABSTRACT

From 10 July 1967 to 6 December 1989, 341 black bears (Ursus americanus) in Great Smoky Mountains National Park were captured and relocated 570 times. Capture, release, and recovery locations of relocated bears were plotted on topographic maps using the Universal Transverse Mercator grid system. Objectives of this study were to delineate the sex and age structure of problem black bears and to determine factors contributing to the success of black bear relocations.

Excluding cubs and dependent yearlings, mean ages at initial capture of male and female bears were 3.9 and 4.6 years, respectively. Males comprised 61.9% of all captured bears, and 54.7%, 72.9%, and 58.0% of cubs, subadults, and adults, respectively. The higher percentage of males was likely due to their larger home ranges and wide dispersal patterns of the subadult age class. Only 18 of 504 tagged research bears (3.6%) were subsequently captured for creating problems; this suggests that problem bears comprise a small percentage of the overall bear population.

Seasonal distribution of captures of problem bears coincided with public visitation in Great Smoky Mountains National Park. Most captures of problem bears were in summer (75.1%) and were associated with areas of high public visitation. A significant interaction (P=0.025) existed between the sex, age class, and season in which bears

initially were captured. Seasonal differences in home range use and activities by different sex and age classes of bears were probably responsible for this interaction.

The number of problem bear relocations each year ranged from 4 to 80. The number of individual problem bears captured each year ranged from 2 to 63 and may indicate fluctuations in the bear population. Changes in National Park Service policies regarding bears, advances in capture techniques, and financial and personnel constraints also were partly responsible for yearly trends in captures of problem bears.

Most relocated bears (55.6%) were never recovered, and 32.4% were recaptured due to persistent nuisance behavior. Recaptured bears ($\bar{x}$=4.1 years) were significantly older (P=0.0052) than those not recaptured ($\bar{x}$=3.0 years). Only 14.3% of bears relocated distances greater than 64 km were recaptured. Mean time elapsed between release and recapture was 297 days; males and females averaged 225 and 399 days, respectively. Bears with previous relocation experience were recaptured more frequently and in fewer days than those relocated for the first time. Several bears returned distances near or exceeding 100 km, overcoming significant natural and artificial barriers such as lakes, rivers, major highways and human developments.

At least 63 bears in this study (18.5%) were killed. Most bear mortality was due to legal harvest, however, no

relocated bears were reported as part of the legal bear harvest in Tennessee. The percentage of males and females killed were 19.7% and 17.3%, respectively. Mean time from relocation to recovery was 253 days. Forty bears were killed the same year they were relocated. Bears were recovered a mean of 43.3 km from their release site and 84.5 km from their capture site.

The success of black bear relocations can be enhanced by designing a definitive relocation strategy based on the sex and age of bears, season captured, relocation distance, release area, and previous experience. Relocations, however, are not practical for all problem bears, and some bears probably should be destroyed. Relocations should be used in combination with other methods to reduce nuisance behavior of bears, and the availability of human food and garbage.

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CHAPTER I

INTRODUCTION

Background

Yellowstone National Park was established in 1872; shortly thereafter, visitors began interacting with bears. As early as 1890, bears were chained to posts for public viewing (Marsh 1972). Yellowstone, Sequoia/Kings Canyon, and Yosemite National Parks maintained daily bear feeding sites near tourist facilities (Ise 1961, Harms 1976 in Hastings 1983, Zardus and Parsons 1980). Food, usually garbage, was hauled to designated areas to attract bears for public viewing. These feeding shows undoubtedly changed the foraging habits and distribution of bears, concentrating them where they were likely to cause trouble.

In the 1950's and 60's, the national parks adopted regulations that prohibited feeding wildlife (Ise 1961, LaFollette 1974). Bear management and control, which included trapping and relocating, or destroying habitual problem bears, also was emphasized (Zardus and Parsons 1980). Despite regulations that prohibited feeding wildlife and emphasis on bear control, visitor-bear conflicts continued to occur. From 1966 to 1976, Yosemite National Park averaged 288 damage incidents per year (Harms 1980). Sequoia/Kings Canyon National Parks averaged 220 bear incidents each year from 1959 to 1976 (Zardus and Parsons

1980). From 1964 to 1976, Great Smoky Mountains National Park (GSMNP or Park) averaged 59 damage incidents each year (Singer and Bratton 1977). Food rewards, as a result of improper garbage disposal and/or feeding, were a contributing factor in many incidents.

In the mid 1970's national parks began developing Bear Management Plans. The purpose of the plan was "to manage visitors, bears, and Park operations in such a manner that the bear's natural existence is not impinged upon, yet provide for safe visitor use that will minimize bear-person conflicts" (NPS 1981:1). Objectives for managing bears are: 1) to preserve and perpetuate populations of black bears under natural conditions; 2) to minimize and prevent person-bear conflicts; and 3) to allow bears to lead a natural life with minimum interference by humans (NPS 1981). Strategies to reduce bear problems included education of visitors and employees, removal of unnatural food, enforcement of park regulations, standardization of bear control procedures, and research and monitoring (NPS 1981).

The Problem

Despite the closure of dumps and implementation of Bear Management Plans, human-bear conflicts continue to occur in many national parks. Yellowstone and GSMNP are well known for their bear problems. Visitor-bear conflicts also exist in Glacier (McArthur 1981), Yosemite (Harms 1980), Sequoia/Kings Canyon (Zardus and Parsons 1980), Crater Lake

(Collum 1974 in Hastings 1983), North Cascades (Martinka 1977 in Hastings 1983), and Shenandoah national parks (Williamson et al. 1980). Violations of NPS regulations regarding feeding and problem bears (Pelton 1975, Singer and Bratton 1977), visitor density (Singer and Bratton 1977, Kaey and Van Wagtendonk 1983), habitat condition (Harms 1979), and, to a lesser degree, bear densities, all appear to contribute to these conflicts.

The opportunistic behavior of bears contributes to the negative interactions between visitors and bears. Their omnivorous food habits allow them to feed on a variety of food items, many of which are only available seasonally. Black bears are a highly mobile, curious, intelligent, and very adaptable animal (Pelton 1982). Given the opportunity, bears will exploit human food sources at landfills, garbage cans, campgrounds, and picnic areas and move long distances to use them (Jonkel and Cowan 1971). Bears learn to associate food with people, coolers, backpacks, tents, trailers, and vehicles, and may become bold or even aggressive in their attempts to obtain it (Craighead and Craighead 1972, Tate 1983); these traits may be passed from mother to offspring (Tate 1983). Bears that feed on human food and garbage exhibit significant weight gains and increased fecundity (Jonkel and Cowan 1971, Rogers 1976, Rogers et al. 1976, McLean and Pelton 1990). Therefore, in terms of energetics, it is advantageous for bears to exploit

nutrient rich foods such as garbage.

Visitor behavior also contributes to and reinforces the nuisance behavior of bears. Generally, visitors are naive regarding the biology and behavior of black bears (Burghardt et al. 1972, Pelton et al. 1976, Petko-Seus and Pelton 1984). Many visitors actively feed bears despite prominently displayed regulations prohibiting the feeding of wildlife (Tate 1983). This active feeding reinforces the nuisance behavior of bears (Stokes 1970, Tate 1983). The desire of visitors to see, photograph, and even touch a "wild" bear outweighs their understanding of Park regulations and the potential danger. As a result, each year several visitors are scratched, bitten, or frightened by bears. Until visitors understand that feeding bears is dangerous and has negative effects, human-bear encounters will continue.

The estimated population density of black bears on a study area in GSMNP ranges from 1 bear per 2.71 km^2 to 1 bear per 3.42 km^2 (Pelton and Marcum 1975, McLean 1991). Extrapolation of these estimates Park-wide result in a population of roughly 600-800 bears. Bait station surveys indicate that bear densities are not uniform in the Park (Johnson 1989). More realistic estimates of the bear population in GSMNP range from 400 to 600 bears (M. Pelton pers. commun.). Approximately 10 million people visit the Park annually, creating a scenario in which the probability

of bear/human encounter is high.

Estimates indicate that problem bears comprise about 5% of the total black bear population in GSMNP (Pelton and Burghardt 1976). This can be roughly calculated based on the average number of management actions each year versus the overall population estimate of the Park. Although the number of bears creating problems is relatively low, the NPS spends a disproportionate amount of time, manpower, and money managing them.

Current Management Strategy

When a human/bear conflict occurs, the NPS must address both the visitor and the bear. Visitors that are guilty of improper food storage or feeding may be fined. The NPS (1981) identified 3 alternatives for handling problem bears in GSMNP: 1) relocate bears within the Park known to be first offenders and exhibiting no belligerent or aggressive behavior; 2) donate any bear known as a second offender and exhibiting aggressive behavior traits to the state wildlife agency in the state in which it was captured; and 3) destroy bears exhibiting aggressive traits.

Capturing and relocating is the primary management alternative for problem bears in GSMNP. However, some relocated bears exhibit the ability to return to the capture area. Distance relocated (Sauer et al. 1969, Beeman and Pelton 1976, Alt et al. 1977, Singer and Bratton 1977, McArthur 1981, Rogers 1986a), physiographic barriers

(McArthur 1981, Fies et al. 1986), age (Erickson et al. 1964, Harger 1970, Alt et al. 1977, Harms 1980, Massopust and Anderson 1984, Rogers 1986b), experience (Beeman and Pelton 1976, McArthur 1981), and human activities and land use patterns (Fies et al. 1986) all likely contribute to the success of black bear relocations. Other potential variables such as sex, reproductive status, season moved, mother-young and sibling-sibling relationships, population density at capture and/or release site, and trauma associated with being captured also may be involved in the homing tendencies and, therefore, relocation success of black bears (Pelton 1984).

Beeman and Pelton (1976) identified potential problems associated with relocating problem bears in GSMNP. First, the Park may not be large enough (approximately 32 km by 70 km) for this management practice. Rogers (1986a) found 81% of adult bears relocated distances less than 64 km returned; 1 bear returned 228 km (Harger 1970). Second, moving bears to remote areas is hindered by the limited road system within the Park. Basically, problem bears are relocated to only 3 areas in GSMNP: Parsons Branch Road, Cataloochee/Mt. Sterling, and Twentymile. Third, relocating problem bears is time consuming, expensive, and limited by the availability of manpower. Finally, the lack of a buffer zone and presence of a high human population density surrounding GSMNP may increase these animals' vulnerability

to poaching.

The biological implications of relocating problem bears is generally not known. Capturing and relocating bears may affect the sex and age structure of both the population into which they were released and that from which they were removed. Relocating problem bears into a population that is near carrying capacity may: 1) lead to competition and displacement of the problem animal or perhaps smaller resident bears; 2) precipitate or stimulate unusual movements of relocated or resident individuals; and 3) increase vulnerability to mortality (Stokes 1970, Rogers 1986a). Removing a large number of bears from an area may exploit the population, creating vacant niches for other problem bears (Kemp 1976, Young and Ruff 1982, Rogers 1986a); this may influence the sex and/or age structure, life expectancy, and fecundity of the remaining individuals.

The Current Project

Since 1967, data on problem bears for GSMNP have been collected and stored in a computer file at The University of Tennessee, Knoxville (UTK). A preliminary study on homing of black bears in GSMNP was conducted prior to 1976 (Beeman and Pelton 1976). Limited telemetry data also are available for problem bears in GSMNP (Beeman 1975, Hastings 1983, Hastings et al. 1987). However, previous studies on problem bears in GSMNP were hampered by small sample sizes and missing data.

Although relocating problem bears appears moderately effective, it is expensive (i.e. transportation costs and man-hours), controversial, and needs to be more efficient in preventing bears from returning to problem areas. Therefore, it is vital that a management strategy address the variables important in the success of black bear relocations. Analysis of these data should help clarify policies and standardize future management procedures for problem bears in GSMNP.

Specific objectives of this study were:

1) to delineate the sex ratios and age structure of problem black bears in Great Smoky Mountains National Park;
2) to determine factors contributing to the effectiveness of black bear relocations in Great Smoky Mountains National Park;
3) to determine the effect of relocation on the mortality of relocated black bears in Great Smoky Mountains National Park.

CHAPTER II

STUDY AREA

Location

Great Smoky Mountains National Park is located approximately between 35° 26' and 35° 47' N latitude and 83° 2' and 84° 0' W longitude, covering 2,072 km^2 (Fig. 1). A single ridge divides the area geographically and forms the political boundary between Tennessee and North Carolina. The area includes parts of Blount, Sevier, and Cocke counties, Tennessee, and Haywood and Swain counties, North Carolina.

The area surrounding the Park includes 2 national parkways, 3 national forests, an indian reservation, and an extensive system of reservoirs developed by the Tennessee Valley Authority (TVA). The Cherokee National Forest, Tennessee, borders the Park to the southwest. The Pisgah National Forest, North Carolina, borders the Park to the northeast. To the south lies the Nantahala National Forest, North Carolina, and the Cherokee Indian Reservation, North Carolina. The land to the north is privately owned.

Physiography and Geology

The Great Smoky Mountains form part of the Unaka Mountain range in the Blue Ridge Province of the Southern Appalachian Highlands (Fenneman 1938). Steep slopes and narrow valley bottoms characterize the area. Elevations

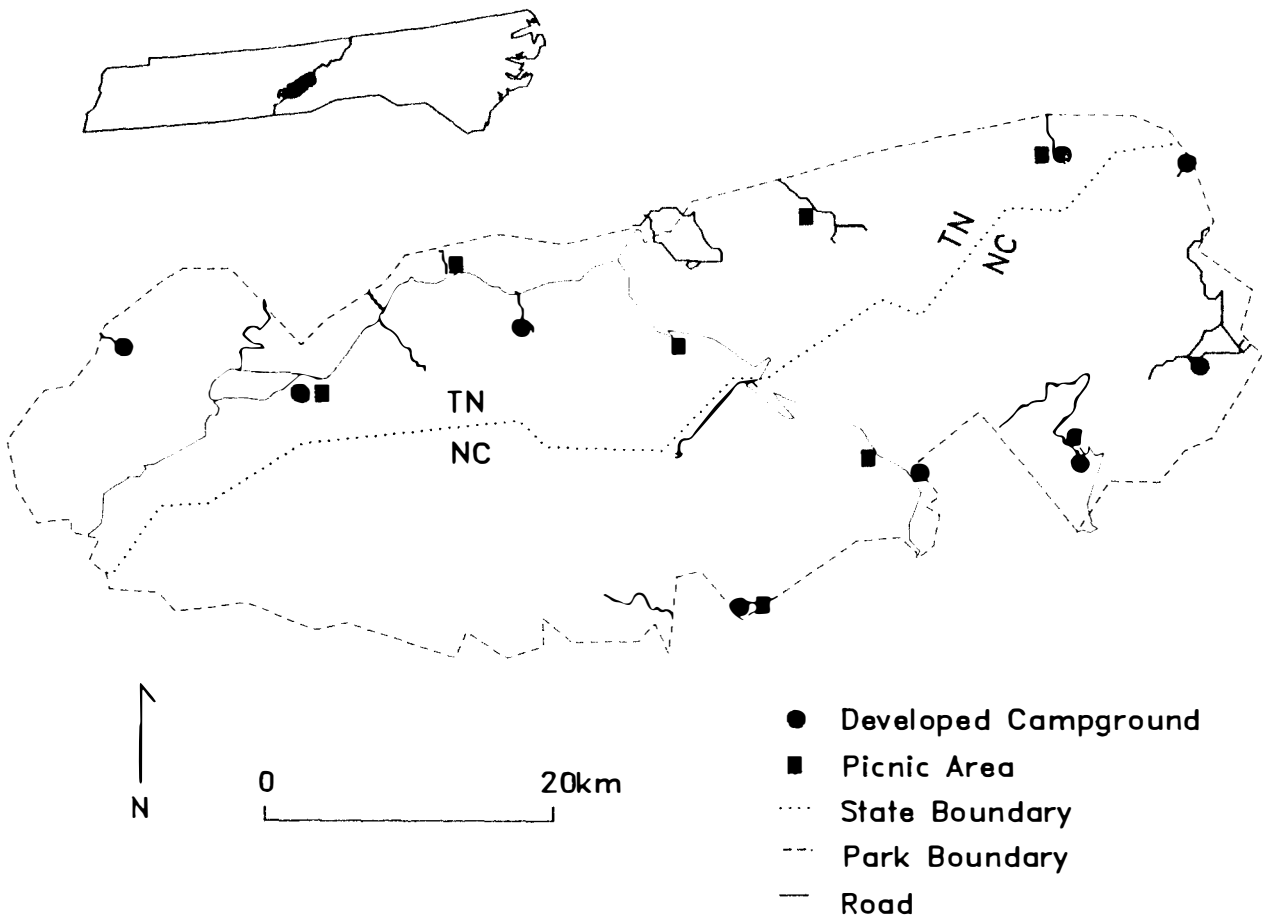

Figure 1. Map of Great Smoky Mountains National Park.

range from 230 m where Abrams Creek leaves the Park to 2024 m at Clingman's Dome. The parent materials of the primary soils within GSMNP are noncalcareous shales, quartzites, and sandstones of the Ocoee series (King and Stupka 1950). Over 900 km of streams dissect the Park and drain into the Oconaluftee and Tuckasegee rivers in North Carolina, and the Little Pigeon and Little Tennessee rivers in Tennessee (NPS 1979).

Climate

The climate of GSMNP, which is influenced by elevation, has been classified as mesothermal perhumid (Thornthwaite 1948). Precipitation averages from 140 cm per year at lower elevations to 220 cm at higher elevations (Stephens 1969). Highest precipitation occurs in July; September and October are the driest months. Average annual temperature ranges from 8°C at higher elevations to 14°C at lower elevations. Highest temperatures occur in July; lowest temperatures in February. Cloud cover increases with elevation and decreases during the warmer part of the year (Stephens 1969).

Biota

Flora. The Park has received world-wide attention as an international biosphere reserve because of the tremendous variety of plant communities. The change in vegetation from Gatlinburg, Tennessee or Cherokee, North Carolina to

Clingman's Dome is comparable to that seen by traveling 1,600 km northward (King and Stupka 1950). Nearly 1,500 taxa of vascular flora exist in the Park, including 288 exotic species (White 1982). Over 2,400 non-flowering plants have been identified, including 50 ferns and fern-allies, 330 mosses and liverworts, 230 lichens, and 1,800 fungi have been identified (King and Stupka 1950).

Approximately 95% of the Park is dominated by forests that comprise a complex of several vegetation types (Stupka 1960). Major forest associations include: spruce-fir, cove hardwoods, hemlock, northern hardwoods, closed oak, and open oak (Table 1) (Shanks 1954). Roughly 65,000 to 81,000 ha of old growth forest still exist within the Park (NPS 1979).

Fauna. Prior to the reintroduction of the river otter (*Lutra canadensis*) (Griess 1987), at least 60 species of mammals were known to inhabit GSMNP; an additional six species are listed as extirpated (Linzey and Linzey 1971). More than 200 species of birds, 80 species of reptiles and amphibians, 80 species of fish, and a tremendous variety of insects and other invertebrates are found within the area (King and Stupka 1950).

History and Land Use

The Cherokee Indians inhabited the area prior to the 1700's. Early pioneers began settling into the area and established small homesteads in the mid to late 1700's. Commercial logging, which occurred in 2 distinct phases,

Table 1. Vegetation types and their important tree species in the Great Smoky Mountains.

Vegetation type	Important species
Cove hardwood	Yellow poplar (*Liriodendron tulipifera*)
	Eastern hemlock (*Tsuga canadensis*)
	Yellow buckeye (*Aesculus octandra*)
	Silverbell (*Halesia carolina*)
	Beech (*Fagus grandiflora*)
	Yellow birch (*Betula alleghaniensis*)
	Black cherry (*Prunus serotina*)
Hemlock	Eastern hemlock
	Yellow birch
	Silverbell
	Fraser magnolia (*Magnolia fraseri*)
Northern hardwood	Beech
	Sugar Maple (*Acer saccharum*)
	Yellow buckeye
	Yellow birch
Closed oak	Chestnut oak (*Quercus prinus*)
	White oak (*Q. alba*)
	Black oak (*Q. velutina*)
	Northern red oak (*Q. rubra*)
	Pignut hickory (*Carya glabra*)
	Mockernut hickory (*C. tomentosa*)
	Sourwood (*Oxydendrum arboreum*)
Open oak-pine	Pitch pine (*Pinus rigida*)
	Scarlet oak (*Q. coccinea*)
	Virginia pine (*P. virginiana*)
	Sassafras (*Sassafras albidum*)
Spruce-fir	Red spruce (*Picea rubens*)
	Fraser fir (*Albies fraseri*)

Source: R. E. Shanks. 1954. Reference list of native plants in Great Smoky Mountains, Botany Department, The University of Tennessee, Knoxville. (Mimeographed).

began about 1880 (Lambert 1961). From 1880 to 1900, logging consisted of peripheral logging or selective cutting. The second logging period, which consisted of machinery cutting and clearcuts, began at about the turn of the century (Lambert 1961). By the early 1900's the activities of logging companies drastically altered the Great Smoky Mountains. From 1900 to 1939 nearly two-thirds of the Great Smoky Mountains was logged or burned. With the logging companies came railroads, improved logging technology, and villages with local markets (Dykeman and Stokely 1978). This influx of railroads and towns made the mountains more accessible.

Establishment of the Park was authorized by an Act of Congress on 22 May 1926. Unlike most national parks, which are established by the federal government, GSMNP was purchased from the logging companies and local families by donations from the people of Tennessee and North Carolina. Because GSMNP is a gift from the people to the federal government, there is no entrance fee to visit the Park.

Roughly two-thirds of the nation's human population live within a 17 hour drive of the Park. Approximately 10 million visitors enter the Park each year, making it the most visited national park in the United States. Recreational activities include viewing the Park by motor vehicle, hiking, camping, horseback riding, bicycling, and water-related recreation (NPS 1979).

CHAPTER III

MATERIALS AND METHODS

Data used for this study were accumulated from GSMNP's Resource Management records on black bear control. Much of this information was already stored in a data base at UTK. Additional data, primarily harvest records, were compiled from wildlife and fisheries agencies in Georgia, North Carolina, South Carolina, Tennessee, and Virginia. Data were compared, corrected for errors, and converted into a standard computer format for statistical analysis (Johnson et al. 1986). These data include 708 observations of 413 bears recorded from 10 July 1967 to 6 December 1989 (Appendix A).

Capture and Handling

Bears were captured using 1) Aldrich spring-activated snares (Aldrich Animal Trap Co., Clallam Bay, WA), 2) barrel traps, 3) trailer-mounted culvert traps, and 4) free ranging immobilization (Johnson and Pelton 1980b). Injections were accomplished using a Cap-chur syringe fired from a CO_2 pistol or rifle (Palmer Chemical and Supply Co., Inc., Douglasville, GA) or a syringe on a rod. Bears were immobilized with a combination of Ketamine, Rompum, and Carbocaine that was injected intramuscularly (Cook 1984); in earlier years, other immobilization drugs were employed (Cook 1982).

Captured bears were weighed, measured, and general body condition recorded; these data were not consistently recorded. Most bears were marked with ear tags and a lip tattoo (Johnson and Pelton 1980a). A first premolar was extracted from most bears and later sectioned and stained (Eagle and Pelton 1978) for aging by cementum-annuli counts (Willey 1974). Cubs and yearlings were easily recognized by body size. External parasites, hair, and blood also were collected from some individuals. Following processing, bears were transferred to culvert traps or hog traps for relocation. These bears were transported to remote areas within GSMNP or donated to state wildlife agencies of North Carolina or Tennessee for relocation.

Definitions

This study included only bears that were captured because they were creating problems. Some bears (n=41) in the data set were in uncertain categories (ie. orphaned cubs (n=6) and individuals involved in bear/vehicle collisions (n=35)); these bears were not included in the analyses. Not all relocated bears were necessarily problem bears (n=12), and some problem bears were not relocated (n=29). Some bears with a previous history of nuisance behavior were later captured and released on traplines as part of the backcountry studies conducted by UTK (n=9). Also, some bears originally captured on traplines by UTK were later captured as problem bears (n=18). Therefore, some animals

were labeled as both problem and research bears (n=27). Research bears that were captured as nuisance bears were included in the analyses.

A relocation was considered successful if a bear was not recaptured as a nuisance. Also, relocated bears that were hunter killed or recaptured in the backcountry as part of the UTK study were considered successful relocations. Ages were divided into 3 groups: 1) cub (less than 1 year old); 2) subadult (less than 4 and greater than 1 year old), and 3) adult (4 or more years old). Seasons were defined as spring (March-May), summer (June-August), and Fall (September-December). Experienced bears were those that had been previously captured and relocated.

Measuring Distances

Capture, release, and recovery sites of bears were plotted on 7.5 minute U.S. Geological Survey topographic maps. Each location was converted to X and Y coordinates using the Universal Transverse Mercator (UTM) grid system. Specific sites could not always be determined. The distance between locations was determined using the formula:

$$D=((X_1-X_2)^2+ (Y_1-Y_2)^2)^{1/2}$$

were D is the distance between locations, X_1 and Y_1 are the coordinates for the first location, and X_2 and Y_2 are the coordinates for the second location. Distances were measured as a straight line without regard to topographic or hydrographic features, resulting in minimum distances.

Park Visitation

Records on monthly and yearly visitation rates were collected for GSMNP (Appendix C). Monthly and yearly visitation in GSMNP were recorded as recreational visits. Recreational visits were determined by multiplying the number of cars at entrance points by the mean number of visitors per car; these figures do not include Park employees or other non-recreational visits. In 1988, the NPS changed the methodology for computing recreational visits, therefore, relationships between problem bears and park visitation include only the period from 1967 to 1987.

Mast Survey Index

The Maximum Production Potential Index (MPPI) (Pozzanghera 1990) was used to examine relationships between production of oak mast and trends in captures of problem bears. The MPPI is a modified index of the Whitehead tree count survey (Whitehead 1969). The MPPI includes oak mast production in the mountain counties of Tennessee (Cocke, Sevier, Blount, Unicoi, Greene, and Monroe) (Pozzanghera 1990). The Tennessee Wildlife Resources Agency (TWRA) did not conduct mast surveys for the Tellico Wildlife Management Area (Monroe county) or Sevier and Unicoi counties in 1989.

Data Analysis

Analyses were performed using the Statistical Analysis System (SAS Institute Inc. 1985). Normality of data were

tested using Univariate procedures (UNIVARIATE). Transformations were used for data that violated the assumption of normality. The number of days from release to recapture and release to recovery (time) were transformed using the natural logarithmic transformation. The square root transformation was used for distance from release location to recovery site.

Chi-square Goodness of Fit was used to test for an even sex ratio. Chi-square test of independence using Frequency procedures (FREQ) were used to test differences in sex ratios among age classes. Log-linear models using Categorical Data Modeling (CATMOD) procedures were used to test capture trends by season, sex, and age class. Frequency of recapture by sex, age class, season relocated, and distance relocated or release area also were tested using log-linear models. Contrast statements were used to test specific hypotheses within models. Since the CATMOD procedure assumes zero cell counts are structural, a small value (1/n) was inserted for all random zeros.

T-test procedures (TTEST) were used to test differences in mean ages of male and female problem bears and differences in mean ages of bears recaptured and those not. General Linear Model (GLM) procedures were used to test for differences in means for time between release to recapture or recovery, and distances from release to recovery sites. Multiple comparisons, using Bonferonni t-tests to control

the experimentwise error rate, were used to test specific hypotheses within models. Correlation (CORR) was used to determine the relationship between seasonal park visitation and captures of problem bears.

CHAPTER IV

RESULTS AND DISCUSSION

From 10 July 1967 to 6 December 1989, 341 problem black bears were captured 570 times. Individual bears were captured 1 to 14 times (Appendix A). An additional 32 bears (16 males, 12 females, and 4 unknowns) were captured and relocated without eartags, tattoos, or other markings used to identify individuals; these bears were eliminated from analyses. Thirty-five bears were involved in bear/vehicle collisions; 29 died, and 6 were captured, rehabilitated, and relocated within GSMNP. Six orphaned cubs also were captured and relocated within GSMNP. Because of their questionable status, bears involved in bear/vehicle collisions and orphaned cubs were eliminated from analyses.

Areas of Conflict

Primary capture areas of problem bears within GSMNP were: 1) Cades Cove (25.9%, n=142); 2) Newfound Gap/Clingman's Dome Road (23.2%, n=127); 3) Chimney's Picnic Area (18.6%, n=102); 4) Smokemont (8.9%, n=49); 5) Cosby (4.7%, n=26); and 6) Elkmont (2.7%, n=15) (Fig. 2). Bears were captured most frequently in these areas because of concentrated visitor use, and therefore greater amounts of food and garbage available to attract bears. Violations of the NPS regulations regarding feeding wildlife and food storage also occur most frequently in these areas, and are

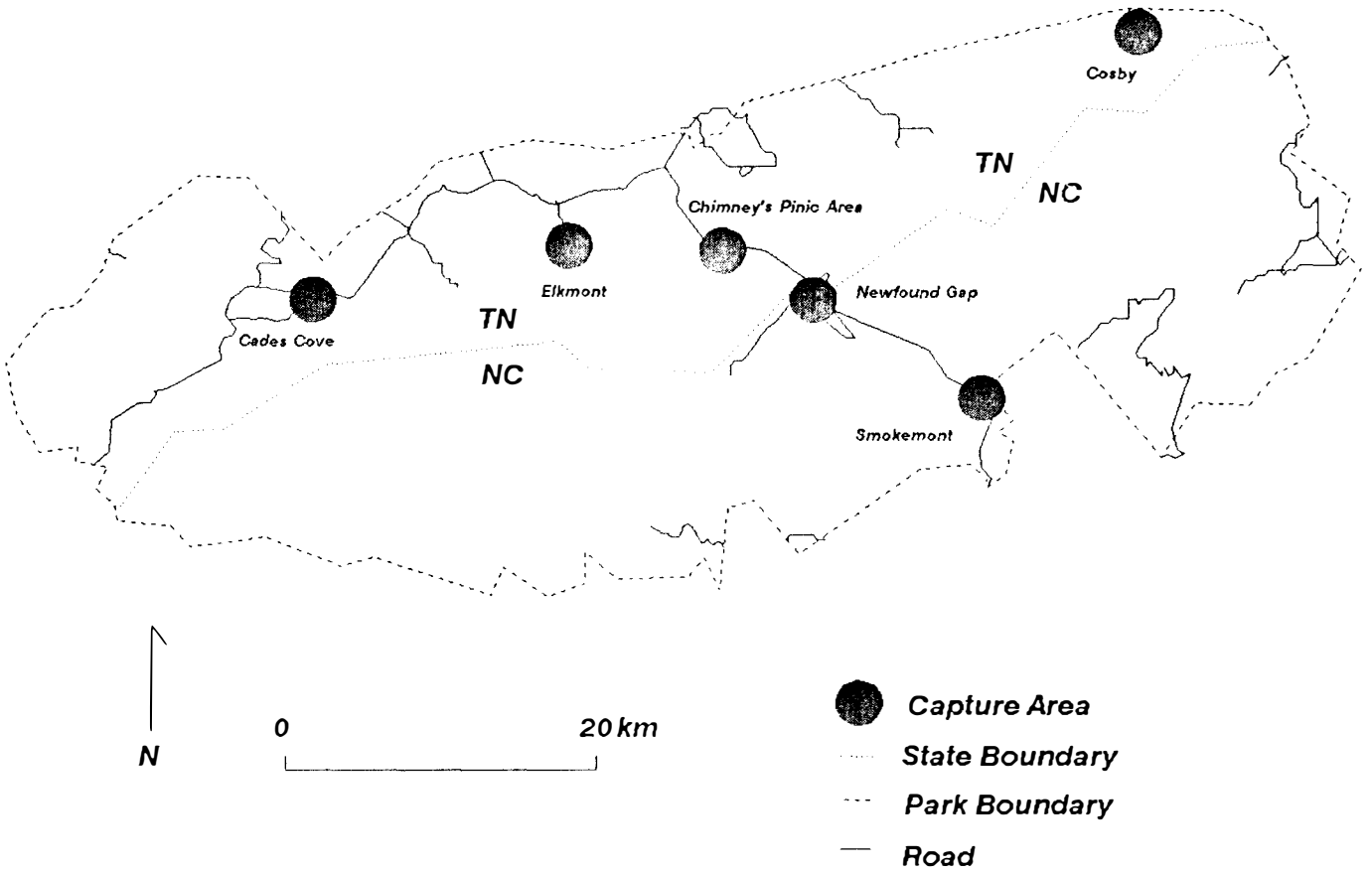

Figure 2. Primary capture areas of problem black bears in Great Smoky Mountains National Park, 1967-1989.

significant factors in habituating problem bears (Singer and Bratton 1977, Tate 1983). Differences in the number of captures of problem bears between areas were not known, but may be a function of local and/or seasonal bear densities, habitat quality, visitor densities, and other ecological and human use parameters (Merrill 1978).

Only 39 captures of problem bears (7.1%) occurred in backcountry areas; this included 10 bears captured and released as part of a problem bear telemetry study (Hastings 1983, Hastings et al. 1987). Primary capture areas of problem bears in the backcountry included, Spence Field (n=12), Walnut Bottoms (n=9), and Mount Leconte (n=8). Fifteen captures of problem bears in the backcountry (38.5%) were associated with the Appalachian Trail, reflecting its high visitor use (Singer and Bratton 1977).

The low number of problem bears captured in the backcountry likely was due to lower visitor densities and, therefore, less human food or garbage available to attract bears. The number of captures of problem bears in the backcountry, however, probably underestimates the severity of problems in those areas (Harms 1980). Because of the inaccessibility of most backcountry areas, the time and manpower needed to capture and transport a problem bear is higher than for the frontcountry; this likely results in more passive management, such as temporary closure of backcountry areas or no action at all. Also, many

human\bear incidents in backcountry areas may go unreported, or not reported until several days afterwards, making it very difficult to identify and/or capture the offending bear (Singer and Bratton 1977, Kaey and Van Wagtendonk 1983). Factors affecting the rate of reporting include ease of reporting and value of damage (Kaey and Van Wagtendonk 1983).

Population Dynamics

Sex and Age Structure. The sex ratio of 336 bears (gender was not recorded for 5 bears), was 164 males:100 females (208 males:128 females, 61.9% males); this sex ratio deviated significantly (DF=1, G^2=19.23, P<0.001) from a 1:1 ratio, assuming that the sex ratio of black bears is approximately equal at birth (Jonkel 1978, Wathen 1983, Elowe and Dodge 1989). Sex ratios previously reported for problem bears in GSMNP ranged from 60 to 87% males (Beeman and Pelton 1976, Singer and Bratton 1977, Carlock et al. 1983, McLean and Pelton 1990). Other problem bear studies also have reported a high proportion of males (Black 1958, Erickson et al. 1964, Barnes and Bray 1967, Sauer et al. 1969, Harger 1970, Piekielek and Burton 1975, Rogers et al. 1976, Alt et al. 1977, Rutherglen and Herbison 1977, Payne 1978, McArthur 1981).

The preponderance of male problem bears in GSMNP is partly explained by differences in home range size and

overlap between male and female bears. In GSMNP, the average home range size of male bears is 1.5 to 9.2 times greater than females bears, with extensive overlap (Beeman 1975, Garshelis 1978, Quigley 1982, Carr 1983). Generally, female bears exhibit territorial behavior (Jonkel and Cowan 1971, Young and Ruff 1982, Clevenger 1986, Rogers 1987a) and seldom exploit artificial food sources outside their territory (Rogers 1987a). Because male bears tend to roam further than females, they are more likely to encounter human-use areas and thus be captured and relocated.

Sex ratios of problem bears at initial capture differed significantly (DF=2, G^2=7.050, P=0.025) between age classes (Table 2). The sex ratio of subadults (n=118) was highly skewed toward males (269 males:100 females; 72.9% males). The sex ratio of cubs, which accounted for 21.1% of captured bears (n=53), was 121 males:100 females (54.7% males). Adults (n=81) comprised 31.9% of captured bears with a sex ratio of 138 males:100 females (58.0% males). Ages were not determined for 46 male (22.1% of all males captured) and 38 female (29.9% of all females captured) bears.

Despite the preponderance of subadult males, mean age at initial capture for male ($\bar{x}$=3.3, SE=0.19, n=162) and female ($\bar{x}$=3.6 SE=0.33, n=90) problem bears were not significantly different (DF=150.3, t=-0.7993, P=0.4254); cubs and yearlings may have contributed this. These bears were aged according to body size, while older bears were

Table 2. Sex and age ratios, by season captured, of problem black bears in Great Smoky Mountains National Park, 1967-1989.

Sex	Season			Total
	Spring	Summer	Fall	
Male				
Cub	0	17	12	29
Subadult	13	63	10	86
Adult	7	37	3	47
Unknown	5	32	9	46
Subtotal	25	149	34	208
Female				
Cub	0	21	3	24
Subadult	3	22	7	32
Adult	0	28	6	34
Unknown	3	28	7	38
Subtotal	6	99	23	128
Total	31	248	57	336

aged by cementum annuli (Willey 1974). Since all cubs and yearlings were aged, the age distribution for both male and female bears may be skewed to younger bears (Fig. 3). Also, cubs and dependent yearling rely upon their mother for food and thus were captured primarily because of the nuisance behavior of their mother. When cubs and dependent yearlings were excluded from the analysis, there was some evidence (DF=116.3, t=-1.7294, P=0.0864) that males ($\bar{x}$=3.9 SE=0.20, n=136) were younger than females ($\bar{x}$=4.6, SE=0.35, n=71). This is consistent with Tate (1983) who described problem bears in GSMNP as primarily older females and younger males.

The older age structure for female problem bears may be partly due to increased movements and nutritional needs of females with cubs. Of 41 female problem bears 3.5 years or older, 22 (54%) were lactating or accompanied by cubs when captured. Ten female problem bears whose ages were not known (26%) also were lactating or accompanied by cubs when captured. Females with offspring use larger areas than solitary females (Alt et al. 1980) and therefore are more likely to encounter and utilize human food and garbage. Because supplemental food sources, such as human food and garbage, enhance reproductive success (Rogers 1976, Rogers et al. 1976, McLean and Pelton 1990), it would be advantageous for females whose home ranges overlap with human-use areas to exploit them.

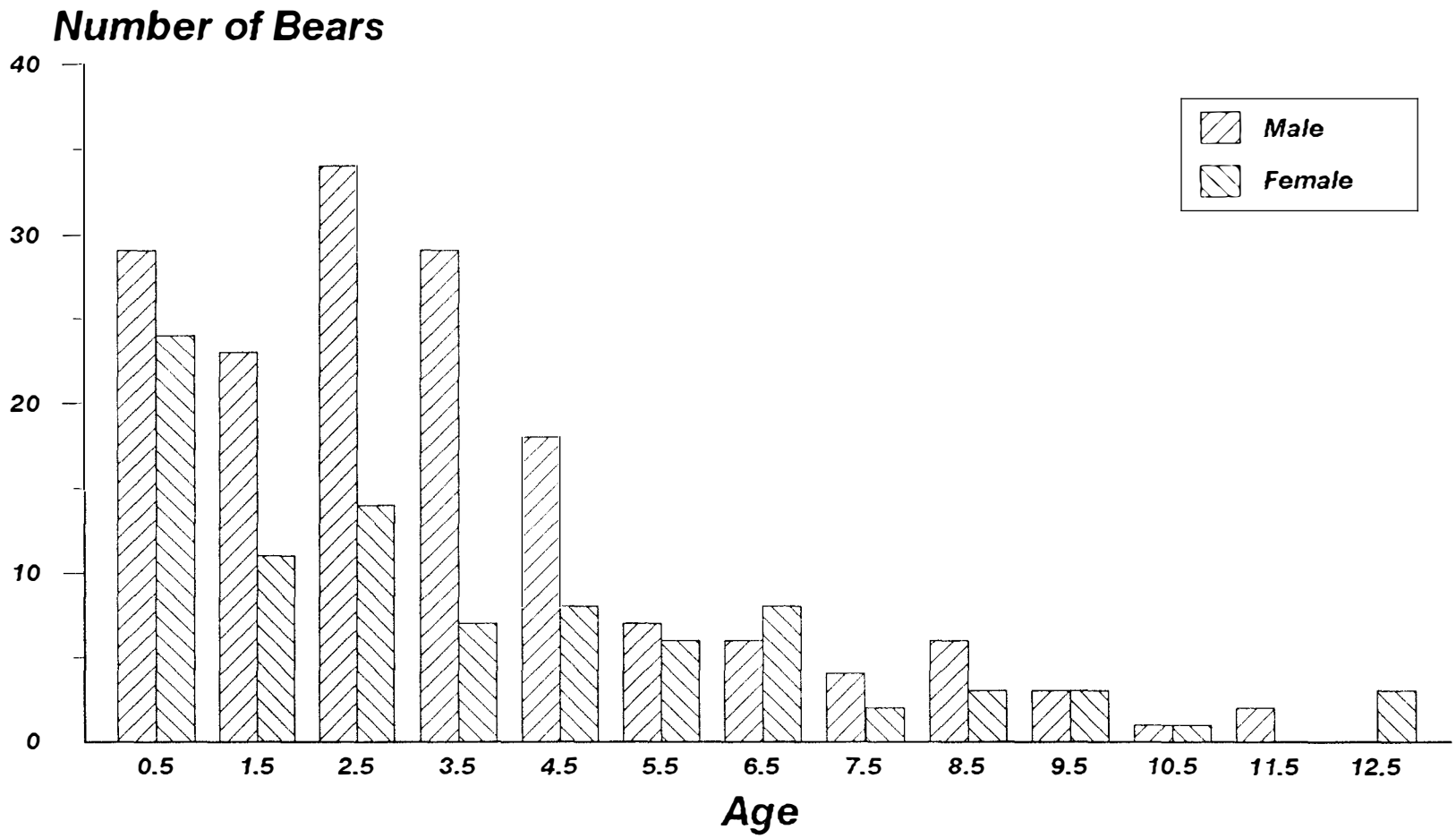

Figure 3. Age distribution of male and female problem black bears captured in Great Smoky Mountains National Park, 1967-1989.

The preponderance of younger male problem bears is probably due to the dispersal behavior of subadults (Jonkel and Cowan 1971, Alt 1978, Rogers 1987a). Dispersing subadult male bears may move long distances from their birthplace before establishing a home range (Rogers 1976, 1987a, Alt 1978, Lentz et al. 1980); these movements increase their likelihood of encountering human-use areas and subsequently being captured. Subadult females generally do not disperse and usually establish a home range within their mother's territory (Clevenger 1987, Rogers 1987a) and thus are less likely to encounter human-use areas.

Social factors also may be responsible for sex and age ratios of problem bears (Erickson et al. 1964, Jonkel and Cowan 1971, Rogers 1976, Rogers et al. 1976, Herrero 1983). Adult male bears force other bears to disperse into marginal habitats (Kemp 1976, Rogers 1976, 1987a, Bunnell and Tait 1981, Garshelis and Pelton 1981, Young and Ruff 1982) and also restrict them from immigrating into an area (Kemp 1976, Young and Ruff 1982). Mattson (1990) suggested that subadult males and adult females were probably more likely to forage near people because areas of higher quality habitat were occupied by adult males. He also suggested that foraging near people may serve as a refuge from adult males. Differences have been noted in the sex and age ratios between problem bears captured by the NPS and research bears captured by UTK (McLean 1991). Research

bears are older than problem bears and probably less likely to succumb to social pressures.

Biases associated with trapping effort and changes in policies regarding bears in GSMNP also were partly responsible for the sex and age ratios of problem bears. Historically, the NPS was reluctant to capture and relocate females with cubs, fearing they would disrupt family units. Trapping methods, which primarily were free range capture and culvert traps, also may be biased to younger and naive bears such as subadult males (Erickson et al. 1964, Johnson and Pelton 1980b).

Conflict By Research Bears. From 1968 to 1989, UTK research personnel captured, marked, and released 504 individual bears in the northwest quarter of GSMNP; 18 of these bears (3.6%; 16 males, 2 females) were subsequently captured 29 times as problem bears. Research bears captured because of nuisance activity were included in analyses and represent 5.3% of the problem bears in this study.

Nuisance activity by research bears occurred within the northwest quarter of GSMNP or in Gatlinburg, which borders this area to the north (Fig. 4). Mean distance from research capture site to nuisance capture site for these bears was 6.7 km (SE=0.8, n=18). The longest distance between the research capture site and nuisance capture site of a bear was 15.2 km. Considering the mean home range size of bears in GSMNP, which ranges from 3 to 101 km^2 depending

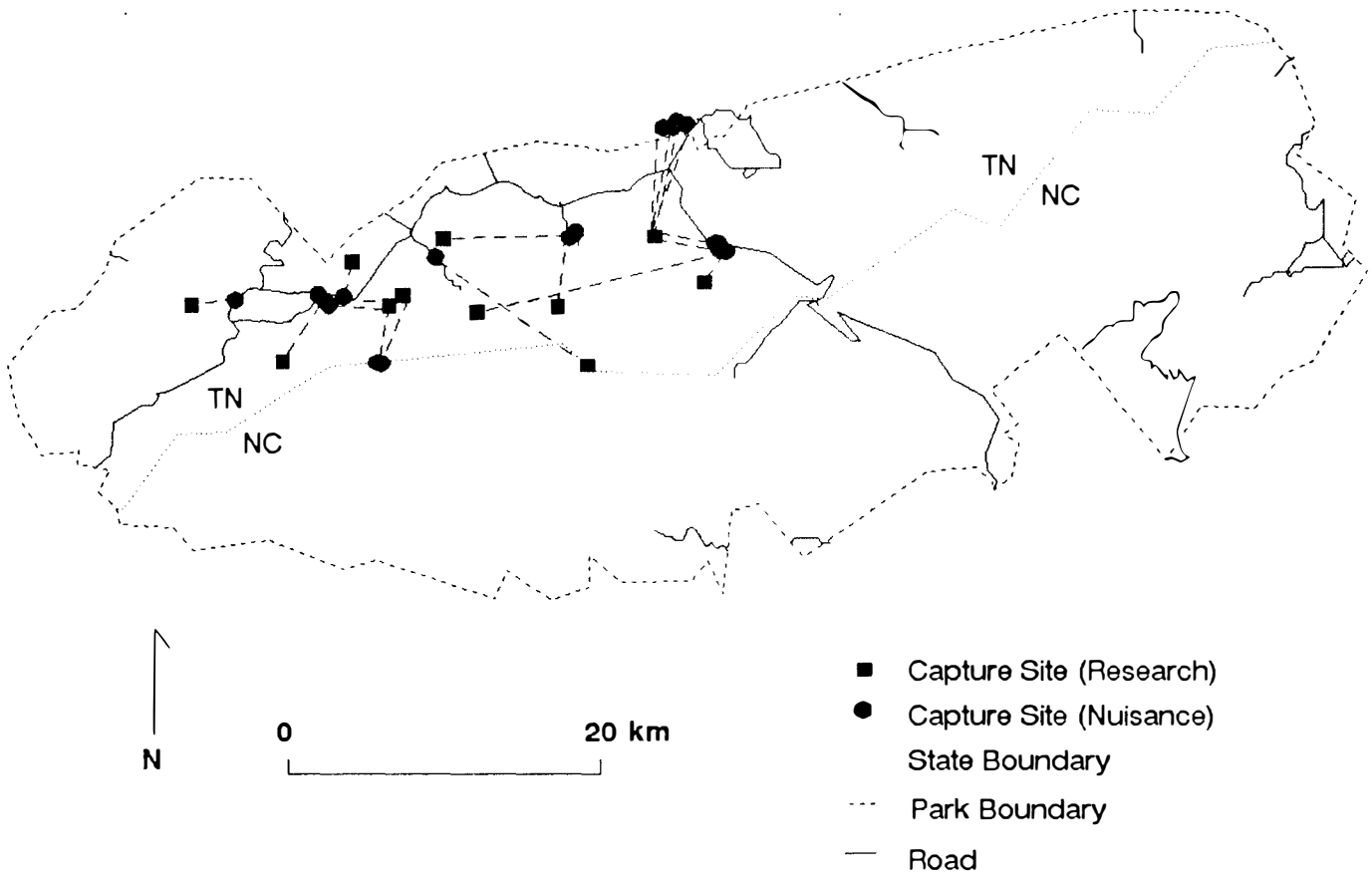

Figure 4. Research and nuisance capture sites of 18 black bears in Great Smoky Mountains National Park, 1967-1989.

on sex and season (Garshelis 1978, Quigley 1982, Carr 1983), it is likely that the nuisance capture site of these bears were within their home ranges.

Considering the home range size, movements, and opportunistic feeding behavior of bears, as well as annual visitation in GSMNP, it was inevitable that some research bears would cause problems. The low percentage of research bears captured because of nuisance activity (3.6%), however, suggests that although the opportunity exists for bears to exploit human-use areas, most do not. Pelton and Burghardt (1976) estimated that problem bears comprise roughly 5% of the total bear population in GSMNP. Assuming that research bears are a random sample of the bear population in GSMNP, the low incidence of conflict by these bears is consistent with previous estimates.

The low percentage of bears causing problems in GSMNP may be related to the extent and proximity of bear habitat to human activity. Much of the higher quality bear habitat in GSMNP is located away from human use areas, and therefore bears are less likely to forage near sources of garbage. Food habits studies indicate that garbage comprises only small percentage of the diet of bears in GSMNP (Eagle and Pelton 1983). Conversely, in Yosemite National Park, where much of the higher quality bear habitat is located in close proximity to human use areas (Graber 1981), garbage comprises 15% of the diet of bears (Graber and White 1983).

Because bears in Yosemite forage near people, problem bears comprise a large percentage of the overall population (Harms 1980).

The low incidence of conflict by research bears in GSMNP also may be a avoidance response. Nuisance behavior by bears is learned and reinforced through food rewards (Stokes 1970, Tate and Pelton 1983). Likewise, avoidance is learned though negative experiences. Bears captured as part of the backcountry research may associate people with the trauma of being captured by footsnares and/or handled, and may learn to avoid human-use areas (Brady and Maehr 1982, Wooding et al. 1988).

Capture Trends

Seasonal and yearly fluctuations in the number of problem bears captured were partly due to changes in the NPS policies regarding bears. Advances in capture techniques, financial and personnel constraints, and inconsistencies in capture effort undoubtedly account for some variation. Interpretation of problem bear capture data therefore were limited to general trends.

Seasonal. Captures of problem bears were not uniform throughout the year. Most captures of problem bears were in summer (75.1%; n=428), followed by fall (14.2%; n=81) and spring (10.7%; n=61) (Fig. 5). Seasonal distribution of captures of problem bears generally coincided with public

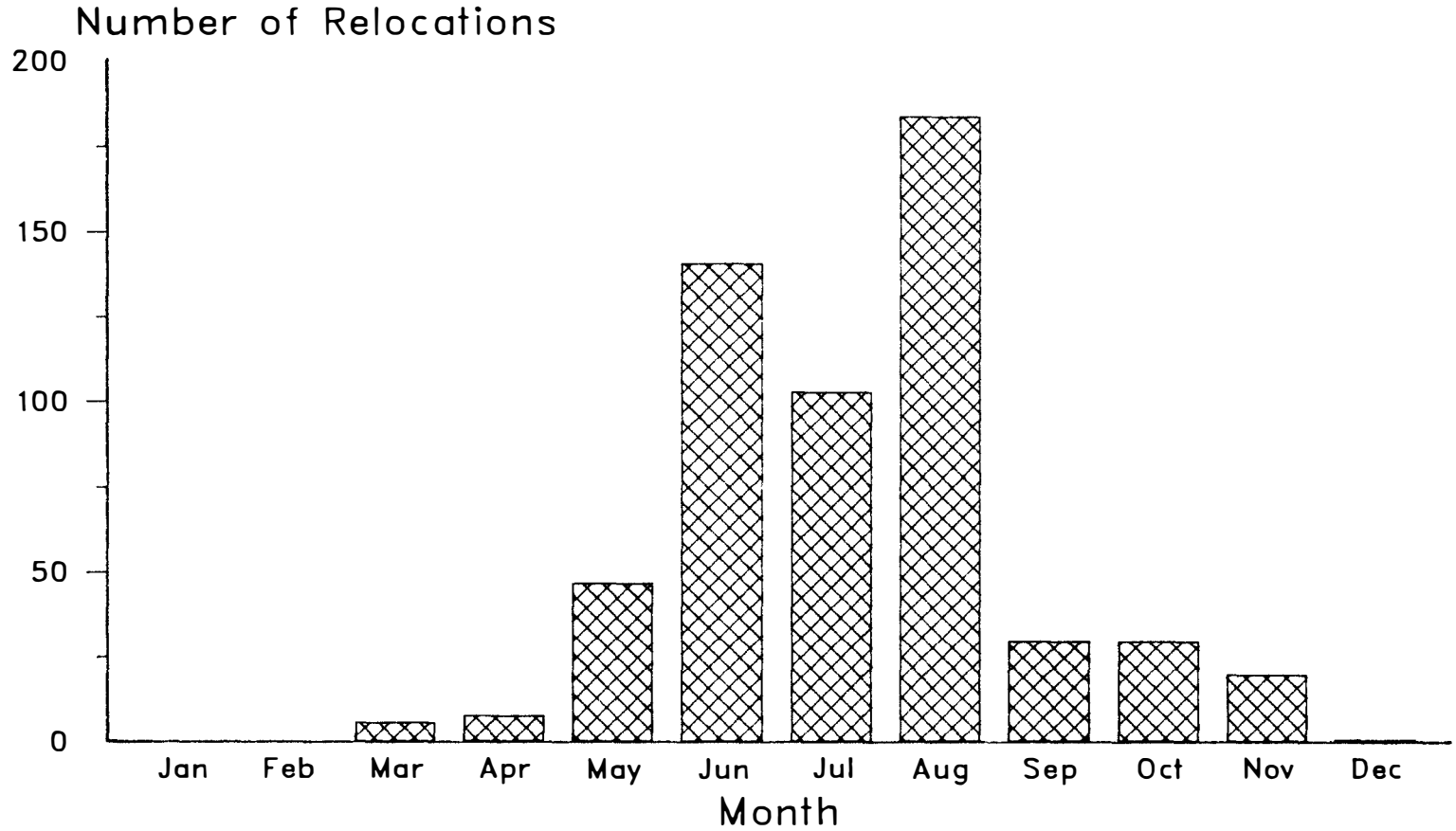

Figure 5. Monthly distribution of problem black bear relocations in Great Smoky Mountains National Park, 1967-1989.

visitation in GSMNP. For the period from 1967 to 1987, a positive correlation existed between the number of problem bears captured each month and monthly recreational visits in GSMNP (r=0.4883, P=0.0001). Months of higher recreational visitation provided more human food and garbage to attract bears, resulting in more interactions between bears and visitors, and thus more captures. Similar trends in human\bear conflicts have been noted in Sequoia/Kings Canyon (Zardus and Parsons 1980), Yellowstone (Barnes and Bray 1967), Yosemite (Harms 1980, Graber 1981) and Glacier national parks (McArthur 1981).

Seasonal differences in home range use and activity patterns of bears (Amstrup and Beecham 1976) were probably also responsible for monthly capture trends. A significant interaction (DF=4, G^2=9.70, P=0.0459) existed between the sex, age class, and season in which bears initially were captured (Table 2). In spring, males comprised 87% (n=20) of captured bears. No adult females or cubs were initially captured in spring. Subadults comprised 45.2% (n=85) of bears captured in summer, and 44.7% (n=17) of those captured in fall (Table 2).

The low number of bears captured in spring is likely related to den emergence and diminished activity patterns. The first few weeks following den emergence, bears are lethargic and eat or drink very little (Nelson et al. 1984 in Rogers 1987a); bears may avoid people during this period.

Hastings (1983) suggested that upon den emergence, bears may take several weeks to habituate to people enough to approach them. The higher incidence of males in spring is likely due to difference in the timing of den emergence and onset of roaming between male and female bears. Males, particularly adults, are the first to begin roaming in spring (Rogers 1987a) and therefore the first to encounter people. Adult females and cubs emerge from their dens later (Eiler 1981, Wathen 1983) and are less mobile than other sex and age groups (Alt 1977, Linzey and Meslow 1977, Eiler 1981, Garris and Pelton 1984) and therefore less likely to be captured in spring.

Increased bear activity during summer (Garshelis and Pelton 1980, Carr 1983) likely contributes to the peak in problem bears captured. Family groups separate and subadults disperse during summer (Jonkel and Cowan 1971, Linzey and Meslow 1977, Clevenger 1986, Rogers 1987a). During late summer, bear movements increase as immature acorns begin to become available (Carr 1983). Increased movements as result of family breakup, subadult dispersal, and acorn availability all likely contribute to human\bear conflicts and thus more captures during summer.

The decrease in the number of problem bear relocations during July was not known but may be related to breeding activities. In GSMNP, most adult females bears are in estrus from late June through late July (Eiler et al. 1989).

During the breeding season, adult males spend much of their time searching for females in estrus and less time foraging, and therefore may be less likely to cause problems.

The decline in the number of bears captured in fall is likely due to seasonal shifts in home range in response to fall foods. In fall, bears shift their activity centers to areas of abundant hard mast (Hastings 1983, Garshelis and Pelton 1981). Human food and garbage comprises a small percentage of the diet of bears in fall (Beeman and Pelton 1980). Adult males shift to their fall home range first and remain there longer than other sex and age groups (Garshelis and Pelton 1981); this likely explains their low incidence of capture during fall (Table 2). Adult males also may restrict younger and less dominant bears from prime fall feeding areas (Garshelis and Pelton 1981), forcing these bears to seek alternative food sources; this may explain the higher incidence of conflict by females and younger males during fall (Table 2).

Yearly. Relocations of problem bears ranged from a low of 4 in 1969 and 1974 to a high of 80 in 1989 ($\bar{x}$=24.6, SE=4.3) (Fig. 6). The number of individual bears captured each year ranged from 2 in 1969 to 63 in 1984 ($\bar{x}$=19.7, SE=3.4) (Fig. 7). Assuming the bear population in GSMNP ranges from 400 to 600 bears (McLean 1991), the mean number of problem bears captured each year represents 3.3% to 4.9% of the bear population. These figures, however, do not



Figure 6. Yearly distribution of problem black bear relocations in Great Smoky Mountains National Park, 1967-1989.

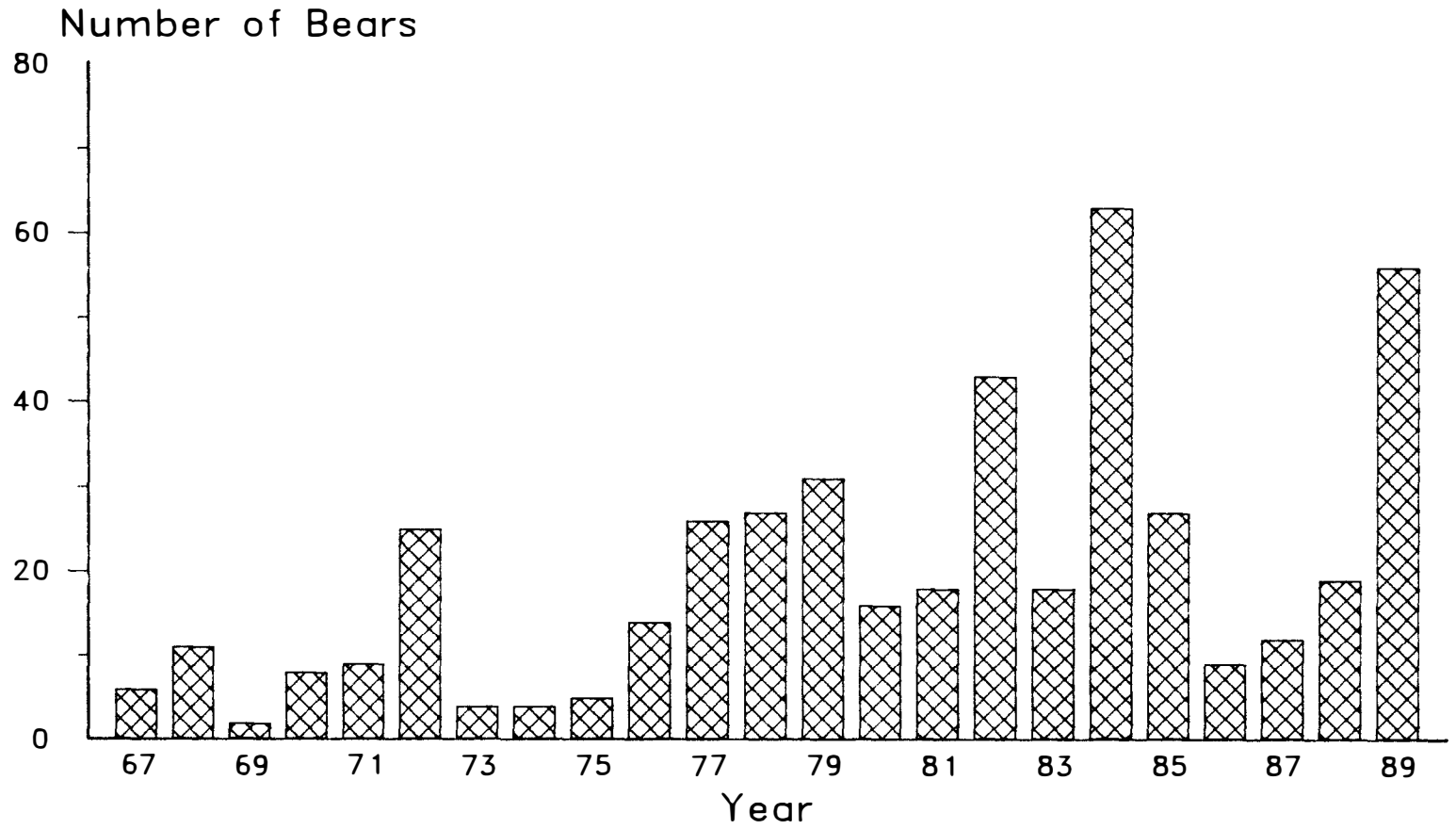

Figure 7. Yearly distribution of the number of problem black bears captured in Great Smoky Mountains National Park, 1967-1989.

reflect the total number of problem bears and/or relocations each year. The TWRA also capture and relocate problem bears from counties adjacent to GSMNP; most of these bears were likely resident to GSMNP. Indisputably other problem bears, particularly those that cause problems in the backcountry of GSMNP, were not captured and relocated.

Yearly fluctuations in the number of captures of problem bears may indicate changes in the bear population in GSMNP. The availability of fall foods, particularly hard mast, is a primary factor regulating the density of bears in GSMNP (McLean 1991). Reproductive success and spring survivorship are greater during years following good hard mast production (Rogers 1987a, Eiler et al. 1989, Elowe and Dodge 1989). Yearly fluctuation in the number of problem bears captured, therefore, may be associated with hard mast production.

A time lag likely exists between increased bear productivity, as a result of abundant hard mast, and peak problem bear activity. For example, both 1980 and 1984 were years of poor oak mast production (Fig. 8). Reproductive success, determined from adult females examined in winter dens, following these years were 26.1% and 0%, respectively (Eiler et al. 1989, Pozzanghera 1990); this resulted in a large portion of adult females that were available for breeding in 1981 and 1985, respectively. The 1981 and 1985 oak mast crops, particularly white oaks, were rated good to

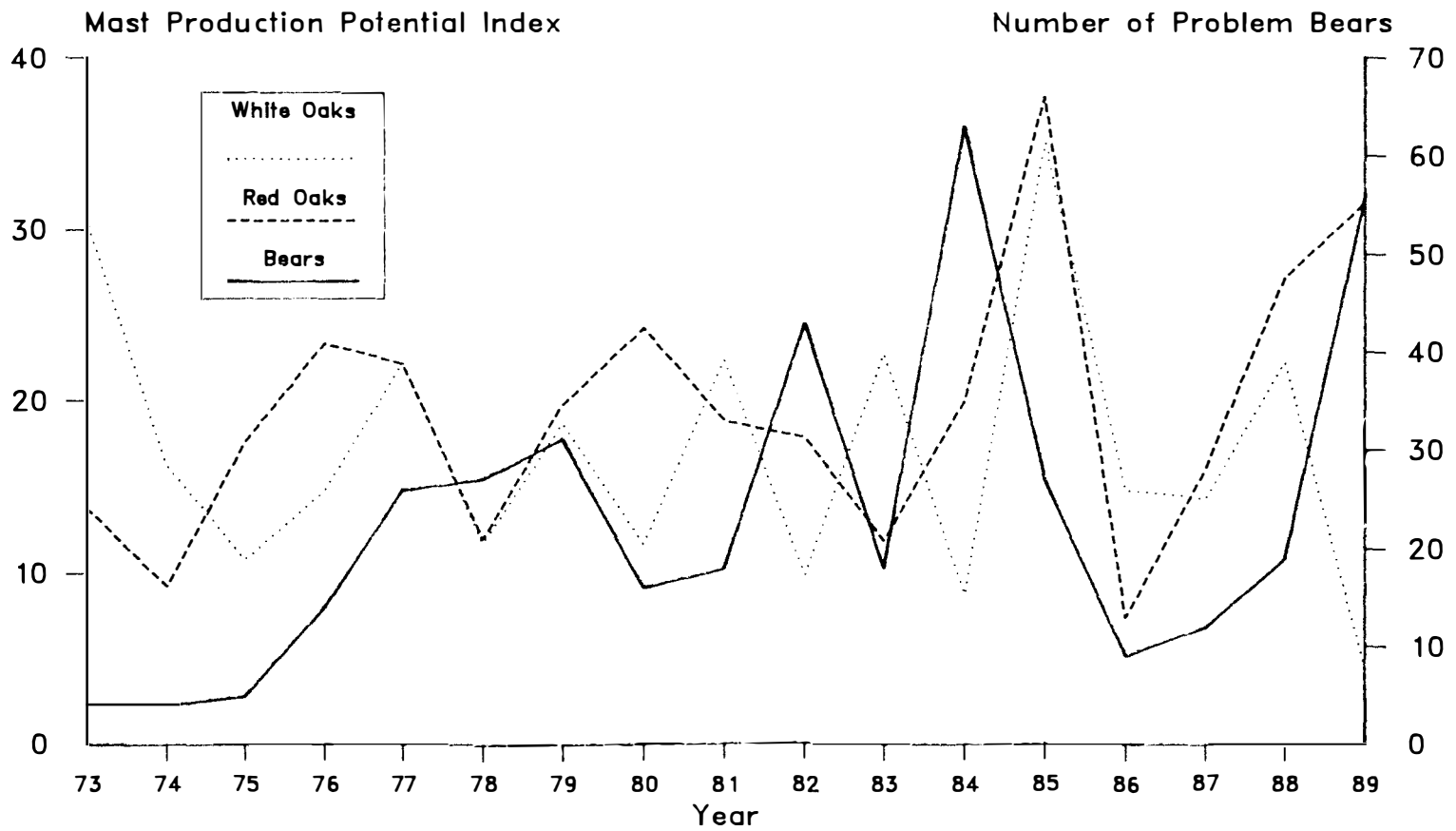

Figure 8. Yearly fluctuations of the oak mast production potential index and the number of problem black bears captured in Great Smoky Mountains National Park, 1973-1989.

excellent (Fig. 8). Reproductive success following these years were 88.5% and 100%, respectively (Eiler et al. 1989, Pozzanghera 1990). The high reproductive success in 1981 and 1986, and possibly higher spring survivorship as a result of good mast crops in fall 1983 and 1988 (Fig. 8), likely contributed to higher bear densities, and therefore a greater number of problem bears captured in 1984 and 1989, respectively (Fig. 7). Similar relationships between mast production and problem bear activity likely exist for other years.

A direct relationship between hard mast production and problem bear captures also may exist for some years. Hard mast failures occur frequently in the southern Appalachians. During years of poor mast production bears may move considerable distances outside their normal home ranges in search of food (Beeman 1975, Garshelis and Pelton 1981, Carr 1983, Rogers 1987a). Long distance movements during periods of food scarcity increase the likelihood of bears encountering and utilizing human food and garbage, and their vulnerability to hunting and poaching (Garshelis and Pelton 1981). The high number of problem bears captured during fall of 1984 (n=22; 34.9% of all bears captured in 1984) was partly due to low mast production that year.

Soft mast, such as berries (Rubus spp., Vaccinium spp., and Gaylussacia spp.), cherries (Prunus serotina), and grapes (Vitis spp.), also are important bear foods (Beeman

and Pelton 1980, Eagle and Pelton 1983). The availability and abundance of soft mast likely affect the population dynamics of bears in GSMNP and thus the number of problem bears captured. Soft mast production in the Southern Appalachians is highly variable (Powell and Seaman 1990). Years of low soft mast production likely stimulate movements by bears, and may result in more bears utilizing human food and garbage. An abundance of soft mast also can moderate the effects of hard mast failures by providing alternative food sources (Garshelis and Pelton 1981, Eiler et al. 1989).

Success of Relocations

Initial Relocations. Of 333 individual bears captured and relocated, 32.4% (n=108) were recaptured as a result of further nuisance behavior, 2.7% (n=9) were recaptured as part of UTK bear research in the backcountry of GSMNP (n=8) and PNF (n=1), 9.3% (n=31) were killed, and 55.6% (n=185) were never recovered (Table 3). Of the 9 bears recaptured as part of the UTK bear research, 1 was killed and 5 were recaptured due to further nuisance behavior. Therefore, the number of relocated bears that were recaptured due to further nuisance behavior totaled 113 (33.9%); this number is a minimum since some bears, particularly those relocated in 1989, may not have had time to cause further problems.

Ninety-three bears (82.3%; 27.9% of all bears) were recaptured within 9 km of their original capture site,

Table 3. Outcome of black bear relocations in Great Smoky Mountains National Park, 1967-1989.

	Number of Relocations				
Result	1	2	3	4	Total
Recaptured as a problem bear	108[a] (32.4)[b]	49[c] (45.0)	29 (59.2)	14 (48.3)	200
At same area[d]	90	41	23	12	
At another area	18	8	6	2	
Not recaptured	185 (55.6)	51 (46.8)	15 (30.6)	14 (48.3)	265
Killed	31 (9.3)	8 (7.3)	5 (10.2)	1 (3.4)	45
Hunter	24	7	5	1	
Other	7	1	0	0	
Recaptured as a research bear[e]	9 (2.7)	1 (0.9)	0	0	10
Total	333	109	49	29	520

[a]Includes 4 bears killed as nuisance bears.

[b]Number in parentheses indicate percentages.

[c]Includes 1 bear killed as a nuisance bear.

[d]Within 9 km of the original capture site.

[e]Relocated bears that were recaptured as part of research conducted by the University of Tennessee in the backcountry of GSMNP and Pisgah National Forest, North Carolina.

suggesting that relocated bears have a strong fidelity to their original capture area. Beeman and Pelton (1976) reported that only 1 of 76 relocated bears in GSMNP were recaptured away from their original capture area. This tendency of relocated bears to return to their original capture area suggests that most bears can be relocated to other areas with little likelihood of them becoming a nuisance in that area. Release areas for problem bears, therefore, should not be eliminated because of their proximity to other potential areas of conflict (Beeman and Pelton 1976).

Mean time elapsed between relocation and recapture of problem bears was 297 days (SE=30.0; n=113). Forty-nine bears (43.4%) were recaptured within the same year they were relocated. Ninety-two bears (81.4%) were recaptured within 14 months of their relocation. It appears relocated bears that cause subsequent problems do so within the next 14 months. In the Greater Yellowstone area, 90% of subsequent captures of relocated grizzly bears (Ursus arctos) also occurred within 14 months (Brannon 1987). Time elapsed between relocation and recapture represents the number of days between captures and therefore should be interpreted as the maximum time required for bears to cause further problems.

Age class. Mean age of recaptured bears ($\bar{x}$=4.1 years, SE=0.3, n=88) was significantly greater (DF=241, t=-

2.8231, P=0.0052) than those not recaptured ($\bar{x}$=3.0, SE=0.2, n=155). Frequency of recapture of adults, subadults, and cubs were 51.3% (n=39), 29.1% (n=34), and 30.0% (n=15), respectively (Fig. 9). Frequency of recapture of adult bears was significantly higher (DF=1, G^2=10.41, P=0.0013) than subadults and cubs. Frequency of recapture for cubs and subadults were not significantly different (DF=1, G^2=0.14, P=0.7114).

There was some evidence that time elapsed between relocation and recapture also differed significantly between age classes (DF=2, F=2.95, P=0.0581). Mean time elapsed between relocation and recapture of cubs, subadults, and adults were 449 (SE=77, n=15), 216 (SE=45, n=34), and 294 (SE=44, n=39) days, respectively (Table 4). Subadult and adult bears were recaptured in significantly fewer days than cubs (DF=1, F=5.14, P=0.0248). Time elapsed between relocation and recapture for subadult and adult bears were not significantly different (DF=1, F=0.90, P=0.3463).

Adult bears were recaptured more frequently because they are more likely to move longer distances (Erickson et al. 1964) and have better homing abilities than cubs and subadults (Harger 1970, Alt et al. 1977, Rogers 1986b). Of recaptured bears, the percentage of cub, subadult, and adult bears recaptured near their original capture area were 86.7% (n=13), 68.6% (n=24), and 90.2% (n=37), respectively. Adult bears have well defined home ranges and probably have a



Figure 9. Frequency of recapture, by age class, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

Table 4. Time elapsed (days) and distance travelled between release and recapture, by sex and age class, for relocated black bears in Great Smoky Mountains National Park, 1967-1989.

	Distance From Release Site To Recapture site (km)			Time From Release To Recapture (Days)		
Age Class	Male	Female	Total	Male	Female	Total
Adult						
$\bar{x}$	35.9	28.1	32.3	238	360	294
N	21	18	39	21	18	39
SE	6.2	7.5	4.8	62	62	44
Subadult						
$\bar{x}$	31.1	22.7	28.9	167	354	216
N	25	9	34	25	9	34
SE	3.2	5.5	2.8	50	89	45
Cub						
$\bar{x}$	41.3	47.7	43.8	361	582	449
N	9	6	15	9	6	15
SE	10.0	13.5	7.8	104	96	77
Total						
$\bar{x}$	34.6	30.2	32.9	225	399	290
N	55	33	88	55	33	88
SE	3.2	5.1	2.7	37	47	30

higher fidelity to their original capture area than subadults. The ability of cubs to return to their capture area likely was exaggerated. Generally, cubs were captured and relocated as part of a family unit, therefore, their movements were dependent upon the behavior and movements of their mother. Cubs relocated independent of their mother presumably are less capable than subadults and adults of returning to the original capture area (Harger 1970, Alt et al. 1977).

The larger size of adult bears also may bias capture and recapture efforts by the NPS. Larger bears tend to be bolder and also attract and congregate Park visitors, which increases the potential for a dangerous confrontation between bears and visitors. To reduce potential negative interactions between bears and visitors, the NPS may be more aggressive in their attempts to recapture larger bears, resulting in a higher frequency of recapture for this group.

Most relocated bears (55.6%; n=185), particularly cubs (61.5%; n=32) and subadults (58.5%; n=68), were never recovered (Table 5). Considering the navigational and homing abilities of bears (Beeman and Pelton 1976, Rogers 1986b, 1987b), it is likely that some relocated bears returned to their original capture area but were not recaptured. Some relocated bears also may have established a home range near their release area or dispersed to the adjacent national forests where bear densities are lower and

Table 5. Outcome, by sex and age class, of black bear relocations in Great Smoky Mountains National Park, 1967-1989.

Sex	Age Class	Result				
		Recaptured as a Problem Bear	Recaptured as a Research Bear[a]	Killed	Unknown	Total
Male	Cub	9	0	2	18	29
	Subadult	23	4	10	49	86
	Adult	22	3	4	17	46
	Unknown	13	0	4	26	43
Subtotal		67	7	20	110	204
Female	Cub	6	0	3	14	23
	Subadult	10	0	3	19	32
	Adult	17	1	2	14	34
	Unknown	8	1	1	26	36
Subtotal		41	2	9	73	125
Unknown		0	0	2	2	4
Total		108	9	31	185	333

[a]Bears that were recaptured as part research conducted by the University of Tennessee in the backcountry of GSMNP and Pisgah National Forest, North Carolina.

habitat quality better (McLean 1991); this may be particularly true for subadult males which were likely dispersing when captured and relocated.

The low number of relocated bears recaptured as part of the UTK backcountry bear research in GSMNP (n=8) suggests that few relocated bears that were not recovered remained near their release area or returned to their original home range. The low number of relocated bears captured as part of the UTK research, however, may be partly due to biases associated with the location and schedule of trapping. The study area for the backcountry research included only the northwest quarter of GSMNP. The area encompassed 2 of 5 primary release areas in GSMNP (Tremont and Parson's Branch Road) and 4 of 6 primary capture areas (Cades Cove, Newfound Gap/Clingman's Dome Road, Chimney's Picnic Area, and Elkmont) of problem bears. Therefore, all relocated bears do not have the same probability of being captured as part of the UTK bear research. Also, although trapping is intensive, due to time and personnel constraints, only 6 to 8 areas can be trapped within a particular year. Most trapping areas are accessible by hiking only, which also limits the number of traps that can be monitored. Each trap line contains from 7 to 10 traps that remain active for 10 to 14 days. This intensive, but transient trapping schedule probably provides little opportunity for relocated bears to encounter traps.

One relocated bear was recaptured as part the UTK bear research in PNF (Brody 1984) and 24 bears were legally harvested by hunters on lands adjacent to GSMNP (Table 3). However, this accounts for only 7.5% of bears captured and relocated. It is likely that a large proportion, if not most, relocated bears that were never recovered, dispersed to adjacent lands and were killed. Poaching is a significant source of mortality of bears in the southern Appalachians. Reagan (1990) estimated that 36% of the mortality for bears on Harmon Den Bear Sanctuary in PNF was due to illegal hunting. Because problem bears are habituated to people, they are probably more vulnerable to legal and illegal hunting than bears on Harmon Den Bear Sanctuary.

Some relocated bears, particularly younger bears, also may have died due to stress associated with being captured and relocated, or natural causes. Subadult bears, particularly males, are generally prone to higher sources of mortality than older bears (Jonkel and Cowan 1971, Young and Ruff 1982). Younger bears relocated into unfamiliar areas are probably less capable of handling aggressive encounters with other bears and may succumb to predation (Rogers 1983, LeCount 1987, Hellgren and Vaughan 1988). Survivorship of relocated cubs is likely dependent upon the time of year. Although cubs 5 to 8 months old are self sufficient (Erickson 1959, Elowe and Dodge 1989), those relocated

during early summer probably sustain higher mortality than those moved in late summer or fall. Rogers (1986a) suggested that mortality may be higher for cubs relocated longer distances.

Distance. Frequency of recapture of relocated problem bears decreased significantly (DF=3, G^2=10.34, P=0.0159) as relocation distance increased (Fig. 10). Only 14.3% (n=5) of bears relocated >64 km were recaptured. Frequency of recapture of bears relocated 0, >0-32, and >32-64 km were 58.3 (n=14), 42.3 (n=22), and 35.6% (n=47), respectively. Mean time elapsed between relocation and recapture for bears relocated 0 ($\bar{x}$=381, SE=91, n=14), >0-32 ($\bar{x}$=419, SE=69, n=22), >32-64 ($\bar{x}$=224, SE=33, n=47), and >64 km ($\bar{x}$=96, SE=76, n=5) were not significantly different (DF=3, F=1.71, P=0.1712).

The lower frequency of recapture for bears relocated longer distances is partly explained by mortality. The percentage of bears killed increased as relocation distance increased, ranging from 4.2% (n=1) for bears released on site to 22.9% (n=8) for bears relocated >64 km (Fig. 11). Higher mortality for bears relocated longer distances is probably due to the diminished protection offered by the release area. Bears relocated longer distances were released outside or near the perimeter of the Park where both legal and illegal hunting is intense.

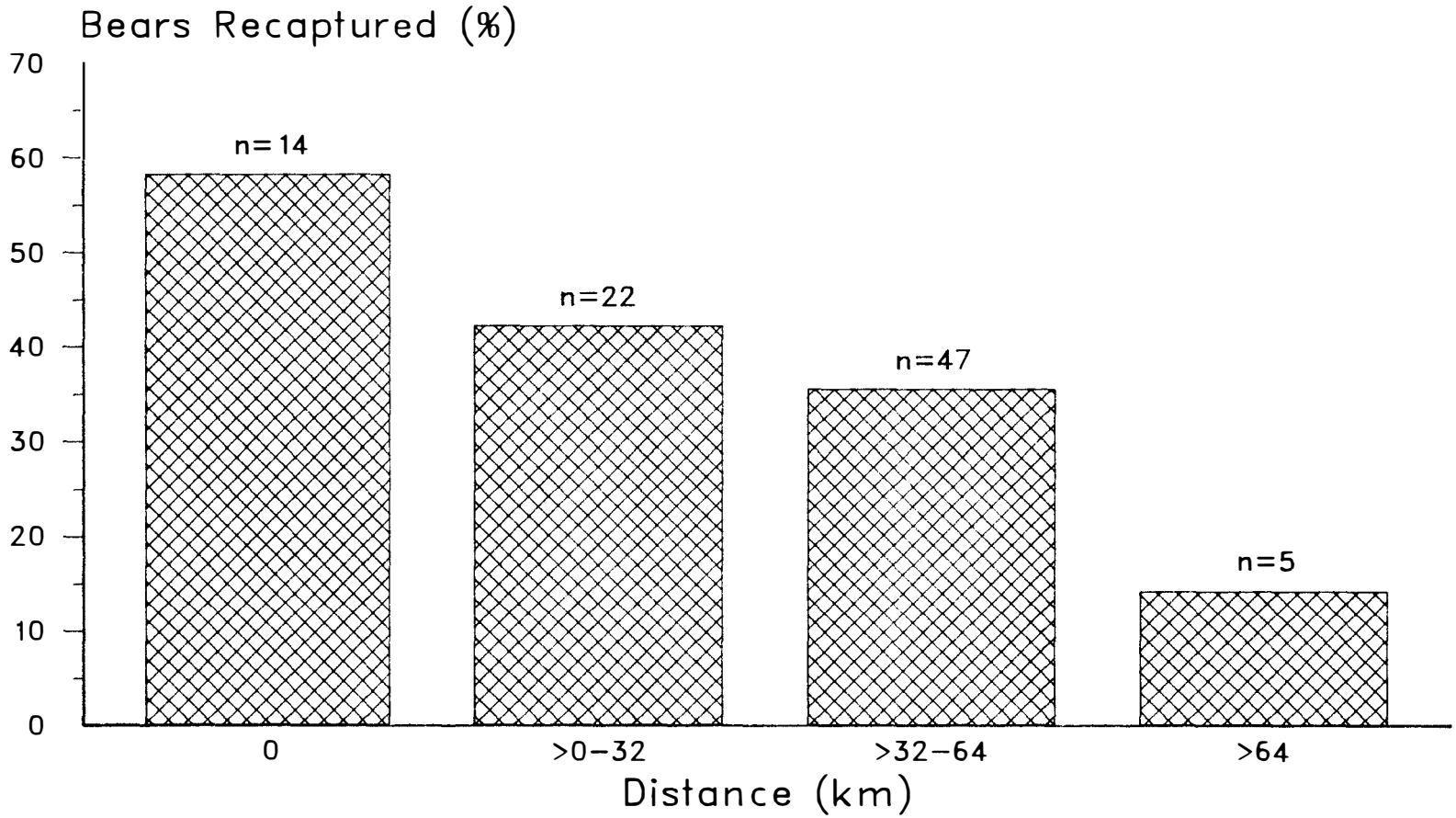

Figure 10. Frequency of recapture, by distance, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

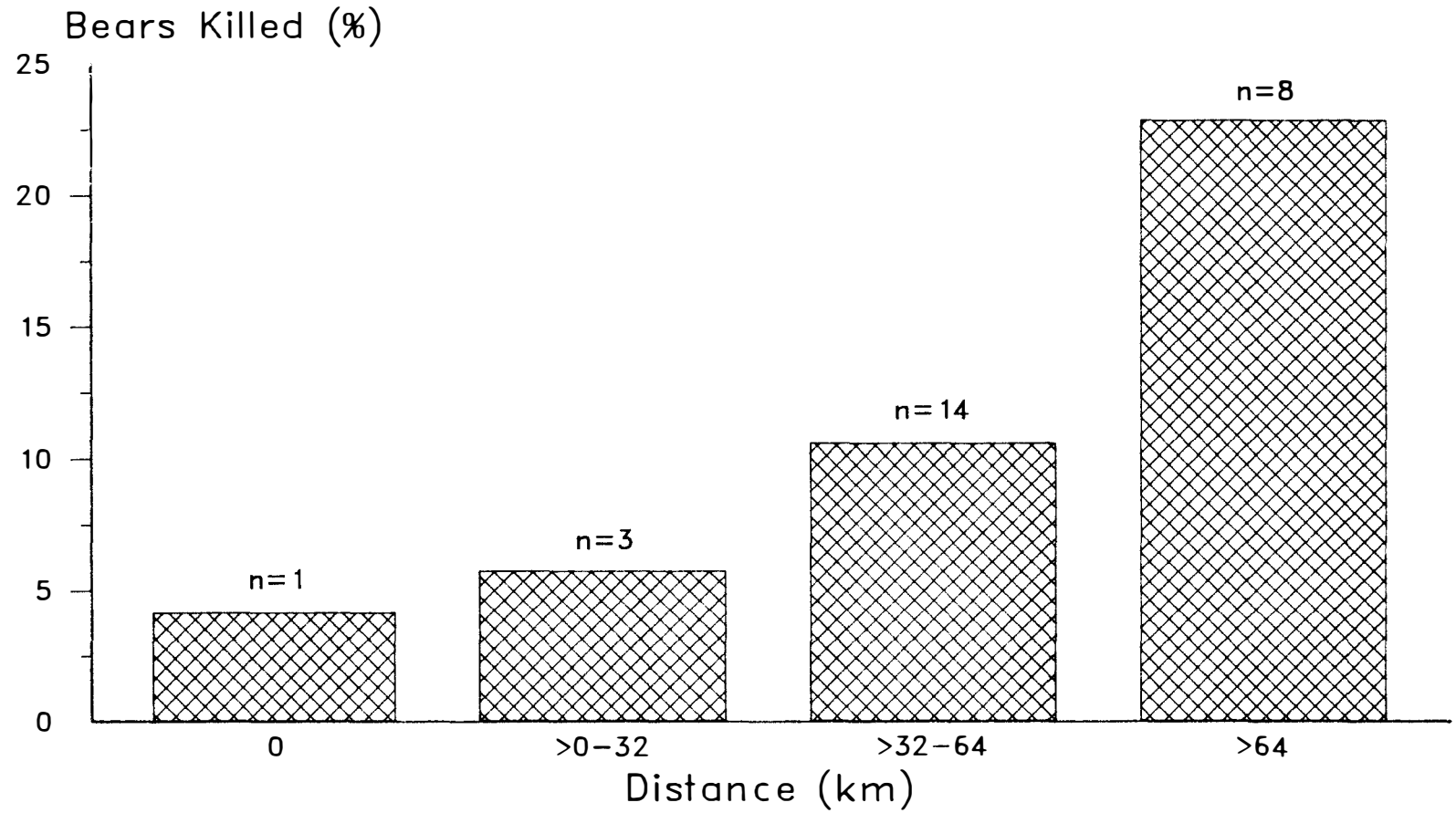

Figure 11. Mortality, by distance, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

The low frequency of recapture for bears relocated longer distances also may be due to physiographic barriers (McArthur 1981, Miller and Ballard 1982) and/or the inability of bears to navigate from longer distances (Rogers 1987b). Of recaptured bears, the percentage that were recaptured near their original capture area for each distance category were 100% (n=14), 95.8% (n=23), and 77.1% (n=37) and 0%, respectively. Beeman and Pelton (1976) suggested that the rough topography of GSMNP may hinder the homing ability of bears relocated long distances. They found approximately 54% of male problem bears in GSMNP relocated <30 km returned to their capture area. Another study in GSMNP reported 86% success for bears relocated 16-30 but only 9% success for bears relocated 3-15 km (Singer and Bratton 1977). In Glacier National Park, distance, number of ridges, elevation gain, and physiographic barriers between capture and release site were highly correlated with the success of bear relocations (McArthur 1981).

It appears that there may be a distance threshold from which most bears are incapable of homing. This study and others (Sauer et al. 1969, Alt et al. 1977, Rogers 1986a) suggest relocation distances >64 km would assure the lowest percentage of bears returning to their capture area. Since most bears cause subsequent problems near their original capture area, relocation distances that challenge the homing ability of bears will likely result in the greatest

management success. However, bears relocated longer distances sustain higher mortality, and are more likely to cause subsequent problems outside their original capture area and in less time than those relocated shorter distances. Also, it should be noted that these results were determined using initial relocation of individual bears, and therefore may be limited by small sample sizes. Most problem bears in GSMNP were not relocated >64 km until their second or third offense. Bears with previous relocation experience (captured and relocated 2 or more times) were recaptured more frequently and more successful in homing from distances >64 km.

Frequency of recapture for bears released on site (58.3%) was not significantly higher (DF=1, G^2=1.47, P=0.2260) than those relocated >0-32 (42.3%) and only marginally higher (DF=1, G^2=3.05, P=0.0809) than those relocated >32-64 (35.6%) (Fig. 10); this may partly be due to small sample sizes. Generally, the NPS does not capture and release problem bears on site as a management alternative except to maintain the integrity of family units when all members cannot be captured. No adult males were released on site. Ten problem bears were captured, instrumented with radio-collars, and released on site as part of problem bear telemetry study (Hastings 1983, Hastings et al. 1987).

The moderate success of capturing, handling, and releasing problem bears on site, however, warrants further investigation into this procedure as a potential management alternative (Brady and Maehr 1982, Wooding et al. 1988). Bears may associate people and/or their food and garbage with the trauma of being captured, and may learn to avoid human-use areas. In Florida, only 14% of apiary-raiding bears that were captured, handled, and released on site were later recaptured because of further problems (Wooding et al. 1988).

Capturing and releasing problem bears on site as a form of aversive stimuli may be particularly useful for bears that are not bold enough to enter human use areas during the day or those causing problems in backcountry areas; this procedure also would distinguish between transients and habitual problem bears and therefore reduce the number of innocent bears relocated. Finally, capturing and releasing problem bears on site also may be a form of mitigation to local hunters who strongly oppose relocating bears from the area.

Interaction of Sex and Season. Frequency of recapture for male and female bears differed significantly (DF=2, G^2=6.07, P=0.0482) according to the season in which they were relocated. Frequency of recapture for male bears relocated in spring, summer, and fall were 63.2% (n=12), 29.0% (n=33), and 41.7% (n=10), respectively (Fig. 12).

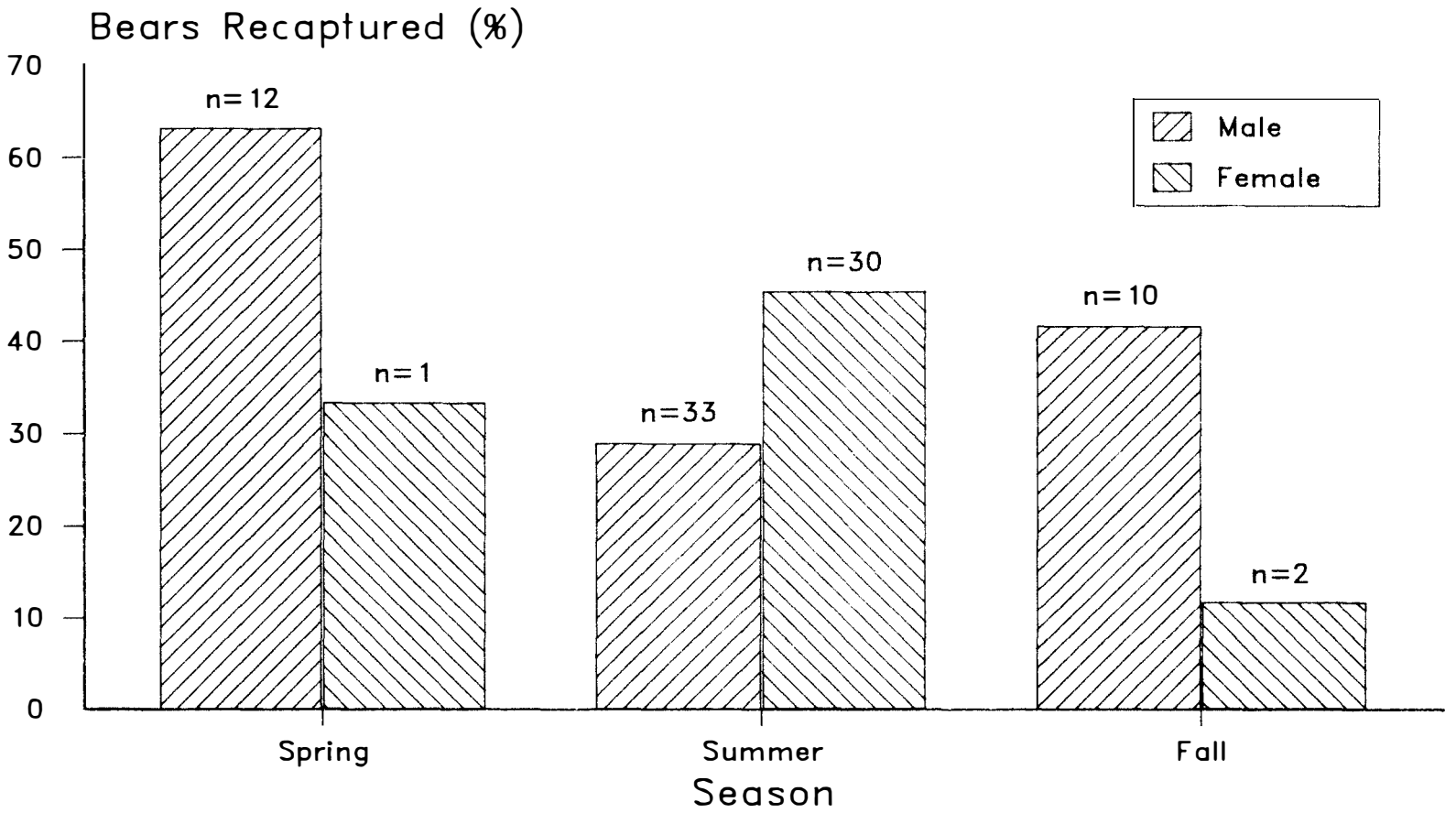

Figure 12. Frequency of recapture, by season and sex, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

Frequency of recapture for female bears relocated each season were 33.3% (n=1), 45.5% (n=30), and 11.8% (n=2), respectively (Fig. 12). Small sample sizes due to missing data, and a marginal level of significance, limit interpretation of this interaction. Due to missing data, only 243 problem bear relocations (73.0%) were used in the analysis.

The interaction between sex and season may partly be explained by the sex and age class of bears captured each season (Table 2). Female bears captured and relocated in spring were subadults. In summer, 68% of relocated male bears were cubs or subadults. Cubs and subadult bears were recaptured less frequently than adult bears, which likely accounts for the lower frequency of recapture for females in spring and males in summer. Age, however, does not appear to explain differences in recapture frequencies between male and female bears relocated in fall. In fall, 88% (n=22) and 62.5% (n=10) of relocated male and female bears were cubs or subadults. A larger sample of spring and fall bears is needed to further evaluate the interaction between sex and season.

Frequency of recapture for all bears relocated in spring, summer, and fall, were 59.1% (n=13), 35.0% (n=63), and 29.3% (n=12), respectively (G^2=9.12, P=0.0105) (Fig. 13). Mean number of days from relocation to recapture for bears relocated each season were 130 (SE=44.3), 330

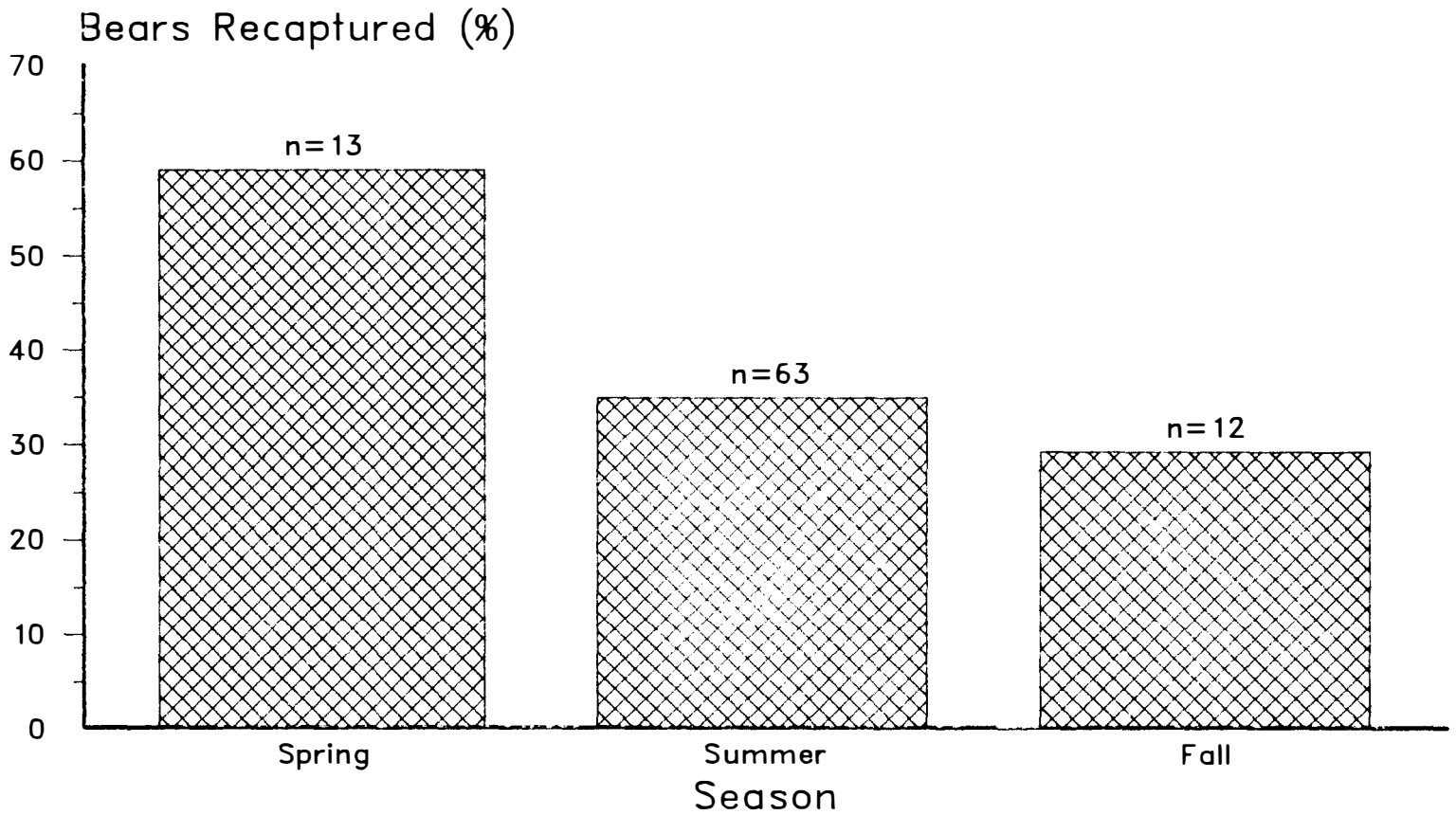

Figure 13. Frequency of recapture, by season, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

(SE=39.4), and 257 (SE=44.4) days, respectively (DF=2, F=0.96, P=0.3860).

Few relocation studies have investigated the frequency of recapture of bears by season. Rutherglen and Herbison (1977) reported a higher frequency of recapture for bears relocated in May. They attributed this to limited release areas away from populated area. Thier and Sizemore (1981) found that grizzly bear relocations in summer were less successful than those in spring and fall. However, they attributed this difference to the type of offense rather than any seasonal effect.

Distance was probably not important in determining the success of relocations by season. Mean distance relocated for bears moved in spring ($\bar{x}$=42.5, SE=5.1), summer ($\bar{x}$=40.2, SE=1.8), and fall ($\bar{x}$=45.0, SE=5.0) were not significantly different (DF=2, F=0.13, P=0.8808). Seasonal differences in the frequency of recapture of relocated bears in GSMNP may be due to plant phenology and the availability of natural foods each season. Fewer high quality natural foods are available in spring than in summer or fall. The lack of natural foods, particularly in spring, may stimulate movements by relocated bears, resulting in a higher frequency of recaptured in a shorter period of time. Food abundance at the release site, therefore, may be a major factor in determining seasonal relocation success (Barnes and Bray 1967, Piekielek and Burton 1975, McArthur 1981).

Frequency of recapture of male and female bears were 35.0% (n=55) and 38.4% (n=33), respectively. However, males were more likely to be recaptured in areas other than their original capture area and in a shorter period of time, whereas female bears were more likely to concentrate their efforts in a single area. Of recaptured bears, 41 males (74.5%) and 32 females (97.0%) were recaptured near their original capture area. Mean time elapsed between relocation and recapture for males ($\bar{x}$=225 days, SE=37, n=55) was significantly less (DF=1, F=7.47, P=0.0077) than females ($\bar{x}$=399 days, SE=47, n=33). Males were probably recaptured in other areas and in less time because they are more aggressive and roam more than females. McArthur (1981) suggested that relocated female bears may be more motivated to return to their capture area because they are territorial.

Release Area. Because of the limited road system, the NPS relocated problem bears primarily to 5 areas within GSMNP (Fig. 14). Generally, bears captured on the west end of the Park (i.e. Cades Cove, Elkmont, etc.) were relocated to the east end (Cataloochee/Mt. Sterling area); those captured on the east end (Cosby, Balsam Mtn., etc.) were relocated to the west end (Parson's Branch Road or Twentymile/Fontana Dam area). Bears were relocated along Tremont Road or in the Greenbriar area usually when time or personnel were limited (K. DeLozier NPS pers. commun.).

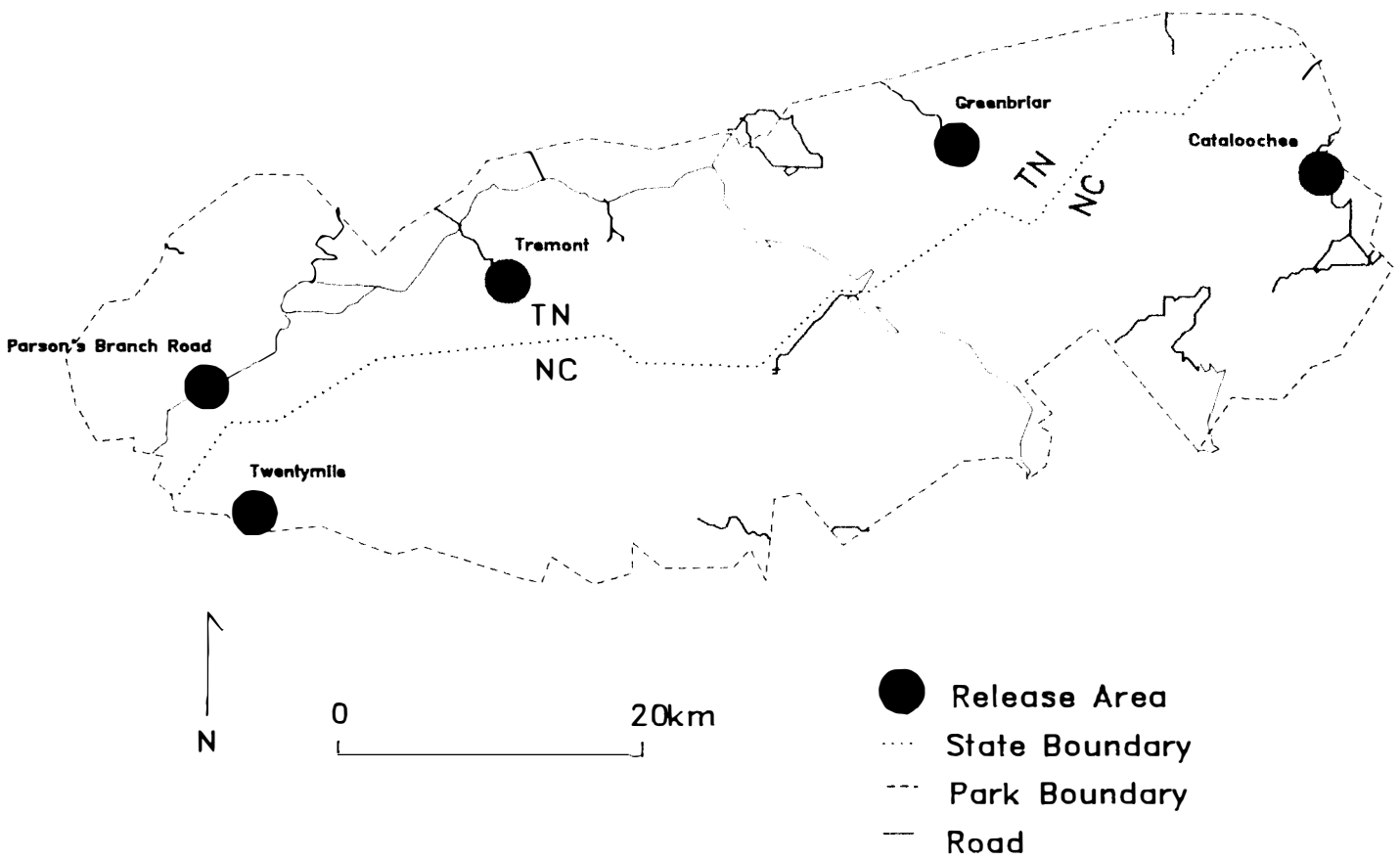

Figure 14. Release locations for problem black bears in Great Smoky Mountains National Park.

Generally, problem bears were donated to states agencies for relocation outside GSMNP when nuisance behavior was persistent (usually after at least 1 relocation within GSMNP) and/or when agencies had time and personnel to transport bears.

A model replacing distance with release area provided some evidence (DF=6, G^2=11.99, P=0.0622) that the frequency of recapture by release area differed according to the season in which bears were relocated (Fig. 15); this marginal level of significance may be a result of small sample sizes. A total of 303 bears were relocated to six release areas (Table 6), however, due to missing data, only 199 were used for statistical analyses. Bears relocated to Tremont and Greenbriar were not included in analyses because these areas were secondary release sites and limited by small sample sizes.

Assuming the season\release area interaction is not significant, frequency of recapture differed significantly (DF=3, G^2=20.65, P=0.0001) by release area (Fig. 16). Frequency of recapture for bears relocated out of the Park (14.8%, n=4) was significantly less (DF=1, G^2=5.49, P=0.0191) than for those relocated to Cataloochee (23.1%, n=18), Twentymile (34.8%, n=8), and Parson's Branch Road (56.3%, n=40). Frequency of recapture for bears relocated to Cataloochee and Twentymile were significantly less (DF=1, G^2=9.99, P=0.0016) than those relocated to Parson's Branch

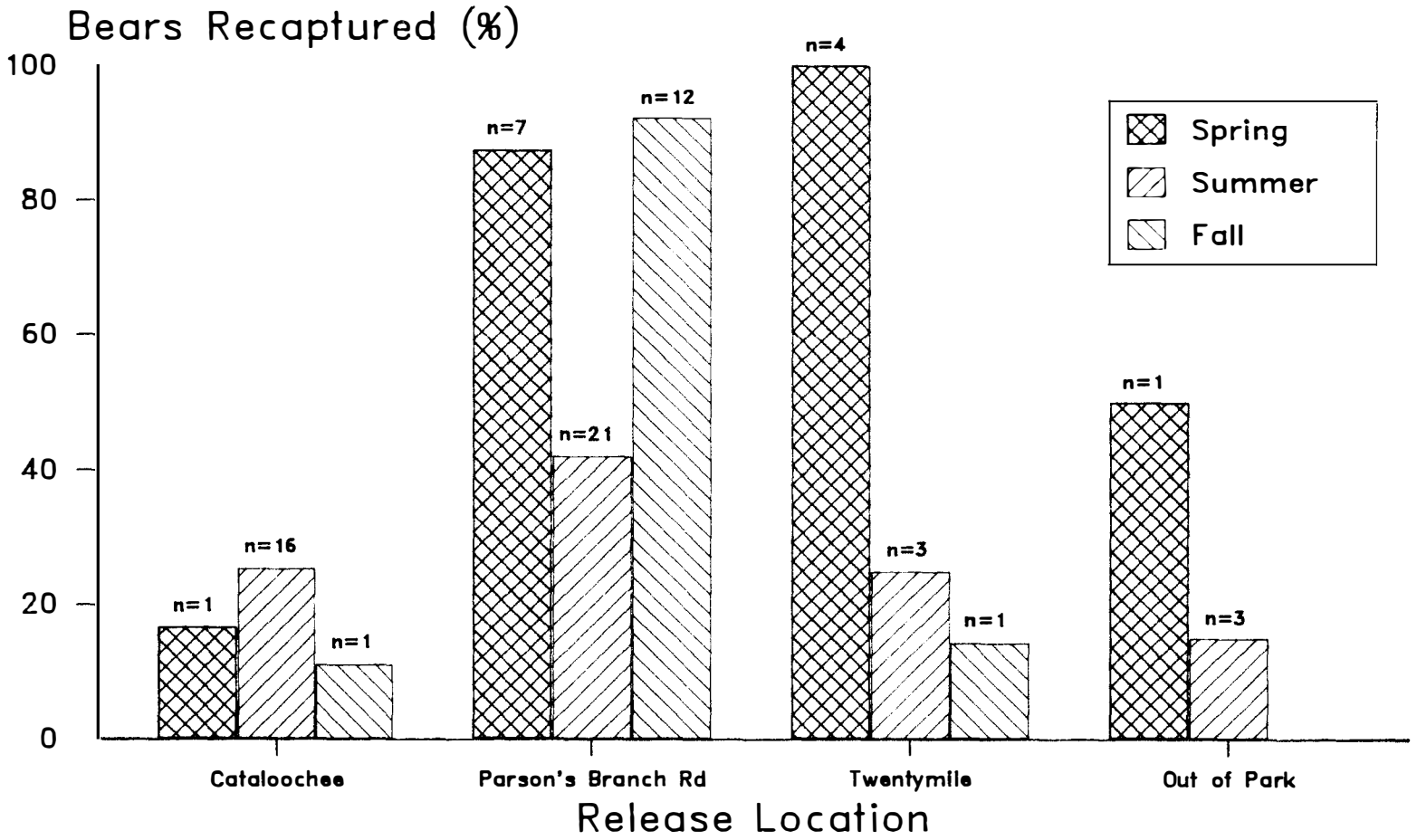

Figure 15. Frequency of recapture, by season and release location, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

Table 6. Outcome of black bear relocations in Great Smoky Mountains National Park, by release area, 1967-1989.

	Result			
Release Area	Unknown	Recaptured	Killed	Total
Cataloochee/Mt. Sterling	64 (67.4)[a]	23 (24.2)	8 (8.4)	95
Parson's Branch Road	44 (45.8)	48 (50.0)	4 (4.2)	96
Twentymile/Fontana Dam	15 (55.6)	8 (29.6)	4 (14.8)	27
Tremont Road	14 (56.0)	10 (40.0)	1 (4.0)	25
Greenbriar	8 (57.1)	5 (35.7)	1 (7.1)	14
Outside Park Boundary	30 (65.2)	5 (10.9)	11 (23.9)	46
Total	175	99	29	303

[a]Number in parentheses indicate percentages.

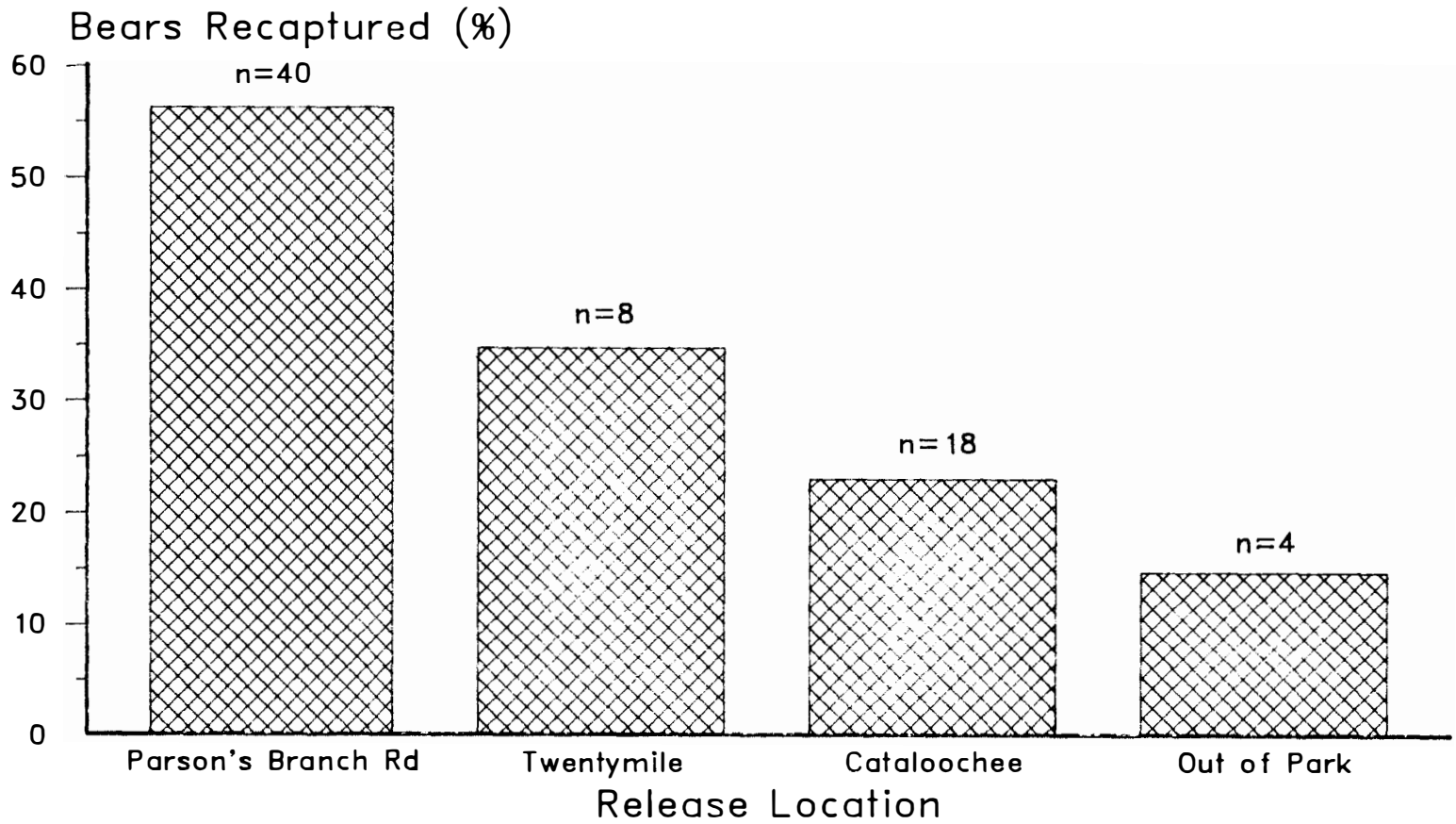

Figure 16. Frequency of recapture, by release location, of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

Road. There was no significant difference (DF=1, G^2=0.70, P=0.4035) in the frequency of recapture for bears relocated to Cataloochee and Twentymile.

Longer relocation distances and higher mortality likely explain the lower frequency of recapture for bears moved out of the Park. Bears relocated out of the Park ($\bar{x}$=106.8 km, SE=1.5, n=27) were moved significantly further (DF=3, F=40.72, P=0.0001) than those moved to Cataloochee ($\bar{x}$=44.6 km, SE=1.7, n=78), Twentymile ($\bar{x}$=46.1 km, SE=2.8, n=23), and Parson's Branch Road ($\bar{x}$=46.2 km, SE=1.7, n=71). As stated previously, the ability of relocated bears to return to their capture areas decreased as the distance relocated increased. Bears relocated outside GSMNP also sustained higher mortality than those relocated within GSMNP (Table 6). Differences in the frequency of recapture for bears relocated to Cataloochee, Twentymile and Parson's Branch Road may be due to illegal hunting. Illegal hunting is thought to be more prevalent in the Cataloochee and Twentymile areas than Parson's Branch Road. Differences in the frequency of recapture between Cataloochee, Twentymile and Parson's Branch Road also may be due to physiographic barriers between capture and release sites (McArthur 1981), bear densities (Rogers 1986a), and/or habitat and food availability (Barnes and Bray 1967, Piekielek and Burton 1975, McArthur 1981).

Although Tremont and Greenbriar areas were not included in statistical analyses, frequency of recapture for bears released in those areas was comparable to other areas within GSMNP (Table 6). Time elapsed between release and recapture for bears relocated to Tremont and Greenbriar areas also was greater ($t=10.82$, $P=0.0017$) than for those moved to Cataloochee, Parson's Branch Road, and Twentymile areas (Table 7). The longer time between release and recapture for bears relocated to Tremont and Greenbriar, and comparable relocation success suggests that these areas have not been fully evaluated and should not be eliminated as potential release sites for problem bears. These areas may be effective release areas for first offending bears, particularly subadults, and probably should be considered in future relocations.

Subsequent Relocations. Bears with previous relocation experience were recaptured more frequently and in fewer days than those relocated for the first time. Frequency of recapture for bears relocated a second, third, and fourth time were 45.9% (n=50), 59.2% (n=29), and 48.3% (n=14), respectively (Table 3). Most experienced bears (79-85%) also were recaptured within 9 km of their original capture area (Table 3). Mean time elapsed between release and recapture for bears relocated a second, third, and fourth occasion were 234 (SE=48; n=49), 274 (SE=73; n=29), and 180 (SE=41; n=14) days, respectively.

Table 7. Time elapsed (days) from release to recapture, by release area, for relocated black bears in Great Smoky Mountains National Park, 1967-1989.

Release Area	All Bears	Bears Included In Analysis
Cataloochee/Mt. Sterling		
$\bar{x}$	322	364
N	22	17
SE	57	68
Parson's Branch Road		
$\bar{x}$	240	205
N	43	34
SE	42	40
Twentymile/Fontana Dam		
$\bar{x}$	133	133
N	8	8
SE	48	48
Greenbriar		
$\bar{x}$	448	560
N	5	4
SE	128	82
Tremont Road		
$\bar{x}$	248	426
N	10	5
SE	85	122
Out of the Park		
$\bar{x}$	464	164
N	4	3
SE	310	119

The higher frequency of recapture for experienced bears was partly due to their older age. Of second, third, and fourth offending bears 51.6% (n=47), 74.4% (n=32), and 84.6% (n=22) respectively, were adults. Adult bears have better homing abilities than younger bears (Harger 1970, Alt et al. 1977, this study). Frequency of recapture of second offending adults (61.5%, n=24) was significantly greater (DF=1, G^2=5.12, P=0.0236) than that of second offending subadults (38.5%, n=15). Age, therefore, should be considered when determining where to relocate second offending bears.

Distance also was important in determining the relocation success of second offending bears. Frequency of recapture for second offending bears relocated >64 km (22.2%, n=4) was significantly less (DF=1, G^2=9.05, P=0.0026) than for those relocated $\leq$64 km (58.3%, n=35) (Fig. 17). However, relocation distances >64 km were less effective for bears relocated a third time. Frequency of recapture of third offending bears relocated >64 km (50%, n=9) was not significantly different (G^2=0.823, P=0.365) than for those relocated $\leq$64 km (63.3%, n=17).

Experienced bears also were more capable of homing from longer distances. Of recaptured second and third offending bears relocated >64 km, 3 (75%; 16.7% of all bears relocated >64 km) and 6 (66.7%; 33.3% of all bears relocated >64 km) were recaptured near their original capture area.

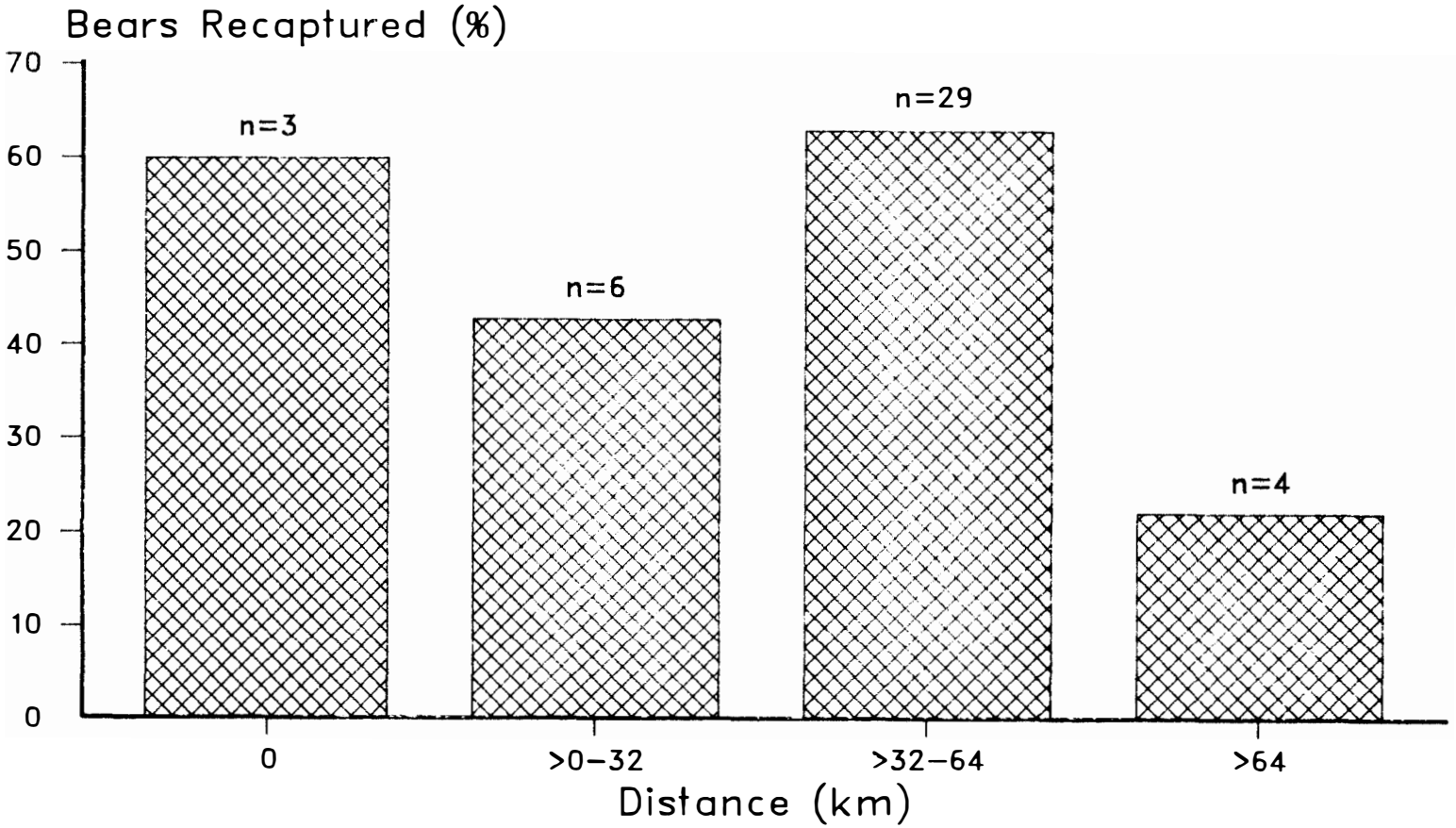

Figure 17. Frequency of recapture, by distance, of problem black bears relocated twice in Great Smoky Mountains National Park, 1967-1989.

Because experienced bears were recaptured more frequently and capable of homing from longer relocation distances, release areas within GSMNP may not be adequate for them. Frequency of recapture for second offending bears relocated to Cataloochee, Parson's Branch Road, Twentymile, and outside GSMNP were 58.8% (n=10), 65.4% (n=17), 66.7% (n=4) and 32.2% (n=10) (Fig. 18). Distance between capture and release sites within GSMNP are probably not far enough to challenge the navigational and homing abilities of experienced bears, resulting in a higher percentage of bears returning to their capture area and thus causing further problems.

The current management strategy for experienced bears is to relocate them to different areas within GSMNP or to donate them to wildlife agencies in one of the adjoining states (NPS 1981). Repeated relocations of problem bears, however, are expensive and probably inappropriate. Bears captured 3 or more times are likely habituated problem bears and probably will never live a "natural life." Repeated relocations of habituated problem bears will likely leave high risk individuals in the population, increasing the probability of a serious human\bear incident (Brannon 1987). Habituated problem bears probably should be euthanized (Craighead and Craighead 1972, Graber 1981). Direct removal by killing is the most economical and effective way of eliminating habituated problem bears. Although destroying

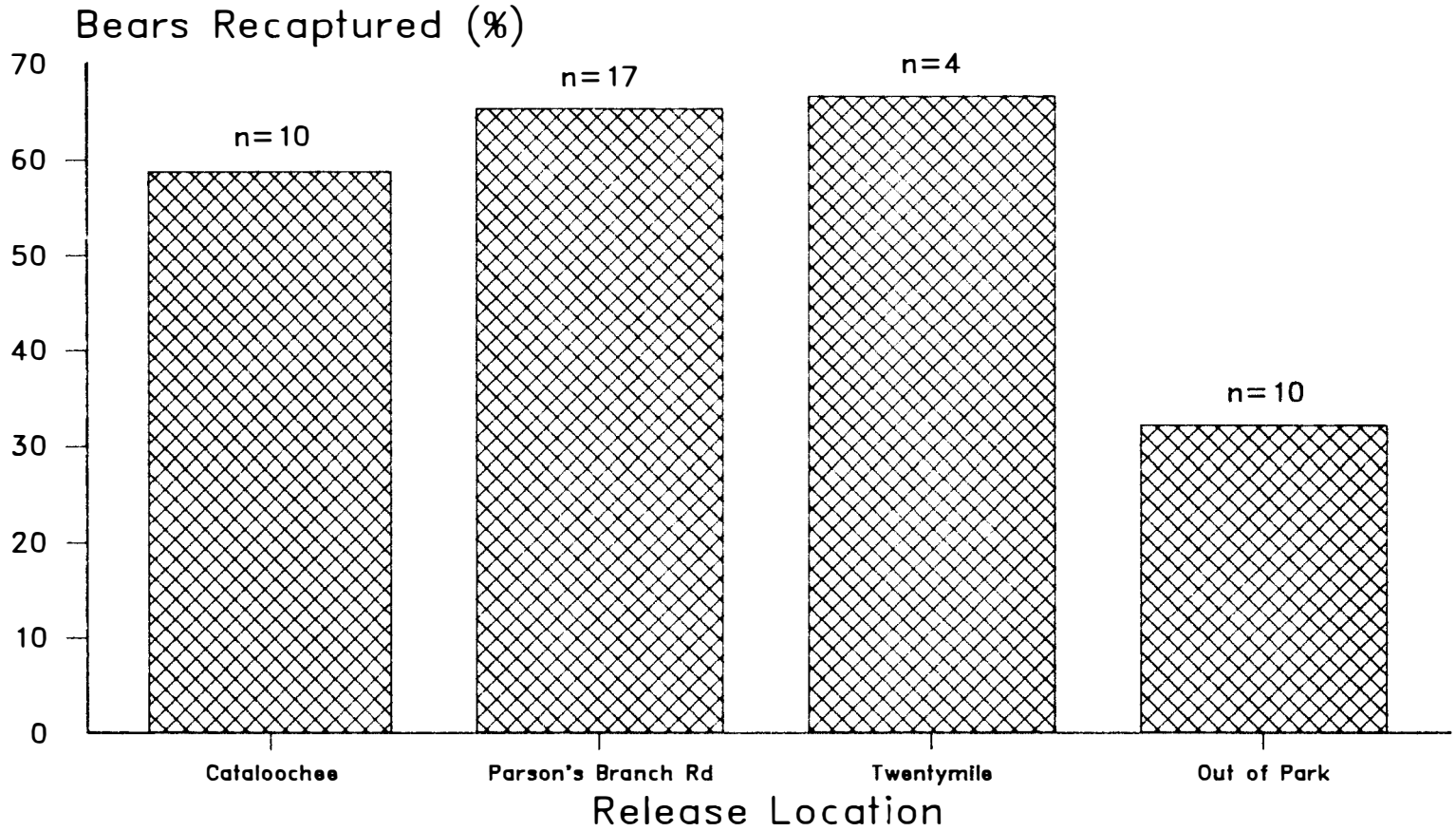

Figure 18. Frequency of recapture, by release location, of problem black bears relocated twice in Great Smoky Mountains National Park, 1967-1989.

bears is socially unacceptable to both visitors and local hunters, it may be the only alternative for some animals.

Mortality

A minimum of 63 (18.5%) of the 341 bears in this study died (Table 8). All but 1 of these were human-caused mortality. Relocated bears were recovered a mean of 43.3 km (SE=5.0, n=48) from their release site (Fig. 19) and 84.5 km (SE=12.2, n=48) from their capture site. Time elapsed from relocation to recovery ranged from 4 to 1949 days ($\bar{x}$=256 days, SE=50, n=51), however, most bears (68.6%, n=35) were recovered within 172 days.

Legal hunting was the primary cause of mortality for relocated bears (Table 8). Relocated bears were legally harvested in North Carolina (n=34), Virginia (n=2), Georgia (n=1), and South Carolina (n=1). Surprisingly, relocated bears were not reported as part of the legal bear harvest in Tennessee; this may partly be due to land use patterns in Tennessee. In Tennessee, the land adjacent to GSMNP is in private ownership, heavily populated, and marginal bear habitat. Bears relocated into unfamiliar territory may avoid heavily populated areas (Fies et al. 1986) and, therefore, may not be available to hunters in Tennessee. The timing of the hunting season in Tennessee also may be responsible for no tag returns of relocated bears. Since most bears were captured and relocated in summer, many may return to the refuge of GSMNP and/or enter winter dens

Table 8. Sources of mortality of problem black bears in Great Smoky Mountains National Park, 1967-1989.

Recovery Type	Males N	Females N	Total N	Total %
Hunter	24	14	38	60.3
Euthanasia/ Handling	7	4	12[a]	19.0
Illegal/ Depredation	6	2	8	12.7
Vehicle	3	1	4	6.3
Unknown	0	1	1	1.6
Total	40	22	63[a]	100

[a]Total includes 1 bear whose gender was not known.

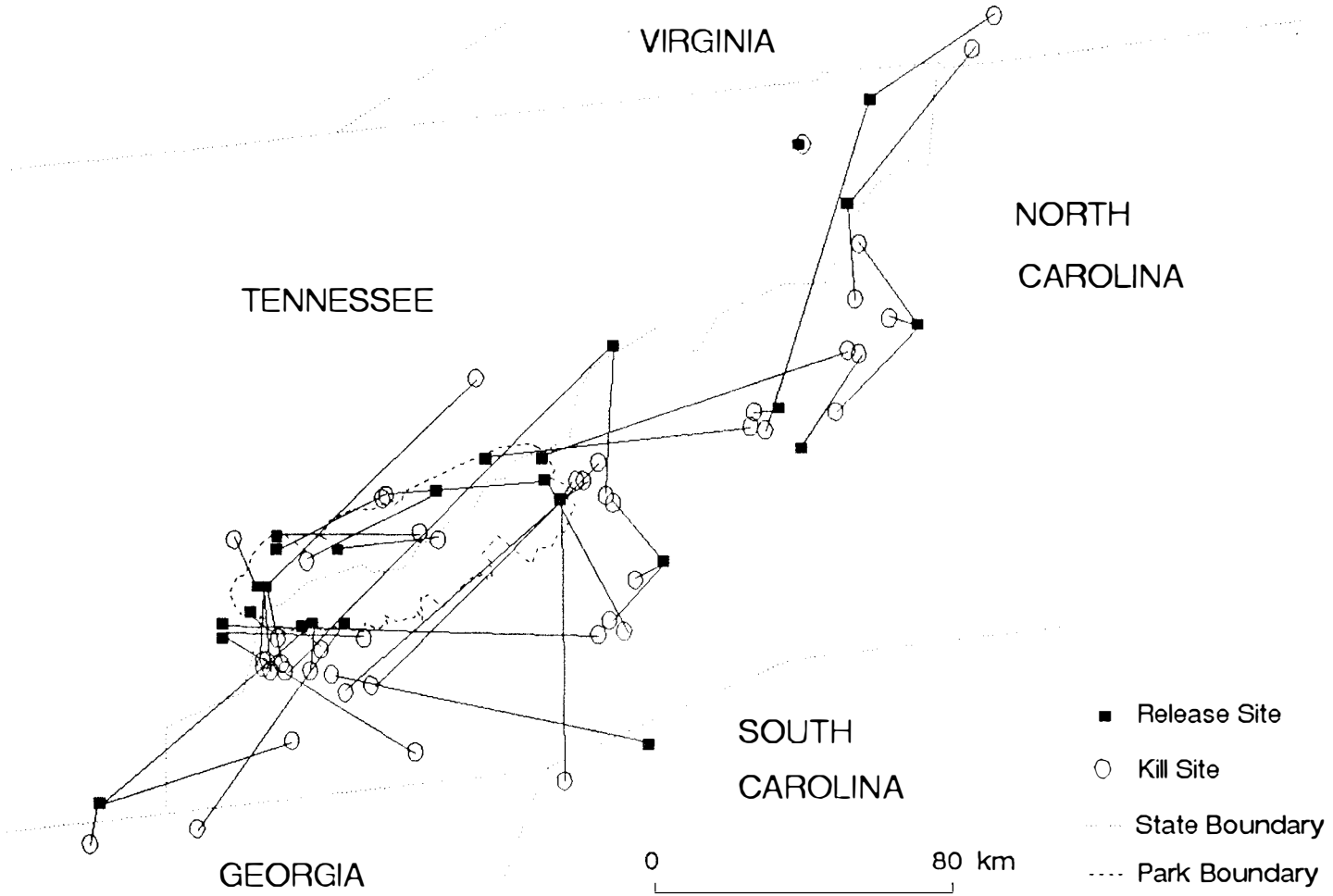

Figure 19. Release and recovery locations of problem black bears relocated in Great Smoky Mountains National Park, 1967-1989.

before the hunting season begin in October and December.

Considering movements of relocated bears and that many bears harvested in Blount, Sevier, and Cocke counties are likely residents of GSMNP, it would seem logical that relocated bears would comprise at least a small percentage of the Tennessee bears harvest. However, for whatever reason, relocated bears have not been reported in the Tennessee bear harvest. Local hunters strongly oppose relocating bears from the area and, therefore, may purposely withhold harvest information. Undoubtedly, some relocated bears dispersed into Tennessee and were killed illegally (Beeman and Pelton 1976).

The proportion of male and female bears recovered were 19.2% (n=40) and 17.3% (n=22), respectively; this sex ratio (182 males:100 females) did not differ (DF=1, G^2=0.180, P<0.750) from the sex ratio reported for all problem bears and suggests both sexes were equally vulnerable to human induced mortality. Generally, male bears are more aggressive and mobile than females and, therefore, sustain higher mortality rates (Beecham 1980, Bunnell and Tait 1981, Wooding and Brady 1987). However, mean distance from release to recovery site for male ($\bar{x}$=45.9 km, SE=6.6, n=32) and female bears ($\bar{x}$=38.0, SE=7.2, n=16) were not significantly different (DF=1, F=0.42, P=0.5204) (Fig. 19). Mean time elapsed from release to recovery for male ($\bar{x}$=287 days, SE=67, n=36) and female bears ($\bar{x}$=181 days, SE=54,

n=15) also were not significantly different (DF=1, F=0.03, P=0.8639). Because most relocated bears were likely released in unfamiliar areas, their movements were likely altered, thus increasing the vulnerability of both males and females to human induced mortality.

Mortality of relocated bears in GSMNP is conservative and should be interpreted as a minimum. As previously stated, 55.6% of the bears in this study were never recaptured or recovered. Intensive trapping in areas near release sites has resulted in few recaptures of relocated bears, suggesting that some die of natural causes or killing by other bears (LeCount 1982, 1987, Rogers 1983, Hellgren and Vaughan 1988). Illegal hunting also is probably a significant source of mortality for relocated bears (Beeman and Pelton 1976) and likely accounts for a substantial number of deaths each year.

Harvest, both legal and illegal, of relocated bears is probably not detrimental to the overall bear population. Problem bears comprise a small percentage of the bear population in GSMNP and are primarily males. In fact, harvest of relocated bears may be beneficial to local populations by increasing hunter success, thereby removing hunting pressure.

Notable Movements

Numerous relocation studies of black bears (Erickson et al. 1964, Sauer et al. 1969, Harger 1970, Rogers 1974, Payne

1975, Alt et al. 1977, Rutherglen and Herbison 1977, Bader 1974 in Berns et al. 1980, Graber 1981, Massopust and Anderson 1984, Rogers 1986b, Maehr et al. 1988), brown or grizzly bears (Pearson 1972, Craighead 1976, Glenn and Miller 1980, Judd and Knight 1980, Miller and Ballard 1982, Brannon 1987) and polar bears (Ursus maritimus) (Stirling et al. 1977) have noted long movements; this study was no exception (Appendix D). Several relocated bears in this study travelled distances near or exceeding 100 km, overcoming physiographic barriers such as lakes, rivers, and major highways (Table 9).

Long excursions are not uncommon for black bears. These movements, however, are usually associated with dispersal (Alt 1978, Rogers 1987a) or periods of food scarcity (Beeman 1975, Garshelis 1978, Quigley 1982, Carr 1983, Rogers 1987a). Except for dispersing males, which may travel distances $\geq$ 219 km before settling (Rogers 1987a), most long movements by nonrelocated black bears are usually less than 64 km (Rogers 1987b) and most return to their original home range.

Long movements by bears in this study were probably not due to food shortages but demonstrate the remarkable orientation and navigation abilities of relocated bears (Rogers 1987b). Other bears probably moved long distance because they were disoriented (Graber 1981). Although relocation distances >64 km were most effective for problem

Table 9. Summary of long distance movements by black bears in Great Smoky Mountains National Park, 1967-1989.

Bear Number	Sex	Age[a] (yrs)	Relocation Distance (km)	Distance Travelled (km)	Time Elapsed (Days)	Homed[b]	Previous Experience	Comments
126	M	7.5	87	87	351	yes	yes	
205	F	8.5	118	118	341	yes	yes	
206	M	2.5	119	119	342	yes	yes	
	M	3.5	92	95	320	yes	yes	
	M	4.5	178	178	20	yes	yes	
	M	4.5	178	93	28	no	yes	Depredation kill.
279	M	4.5	663	142	401	no	?	Depredation kill.
297	F	13.5	152	73	73	no	yes	
330	M	2.5	36	109	430	no	no	Hunter killed.
353	M	4.5	57	105	1949	no	no	Hunter killed.
390	F	8.5	118	93	22	no	yes	
472	F	8.5	0	108	464	no	yes	Equipped with radio-collar.
611	M	2.5	68	81	102	no	no	Hunter killed.
661	M	4.5	95	89	40	yes	yes	
	M	4.5	116	94	22	no	yes	
	M	5.5	94	89	28	yes	yes	
P010	M	1.5	48	87	1158	no	no	Hunter killed.
P013	M	6.5	71	123	56	no	yes	Hunter killed.
P015	F	0.5	34	73	495	no	no	Hunter killed.
P022	F		55	114	54	no	yes	
	F		47	92	99	no	yes	Hunter killed.
P023	M	2.5	56	79	334	no	no	Roadkill.
P087	M	0.5	118	97	22	no	no	Cub of bear 390.
P090	M	6.5	116	116	39	yes	yes	

Table 9. (Continued).

Bear Number	Sex	Age[a] (yrs)	Relocation Distance (km)	Distance Travelled (km)	Time Elapsed (Days)	Homed[b]	Previous Experience	Comments
P151	F	4.5	124	115	1084	no	yes	
	F	7.5	179	97	18	no	yes	
P165	F	5.5	182	182	215	yes	yes	
P168	F	2.5	43	86	154	no	yes	Roadkill.
P172	F	10.5	95	14	3	no	yes	
	F	10.5	12	98	733	yes[c]	yes	
P303	M	4.5	116	116	15	yes	yes	

[a]Age when captured and relocated

[b]Within 9 km of the original capture site.

[c]Bear returned to her original capture area in GSMNP after being captured and relocated by the Georgia Department of Natural Resources.

bears in GSMNP, the ability of relocated black bears to travel long distances and/or return to their site of capture should not be underestimated. Two male bears (P303 and 206) in this study returned 116 and 178 km from their release sites to capture sites in 15 and 20 days, respectively (Table 9)!

Management Implications

Roughly 10 million people visit GSMNP annually. Because the bear population in GSMNP is protected, it is likely at or near carrying capacity, creating a situation in which the probability of a human/bear interaction is high. However, most bears in GSMNP avoid people. Problem bears comprise a small percentage of the overall bear population and are primarily younger males and older females. Although the availability of human food and garbage is the principal factor regulating problem bear activity, the preponderance of younger males and older females as problem bears suggests that social factors also may be important. Adult males may restrict less dominant bears from prime feeding areas, forcing them to forage near people (Mattson 1990).

Movements associated with dispersal, mating, and the availability and abundance of natural foods are probably also important in regulating nuisance activity by bears in GSMNP. The relationship between natural food abundance and nuisance activity, however, is difficult to determine. Except for hard mast, little quantitative data are available

regarding the abundance of bear foods in GSMNP. Hard mast regulates bear densities in GSMNP (McLean 1991) and, probably yearly fluctuations in the number of problem bears captured. Future research should focus on techniques to measure natural food abundance and its relationship to problem bear trends.

Due to the number and concentration of visitors, and presence of their food and garbage, bears will continue to be attracted to human-use areas in GSMNP. Stricter enforcement of policies regarding bears and garbage, and public education may alleviate some problems. However, compliance of policies regarding bears and garbage probably will never reach 100%. Relocating problem bears, therefore, will continue to be an important component of the bear management plan for GSMNP.

Relocating problem bears is controversial, time consuming, and expensive. This study indicates that relocating problem bears is a moderately effective management tool. Only 33.9% of relocated bears were recaptured due to subsequent nuisance behavior. Relocation success, however, could be improved by developing a specific set of guidelines to standardize the decision-making process when dealing with problem bears. Variables most important in determining relocation success of problem bears in GSMNP include the age of the bear, potential release area or distance relocated, and previous experience. Managers need

to recognize these variable and develop a detailed protocol based on them.

Of recaptured bears, most (82.3%) were recaptured near their original capture area. Some relocated problem bears exhibit remarkable homing abilities, overcoming physiographic barriers such as lakes, rivers and major highways. The mechanisms bears use to navigate from long distances is not known, but should not be underestimated. The tendency of relocated bears to return to their capture area suggests that potential release areas should not be eliminated due to their proximity to human dwellings.

Bears that cause persistent problems are a small but distinct cohort. Many of these bears are likely habituated to people and/or their food and garbage. Managers need to recognize that the management strategy for habituated problem bears should not be the same as that for bears captured for the first time. Habituated problem bears should be relocated longer distances and preferably outside the boundary of GSMNP. Some habituated bears will probably never revert to "normal" behavior and therefore probably should be euthanized. The decision to euthanize a bear should be made only after careful deliberation of past relocations. The number of bears that would need to be euthanized is probably small relative to the number that die due to hunters and/or other sources each year. Killing probably should not be a management alternative for first

offending bears since it may result in the unnecessary death of innocent bears.

Although relocating problem bears is an effective management tool, the biological implications associated with it are not understood. It is not known what impact, if any, removing bears from an area has on local populations, nor is it known how these bears may affect the population into which they are released. Relocation of a large number of adult bears, particularly within a year, could affect the sex and age structure of local populations. Relocating adult females may result in a decline in their reproduction the following year (Miller and Ballard 1982, Brannon 1987) which could affect recruitment. Relocation of adult male bears may disrupt the intrinsic control of the population (Bunnell and Tait 1981) and result in an influx of subadult males from other areas (Kemp 1976, Young and Ruff 1982, Tate and Pelton 1983, Rogers 1987a); this may become self-perpetuating, resulting in more problem bears and a higher number of human/bear conflicts. Relocated bears that remain near their release area may increase competition for food and space and may disrupt the social structure of local populations (Rogers 1986a).

Most relocated problem bears (55.6%), particularly cubs and subadults, were never recovered. There was little evidence to suggest that these bears remained in their release area or returned to their capture area. It is

likely that many of these bears dispersed from their release area and were killed. Since problem bears are not afraid to approach people, relocating them, particularly outside the boundary of GSMNP, probably increases their vulnerability to hunting and poaching. Some of these bears also may have died from other causes including stress and predation by other bears. Future research should focus on determining the ultimate fate of bears never recovered.

At least 18.5% of bears in this study died; most were killed by hunters. Since problem bears comprise only a small percentage of bears in GSMNP, and are primarily younger males, their loss through hunting or other sources of mortality probably has little impact on the overall population. Hunter harvest of relocated problem bears may be beneficial to local populations by increasing hunter success, thereby removing pressure from resident bears. However, hunter harvest is controversial with respect to the bear management plan of GSMNP. The rationale for relocating bears is to allow them to live a natural life with a minimum of human interference (NPS 1981).

To properly manage bears in GSMNP, the movements and fates of relocated bears needs to be more fully understood. Several sections of this study were limited by small sample sizes and missing data, limiting interpretation. The importance of proper data collection and storage, and information exchange between agencies cannot be

overemphasized. More detailed information regarding movements and fates of relocated bears could be obtained through instrumenting bears with radio-collars. A telemetry study would further evaluate both management success and biological implications of relocating bears; this information could be incorporated into the GSMNP bear management plan as an aide in determining if and/or where problem bears should be relocated.

More research also is needed regarding innovative techniques to prevent bears from obtaining food and diverting bears from human-use areas. The effectiveness of food lockers and suspension cables should be tested in areas with the greatest number of conflicts. Capturing and releasing bears on site as aversive stimuli appears to be effective for some bears, however, this technique has not been properly evaluated in GSMNP. The use of deterrents and/or repellents also has proven to be moderately effective in reducing bear damage (Gilbert and Roy 1977, Wooldridge 1980) and probably warrants further investigation. If properly tested and applied, aversive conditioning could potentially reduce the number of problem bear relocations.

CHAPTER V

SUMMARY AND CONCLUSIONS

1. A capture-recapture study on problem black bears was conducted in Great Smoky Mountains National Park. Data were collected for 341 black bears captured and relocated 570 times from 10 July 1967 to 6 December 1989.

2. Males comprised 61.9% of the problem bears captured and 54.7%, 72.9%, and 58.0% of cubs, subadults, and adults captured. The higher percentage of males captured likely was due to their larger home ranges and the greater mobility of the subadult male age class.

3. Excluding cubs and dependent yearlings, mean age of male and female bears at initial capture were 3.9 and 4.6 years, respectively (P=0.0864). The preponderance of younger males and older females suggests that social factors may be important in regulating problem bear activity. Adult males may restrict less dominant bears from prime feeding areas, forcing them to forage in marginal habitat and/or near people.

4. Only 18 of 504 bears captured as part of the UTK research were subsequently captured because they were causing problems. Bears captured as part of the UTK research were older than problem bears and, therefore, probably less likely to succumb to social pressures.

5. Seasonal trends in captures of problem bears generally coincided with seasonal public visitation in GSMNP (P=0.0001). Most problem bears were captured in summer (75.1%), followed by fall (14.2%) and spring (10.7%). Months of higher public visitation in GSMNP provided more human food and garbage to attract bears, resulting in more captures during these months.

6. Seasonal differences in home range use and activity patterns of bears were probably also important in seasonal capture trends. Sex and age of captured bears differed by season (P=0.0459). No adult females or cubs were initially captured in spring because of their later den emergence and restricted movements during that season. The highest percentage of bears captured in summer were dispersing subadults males (33.5%). The decline in captures of problem bears in fall was likely due to home range shifts in response to hard mast availability.

7. The number of individual problem bears captured each year ranged from 2 to 63, and may indicate changes in the overall bear population in GSMNP. Hard mast has a significant influence on the population dynamics of bears in GSMNP and may regulate yearly fluctuations in the number of problem bears captured. Changes in policies regarding problem bears, advances in capture techniques, and financial and personnel constraints also account for some yearly variation in captures of problem bears.

8. Of 333 individual bears captured and relocated, 32.4% were recaptured because of subsequent problems, 2.7% were recaptured as part of the UTK bear research, 9.3% were killed, and 55.6% were never recovered. It is likely that a substantial number of bears that were never recovered dispersed from their release areas and were killed.

9. Of recaptured bears, most (82.3%) were recaptured within 9 km of their original capture site, suggesting bears have a strong fidelity to their original capture area.

10. Time elapsed between release and recapture ranged from 2 to 1453 days ($\bar{x}$=297 days). Forty-nine bears were recaptured within the same year they were relocated.

11. Mean age of recaptured bears (4.1 years) was significantly greater (P=0.0052) than those not recaptured (3.0 years). Adult bears (51.3%) were recaptured more frequently (P=0.0013) than subadults (29.1%) and cubs (30.0%). Subadults and cubs may be more likely to establish home ranges within the areas they were released, and mortality of subadults and cubs likely is higher than that of adults.

12. Frequency of recapture decreased significantly (P=0.0159) as the distance bears were relocated increased. Bears relocated longer distances were less capable of returning to their capture area. Bears relocated longer distances also sustained higher mortality, probably because they were released outside the Park or near its boundary,

where hunting pressure is intense.

13. Capturing and releasing problem bears on site was successful in eliminating nuisance behavior of some bears. Bears captured and released on site may associate the trauma of being captured with people and/or their food and garbage and may learn to avoid human use areas.

14. Frequency of recapture for male and female problem bears differed according to the season in which they were relocated (P=0.0482). Frequency of recapture for males relocated in spring, summer, and fall were 63.2%, 29.0%, and 42.7%, respectively. Frequency of recapture for females each season were 33.3%, 45.5%, and 11.8%, respectively. This interaction was likely due to age differences of males and females captured and relocated each season.

15. Frequency of recapture of relocated bears differed significantly by release areas (P=0.0001). Only 14.8% of bears relocated out of the Park were recaptured. Bears relocated out of the Park were moved longer distances and sustained higher mortality. Relocations within the Park were most successful for bears moved to the Cataloochee/Mt. Sterling area and least successful for those moved to Parson's Branch Road. Differences in relocation success for bears released within the Park were not known but were probably not related to distance.

16. Bears with previous relocation experience were recaptured more frequently and in a shorter period of time

than those relocated for the first time. Bears with previous experience were older and likely habituated to people and/or their food and garbage.

17. At least 63 of the 341 bears in this study were killed. All but 1 mortality was human caused. Most mortality (60.3%) was due to hunters legally harvesting bears. Since problem bears are not afraid to approach people, relocating them into unfamiliar areas likely increases their vulnerability to hunting and other human induced mortality.

18. The percentage of male (19.7%) and female (17.3%) problem bears killed were not significantly different ($P<0.750$). Relocating problem bears probably increases the vulnerability of both males and females to human induced mortality.

19. Some relocated problem bears in this study made notable long range movements. Two male bears in this study travelled 116 and 178 km from their release site to their capture site in 15 and 20 days, respectively. The ability of black bears to travel long distances and/or return to their site of capture should not be underestimated.

20. Management implications were: 1) capturing and releasing bears on site may be effective for some problem bears and also may be useful in distinguishing transients from habitual problem bears; 2) adult bears are recaptured more frequently and therefore should be relocated longer

distances; 3) bears relocated out of the Park were recaptured less frequently than bears relocated within the Park, but also sustained high mortality; 4) relocations are not practical for all bears, and in some situations (bears with previous relocation experience) bears should be destroyed; 5) relocated bears that were never recovered likely dispersed from their release area and were killed; 6) a telemetry study is needed to further evaluate the biological and management implications of relocating problem bears in GSMNP.

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APPENDICES

APPENDIX A

Table 10. Summary of data on problem black bears captured in Great Smoky Mountains National Park, 1967-1989.

Bear Number	Ear Tags[a] Right	Left	Tattoo	Capture Date	Capture[b] Location	Release[b] Location	Release Date	Sex	Age	Weight (kg)
001	W 20	P 10		200871	23			M	4.5	146
001	B 7	B 8		240572	23	04	240572	M	5.5	175
001	B 7	B 8		130672	23	47	140672	M	5.5	159
001	B 30	B 8		190772	23	38	200772	M	5.5	153
002				180572	23			M	9.5	130
003	W 5	Y 5		260670	23	50		M	7.5	
003	W 5	Y 5		140770	23	51		M	7.5	
003	W 5	Y 5		070870	23			M	7.5	
003	W 5	Y 5		060671	23	04		M	8.5	100
003	W 26	Y 26		090672	23	E	100672	M	9.5	158
003				230872	23	04	240872	M	9.5	155
003		Y 26		110673	23		110673	M	10.5	127
003	W 55	Y 26		030873	23			M	10.5	145
003	W 55	Y 26	80	190873	48		190873	M	10.5	136
004	Y 8	B 10		010771	23	48		M		77
004	Y 8	B 10		100971	23	04		M		
004	B 26	Y 27		140672	23	52	140672	M		118
004				170872	23	52	180872	M		142
004	B 52	Y 27		170673	23	41	170673	M		145
005	R 27	R 26		200672	01	01		M	3.5	114
005				110772	01	01		M	3.5	92
005	R 51	R 26		290673	01	01	290673	M	4.5	110
005	R 51			190674	01	01	190674	M	5.5	100
005	R 51			230675	02	02	230675	M	6.5	127
005	M 37	Y322	A26	200876	01	01	200876	M	7.5	120
005	B359	M 37	A26	210878	23	12	240878	M	9.5	141
005	M491	B491	A26	300679	02	02	300679	M	10.5	136
006	W 28	W 27		230672	B	50	240672	M	5.5	122
007	W 36	W 37		030772	B	12	030772	M	1.5	23
009	R 29	Y 30	077	060672	49	49	060672	F	4.5	55
009				270773	49	49	270773	F	5.5	64
010	B 27	B 28	088	070772	49	49	070772	M	1.5	14
011	R 28	W 30	001	130772	49	49	130772	M	1.5	27
013	W 29	B 29	99	120772	49	49	120772	F	1.5	9
013	W 29	B 29	09	210674	01	01	210674	F	3.5	32
013				100774	01	01	100774	F	3.5	
013	W 29	B 29	09	130974	49	49	130974	F	3.5	27
013	W 29	B 29	09	75	74			F	4.5	
014	Y 32	W 31	5/5	200772	D	41	210772	M		116
014				090872	D	04	100872	M		122
014				210872	D	52	220872	M		125
015	B 11	P 7		150870	23	48				136
015	B 11	P 7		230870	23	54				
015	B 11	P 7		090771	23	48				
015	B 11	P 7		270871	23	55				
015	B 11	P 7		200772	23	53				
017	Y 33	R 31	8/8	280772	56	56	280772	M	0.5	7
017			38	201074	53	01	201074	M	2.5	70
017	Y 33	R 31	38	040975	11	11	040975	M	3.5	66
017			38	070776	11	11	070776	M	4.5	70
017			38	100876	53	48	110876	M	4.5	77
019	R 34	R 33	1/2	280772	D	29	290772	F	5.5	65
020	42	41		100669	23	48		M	0.5	14
020	Y 23	G 7		030870	23	48		M	1.5	110
020	Y 23	G 7		200870	23	48		M	1.5	114
020	42	41		300871	23	48		M	2.5	
020	Y 38	Y 37	1/5	040872	23	48	050872	M	3.5	116
020	Y 38	Y 37	1/5	140872	23	05	150872	M	3.5	
021	P 4	P 3		170870	23			M	8.5	170
021	P 4	P 3		011070	23	04		M	8.5	
021	P 4	P 3		170871	23	48		M	9.5	191
021	P 4	P 3		200871	23	05		M	9.5	
021	P 4	P 3		250871	23	48		M	9.5	182
021	R 38	R 39		030872	23	05	040872	M	10.5	182
021	R 38	R 39		230872	23	05	240872	M	10.5	189

Table 10. (Continued).

Bear Number	Ear Tags Right	Ear Tags Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
022	B 3	B 2		130870	23	48		M	6.5	205
022	Y 36	Y 35	1/4	040872	23	05	050872	M	8.5	166
023	19	18		060668	23	57		M		136
023	19	18		300569	23	48		M		136
023	19	18		060669	23	04		M		136
023	19	18		010969	23	04		M		159
023	Y 4	Y 3		080570	23	48		M		145
023	Y 4	Y 3		230570	23	05		M		
023	Y 4	Y 3		260670	23	48		M		
023	Y 4	Y 3		080870	23	48		M		
023	Y 4	Y 3		130870	23	48		M		159
023	Y 4	Y 3		210870	23	51		M		
023	Y 3	Y 4		270870	23	45		M		
023	Y 3	Y 4		240571	23	57		M		
023	B 37	B 36	118	140872	23	52	150872	M		145
023	B 37	B 36	1/8	180872	23	05	180872	M		145
024	Y 34	Y 35	1/7	150872	23	29	150872	M	2.5	57
025	R 37	R 47	1/9	160872	46	52	160872	M	7.5	175
025	R 37	R 47	1/9	150972	22			M	7.5	198
028	R 42	R 43	013	110972	31	29	110972	M	6.5	74
029	B 40	W 33		080972	D	28	080972	M		82
031	Y 40			070772	43	25	070772	M	0.5	10
032	W 42			071172	42	25	070772	F		46
033	B 41	B 46		141172	81	29	141172	M	0.5	11
034	B 39			141172	81	29	141172	M	0.5	7
065	B 32	W 10		271173	53	41	271173	M	11.5	170
068	W 54	W 53	07	190674	01	01	190674	M	4.5	39
068	W 54	W 53	07	270674	01	01	270674	M	4.5	
068	W 54		07	080775	01	01	080775	M	5.5	59
068	W 54		07	130975	11	11	130975	M	5.5	64
068	54	53		070678	23	55	070678	M	8.5	68
084	B 87	B 86	23	050874	10	10	050874	M	6.5	75
084	M 44	M190	23	160976	46	04	160976	M	8.5	136
084	M 44	W 74	D12	180677	10	10	180677	M	9.5	136
084	M 44	W 74	D12	120877	46	04	130877	M	9.5	125
084	M 44	R366	D12	310878	46	E	010978	M	10.5	227
084	M109	R621	D12	100879	46	05	110879	M	11.5	125
084	M109	R621	621	070880	46	28	070880	M	12.5	148
089	B 98	B 97		270874	44	58	270874	F		80
090	R 5	R 6		130970	39	39	130970	F		84
090	B 99	R 9		050974	44	58	050974	F		91
104	B 1	B 2	52	030775	H	59	030775	M	2.5	50
104	B 1	B 2	52	220875				M	2.5	
106	B 4	R 88	54	090775	09	09	090775	M	7.5	66
106	B 4	R 88	54	140776	28	40	150776	M	8.5	89
122	R 95	B 15	79	180875	07	07	180875	M	5.5	75
122	R 95	B 15		290577	23	55	300577	M	7.5	114
122	R 95	B 15		120878	23			M	8.5	109
123	B 17	B 16	80	210875	I	58	220875	F	2.5	36
124	B 19	B 18	81	220875	44	44	220875	F	6.5	36
124	M254	M255	81	220876	81	60	220876	F	7.5	
125	M175	M178	82	250875	28	41	260875	M	2.5	34
126	B 23	B 22	83	270875	23	41	280875	M	6.5	148
126	23	22		210576	23	45	210576	M	7.5	182
126	M 46		83	230876	23	60	230876	M	7.5	130
126	M 96	M308	83	090877	23	33	090877	M	8.5	136
132	G 10	G 9	100	190576	JJ	58	190576	M	5.5	100
143	Y309	M 14	D1	210776	D	E	220776	F	6.5	60
143	Y309	M 14	D1	101076	92			F	6.5	
157	257	257		130876	30	35	140876	M	9.5	159
157	257	256	110	270877	30	27	280877	M	10.5	132
157	257	256	110	131277	92			M	10.5	
171	187	186		310577	28	E	010677	M		
172	M 45	G 25	P1	310577	28	04	020677	M	2.5	
172	M 45	G 25	P1	300677	28			M	2.5	
177	M 67	W 8	93	220677	23	58	230677	M	1.5	32

Table 10. (Continued).

Bear Number	Ear Tags Right	Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
178	M 69	R 68	P2	230677	23	58	230677	M	1.5	32
186	B 72	M100	P3	110777	81	E	110777	F	2.5	36
186	72			040678	N	58	050678	F	3.5	68
186	R609	M 97	609	040679	X	58	050679	F	4.5	68
186	R609			220679	N	N	220679	F	4.5	68
186	R609	M107	609	310779	X	63	020879	F	4.5	64
196	M 89	R307	P4	020877	P	37	020877	M	2.5	52
196		R307	P4	170678	22			M	3.5	52
197	M 88	R 59	M83	070877	23	38	070877	M	8.5	134
197	M458	R367	M83	120978	23	44	120978	M	9.5	114
203	R319	M 33	P6	180877	81	81	180877	F	6.5	52
203	R319	M 33	P6	270878	D	E	280878	F	7.5	
203	Y323	M 33	P6	231078	D	21	241078	F	7.5	100
203	R606	M 94	606	280579	25	62	300579	F	8.5	55
203	R606	M 94	606	221079	62			F	8.5	
204	M 99	R318	P7	210877	26	27	220877	M	2.5	75
205	M317	M 29	P8	230877	81	E	230877	F	6.5	55
205	R614	M101	614	300679	Q	67	020779	F	7.5	64
205	R614	M101	614	070680	Q	16	100680	F	8.5	43
205	R614	M101		181180	90			F	9.5	80
206	M 28	R311	P9	230877	81	E	230877	M	0.5	18
206	M 92	R604	604	180579	28	16	190579	M	2.5	45
206	M 92	R604		030779	N	67	040779	M	2.5	45
206	M 92	R624	624	100680	25	73	120680	M	3.5	68
206	M 92	R624	P9	280481	28	95	300481	M	4.5	95
206	M 92	R624	624	200581	28	95	260581	M	4.5	77
206	M 92	R624	624	230681	85			M	4.5	
207				230877	T	63	230877	F	5.5	8
220	M189	M 90	P5	030877	28	28	030877	F	3.5	52
220	M189	M 90	P5	191077	28	21		F	3.5	59
222	M451	M451		180678	23			M	3.5	
222	M451	B451		210878	33	48	210878	M	3.5	
223	M452	B452	452	190678	24	E	200678	M	3.5	101
223	M452	B452	452	030778	64	18	030778	M	3.5	100
225	M451	R352	352	270678	26	27		M	3.5	36
229	R577	M577	577	130383	31	31	130383	F		48
233	M473	R373	373	130778	28	05	130778	M		58
233	M473	R373		100878	Q	43	110878	M		59
234	M454	R355	355	170778	28	29	180778	M	4.5	62
234	M454		355	060978	81			M	4.5	64
239	M598	W598	598	130383	31	31	130383	M	1.5	18
240	M453	B453	453	210678	30	04	210678	F	5.5	67
240	R575	M 77	575	260679	30	30	280679	F	6.5	73
240	R575	M 77	575	180779	30	66	200779	F	6.5	
240	R575	M 77		311081	94			F	8.5	
241	M452	R353	353	270678	28	E	280778	M	4.5	50
245	R354	M453	354	030778	31	E	040778	F		45
248	356	184	354	300678	Q		300678	F	8.5	64
248	R356	184	326	170778	28	29	180778	F	8.5	68
256	M455	R358	358	140878	33	E	150878	M		55
259				210878	33	29	220878	M		
260	M475	R360	360	230878	V	E	240878	M	1.5	59
260	M475	R360	360	280878	N	16	290878	M	1.5	
260	M103	R615	360	300679	N	67	020779	M	2.5	64
260	M103	R615	360	151180	82			M	3.5	
261	M456	R361	361	230878	N	E	240878	M	1.5	34
261	M456	R361	361	151079	92			M	2.5	
272	B482	M482	482	100978	01	01	100978	F	3.5	48
272	B482		482	080781	49	49	080781	F	6.5	64
272	G596	M596	482	160982	49	49	160982	F	7.5	
272	M 54	M 54	54	290688	49	95	050788	F	13.5	70
272	M 54	M 54	54	080689	74	74	080689	F	14.5	
274				251078	30			M		75
275		706		280977	33	29	290977	M		73
275		706	X06	150578	33	E	160578	M		59
277	M 87	R601	601	290479	28	58	010579	M	2.5	36

Table 10. (Continued).

Bear Number	Ear Tags Right	Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
278	M 90	R602	602	110579	33	04	120579	M	4.5	73
278		R602	602	230779	05	05	230779	M	4.5	68
278	602	R602	602	270779	05			M	4.5	
279	M 91	R603	603	170579	33	65	210579	M	4.5	107
279	M 91	R603	603	250680	65			M	5.5	120
280	M 93	R605	605	200579	81	05	210579	M	5.5	91
280	R605	M 93	605	080679	W	62	110679	M	5.5	
280	R605	M 93	605	251079	62			M	5.5	
281	M 94	R607	607	010679	24	E	020679	M	3.5	77
285	M 96	R608	608	040679	25	37	040679	M	2.5	55
286				040679	X	58	050679	M	0.5	5
287				040679	X	58	050679	F	0.5	4
290	R549	M 75	549	110679	28	16		F	12.5	68
290	R549	M 75	549	210879	28	20		F	12.5	
290	R549	M 75	549	140881	28	28	150881	F	14.5	77
291	M100	R612	612	120679	28	16	140679	M	1.5	23
292	M 76	R550	550	120679	28	16		M	2.5	30
296	M102	R613	613	220679	28	58	230679	M	3.5	64
297	R576	M 78	576	270679	30	30	280679	F	12.5	
297	R577	M 78	576	040979	30	E	050979	F	12.5	93
297	R577	M 78	577	230380	30	30	230380	F	13.5	
297	R577	M 78	577	110580	30	66	130580	F	13.5	80
297	R577	M 78	577	160680	30	62	160680	F	13.5	80
297	R577	M 78	577	280880	J	L	280880	F	13.5	105
298	R616	M104	616	300679	V	05	010779	F	3.5	32
306	M106	R617	617	310779	X	63	020879	M	0.5	8
307	R618	M105	618	310779	25			F		
308	R620	M109	620	310779	30	E	010879	F	12.5	77
316	M 80	R578		040979	30	E	050979	M	0.5	
316	M 80	R578	578	230380	30	30	230380	M	1.5	20
316	M 80	R578	578	160680	30	62	160680	M	1.5	23
316	80			061180	86			M	1.5	
317	M 81	R579		040979	30	E	050979	M	0.5	
317	M 81	R579	579	230380	30	30	230380	M	1.5	24
317	M 81	R579	579	110580	30	66	130580	M	1.5	24
317	M 81	R579	579	200680	30	62	230680	M	1.5	32
318	M 82	584		040979	30	E	050979	M	0.5	
318	M 82	R584	584	230380	30	30	230380	M	1.5	13
318	M 82	R584	584	110580	30	66	130580	M	1.5	19
318	M 82	R584		161280	93			M	1.5	
319	M 83	585		040979	30	E	050979	M	0.5	
319	M 83	R585	585	230380	30	30	230380	M	1.5	28
319	M 83	R585	585	110580	30	66	130580	M	1.5	30
319	M 83		585	160680	30	62	160680	M	1.5	30
320	M 79	R586	586	161079	33	50	171079	M	3.5	80
320	M 79	R586	586	180780	46	58	180780	M	4.5	93
320	M 79	R586	586	290780	33	63	310780	M	4.5	91
321	R590	M 86	590	221079	22	63	221079	F	6.5	55
321	R590	M 86		101279	74			F	6.5	
322	R589	M 85		221079	22	63	221079	F	0.5	8
323	R589			221079	22			F	0.5	7
324	99	R611	610	110679	28	66	130679	M	3.5	64
325	M120	R625	625	010880	28	04	010880	M	3.5	61
325	M120	R625	625	040581	28	16	050581	M	4.5	
325	M120	R727	625	290681	28	95	010781	M	4.5	80
325	120			171181	G			M	4.5	116
326	M118	M119	118	200680	28	71	200680	F	2.5	45
327				280880	25			M		
328	M122	M123	122	280880	46	E	290880	M	4.5	61
330	M121	R626	626	050880	28	71	080880	M	2.5	48
330	121			121081	88			M	3.5	
331				070680	Q	70	100680	F	0.5	2
332				070680	Q		100680	F	0.5	2
333	R622	M117	622	090680	23	44	120680	F	1.5	30
353	M521	521	521	200880	08	08	200880	M	2.5	41
353	M521	B521	521	020781	08	08	020781	M	3.5	45

Table 10. (Continued).

Bear Number	Ear Tags Right	Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
353	M521	B521		030782	22	16	030782	M	4.5	57
353	521			031187	94			M	9.5	
363	M542	B542	542	060281	08	08	060281	M	1.5	11
363	M542	B542	542	300881	08	08	300881	M	1.5	25
363	M542	B542	542	090382			090382	M	2.5	
363	M542	B542	542	030782	08	08	030782	M	2.5	25
363	M542	B542		131083	28	50	141083	M	3.5	63
376	M544	B544	544	230681	08	08	230681	M	5.5	45
376	544			200882	22	63	200882	M	6.5	73
377	M545	B545	545	230681	08	08	230681	M	3.5	50
377	545			040882	22	63	040882	M	4.5	80
383	W583	M583		310781	75	75	310781	F	0.5	7
384	M625	G625	625	130882	75	75	130882	M	0.5	9
384	M447	R546	625	131182	Z	04	141182	M	0.5	17
384	M447	R732		030684	28	67	050684	M	2.5	46
389	R578	M578	578	050881	75	75	050881	F	2.5	20
389	R578	M678	578	210383	75	75	210383	F	4.5	27
390	G580	M580	580	050881	75	75	050881	F	6.5	55
390	G580	M580	580	220882	N	63	230882	F	7.5	55
390	R594	M292	594	070783	Q	67	070783	F	8.5	56
390	R594	M292		290783	PP	82	290783	F	8.5	68
391	M579	R579	579	050881	75	75	050881	M	0.5	
391	R579	M579		180684	28	67	190684	M	3.5	62
394	M664	B664	664	280881	08	08	280881	M	7.5	75
394	M 19	M 19	19	140885	22	58	150585	M	11.5	92
416	R598	M301	598	270681	56	56	270681	F	4.5	55
416	730	M145	598	020684	56	67	030684	F	7.5	63
417	G593	M593	593	130383	31	31	130383	F	1.5	15
457	M597	W597	597	160982	49	49	160982	M	0.5	15
458	R599	M599	599	160982	49	49	160982	F	3.5	45
459	M476	R877	877	180882	BB	74	180882	M	5.5	100
459	M 20	M 20	20	200885	BB	50	210885	M	8.5	86
460	R600	M300	600	030683	23	AA	030683	F	4.5	56
460	R600	M300		090683	CC	58	090683	F	4.5	
460	R600	M300		250883	23	45	260883	F	4.5	57
460	R600	M300		210584	23	83	230584	F	5.5	
461	W582	M582	582	010881	75	75	010881	F	4.5	45
461	W582	M582	582	130882	75	75	130882	F	5.5	45
461	M772	M582	582	131182	Z	04	141182	F	5.5	55
461	R772	M582		281084	28	28	281084	F	7.5	59
461	R772	M582	582	261184	25	36	271184	F	7.5	68
461	772	582		84	92			F	7.5	
462	G581	M581	581	040882	31	31	040882	F	3.5	59
462	G581	M581	581	040982	71	16	050982	F	3.5	64
463	R577	M577	577	030882	31	31	030882	F	9.5	50
464	W584	M584	584	200782	49	49	200782	F	7.5	55
465	M576	R576	576	100782	49	49	100782	M	2.5	68
465	M576	R576	576	150782	23	33	160782	M	2.5	80
468	M328	R755	755	150881	28	50	150881	M		77
468	M329	R756	755	220881	28	16	230881	M		84
469	M327	R754	754	190781	28	04	200781	M	2.5	34
469	M327	R754	754	270682	44	16	300682	M	3.5	61
469	M327	R754	754	150683	44	58	160683	M	4.5	83
470	R752	R751	751	050678	23	45		F	2.5	
470	R752	R751	751	090680	23	58		F	4.5	
470	R752	R751	751	140681	23	21	150681	F	5.5	59
472	R737	M336	737	140884	33	11	140884	F	8.5	63
472	R737	M336	737	270884	04	04	270884	F	8.5	52
472		336		120485	74	87		F	9.5	42
474	M125	R726	726	190381	31	67	190381	M	3.5	68
475	R753	M326	753	050781	R	58	060781	F		68
476		M215		140681	23		140681	F	0.5	12
477		M399		140681	23	21	150681	F	0.5	5
478	M124			140681	23	21	150681	M	0.5	5
478	M124			171184	92			M	3.5	
512	M752	B752	752	130786	08	08	130786	M	3.5	45

Table 10. (Continued).

Bear Number	Ear Tags Right	Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
512	M 56	M752	56	100788	28	04	110788	M	5.5	91
513	M 15	M 15	15	080785	28	04	090785	M	2.5	23
513	M 15	M 15	15	130786	08	08	130786	M	3.5	45
513		M 52	52	250688	23	58	260688	M	5.5	85
513	M 52	M 52	52	050889	23	58	060889	M	6.5	110
513	M 52	M 52		230889	74	74	230889	M	6.5	
554	R537	R538		140682	28	04	150682	M		125
565	M340			140884	33	II	140884	F	0.5	7
565	M340			120485	74	87	120485	F	1.5	10
570	M788	B788	788	210688	14	14	210688	M	3.5	30
570	M788	B788	788	200589	46	58	210589	M	4.5	72
570	M788	B788	788	260689	46	04	260689	M	4.5	80
570	R508	B788		250889	22	80	250889	M	4.5	
587	M842	B842	842	280788	11	11	280788	M	3.5	34
587	M842	B842	842	060689	28	58	060689	M	4.5	64
596	M859	B859	859	100888	96	96	100888	M	3.5	45
596	M861	B859	859	110789	96	96	110789	M	4.5	57
596	M861	B859	859	270789	QQ	58	270789	M	4.5	65
596	M861	M859		161089	99			M	4.5	
611	M874	B874	874	160689	03	03	160689	M	2.5	75
611	M874	B874	874	080789	23	58	090789	M	2.5	68
611	M874	B874		191089	74			M	2.5	
661	M 5	M 5	5	240585	UU	II	250585	M	1.5	18
661	M 5	M 5	5	050686	28	58	060686	M	3.5	57
661	M 5	M 5	5	280687	23	58	290687	M	3.5	64
661	M 75	M 75	75	190688	23	67	200688	M	4.5	105
661	M 75	M 75	75	300788	23	58	010888	M	4.5	95
661	M 75	M 75	75	090888	43	67	100888	M	4.5	108
661	M 75	M 75	75	010988	23	37	020988	M	4.5	99
661	M 75	M 75	75	230689	23	67	240689	M	5.5	159
661	M 75	M 75	75	220789	23	83	250789	M	5.5	130
661	M 75	M 75	75	040889	74	79	040889	M	5.5	
911	R539	M451	539	250682	44	58	250682	F		36
911	R539	M451	539	110683	78	78	110683	F		41
P001	146	147		271067	30	66	271067	M		232
P001	146	147		031167	93			M		
P002	213	214		120868	30			F		
P003	207	208		240568	30			M		
P004	203	204		220568	30	86	220568	M		
P004	203	204		131069	86			M		
P005	211	212		120868	30	85	120868	M		
P005	211	212		131069	85			M		136
P007		50		020977	28	37	030977	M		80
P007	50	50		110977	74			M		
P010		M 52		220877	23	38	220877	M	1.5	114
P010		M 52		231080	85			M	4.5	136
P011	R757	M426	757	300682	44	58	010782	F	3.5	57
P011	757			271082	90			F	3.5	70
P012	R774	M449	774	150882	25	58	160882	F	2.5	39
P012	R774	M444		211082	78			F	2.5	
P013	M438	R543	543	070882	44	71	080882	M	6.5	91
P013	M446	R543	543	210882	44	63	230882	M	6.5	102
P013	446	R543		181082	92			M	6.5	
P015		M428		300682	44	58	010782	F	0.5	8
P015		M428		081183	92			F	0.5	
P016	676			261184	25	36		F	0.5	16
P016	676			151284	92			F	0.5	
P017	R760	M440	440	120882	26	58	130882	F	4.5	53
P017	R760	M440		010884	26	E	020884	F	6.5	67
P017	R760	M440		161084	92			F	6.5	70
P020	R587	M167	587	140683	GG	50	140683	F		60
P020	R587	M167	587	030685	HH	83	040685	F		60
P020		167		231185	62			F		
P021	M 18	M 18	18	120885	25	AA	130885	M	1.5	20
P021	M 18	M 18	18	231185	25			M	1.5	
P022	R763	M448		200882	33	04	230882	F		61

Table 10. (Continued).

Bear Number	Ear Tags Right	Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
P022	R763	M448	763	170685	33	11	180685	F		55
P022	R763	M448		110885	74	74	110885	F		57
P022	R763	M448		181185	92			F		
P023	M 9	M 9	8	080685	33	34	080685	M	2.5	59
P023	M 9	M 9	9	080586	74			M	3.5	89
P024	M 44	M 44	44	270787	28	67	280787	F	0.5	10
P024	M 44	M 44		211187	92			F	0.5	
P025	M 43	M 43	43	270787	28	67	280787	M	0.5	12
P025	M 43	M 43		211187	92			M	0.5	
P026	M 7	M 7	7	030685	HH	83	040685	M		23
P026	7			201185	74			M		
P028	M146	R749	749	030884	46	67	180884	M	3.5	70
P028	M146	R749		181084	89			M		70
P029	128	129		100767	30	93	100767	M		125
P030	126	127		110767	30	93	110767	F		68
P031	138	139		290767	30	84	290767	F		23
P032	140	141		110867	30	92	110867	F		114
P033	144	145		261067	30	66	261067	M		91
P034	205	206		240568	30	85	240568			
P035	209	210		030668	30	86	030668	M		
P036	215	216		170868	30	93	170868	M		
P037	217	218		180868	30	93	180868	M		
P038	219	220		200868	30	93	200868	M		
P039	16			070671	57	92	070671	M		
P040	221	222		200868	30	93	200868	M		
P040	221	222		110572	30	97	110572	M		
P041				160576	23	KK	160576	M		159
P042				030676	30	58	030676	M		91
P043				180676	81	58	180676			34
P044				230776	81	58	230776	F		75
P045	182	183		200676	28	04	200676	M		68
P046	M251	M250		210676	81	58	210676	F		55
P047	106	107		020476	73		020476	M		
P048	101	102		020476	73		020476	F		
P049		6		180676	28	04	180676	F		68
P050	192	193		010776	28	04	010776			102
P050	M192			040677	28		060677			91
P051				180677	26	58	180677	M		102
P052	701			060877	45	E	070877	M		52
P053	702			130877	45	58	130877	M		91
P054		191		140877	28	E	140877	M		45
P055		705		180877	33	43	190877	F		45
P056	51	50		180877	23	KK	190877	F		39
P056	51			050678	23	55	050678	F		68
P057				110678	30		110678	F		68
P058	M269			190578	30	29	190578			
P060	56	55		050878	23	55	060878	M	1.5	18
P061	375	1		170878	23	45	180878	M		57
P062				180779	30	66	180779	M	0.5	
P063				180779	30	66	180779	M	0.5	
P064	M 49	M 49	49	070688	28	58	080688	M	3.5	39
P064	M 49	M 49	49	050788	33	E	050788	M	3.5	44
P065				190781	28	04	220781	M		34
P068	M 47	M 47	47	040688	28	04	060688	M	4.5	57
P068	M 47	M 47	47	160688	28	95	170688	M	4.5	61
P069	M 53	M 53	53	020788	28	58	030788	M	8.5	80
P069	M 53	M 53	53	270788	28	04	280788	M	8.5	93
P069	M 53	M 53	53	120689	28	67	130689	M	9.5	139
P070		M427		300682	44	58	010782	F	0.5	9
P071	M450	R540	540	090782	28	58	100782	M	1.5	29
P072	M430	R548	548	100782	40	27	100782	M		66
P073	R681	M431	681	120782	23	38	120782	F		48
P074	R547	M434	547	190782	30	58	200782	F		48
P075	M436			190782	30	58	200782	F	0.5	6
P076		M435		190782	30	58	200782	F	0.5	5
P077	R542	M437	542	250782	28	04	260782	F		61

Table 10. (Continued).

Bear	Ear Tags			Capture	Capture	Release	Release			Weight
Number	Right	Left	Tattoo	Date	Location	Location	Date	Sex	Age	(kg)
P078	M441	R761		120882	26	58	130882	M	0.5	4
P079	M443	R775	775	150882	25	58	160882	M	1.5	30
P080	R764	M280	764	280882	LL	58	300882	F	0.5	6
P081	M281	R765	765	280882	LL	58	300882	M	0.5	7
P082	R766	M282	766	280882	LL	58	300882	F		61
P083	M432	R541	541	130782	28	71	140782	M		84
P083	M432	R541	541	130882	28	73	140882	M		89
P085	M597		597	110683	26	50	130683	M		99
P086	M290	R770	770	240683	23	58	250683	M		20
P087	M295	M294		070783	Q	67	070783	M	0.5	5
P087	295	294		290783	PP	82	290783	M	0.5	
P088	M350	R850	850	190783	23	58	200783	M		
P089	M702	R701	701	301083	28	50	311083	M		47
P090	M 51	M 51	51	260688	28	58	270688	M	5.5	119
P090	M 51	M 51	51	310589	28	04	310589	M	6.5	139
P090	M 51	M 51	51	210689	28	67	220689	M	6.5	129
P090	M 51	M 51	51	310789	28	67	010889	M	6.5	105
P091				030984	28	83	050984	F	0.5	
P092				210584	23	83	230584	M	0.5	7
P093				210584	23	83	230584	M	0.5	7
P095	R653	M404		310884	28	43	150984	F		18
P096	M423	742		310884	28	43	150984	M		11
P097	728	M297	728	230584	23	58	240584	F	1.5	34
P098	M341			140884	33	11	140884	F	0.5	8
P099	M 48	M 48	48	050688	28	04	070688	M	3.5	50
P100	M298	R731	731	010684	28	50	010684	M		
P101	R762	M442		120882	26	58	130882	F	0.5	3
P101	R762	M442	762	050684	26	50	060684	F	2.5	40
P102	M299	R733	733	060684	22	50	070684	M	2.5	40
P103	M375	R734	734	120784	23	NN	140784	M	3.5	101
P104	736	M370	736	280784	23	58	280784	F	1.5	40
P105	M291	R771	771	240683	23	58	250683	M		20
P105	M291	R771	771	280784	23	NN	290784	M		61
P106	M147			010884	26	E	010884	M	0.5	5
P107	M148			010884	26	E	020884	M	0.5	6
P108	M149			010884	26	E	020884	F	0.5	8
P109	R748	M371		040884	30	05	060884	F		53
P110		M369		040884	30	05	060884	F	0.5	8
P111	M368			040884	30	05	060884	M	0.5	10
P112		M367		040884	30	05	060884	F	0.5	5
P113	M144			060884	33	E	070884	M	0.5	13
P114	M372			060884	33	E	070884	M	0.5	12
P115	R746	M143		060884	33	E	070884	F		58
P116	M335	R745	745	070884	30	04	070884	M	2.5	40
P117	M342	R744		130884	23	NN	160884	M		11
P118	M401	R739	739	160884	BB	58	180884	M	4.5	123
P119	R743	M343		130884	23	NN	160884	F		11
P119	R743	M343		180884	22	58	180884	F		9
P119	R743	M343		231084	23	83	241084	F		19
P120	R544	M445	544	220882	44	58	230882	F		39
P120	R544	M445	544	290882	44	60	300882	F		36
P120	544	M445	544	170684	F	04	190684	F		53
P121	M 46	M 46	46	250388	II	74	140488	M	1.5	13
P122	R735	M449	735	190684	N	50	200684	F	2.5	52
P123	654	405		300884	GG	83	120984	F	0.5	8
P124	655	408		300884	GG	83	120984	F	0.5	9
P125	R545	M433	545	160782	28	04	160782	F		64
P125	R545			030984	28	83	050984	F		64
P126	M658	M345	658	250984	28	36	270984	M	2.5	69
P127	R662	M413		041084	OO	36	041084	F	4.5	61
P128	M411	R660		041084	OO	36	041084	M	0.5	10
P129	M412	R659		041084	OO	36	041084	M	0.5	10
P130	M410	R661		041084	OO	36	041084	M	0.5	11
P131	M414	R663		051084	OO	36	051084	F		63
P133	R664	M415	664	191084	OO	29	201084	F	2.5	50
P134	M666	M346		211084	QQ	29	211084	F		16

Table 10. (Continued).

Bear Number	Ear Tags Right	Ear Tags Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
P136	673	421		281084	23	46	311084	F		22
P137	M657	M344	657	250984	28	36	270984	M	2.5	57
P137	M344	R657	657	291084	28	83	291084	M	2.5	64
P138	M675	M348	675	031184	23	58	031184	F	2.5	41
P139	M665	M347		211084	QQ	29	211084	M		20
P139	M665	347		121184	22	E	131184	M		19
P140	697			261184	25	36	271184	F		13
P141	M365	R729	729	240584	N	04	250584	M	1.5	34
P141	M365	R729		040684	Y	67	040684	M	1.5	30
P142	M349	M656	656	140984	N	41	150984	M	2.5	45
P142	M349	M656	656	181184	N	04	201184	M	2.5	47
P142	M656	M349	656	231184	25	58	241184	M	2.5	47
P143	R769	M289	769	240683	23	58	250683	F	0.5	16
P143	R595	M165	595	220584	23	58	240584	F	1.5	27
P143	R595	M165	595	280784	23	58	280784	F	1.5	45
P143	R595			130884	23	83	130884	F	1.5	
P144	741	424	741	300884	GG	83	120984	F		48
P144	741	424	741	141184	83			F		
P145	M429	R758		020782	44	58	030782	F	2.5	34
P145	R767	M287	767	080683	44	04	090683	F	3.5	40
P145	750	M287	750	280584	44	58	310584	F	4.5	47
P145	R750	M287	750	100684	44	67	110684	F	4.5	58
P146	M 1	M 1	1	040385	RR	46	080385	M	0.5	7
P147	M 2	M 2	2	210385	32	SS	210385	F		15
P149	M667	416		251084	23	58	261084	M		25
P149	M416	R667	667	040685	23	67	050685	M		19
P150	669	417		251084	23	58	261084	F		20
P150	R669	M417	669	040685	23	67	050685	F		18
P151	R759	M439	759	140882	44	45	150882	F	1.5	30
P151	R759	M439	759	080684	TT	04	110684	F	3.5	52
P151	R759	M439	759	080685	TT	67	100685	F	4.5	54
P151	M759	M759	759	290588	44	95	310588	F	7.5	55
P151	R	M439		180688	63	63	180688	F	7.5	
P152	M402	R740	740	240884	N	04	250884	M	1.5	53
P152	M402	R740	740	090685	P	67	100685	M	2.5	55
P153	M 3	M 3	3	210585	28	34	220585	M	3.5	81
P153	M 3	M 3	3	170685	46	67	170685	M	3.5	83
P154	M 12	M 12		240685	O	DD	260685	M	1.5	36
P155	M 13	M 13	13	260685	28	37	260685	M	2.5	48
P156	M 14	M 14	14	080785	28	04	090785	F		57
P157	M 16	M 16	16	080785	28	04	090785	F		24
P158	M 4	M 4	4	240585	UU	II	250585	F	3.5	51
P158	M 4	M 4	4	100785	VV	71	110785	F	3.5	59
P159	M 17	M 17	17	100785	VV	71	110785	F	10.5	51
P160	M 6	M 6	6	240585	UU	II	250585	M	1.5	17
P160	M 6	M 6	6	270885	WW	58	270885	M	1.5	35
P161	M 21	M 21	21	160985	74	46	160985	M	1.5	28
P162	M 23	M 23	23	090686	26	E	090686	M	3.5	75
P162	M 23	M 23	23	200686	30	67	210686	M	3.5	68
P163	M 10	M 10	10	120685	N	04	120685	F	5.5	60
P163	M 10	M 10		070885	N	04	070885	F	5.5	67
P163	M 29	M 29		050786	N	58	060786	F	6.5	68
P163	M 29	M 29	29	240689	N	58	240689	F	9.5	68
P163	M 29	M 29	29	120889	N	79	130889	F	9.5	78
P164	R672	M420	672	271084	28	05	291084	F	4.5	82
P164	R672	M420	672	030685	28	II	050685	F	5.5	54
P164	R672	M420	672	160685	28	37	170685	F	5.5	53
P164	R672	M420	672	270787	28	67	280787	F	7.5	67
P165	R599	M288	599	240683	23	58	250683	F	4.5	47
P165	R738	M288	738	170884	23	58	180884	F	5.5	61
P165	R738	M288		231084	23	83	241084	F	5.5	72
P165	R738	M288	738	270585	23	83	290585	F	6.5	55
P166	M 11	M 11	11	120685	N	E	120685	M	10.5	54
P166	M 22	M 22	22	140586	N	58	140586	M	11.5	79
P167		M 26		050786	N	58	060786	F	0.5	8
P167	M 59	M 59	59	260788	N	04	040888	F	2.5	39

Table 10. (Continued).

Bear Number	Ear Tags Right	Ear Tags Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
P167	M 59	M 59	59	110888	08	08	110888	F	2.5	39
P167	M 59	M 59	59	250689	N	58	260689	F	3.5	44
P167	M 59	M 59	59	110889	N	79	130889	F	3.5	48
P168		M 27		050786	N	58	060786	F	0.5	7
P168	M 57	M 27	57	230788	81	04	250788	F	2.5	28
P168	M 57	M 27		261288	74			F	2.5	
P169		M 28		050786	N	58	060786	F	0.5	8
P169	M 61	M 61	61	060888	25	04	080888	F	2.5	40
P170	M 34	M 34	34	250986	43	XX	290986	M	0.5	14
P171	M 30	M 30	30	150886	81			F	2.5	31
P172	R670	M418	670	251084	23	58	261084	F	9.5	76
P172	M 8	M418	8	030685	23	67	050685	F	10.5	53
P172	M 8	M418		080685	74	82	080685	F	10.5	68
P172	M 35	M 35	35	110687	23	58	120687	F	12.5	64
P173	M 37	M 37	37	170687	28	58	180687	M	2.5	33
P174	M 38	M 38	38	170687	28	58	180687	F	6.5	57
P176	M 24	M 24	24	210686	YY	58	210686	F	2.5	27
P176		24	24	010787	YY	04	020787	F	3.5	40
P176	M 50	M 50	50	160688	N	95	170688	F	4.5	50
P177	M 39	M 39	39	060787	YY	58	060787	M	3.5	41
P178	M 40	M 40		080787	23	58	090787	F	1.5	23
P179	M 41	M 41	41	200787	28	58	210787	M	2.5	25
P180	M 42	M 42	42	270787	28	67	280787	M	0.5	11
P181	M 45	M 45	45	220987	98	13	280987	M	7.5	99
P182				040687	23	58	120687	M	1.5	20
P183				110687	23	58	120687	M	1.5	20
P184				110687	23	58	120687	M	1.5	30
P187				290687	25	61	070787	F	0.5	5
P188	M 58	M 58	58	020888	22	58	020888	M	3.5	
P190	M 62	M 62	62	090888	28	58	100888	F	1.5	25
P190	62	62	62	111188	74			F	1.5	
P191	M 65	M 65	65	240888	28	37	250888	F		82
P192	M 63	M 63	63	110888	HH			F	5.5	61
P205				190982	43			F		41
P206				221079	22			M	0.5	7
P207				221079	22	63	221079	F	0.5	8
P208				110678	30			M	0.5	
P209				110678	30				0.5	
P210				120878	23					182
P211				241078	53	29	251078	F		
P212				180676	28	04	180676	F		68
P213				180676	28	04	180676		0.5	
P214				180676	28	04	180676		0.5	
P215	M 66	2570	66	261188	22	04	271188	M	2.5	67
P215	M 66	R2570		140889	T			M	3.5	68
P217	M 64	M 64	64	250489	28	04	280489	M		71
P217	M 64	M 64	64	130689	46	67	140689	M		71
P218	M 67	M 67	67	180489	28	05	190489	M	2.5	73
P218	M 67	M 67	67	160589	28	67	170589	M	2.5	70
P219	M 68	M 68	68	190589	23	58	200589	M	1.5	56
P221	M 98	M 98	98	070889	33	27	080889	M	3.5	95
P221	M 98	M 98		161189	74			M	3.5	
P222	M 99	M 99	99	080889	30	04	090889	M	2.5	70
P223	M100	M100	100	110889	24	27	110889	M	4.5	97
P223	M100	M100	100	021189	74			M	4.5	
P224	M101		101	110889	N	27	110889	M	2.5	60
P225	M102		102	110889	40	04	120889	M	7.5	97
P226	M103		103	160889	33	27	160889	M	3.5	47
P227	M104		104	180889	33	27	190889	M	5.5	76
P228	M105		105	240889	23	58	250889	M	3.5	59
P229		M106	106	280889	23	58	290889	M	4.5	105
P231	M113	M113	113	051289	23	58	061289	F	8.5	103
P232	M109	M109	109	051189	25	58	261189	F	1.5	35
P233	M112	M112	112	231189	23	58	241189	F	5.5	79
P234	M111	M111	111	201189	23	37	201189	M	2.5	40
P235	M110	M110	110	131189	23	58	131189	F	1.5	34

Table 10. (Continued).

Bear Number	Ear Tags Right	Ear Tags Left	Tattoo	Capture Date	Capture Location	Release Location	Release Date	Sex	Age	Weight (kg)
P236	M108	M108	108	011189	23	58	121189	M	1.5	22
P237	M107	M107	107	051189	23	58	051189	F	2.5	22
P240				020788	49	95	050788	M	0.5	4
P241				290688	49	95	050788	F	0.5	6
P242				290688	49	95	050788	M	0.5	4
P243				290688	49	95	050788	F	0.5	5
P300	M 69	M 69	69	220589	28	04	230589	M	3.5	70
P300	M 69	M 69	69	140789	28	58	150789	M	3.5	68
P300	M 69	M 69	69	310789	28	67	010889	M	3.5	87
P301	M 70	M 70	70	220589	46	04	220589	M	2.5	78
P301	M 70	M 70	70	250689	04	04	250689	M	2.5	80
P301	M 70	M 70	70	310889	28	58	310889	M	2.5	80
P302	M 71	M 71	71	290589	28	04	290589	M	3.5	41
P302	M 71	M 71	71	040889	28	58	050889	M	3.5	40
P303	M 73	M 73	73	110689	28	58	110689	M	4.5	60
P303	M 73	M 73	73	020889	28	27	030889	M	4.5	91
P303	M 73	M 73	73	130889	28	67	150889	M	4.5	95
P303	M 73	M 73	73	300889	28	79	310889	M	4.5	97
P304	M 79	M 79	79	180689	55	04	180689	M	4.5	78
P304	M 79	M 79	79	120889	55	27	130889	M	4.5	78
P304	M 79	M 79	79	280989	28			M	4.5	82
P305	M 81	M 81	81	060789	28	04	070789	M	1.5	40
P305	M 81	M 81	81	120789	96	96	120789	M	1.5	30
P306	M 72	M 72	72	110689	28	58	110689	M	2.5	56
P307	M 77	M 77	77	180689	23	58	180689	M	2.5	98
P308	M 78	M 78	78	170689	24	04	180689	M	6.5	134
P308	M 78	M 78	78	230689	74	04	230689	M	6.5	132
P309	M 80	M 80	80	240689	N	04	240689	M	1.5	32
P309	M 80	M 80		171089	92			M	1.5	
P310	M 82	M 82	82	080789	N	04	090789	F	1.5	27
P311	M 83	M 83	83	090789	23	58	100789	M	1.5	28
P312	M 84	M 84	84	110789	23	58	110789	F	2.5	
P313	M 85	M 85	85	140789	23	58	150789	F	1.5	34
P314	M 86	M 86	86	180789	23	58	190789	M	3.5	51
P315	M 87	M 87	87	180789	33	04	190789	M		117
P316	M 88	M 88	88	200789	33	04	200789	F	9.5	77
P317	M 89	M 89	89	200789	23	58	210789	M	3.5	53
P318	M 90	M 90	90	220789	28	04	230789	M	3.5	75
P319	M 76	M 76		140689	33	04	140689	M	3.5	68
P319	M 76	M 76	76	240789	23	27	250789	M	3.5	71
P320	M 91	M 91	91	250789	23	58	260789	M	2.5	60
P321	M 92	M 92	92	280789	23	58	300789	M	2.5	74
P322	M 93	M 93	93	300789	23	58	310789	F	7.5	79
P323	M 94	M 94	94	020889	33	04	020889	F	2.5	28
P324	M 95	M 95	95	030889	46	27	040889	M	3.5	90
P324	M 95	M 95		090889	MM	67	090889	M	3.5	
P325	M 96	M 96	96	040889	N	04	040889	M	4.5	73
P325	M 96	M 96	96	220889	23	58	230889	M	4.5	76
P326	M 97	M 97	97	040889	98	58	040889	M	3.5	63

[a]Ear Tag Colors: B=Blue, G=Green, M=Metal or Silver, O=Orange, P=Purple, R=Red, Y=Yellow.

[b]Capture and release codes listed in Table 11.

APPENDIX B

Table 11. Codes for black bear capture and release sites.

Code	Location	Code	Location
00	Curry Mtn.	43	Sugarland Vis. Ctr.
01	Bote Mtn	44	Clingman's Dome Rd.
02	Defeat Rdg.	45	Greenbriar
03	Rabbit Ck.	46	Elkmont
04	Parson's Branch Rd.	47	Indian Camp Rd.
05	Bunker Hill Rd.	48	Old Tremont
06	Colen Ground Rdg.	49	Spence Field
07	Ekaneetle Gap Loop	50	Forge Ck.
08	Sugarland Mtn.-Husky Gap	51	Cooper Ck.
09	Rough Ck., Upper Sugarland Mtn.	52	Cooper Rd.
		53	Tremont Evn. Ed. Ctr.
10	Bent Arm	54	Davenport Gap
11	Green Camp Gap	55	Ramsey's Cascade
12	Tremont Rd.-Long Br.	56	Siler's Bald
13	Jakes Ck.-Miry Rdg.-Derrick Loop	57	Hwy 129
		58	Little Cataloochee
14	Lumber Rdg.	59	Schoolhouse Gap
15	Hornet Tree Top	60	Cocke Co., TN
16	Tellico WMA	61	Hwy 441, NC
17	Dead End Rd.-Falls Br.	62	Avery Co., NC
18	Double Camp	63	Greene Co., TN
19	Cowcamp Rdg.	64	McMinn Co., TN
20	Sawmill Rd.-Bivens Br.	65	Coastal, NC
21	Citico	66	Henderson Co., NC
22	Gatlinburg	67	Polk Co., TN
23	Cades Cove	68	Indian Boundary
24	Cataloochee	69	Horse Ck. Rec. Area
25	Hwy 441, TN	70	Green Cove
26	Collins Ck.	71	Big Creek
27	20-Mile	72	Hannah Mtn. Tr.
28	Chimney Tops	73	Unicoi Co., TN
29	Tremont Turnaround	74	Other
30	Smokemont	75	Mt. Leconte
31	Walnut Bottoms	76	Harmon Den Mtn.
32	Oconaluftee	77	Hurricane Rdg.
33	Cosby	78	12-Mile Strip
34	Hazel Ck.	79	Carter Co., TN
35	Cataloochee Divide	80	Sevier Co., TN
36	Mining Property, NC	81	Newfound Gap
37	Mt. Sterling Gap	82	Cohutta WMA, GA
38	Indian Camp Ck.	83	Sullivan Co., TN
39	Collins Gap	84	N. Transylvania Co., NC
40	Balsam Mtn. CG.	85	Yancey Co., NC
41	Upper Tremont Rd.	86	McDowell Co., NC
42	Little Bald	87	Fannin Co., NC

Table 11. (Continued).

Code	Location	Code	Location
88	Burke Co., NC	V	Rocky Hollow
89	Cherokee Co., NC	W	Noland Divide OL
90	Macon Co., NC	X	Treewells
91	Swain Co., NC	Y	Maryville, TN
92	Graham Co., NC	Z	Big Walnut
93	Haywood Co., NC	AA	Old Sugarlands
94	Jackson Co., NC	BB	Deep Ck. CG
95	Johnson Co., TN	CC	Wears Valley
96	Turkeypen Rdg.	DD	English Mtn.
97	Clay Co., NC	EE	Laurel Br. Dump
98	Metcalf Bottoms	FF	Swiftback Sycamore
99	Madison Co., NC	GG	Roaring Fork
A	Spivey Cove Dump	HH	Grotto Falls, P.A.
B	McCaully Place	II	Calhoun Br.
C	Forge Ck. Prim. CG	JJ	Hazel Ck.
D	Walker Prong	KK	Sinks
E	Sams Gap	LL	Deep Ck. OL
F	Oconaluftee OL	MM	Monroe Co., TN
G	Smyth Co., VA	NN	Porter Flats
H	#4 OL Hwy 441, TN	OO	Trout Farm, Hwy 321
I	#3 OL Hwy 441, NC	PP	Cherokee Co., GA
J	Grindstone CG, VA	QQ	Crib Gap
L	Clinch Mtn. WMA, VA	RR	Townsend Y
M	Sugarland Flats	SS	Pilkey Ck.
N	Morton OL	TT	Swinging Br.
O	McCarter Stables	UU	Uplands Lab.
P	Upper Tunnel	VV	Rainbow Falls
Q	Alum Cave P.A.	WW	Baskins Ck.
R	Little River Rd	XX	Campsite #24
S	Headquarters	YY	#1 OL Hwy 441, TN
T	Blount Co., TN	ZZ	Cherokee Indian Res.
U	Campsite #37		

APPENDIX C

Table 12. Summary of monthly public visitation in Great Smoky Mountains National Park, 1967-1987.

Year	Total Visits (Thousands)												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1967	168	144	248	397	444	1,017	1,350	1,237	614	710	230	152	6,710
1968	114	141	200	408	447	906	1,382	1,366	649	719	204	132	6,667
1969	107	98	172	356	459	940	1,286	1,289	530	737	237	121	6,331
1970	104	126	228	325	544	1,017	1,334	1,325	601	806	208	160	6,778
1971	109	118	173	448	528	926	1,526	1,323	707	864	313	143	7,179
1972	151	161	261	530	626	1,052	1,572	1,526	773	930	288	170	8,041
1973	146	164	221	541	600	1,048	1,416	1,488	834	959	350	124	7,892
1974	100	125	202	432	619	1,021	1,563	1,445	757	1,047	339	156	7,808
1975	173	191	353	491	771	1,222	1,492	1,612	714	983	356	183	8,541
1976	168	228	318	658	763	1,148	1,608	1,579	867	1,109	357	186	8,991
1977	150	167	301	656	784	1,214	1,807	1,523	888	1,144	332	206	9,174
1978	144	184	333	521	685	1,142	1,625	1,343	851	1,150	380	213	8,570
1979	130	161	309	650	666	994	1,324	1,274	779	1,114	378	239	8,020
1980	208	192	260	553	716	1,106	1,439	1,410	802	1,076	448	231	8,441
1981	195	201	270	605	737	1,079	1,379	1,368	831	1,107	357	201	8,331
1982	136	183	240	519	861	1,080	1,318	1,187	886	1,227	341	199	8,178
1983	175	211	289	472	683	1,059	1,526	1,252	880	1,266	434	188	8,435
1984	158	231	300	546	638	1,141	1,445	1,281	925	1,134	430	279	8,508
1985	174	198	422	599	632	1,216	1,611	1,391	996	1,340	503	237	9,319
1986	206	200	457	649	825	1,284	1,762	1,400	920	1,285	560	286	9,836
1987	260	228	415	570	868	1,317	1,628	1,512	990	1,577	568	277	10,210

APPENDIX D

Female P165 was 4.5 years old when originally captured at Cades Cove on 24 June 1983; she was relocated 62 km to Little Cataloochee. Female P165 was recaptured at Cades Cove on 17 August 1984 and relocated to Little Cataloochee for a second time. On 23 October 1984, female P165 was recaptured at Cades Cove for the third time; the TWRA relocated her 182 km to Sullivan Co., TN. On 27 May 1985, female P165 was recaptured for the fourth time at Cades Cove; the TWRA relocated her to Sullivan Co., TN for the second time.

Female 205 was 6.5 years old when originally captured at Newfound Gap on 23 August 1977; her 1 male cub (bear 206) also was captured. Both bears were relocated 42 km to Parson's Branch Road. On 30 June 1979, female 205 was recaptured at Alum Cave Parking Area. On 2 July 1979, the TWRA relocated her 118 km to Polk Co., TN. On 7 July 1980, female 205 was recaptured at Alum Cave Parking Area. The TWRA relocated her 59 km to the Tellico Wildlife Management Area on 10 July 1980. Female 205 was hunter killed in Macon Co., NC on 18 November 1980.

Male 206 was recaptured at Chimney's Picnic Area on 18 May 1979; the TWRA relocated him 55 km to the Tellico Wildlife Management Area. Male 206 was recaptured at Morton Overlook on 3 July 1979. On 4 July the TWRA relocated him 120 km to Polk, Co., TN. Male 206 was recaptured on 10 June 1980 along Hwy 441. On 12 June 1980, the TWRA relocated him

91.7 km to Unicoi Co., TN. On 28 April 1981, male 206 was recaptured at Chimney's Picnic Area. On 30 April 1981, the TWRA relocated him 178 km to Johnson Co., TN. On 20 May 1981, male 206 was recaptured at Chimney's Picnic Area and relocated a second time to Johnson Co. on 26 May 1981. On 23 June 1981, male 206 was destroyed at Mt. Mitchell State Park, NC, 93.2 km from where he was released in Johnson Co., TN.

Female P151 was a yearling when originally captured along Clingman's Dome Road on 14 August 1982; she was relocated 15 km to Greenbriar. On 8 June 1984, female P151 was recaptured along Highway 441 and relocated 54 km to Parson's Branch Road on 11 June 1984. On 8 June 1985, female P151 was recaptured along Highway 441; the TWRA relocated her 124 km to Polk Co., TN. On 29 May 1988, female P151 was recaptured along Clingman's Dome Road; the TWRA relocated her 179 km to Johnson Co., TN on 31 May 1988. Female P151 was recaptured by TWRA on 18 June 1988 in downtown Greenville, TN and relocated 21 km to the Andrew Johnson Bear Reserve in Green Co., TN.

Female P172 was 9.5 years old when originally captured at Cades Cove on 25 October 1984; her 2 cubs (bears P149 and P150) also were captured and all 3 bears were relocated 62 km to Little Cataloochee. On 3 June 1985, female P172 was recaptured in Cades Cove; both of her yearlings (bears P149 and P150) were captured the next day. On 5 June 1985, the

TWRA relocated all 3 bears 95 km to Polk, Co., TN. On 8 June 1985, female P172 was recaptured in Epworth, Ga, and relocated 12 km to the Cohutta WMA. On 11 June 1987, female P172 and 3 male cubs (unmarked) from a separate litter were captured in Cades Cove; all 4 bears were relocated 62 km to Little Cataloochee.

Female 390 was 6.5 years old when originally captured at Mt. LeConte on 5 August 1981. She was accompanied by 3 cubs (383, 391, and 1 unmarked). Cub 383 was captured on 31 July 1981 while 391 was captured on 5 August 1981. Female 390 was instrumented with a radio-collar and released on site as part of a backcountry problem bear study (Hastings 1983, Hastings et al. 1987). On 22 August 1982, female 390 was recaptured at Morton overlook; the TWRA relocated her 66.1 km to Greene Co., TN. On 7 July 1983, female 390 and a male cub (bear P087) from a separate litter were captured at Alum Cave Parking Area; the TWRA relocated both bears 118.2 km to Polk Co., TN. Female 390 and male P087 were recaptured by the Georgia Game and Fish Division on 29 July 1983 in Cherokee Co, GA, 97.3 km from their release site in Polk Co. TN; both bears were relocated 93 km to the Cohutta WMA, GA.

Male 391, an offspring of female 390 was recaptured at Chimney's Picnic Area on 18 June 1984, nearly 3 years following his initial capture as a cub; the TWRA relocated him 116 km to Polk Co., TN.

Female 297 was 12.5 years old when originally captured at Smokemont on 27 June 1979. Female 297 was accompanied by 4 cubs, however, they could not be captured, therefore, she was released on site. On 4 September 1979, female 297 and her 4 cubs (bears 316, 317, 318, 319) were captured at Smokemont. Female 297 was instrumented with a radio-collar as part of a black bear reproductive study (Eiler 1981) and all 5 bears were relocated 53 km to Parson's Branch Road. On 23 March 1980, female 297 and her 4 yearlings were located in a den near Smokemont. On 11 May 1980, female 297 and yearlings 317, 318, and 319 were recaptured at Smokemont; the NCWRC relocated all 4 bears 58 km to Henderson Co., NC. On 16 June 1980, female 297 and yearlings 316 and 319 were recaptured at Smokemont; the NCWRC relocated all 3 bears 152 km to Avery Co., NC. Yearling 317 was captured at Smokemont on 20 June 1980 and relocated to Avery Co. NC on 23 June 1980. On 28 August 1980, female 297 was captured at Grindstone Campground, VA, 72.8 km from her release site in Avery Co., NC; she was relocated 37 km to Clinch Mountain WMA, VA. Yearling 316 was hunter killed in McDowell Co. NC on 6 November 1980. Yearling 318 was hunter killed on 16 December 1980 in Haywood Co. NC.

Female 472 was 8.5 years old when originally captured at Cosby on 14 August 1984; her 2 cubs (bears 565 and P098) also were captured. All 3 bears were relocated 55 km to

Calhoun Branch. On 27 August 1984, female 472 was recaptured on Parson's Branch Road as part of a UT bear study (Pozzanghera 1990); 1 cub (possibly 565) also was observed but not identified. Female 472 was instrumented with a radio-collar and released on site. On 12 April 1985, female 472 and cub 565 were captured in Gilmer Co., GA, 108 km from her previous capture site; both bears were relocated 27 km to the Blue Ridge WMA in Fannin Co., GA.

Female P022 (age unknown) was originally captured at Cosby on 20 August 1982; she was relocated 67 km to Parson's Branch Road on 23 August 1982. On 17 June 1985, female P022 was recaptured at Cosby and relocated 55 km to Calhoun Branch the following day. On 11 August 1985, female P022 was captured near Oakway, SC (Pickens Co.), 114 km from her previous release site; she was relocated 47 km to north Pickens Co., SC. Female P022 may have been illegally captured and transported to South Carolina prior to her recapture (W. Cook NPS pers. commun.). On 18 November 1985, female P022 was killed in Graham Co., NC, 92 km from her release site in South Carolina.

Male P303 was 4.5 years old when originally captured at Chimney's Picnic Area on 11 June 1989; he was relocated 36 km to Little Cataloochee. Male P303 was recaptured on 2 August 1989 at Chimney's Picnic Area and relocated 38 km to Twentymile on 3 August 1989. Male P303 was recaptured for a third time at Chimney's Picnic Area on 13 August 1989; on 15

August 1989, the TWRA relocated him 116 km to Polk Co., TN. On 30 August 1989, male P303 was recapture for the fourth time at Chimney's Picnic Area; the TWRA relocated him 148 km to Carter Co., TN on 31 August 1989.

Male 126 was 6.5 years old when originally captured at Cades Cove on 27 August 1975; he was relocated 10 km to upper Tremont Road. On 21 May 1976, male 126 was recaptured at Cades Cove and relocated 37 km to Greenbriar. On 23 August 1976, male 126 was recaptured for the third time at Cades Cove; the TWRA relocated him 87 km to Cocke Co., TN. On 9 August 1977, male 126 was recaptured at Cades Cove for the fourth time and relocated 53 km to Cosby.

Male P090 was 5.5 years old when originally captured at Chimney's Picnic Area on 26 June 1988; he was relocated 30 km to Little Cataloochee on 27 June 1988. On 31 May 1989, male P090 was recaptured at Chimney's Picnic Area and relocated 43 km to Parson's Branch Road. On 21 June 1989, male P090 was captured for the third time at Chimney's Picnic Area; the TWRA relocated him 116 km to Polk Co., TN. on 22 June 1989. On 31 July 1989, male P090 was recaptured at Chimney's Picnic Area; he was relocated to Polk Co., TN.

Male 661 exhibited the most notable movements of all relocated bears in GSMNP. Male 661 was a yearling when originally captured at Uplands Research facility on 24 May, 1985; he was relocated 31 km to Calhoun Branch. On 5 June 1986, male 661 was recaptured at Chimney's picnic area and

relocated 36 km to Little Cataloochee. On 28 June 1987, male 661 was recaptured at Cades Cove and relocated 62 km to Little Cataloochee. On 19 June 1988, male 661 was captured at Cades Cove; the TWRA relocated him 95 km to Polk Co., TN. Male 661 was recaptured at Cades Cove on 30 July 1988 and relocated 68 km to Little Cataloochee. On 9 August 1988, male 661 was recaptured near Sugarlands Visitor Center; he was relocated 116 km to Polk county, TN on 10 August 1988. On 1 September 1988, male 661 was recaptured at Cades Cove and relocated 62 km to Mt. Sterling. On 23 June 1989, male 661 was recaptured in Cades Cove; the TWRA relocated him 94 km to Polk Co., TN. On 22 July 1989, male 661 was recaptured in Cades Cove; he was relocated 190 km to Sullivan Co., TN. On 4 August 1989, male 661 was recaptured in Johnson City by the TWRA; he was relocated 22 km to Carter Co., TN. On 11 May 1990 male 661 was recaptured in Cades Cove; he was relocated to the George Washington National Forest, VA by the Virginia Game and Inland Fisheries. On 11 June 1990, male 661 was recaptured in Parisburg, VA and relocated to the GWNF. In mid June (exact date not known) male 661 was captured in Roanoke, VA and released in nearby mountains (exact location not known). On 18 July 1990, male 661 was captured in Johnson City, TN by the TWRA; he was relocated to Carter Co., TN. On 21 July 1990, male 661 was killed by poachers in Unicoi Co., TN.

VITA

William Henry Stiver was born in Lansing, Michigan on October 14, 1964. He graduated from Potterville High School in 1982. He attended Central Michigan University from 1982 to 1984 and Michigan State University from 1984 to 1987. He received a Bachelor of Science degree in Fisheries and Wildlife from Michigan State University in spring 1987. He entered the graduate program in the Department of Forestry, Wildlife and Fisheries at The University of Tennessee, Knoxville in March 1988. He was employed as a Biologist I/Data Analyst for the Oklahoma Department of Wildlife Conservation from July 1990 to May 1991. He is currently working for Great Smoky Mountains National Park as a Wildlife Biological Technician.