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I am submitting herewith this thesis written by Robert C. Maddrey entitled "Morphology, Reproduction, Food Habits, Crop Depredation, and Mortality of Black Bears on the Neuse-Pamlico Peninsula, North Carolina." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

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MORPHOLOGY, REPRODUCTION, FOOD HABITS, CROP DEPREDATION, AND MORTALITY OF BLACK BEARS ON THE NEUSE-PAMLICO PENINSULA, NORTH CAROLINA

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Robert Calvin Maddrey

May 1995

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Thesis
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.M33

DEDICATION

To my future hunting partners, Ryan and Russ

and

To the memory of Neuse River Deacon

ACKNOWLEDGMENTS

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ABSTRACT

Black bear research was conducted on the Neuse-Pamlico peninsula of coastal North Carolina from May 1992 to June 1994 to examine morphology, reproduction, food habits, crop depredation and mortality parameters. Eighty-nine bears were captured 102 times. Sex ratios were nearly 1:1. Harvested bears were significantly older than captured bears. Neuse-Pamlico bears had high body growth rates when compared with bears from other areas. Breeding began for most females at 2.5 years of age although first time breeders were less successful than older bears. Mean litter size ($x = 2.4$) was less than would be expected in an area with such abundant dependable food sources. Seasonal diets were heavily dependent on agricultural crops such as wheat, corn, and soybeans and diets of adult males in fall were predominantly crop foods (86%). Diets of adult female and sub-adult diets contained significantly less crop foods, however, suggesting that adult males precluded use of agricultural fields by other bears during fall. Natural foods predominantly eaten by bears were plants associated with disturbed areas, except for black gum berries in the fall. The loss of naturally occurring food items has

forced bears to rely on agricultural foods for a large percentage of their diet. Crop species changes or conversion of cropland to other uses would be very detrimental to bears because there would not be enough natural foods available on an annual basis to support the current population. Corn damage caused by bears was greatest during the milk stage in mid-July and decreased until the corn was harvested. Over half the farmers questioned on the Neuse-Pamlico peninsula had crops damaged by bears in 1993 with corn as the major crop loss in terms of acreage and dollars. A small percentage (0.6%) of the total crop acreage was damaged by bears; however the loss of other natural food sources, especially black gum may cause crop depredation to increase. One hundred and ten bears were harvested by hunters during the two-year period. Most bears were harvested adjacent to agricultural crops. All adult males were harvested in the morning by still hunters, whereas females, younger and smaller bears were generally harvested in the afternoon. Any future changes to black bear hunting seasons must take into account how hunting methodology affects the sex and age structure of the harvest. Twenty-seven additional bears were lost to other mortality factors, principally road kills.

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CHAPTER I

INTRODUCTION

Black bears (*Ursus americanus*) in North Carolina occupy two physically distinct geographic areas, the western mountains and the eastern coastal plain (Fig. 1). The coastal plain population has often been described as highly fragmented and relegated to islands of natural habitat such as pocosins (Monschein 1980, Hellgren 1988, Hellgren et al. 1991). Although the above may have been the case in the late 1970's when large scale land conversions were in progress and long hunting seasons were in effect, the current bear population inhabits a contiguous array of habitat types throughout the entire coastal plain (Warburton et al. 1993). Bear populations are not confined to remaining pocosins and protected areas but are inhabiting a mixture of agricultural areas, cutover woodlands, commercial tree farms and native forested habitats. North Carolina currently has the largest block of contiguous, occupied coastal plain black bear range in the southeastern United States covering 2,244,661 ha (Warburton 1994).

The mountain bear population has been the focal point of numerous research activities, whereas the coastal population has received limited study (Hardy 1974, Hamilton

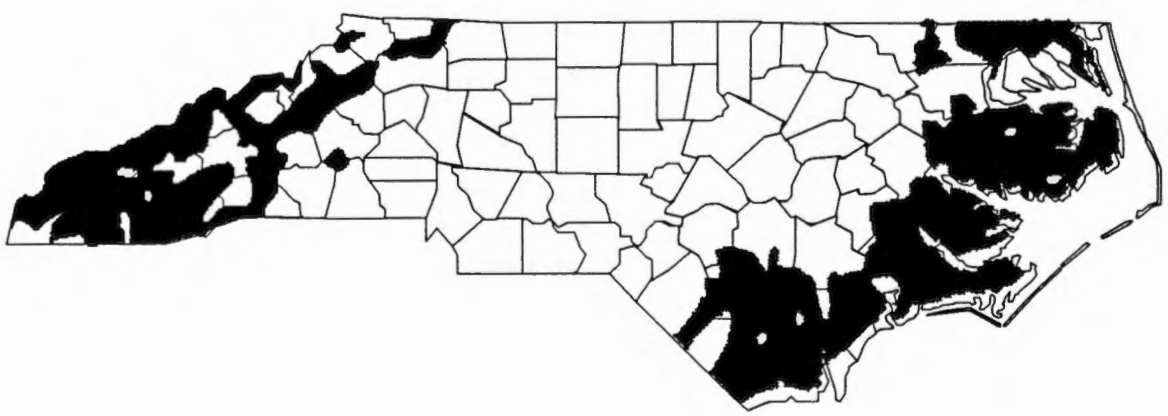
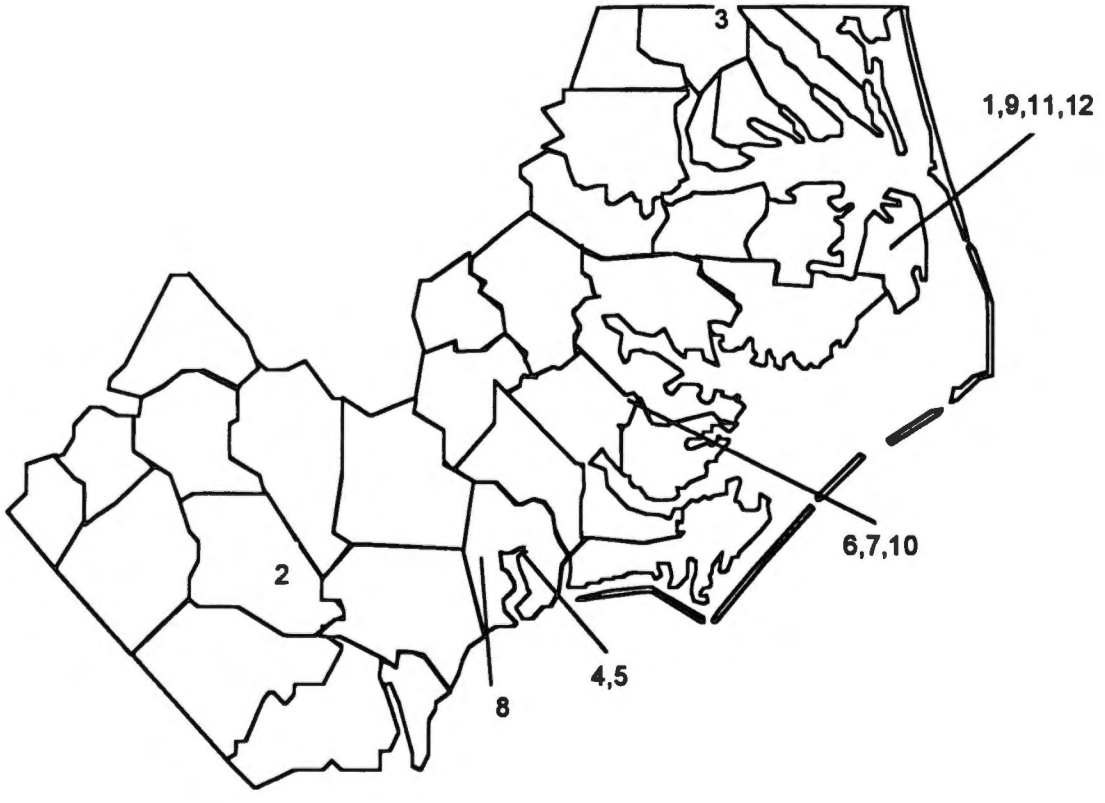


Figure 1. Black bear range in North Carolina in 1991 (Warburton 1994).

1978, Hellgren 1988, Lombardo 1993). Most of the past and current studies examined black bear ecology on areas with some degree of habitat protection such as wildlife refuges (Hellgren 1988, Brandenburg (in press), Allen (in progress), Folta (in progress)) or on military bases (Lombardo 1993, Brandenburg (in press), Studer (in progress)). The study area of Hardy (1974) in Dare County eventually became Alligator River National Wildlife Refuge in 1981. Only the research by Hamilton (1978) examined bear ecology in an area of changing land use and human interactions (Fig. 2). No studies in North Carolina have investigated bear sub-populations in the agricultural/tree farm areas of the central and northern coastal plain which were the former pocosins and swamps cleared and drained in the 1970's.

The Neuse-Pamlico study was initiated in an attempt to understand how bears interact with these intensively managed agricultural and forest ecosystems on private land. Bear/human interactions are commonplace in this area due to the close proximity of bear range to human habitation and agricultural interests (Warburton et al. 1993). Because a large portion of the bear range in coastal North Carolina is in private ownership, a better understanding of bear ecology on these lands is essential if management of the bear resource is to be successful.



1. Hardy (1974)
2. Hamilton (1978)
3. Hellgren (1988)
4. Lombardo (1993)
5. Brandenburg (In press)
6. Maddrey (1995)
7. Jones (In press)
8. Studer (In progress)
9. Brandenburg (In press)
10. Martorello (In progress)
11. Allen (In progress)
12. Folta (In progress)

Figure 2. Map depicting locations of current and past bear projects in coastal North Carolina.

The objectives of this study were:

(1) To determine growth rates and body size of NPP bears and how they compare with bears from other populations. The hypothesis that NPP bears are larger than bear from other areas was tested.

(2) To determine the reproductive rate of female NPP black bears.

(3) To determine the extent bears use agricultural crops for food. The hypothesis that NPP bears eat a higher percentage of agricultural crop foods than natural foods was tested.

(4) To determine differences in fall diets between sex and age groups. The hypothesis that adult males consume more crop foods in fall than other segments of the population.

(5) To determine the initiation and extent of bear damage to agricultural crops. The hypothesis that actual crop damage was greater than that reported by farmers was tested.

(6) To test the effectiveness of aerial videography in mapping bear crop damage.

(7) To determine attitudes and perceptions of NPP farmers concerning crop depredation losses.

(8) To determine mortality factors and to examine and describe bear hunting methodology.

CHAPTER II

STUDY AREA

OVERVIEW

Location

The Neuse-Pamlico peninsula (NPP) is located in central eastern North Carolina and encompasses portions of Beaufort and Craven Counties and all of Pamlico County. It is bounded by the Pamlico River to the North and the Neuse River to the South. Pamlico Sound forms the eastern boundary (Fig. 3). The landscape of the 150,000-ha peninsula is rural with forestry and agriculture being predominant land uses. Weyerhaeuser Forest Products Company is the largest landowner on the peninsula (65,000-ha) and primarily manages its land in short-rotation loblolly pine (*Pinus taeda*) production. Other large forest landowners include Texasgulf Phosphate Company, Champion International, Federal Paperboard, Bates Lumber Company and Taylor Land and Timber Company. The only significant public ownership is the Goose Creek Game Lands which are owned by the North Carolina Wildlife Resources Commission (NCWRC).

Agricultural lands on the peninsula encompass approximately 40,000 ha with principal crops being corn, soybeans, winter wheat, potatoes, cotton and tobacco

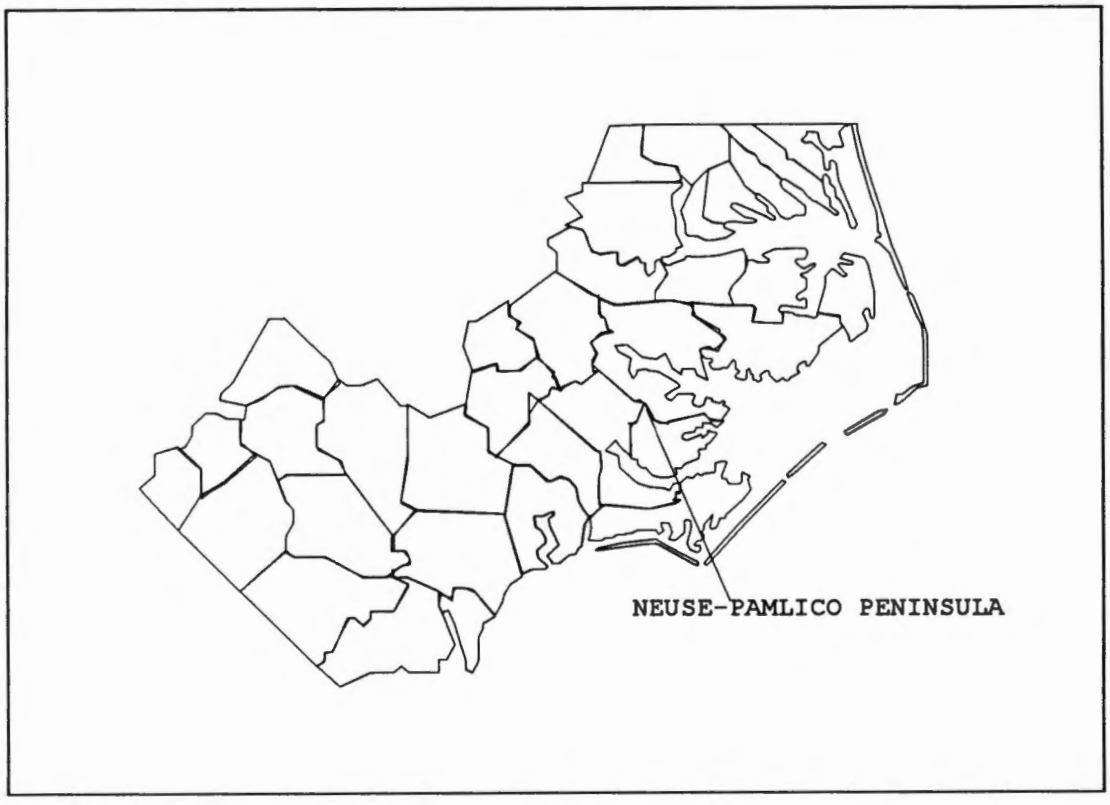


Figure 3. Map depicting location of Neuse-Pamlico peninsula.

Two smaller areas were selected for intensive study (Fig. 4). The 29,617-ha Gum Swamp study area in the eastern end of the peninsula is a mixture of hardwood swamps, pine plantations, pocosins and large agricultural areas. Many of the remaining hardwood forests are gradually being converted to pine plantations.

The 47,895-ha Big Pocosin study area in the central portion of the peninsula is dominated by loblolly pine plantations of various age classes. Smaller acreages of non-commercial forestland contain a mixture of hardwood and pine/hardwood habitats. Agricultural areas are generally smaller and less intensively managed than those in the Gum Swamp.

These two areas were selected due to their differences in woodland habitat types. The Gum Swamp contains many of the attributes of a natural hardwood system although most of the Weyerhaeuser ownership is scheduled to be converted to pine plantations. Most of the Weyerhaeuser ownership in the Big Pocosin has already been converted to pine plantations.

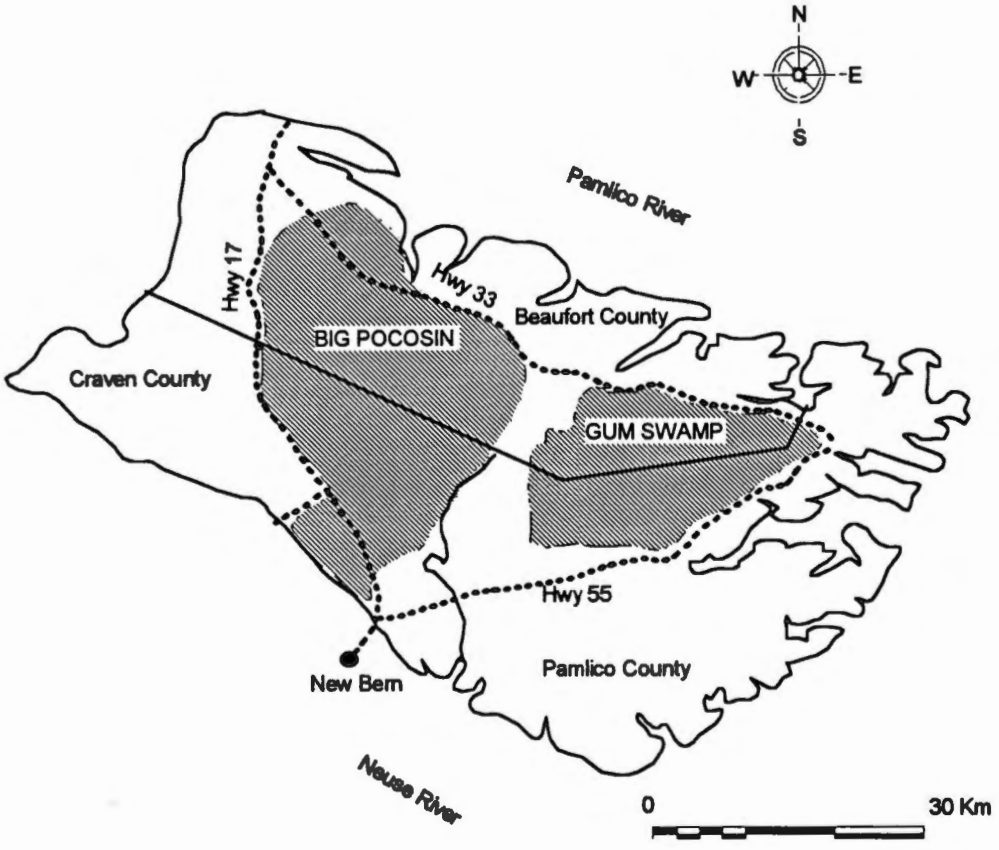


Figure 4. Map depicting Big Pocosin and Gum Swamp study areas.

Physiography and Geology

The NPP is drained by the Neuse and Pamlico River systems. Most of the land is level (90-95%) with gentle slopes along stream terraces. The major geographic feature in the area is the Minnesott ridge which was formed at the shoreline of an ancient ocean. This ridge bisects the Gum Swamp study area along North Carolina Highway 306. Elevations on the peninsula range from sea level to about 18 m. Approximately 75-80% of the soils are in poorly drained classifications.

CHAPTER III

MATERIALS AND METHODS

OVERVIEW

Trapping and Handling

Black bears were predominantly captured with Aldrich spring activated foot snares (Johnson and Pelton 1980). Automobile hood springs were used on anchor cables to lessen foot injuries. Cage traps were used to a lesser extent. Trapping was conducted from the end of May to early September, 1992 and from early May to late August, 1993. Most traps were located near agricultural fields or road crossings due to common bear sign and frequent sightings in these areas. Trapping rotated between study areas depending on use of agricultural crops by bears. An attempt was made to capture an equal number of bears on each study area. Traps were baited with bakery products and raspberry extract and were checked daily starting about 0830; this allowed time for bears to visit traps during the morning activity period. Multiple captures of bears on some days left some bears in snares until early afternoon.

Trail sets were most often used. Initially, the snare cable was covered, as is the norm in most snare trapping. However, uncovered snare cables were used in most sets during 1993 to preclude the bear from stepping on the cable and eluding capture. Cubby sets were used in some situations, especially if the set was tripped several days in row. Cage trapping was used only on the Gum Swamp study area in places where snare trapping was not feasible due to lack of suitable anchor trees.

Trapped bears were immobilized with a 1:2:0.2 mg mixture of Xylazine hydrochloride (Rompum, Haver Lockhart, Inc. Shawnee, KS.). Ketamine hydrochloride, (Ketaset, Bristol Laboratories, Syracuse, NY) and Mepivicaine hydrochloride (Carbocaine-V, Winthrop Laboratories, New York, NY). Jab sticks were used to administer the drug at a rate of 1 ml per 22.5 kg. body weight.

Immobilized bears were measured and weighed to the nearest 5 kg. Chest blazes, fighting wounds, injuries and other identifying marks were noted. Lactating females were administered Oxytocin (Burns Veterinary Supply, Oakland, CA) to counteract Ketaset which inhibits milk letdown.

First premolars were extracted for age determination using cementum annuli analysis (Stoneburg and Jonkel 1966,

Willey 1974, Eagle and Pelton 1978). All bears were ear tagged with numbered aluminum tags and circular aluminum tags with corresponding numbers. In addition, corresponding numbers were tattooed on the upper inner lip. In 1992, numbers were also tattooed in the groin area, a practice that was discontinued in 1993 due to poor tattoo retention.

Liquamycin (Phizer Laboratories, New York, NY) was administered intramuscularly at a rate of 1 ml per 22.5 kg body weight as an antibiotic. Surface wounds were swabbed with either mycatracin or betadine to prevent infection from trap-related injuries. Yohimbine (Lloyd laboratories, Shenandoah, Iowa) was used as an antagonist for xylazine and was administered intramuscularly or through the medial saphenous vein of the lower leg at a rate of 1 ml per 22.5 kg of body weight.

Age Structure, Morphology and Reproduction

The external genitalia of captured female bears was inspected for signs of vulval swelling to determine dates of estrus (Jonkel and Cowan 1971, Eiler 1981). The presence of cubs and lactation was also noted. Sightings of cubs with captured females and sightings of non-captured family groups were used to determine litter sizes.

tracts were collected from hunter-harvested bears and checked for presence of corpora lutea and placental scars to determine age at primiparity and litter sizes. Pairing of cementum annuli in first premolars was examined from hunter harvested females to determine reproductive histories (Coy and Garshelis 1992).

Data were collected from 2 abandoned newborn cubs in the winter of 1993. Cub age and birth date were estimated from head hair length as described by Alt (1989).

Weights of bears were plotted according to age class, sex, and season. Summer capture weights were compared to fall harvest weights to assess growth rates. Weights of recaptured bears and harvested tagged bears were used to determine rate of weight gain of individuals.

Chi square goodness of fit tests were used to test differences in sex ratios. The z-test for comparing binomial proportions was used to detect differences in age and sex classes (Ott 1988).

Food Habits

Food habits were determined from analysis of 364 scats and 76 stomach samples (Martin et al. 1946, Tisch 1961, Korschgen 1980). Scats were incidentally collected during other research activities in the two study areas. They

were placed in individual plastic bags, labeled and frozen. Samples were later thawed and washed through sieves to separate individual food items. Contents were identified to species, if possible. Percent volume of individual food items was occularly estimated and percent frequency of occurrence was noted. Items estimated as <1.0% of total volume were listed as trace amounts. Seasons were classified by changes in diet: Spring (1 April - 30 June), Summer (1 July - 30 September), Fall (1 October - 30 December), Winter (1 January - 31 March).

Stomach samples were collected from hunter-harvested bears during the November hunting season throughout the entire NPP. A 36-ml sample was taken from large stomachs and entire stomach contents from smaller bears. The samples were frozen for later analysis. Frozen samples were thawed, washed through a 28-mm sieve and analyzed. Aggregate percent volumes of food items were compared between ages, sexes, and years.

A reference collection of bear food items was made during the study to aid in identification of samples. Unknown species were identified through use of identification keys (Brockman 1979, Radford et al. 1979).

Crop Depredation

In the summer of 1993, a weekly aerial survey of corn fields in the Gum Swamp study area was conducted to determine the initiation, extent, and duration of crop damage. Surveys were limited to the Gum Swamp because it more closely approximated the commercial agricultural landscape of northeastern North Carolina and military "restricted flight areas" in coastal North Carolina made flight scheduling difficult over large areas. Aerial photos of the entire study area were obtained from Pamlico and Beaufort Counties' Agricultural Stabilization and Conservation Service (ASCS) offices and all corn fields were identified and plotted. Individual maps were made of each corn field with surrounding vegetation and other crops noted.

Initially, crop depredation analysis was to consist of aerial surveys of wheat, corn, and soybean damage. Bear damage to corn is readily identifiable from the air due to the stalk damage incurred. Bear damage to wheat was not surveyed because it was not discernible from deer damage and wind damage from the air. Soybeans damage could also not be distinguished from deer damage and was not surveyed. Once corn damage was seen from the ground, aerial flights were initiated. On the initial flight, 35 mm still photos

were taken of each damaged area and the area was drawn in on the corresponding field map. Due to the large numbers of photos taken on this first flight, subsequent surveys consisted of video taping damaged areas of each corn field with a hand-held video camera from approximately 100m altitude. Smaller areas of damage were drawn on the field maps while in the air. Large fields with multiple damage areas were usually filmed 2-3 times from different angles and areas were drawn onto the field maps after playback on a video cassette recorder. The single frame playback mode was used to maximize accuracy. Total stalk damage in hectares for the entire study area was computed each week and for the entire crop season.

A mail survey on bear crop damage and farmer attitudes on the Neuse-Pamlico peninsula was developed for farm operators. The list of farm operators was provided by the ASCS from Beaufort, Craven and Pamlico Counties. A farm operator was defined by ASCS as anyone who participated in a federal crop program or received crop subsidy payments. This list of farm operators included many individuals who were not actually farmers. Beginning in April 1994, a cover letter and questionnaire were mailed to 256 farm operators (Filion 1980). Due to delays in obtaining an

address list from ASCS, Beaufort County farm operators were mailed their questionnaires in June 1994. A second cover letter and questionnaire was sent to non-respondents after approximately 3 weeks. A final reminder and closing date postcard was sent 1 month later.

The survey consisted of 21 questions concerning attitudes toward bears and crop damage caused by bears and was patterned after similar mail surveys done by Wigley and Garner (1986), Craven (1989), Wigley et al. (1989), and Clark et al. (1991) The last 5 questions were optional and dealt with personal information such as age, sex, race, educational background and income. Chi square analysis was performed to determine relationships between bear damage levels and farm operator attitudes.

Mortality

Black bears are hunted on the Neuse-Pamlico peninsula for 6 days beginning the second Monday in November. Four hunter check stations were set up and maintained for the entire season in 1992 and 1993. Approximately 3 weeks before the season, posters outlining the locations of the check stations were placed in most businesses and stores in the three county area. Check stations were operated from

0730 to 1930. Morphological data similar to bear capture samples were collected from each bear brought to the check station. Data were taken from all bears on the peninsula, not just from those within the Gum Swamp and Big Pocosin study areas. In addition, tooth samples, stomach samples and reproductive tracts were collected. Hunting information including time of harvest, weapon type, and hunting method was also collected. Data was compared between seasons and with other areas of the coastal plain. Time of harvest was compared between age and sex groups using the students t-test.

In 1993, a short questionnaire was given to successful bear hunters who brought bears to check stations. This questionnaire covered topics such as hunter success rates, proximity to agricultural fields, and satisfaction with season timing and lengths.

After the season, harvest kill cards were audited to determine if any successful bear hunters did not come to the check stations. All such identified hunters were contacted by phone and were asked for information concerning their harvested bear. This partial information was added to the harvest data set. Data from other mortalities such as poaching, road kills, depredation and research activities also were collected.

CHAPTER IV

AGE STRUCTURE, MORPHOLOGY, AND REPRODUCTION

RESULTS

Sex and Age Ratios

One hundred two captures of 89 bears were made during the 1992 and 1993 trapping seasons (Table 1). No bears were recaptured during the 1992 trapping season but there were 13 recaptures of 11 bears in 1993, including 4 bears originally captured in 1992. The overall capture success rate(# captures/# trap nights x 100%) of 9.7% was considerably higher than reported for other coastal plain studies (Table 2). The Gum Swamp study area success rate of 14.5% was more than double the success rate of the Big Pocosin and was one of the highest reported in the literature (Table 3).

The sex ratio of all captured bears (46M:43F) did not differ from 1:1 (P=0.822) nor did the sex ratios from the Gum Swamp (27M:24F)(p=0.778). The Big Pocosin study area sex ratio of 19M:19F was 1:1 for both years combined. Adult bear (>3.0 yrs.) sex ratios (25M:26F) were nearly equal. Sub-adults sex ratios, 21M:15F were not significantly different (P=0.406).

Table 1. Trapping summary for the Neuse-Pamlico peninsula, 1992-1993 (excluding recaptures).

	Big Pocosin		Gum Swamp	
	Male	Female	Male	Female
1992	13	9	11	9
1993	6	10	16	15
Total	19	19	27	24

Table 2. Trapping success on the Neuse-Pamlico peninsula study area, 1992-1993.

YEAR	AREA	TRAP NIGHTS	BEAR VISITS	BEAR CAPTURES	CAPTURE SUCCESS
1992	Big Pocosin	421	32	22	5.2%
1993	Big Pocosin	201	22	17	8.5%
1992	Gum Swamp	193	48	20	10.4%
1993	Gum Swamp	240	79	43	17.9%
1992	Total	614	80	42	6.8%
1993	Total	443	101	60	13.5%
Total	Big Pocosin	622	54	39	6.3%
Total	Gum Swamp	433	127	63	14.5%
Total	Total	1055	181	102	9.7%

Table 3. Trapping success for black bear studies in the southeastern United States.

Area	Trap Nights per Capture	Success Rate	Reference
Ouachita Mtns., AR	1/25.3	4.0%	Clark (1991)
Ozark Mtns., AR	1/38.8	2.6%	Clark (1991)
Camp LeJeune, NC	1/79.0	1.2%	Lombardo (1993)
Bladen County, NC	1/50.0	2.0%	Hamilton (1978)
Dismal Swamp, VA	1/28.6	3.5%	Hellgren (1988)
Smoky Mtns., TN	1/8.8	11.4%	Johnson (1978)
Smoky Mtns., TN	1/14.7	6.8%	Pozzanghera(1990)
Pisgah, NC	1/26.8	3.7%	Warburton (1984)
Harmon Den, NC	1/27.5	3.6%	Brody (1984)
Harmon Den, NC	1/46.0	2.2%	Beringer (1986)
Harmon Den, NC	1/36.0	2.7%	Siebert (1989)
Atchafalaya, LA	1/40.4	2.5%	Pace et al.(1993)
Appalachicola, FL	1/45.8	2.2%	Siebert (1993)
Gum Swamp, NC	1/6.9	14.5%	This Study
Big Pocosin, NC	1/16.0	6.3%	This Study

Ages of captured bears ranged from 1.5 - 10.5 years old ($\underline{x}$=4.1, n=87)(Fig. 5). The average age of males (3.8, n=46) was not significantly different from females (4.4, n=41)(p=0.084). In the Gum Swamp, the average age of males was 4.0 and the average age of females was 4.5 (Fig. 6). Big Pocosin bears had an average age of 3.8, with males at 3.6 and females at 4.4 (Fig. 7). Adults comprised 58.6% of the captured bears.

Sex ratios of harvested bears were not significantly different in 1992 (54.5%)(X^2=0.29, 1 df p=0.590) or in 1993 (56.4%)(X^2=0.66, 1 df, p=0.416). Sex ratios of sub-adults (61.1%) (X^2=0.41, 1df, p=0.522) and adults (59.2%)(X^2=0.71, 1 df, p=0.399) also were not different.

The average age of harvested bears was 5.8 years old (n=89)(Fig. 8). Harvested females ($\underline{x}$=6.34, n=50) were not significantly older than males ($\underline{x}$=5.05 n=39)(p=0.196). The proportion of adults in the harvest was 56.6% . Adults comprised 56.4% of the male harvest and 56.8% of the female harvest. In 1992, 56.8% of harvested bears were sub-adults, compared to only 31.3% in 1993. Only 1 cub was harvested and 15 (16.6%) harvested bears were 10 years of age or older. Harvested bears were significantly older than captured bears (P=0.036).

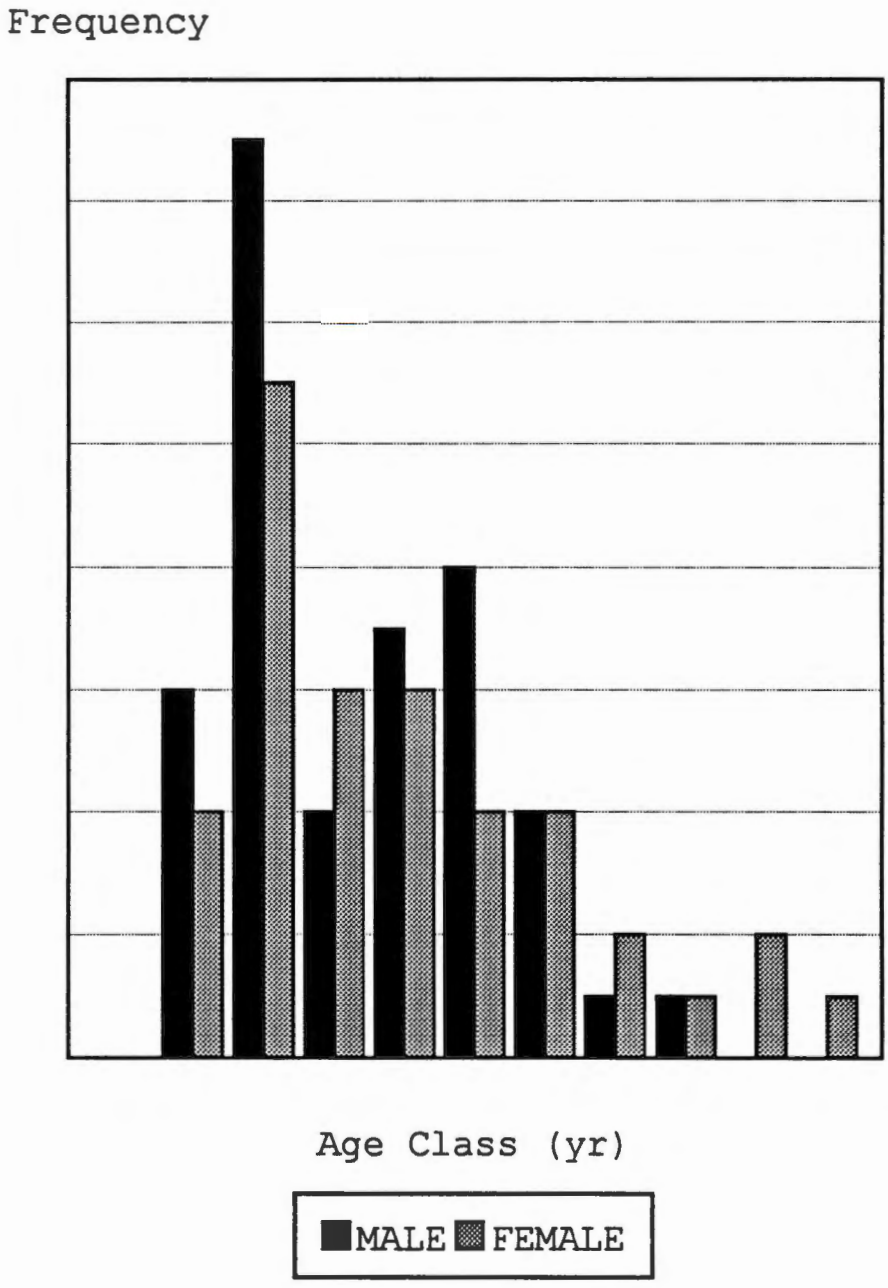


Figure 5. Age frequency distribution of black bears captured on the Neuse-Pamlico peninsula, 1992-1993.

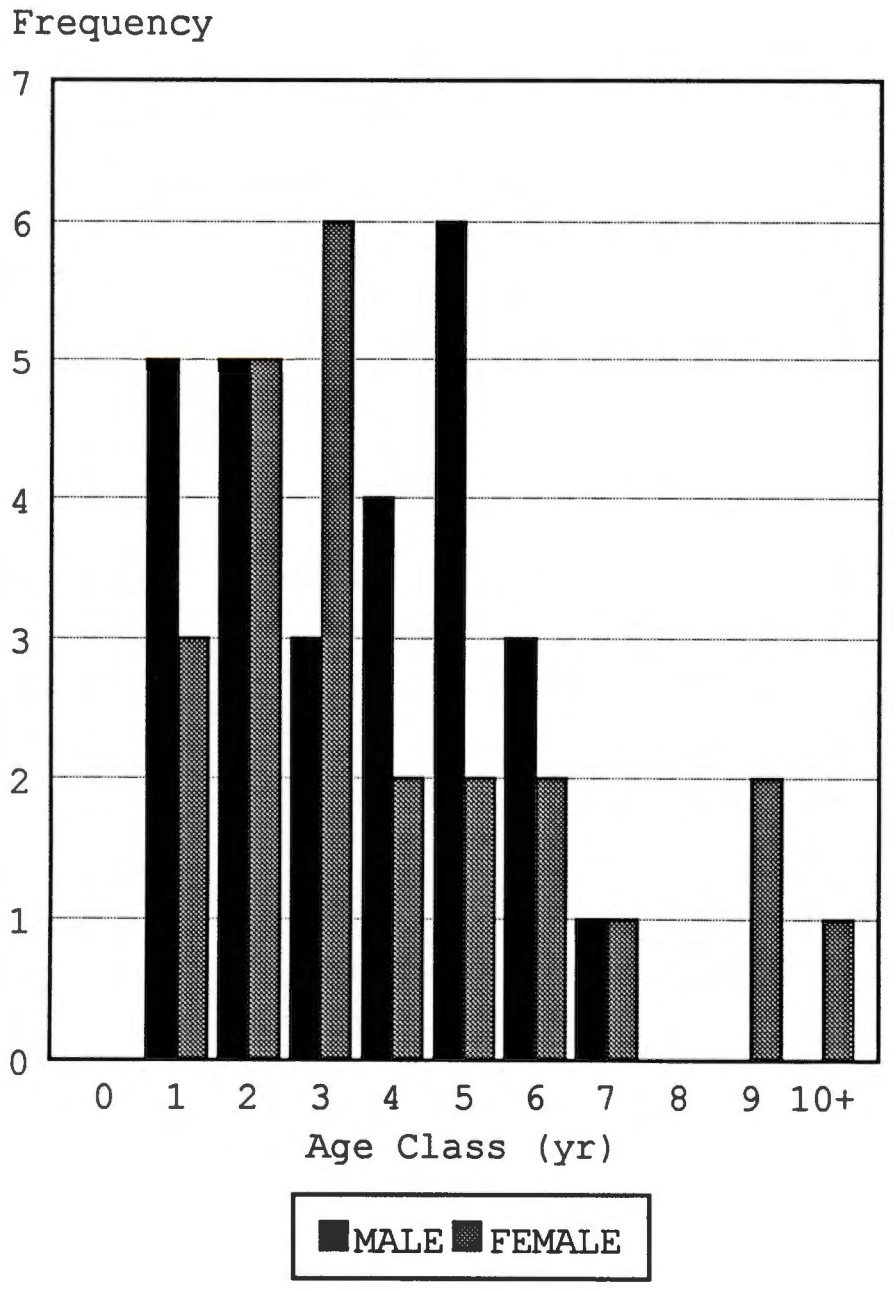


Figure 6. Age frequency distribution of black bears captured on the Gum Swamp study area, 1992-1993.

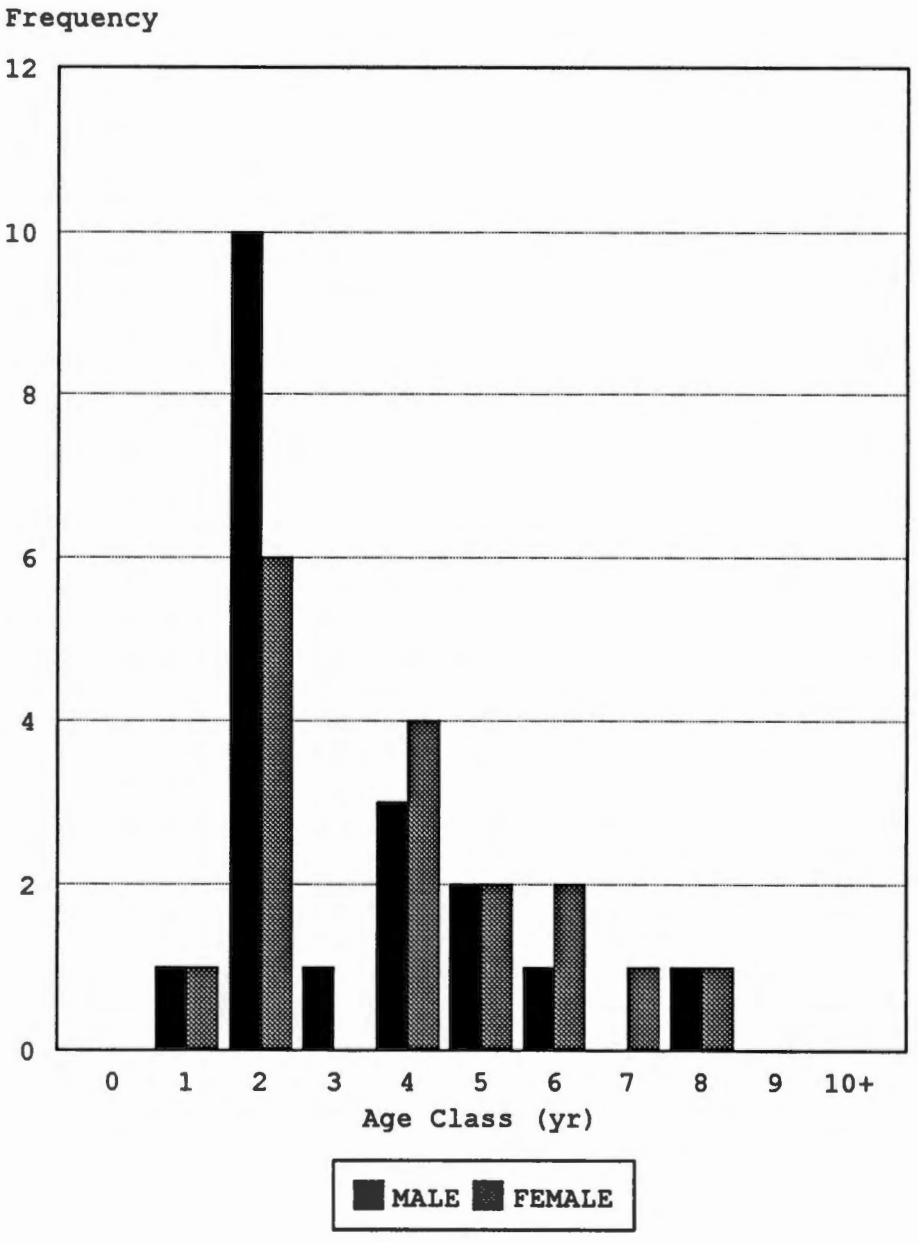


Figure 7. Age frequency distribution of black bears captured on the Big Pocosin study area 1992-1993.

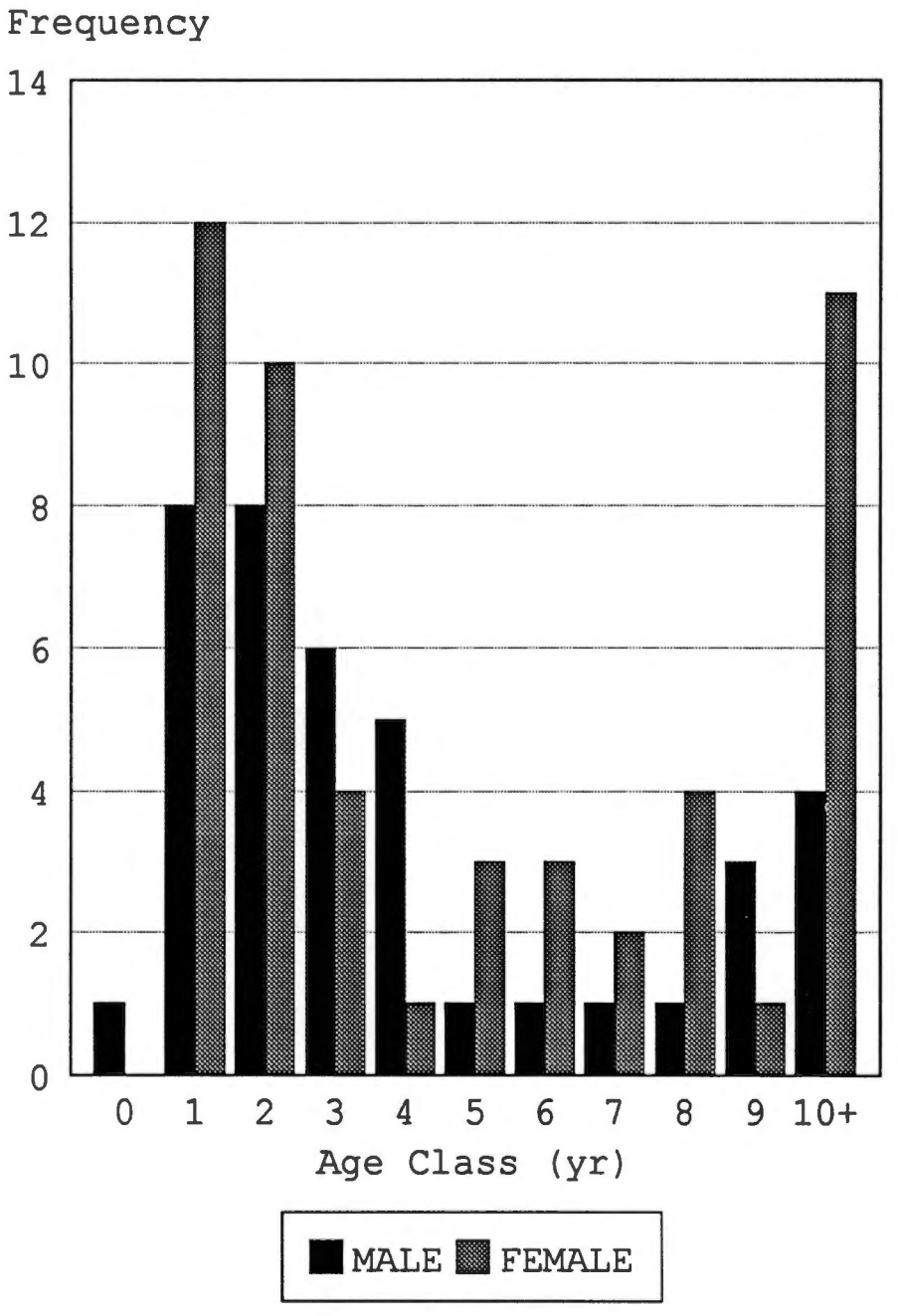


Figure 8. Age frequency distribution of black bears harvested on the Neuse-Pamlico peninsula, 1992-1993.

Body Size

Captured and harvested male bears were heavier than females in all age classes. Captured males and females increased steadily in weight until about ages 6-8, however the male growth curve was much steeper (Fig. 9). Harvest samples showed similar results but with greater variation in older age classes among females (Fig. 10). Weights of male harvested bears paralleled capture weights until 6 years of age; at this point harvest weights were greatly increased over capture weights (Fig. 11). Female harvest samples paralleled those of capture samples and did not show the large increase in older age classes seen in males (Fig. 12). Small sample sizes in older age classes made interpretation difficult. The largest captured male weighed 181.8 kg whereas the largest harvested male weighed 263.6 kg. The largest captured female weighed 86.4 kg and the largest harvested female weighed 125.0 kg.

Total length measurements from capture and harvest samples of both males and females began leveling off at 4.5 years of age (Table 4). Chest circumferences samples showed small but steady increases until 8-9 years old. Small sample sizes made it difficult to interpret data from

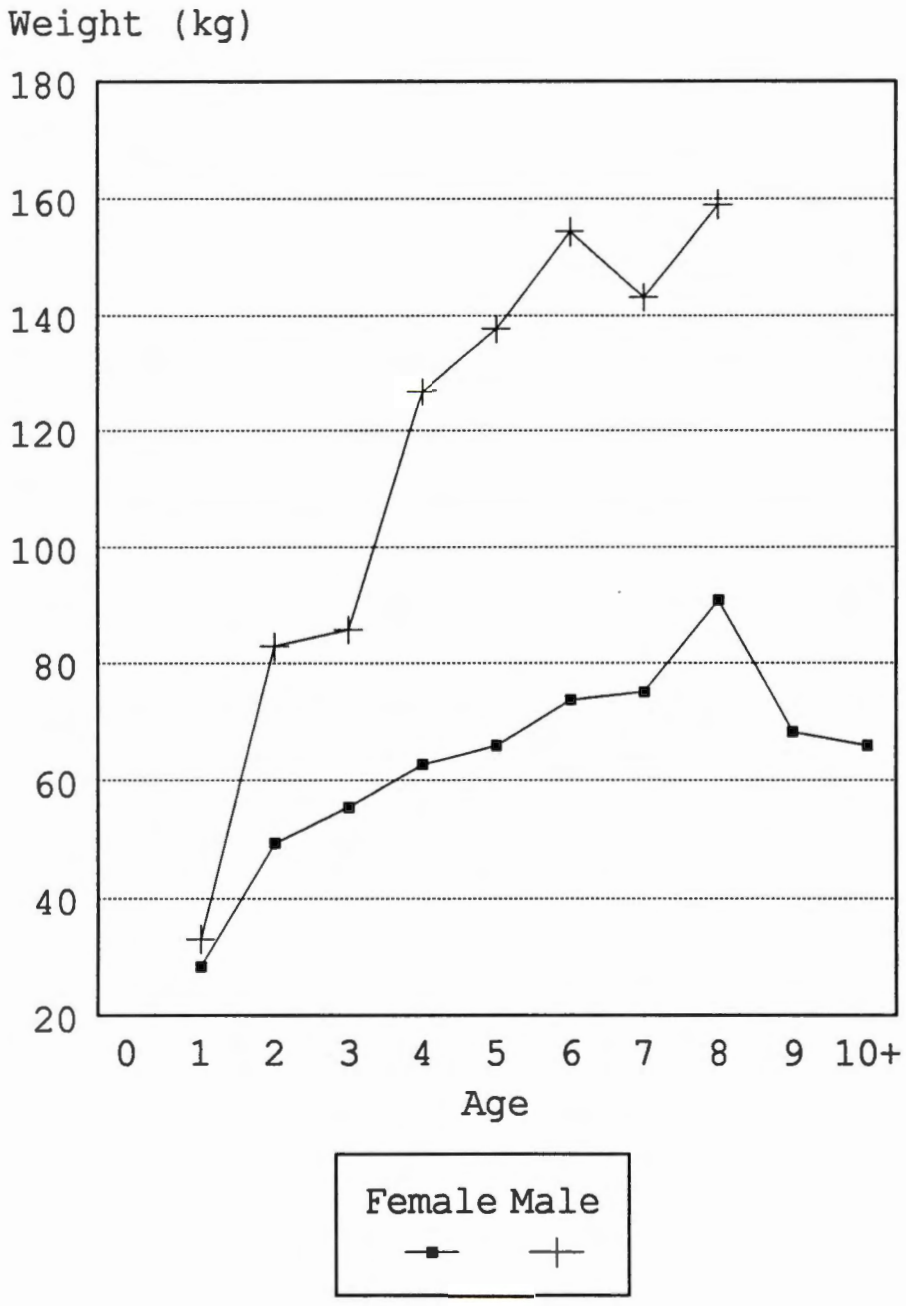


Figure 9. Mean weights of black bears captured on the Neuse-Pamlico peninsula, 1992-1993.



Figure 10. Mean weights of black bears harvested on the Neuse-Pamlico peninsula, 1992-1993.

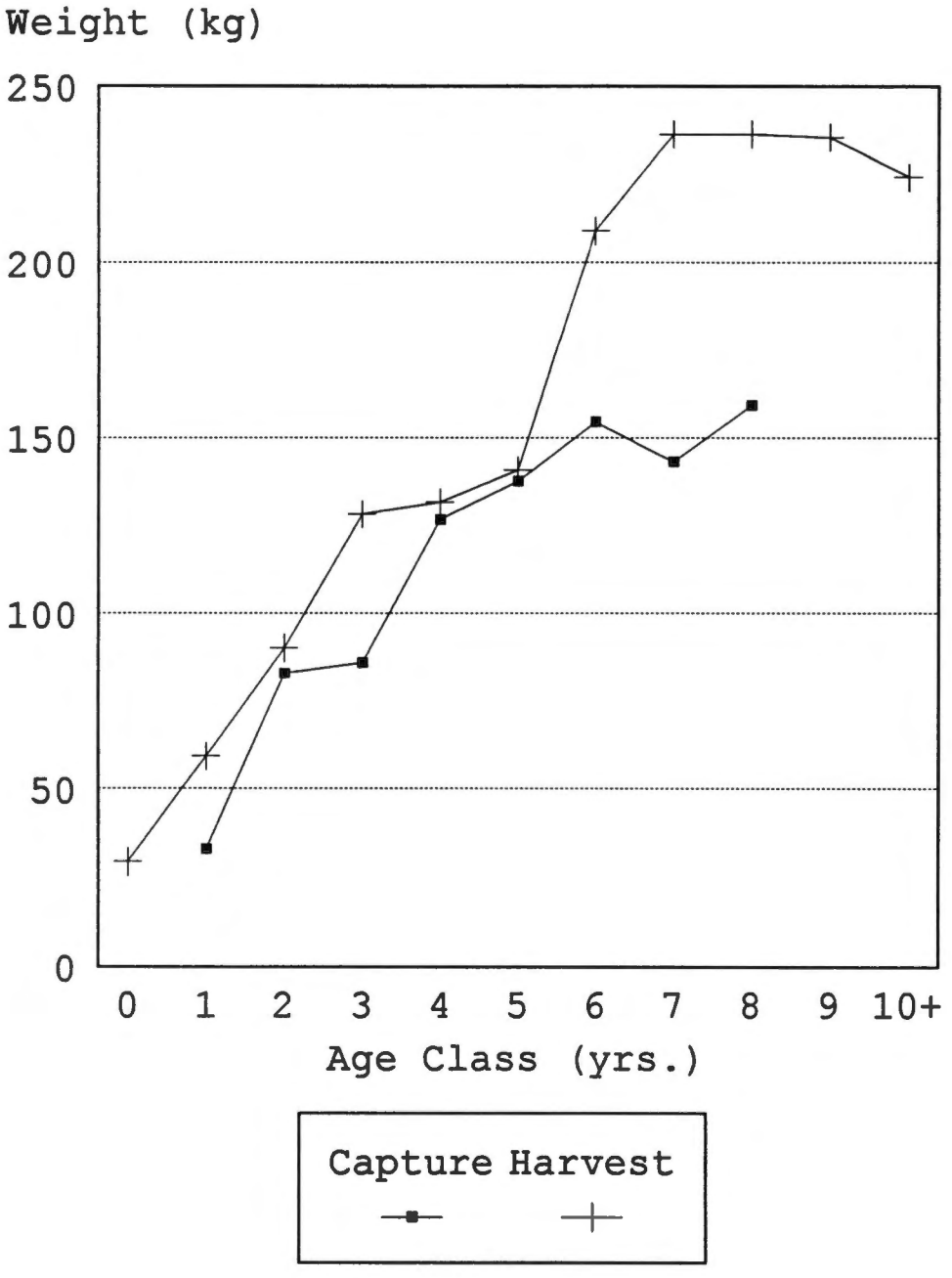


Figure 11. Mean weights of male black bears captured and harvested on the Neuse-Pamlico peninsula, 1992-1993.

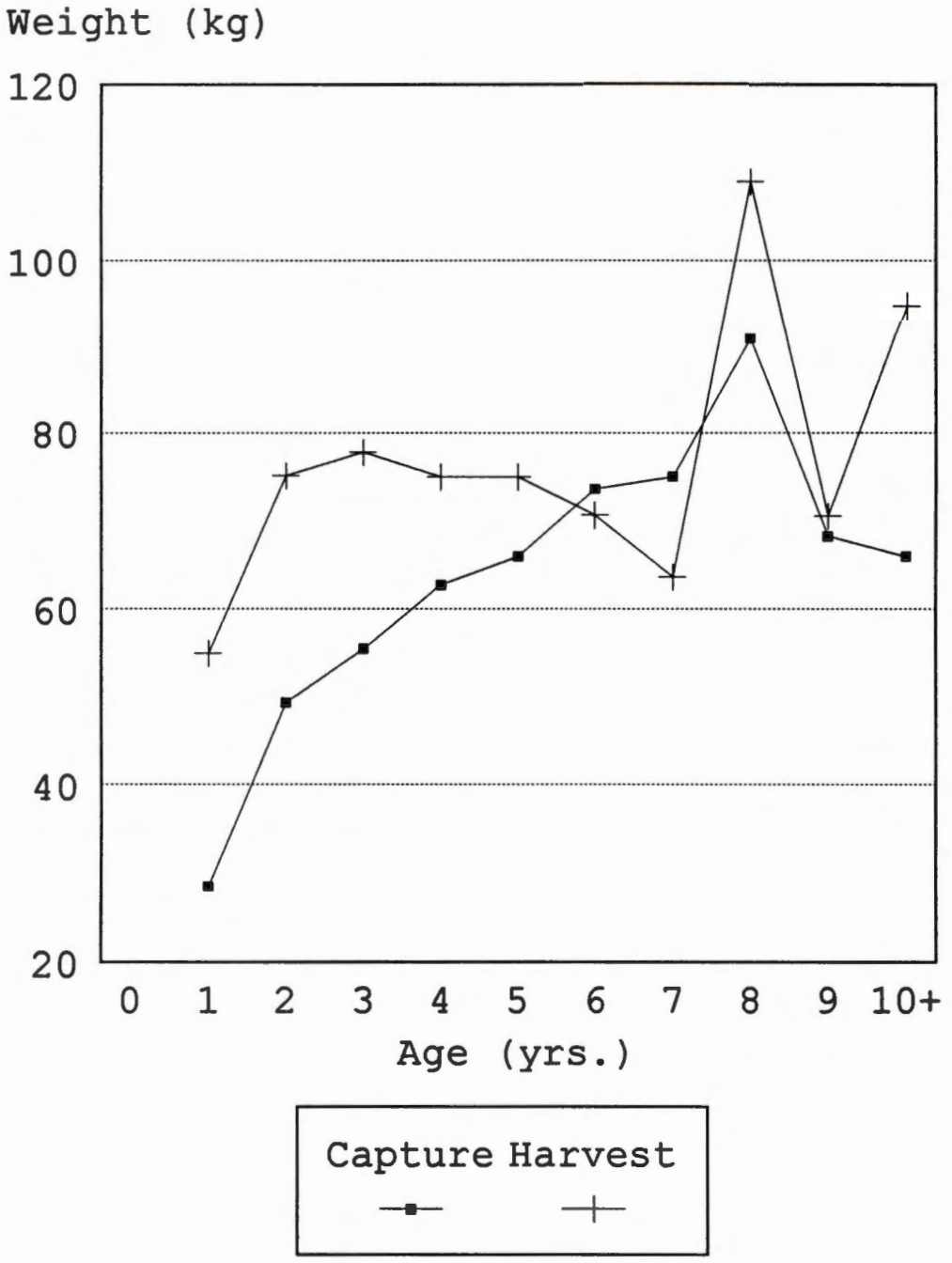


Figure 12. Mean weights of female black bears captured and harvested on the Neuse-Pamlico peninsula, 1992-1993.

Table 4. Mean total length and mean chest circumference for black bear capture and harvest samples.

	Total Length							
Age Class	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5+
Male capture	125	160	164	184	184	180	191	195
Male harvest	138	158	169	179	178	188	196	192
Female capture	121	143	150	152	156	156	157	155
Female harvest	139	144	145		152	136		154

	Chest Circumference							
Age Class	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5+
Male capture	65	87	94	108	110	119	119	126
Male harvest	83	93	118	125	123	127	159	146
Female capture	62	74	76	81	82	88	88	88
Female harvest	80	91	96	88	88	92	105	105

older bears. Harvest sample chest circumference was much larger than capture samples. Total length measurements remained consistent.

Fifteen tagged bears (11M:4F) were recaptured or harvested during the study. Small sample sizes did not allow for statistical analysis of sex or age classes; however, the results provided anecdotal information on growth. Ten bears were recaptured/harvested within a single year. Nine of these gained weight between capture and recapture/harvest averaging 0.21 kg/day. The remaining bear, an adult male, lost 6.8 kg during a 49-day period of the breeding season. A sub-adult male caught and recaptured during approximately the same time period gained 6.8 kg. Weight gains between summer capture and fall harvest averaged 32.9 kg for 3 male bears. A single female in this category gained 36.4 kg. Five males caught as 2.5 year olds in 1992 were harvested in 1993 and averaged a weight gain of 51.3 kg.

Breeding

Eight of 46 (17.4%) captured or recaptured females were found to be in estrus during the study period. The breeding period spanned 62 days from 2 June - 4 August with a mean of 3 July. In 1992, 4 females were found to be in estrus during the period 2 June - 12 July and in 1993, 4 females were found to be in estrus during the period 8 July - 4 August. In this study, ages of bears in estrus ranged from 2.5 to 9.5 years of age (Table 5). Four of 11 (36%) of 2.5-year old captured females were found to be in estrus. Two of 6 females (33%) in the 3.5-year age class had cubs present or were lactating when captured; this indicates breeding activity at 2.5 years of age.

Counts of corpora lutea and placental scars from reproductive tracts of harvested females provided additional information on age of primiparity and litter sizes (Table 6). Sixty-four percent of the tracts in the 2.5 year age class contained corpora lutea. All bears in the 3.5 age class or older had either corpora lutea (60%) or placental scars (40%). No harvested yearlings were found to have corpora lutea; however, 1 bear in the 2.5 age class had 2 placental scars indicating breeding at 1.5. Teat color and development of this female were indicative of females which had nursed cubs.

Table 5. Reproductive information from captured female black bears on the Neuse-Pamlico peninsula, 1992-1993.

AGE	NUMBER	IN ESTRUS	CUBS PRESENT	LACTATING	NO ACTIVITY
0.50	0	0	0	0	0
1.50	4	0	0	0	4
2.50	11	4	0	0	7
3.50	8	1	1	1	5
4.50	6	1	2	0	3
5.50	4	0	1	2	1
6.50	4	1	0	1	2
7.50	2	0	0	1	1
8.50	1	0	0	1	0
9.50	2	1	0	1	0
10.50	1	0	1	0	0
11.50	1	0	0	0	1
Unknown	2	0	1	0	1
Totals	46	8	6	7	25

Table 6. Reproductive tract information from hunter harvested female bears from the Neuse-Pamlico peninsula, 1992-1993.

AGE	NUMBER	NUMBER WITH CL[a]	AVERAGE # OF CL	NUMBER WITH PS[b]	AVERAGE # OF PS
1.75	10	0	0.0	0	0.0
2.75	11	7	1.9	1	2.0
3.75	4	3	2.3	1	2.0
4.75	1	0	0.0	1	2.0
5.75	3	0	0.0	3	2.0
6.75	3	1	2.0	2	2.5
7.75	1	0	0.0	1	3.0
8.75	4	2	3.0	2	2.0
9.75	1	0	0.0	1	2.0
10.75+	8	3	2.7	5	3.0

[a] Corpora Lutea
[b] Placental Scars

Litter Size

Litter sizes were obtained from 2 sources; observations of cubs with females and corpora lutea/placental scar counts. The average litter size of 12 captured females observed with cubs was 1.9. Sightings of untagged females with cubs (n=4) averaged 1.8 cubs. Observational information when cubs are 4-7 months old is likely to underestimate litter size because all cubs may not be present. Corpora lutea and placental scar counts should be a more accurate measure of litter size than observational counts assuming losses within litters are minimal. Litter sizes from corpora lutea counts and from placental scars averaged 2.4.

Reproductive Histories

Teeth from 28 female bears >4.0 years of age were examined. Particular attention was paid to teeth from bears known to have cubs when captured to see if layering substantiated the absence of cubs the previous year. Layering was not as pronounced as that shown in photos from bears in Minnesota (Coy and Garshelis 1992); however, paired annuli were evident in 19 teeth. No paired annuli were seen in 9 samples. Partial histories were read from 4

samples and complete histories from the remaining 15 teeth. Initial dates of first litters were obtained from 19 samples. Age of primiparity ranged from 3-6 years of age($\underline{x}$=3.6). Nine (47.4%) of the samples showed females had first litters at 3.0 years of age. Eight bears had initial litters at 4 years of age, 1 bear at 5 years and 1 at 6. It could not be determined if the late initial age of the latter 2 bears was caused by lack of cementum layer pairing, loss of cubs, or late breeding age.

Alternate year cub production was evident in bears that had produced more than one litter (n=11). Only 1 bear, a 14.75-year old harvested female, showed evidence of having skipped a year. Paired annuli showed she had cubs at ages 3, 5, 7, and 10. No determination could be made from her 11+ years of life because the annuli were too close together.

Only 5 of 10 teeth from female bears >4.0 years old whose reproductive status was known at the time of capture showed annuli pairing. Four of the five corroborated the annuli pairing technique in that paired annuli were seen in years with known litters.

Birthing Dates

Birthing dates of bears on the NPP were determined from data taken from two abandoned cubs in the Big Pocosin. These cubs were abandoned by their mother during den research activities in February 1993. Alt (1989) estimated birthing dates by the hair length on the top of the cub's head. Based on this technique (hair length of 14mm), the birth date of this litter was estimated to be 28 January.

DISCUSSION

Sex and Age Ratios

Sex and age ratios from capture and kill samples have been used to determine exploitation levels of bear populations (Gilbert et al. 1978, Beck 1991). Samples whose ratios were skewed toward females or toward younger age classes were generally considered to be exploited populations. Determining exploitation levels of bears from age and sex data is wrought with problems (Garshelis 1993). Trap and harvest bias, and natality and mortality patterns can disguise the actual sex and age structure. The exploitation level of bears on the NPP is impossible to determine from sex and age ratios of the capture and harvest samples. Natality and mortality rates could lower the average age and alter sex ratios. Total mortality on the NPP is hard to determine because of bears shot by farmers and not reported. Actual numbers of road kills are an unknown due to animals leaving the roadway after being hit and dying later. Also, hunting methods on the NPP play a large part in determining the age and sex parameters of the population and preclude us from making definite assumptions about the exploitation level of bears in this study from age and sex data.

Cubs are generally born in 1:1 sex ratios (Jonkel and Cowan 1971, Pelton 1982, Alt 1989), but many bear studies, report adult ratios skewed toward males (Table 7). Males tend to have greater home ranges than females and thus are more likely to come into contact with traps. (Bunnell and Tait 1980). Furthermore, most bear trapping occurs during the summer months when sub-adult males are dispersing and adult males are engaged in breeding activities. This increased movement by male bears could impact sex ratios of capture samples. Conversely, male bears are usually much more vulnerable to hunting because their greater movements creates a higher incidence of contact with hunters and also because of hunter selectivity for larger animals (Rogers 1976, Alt 1980a, Alt 1980b, Bunnell and Tait 1980, Pelton 1982, Kolenosky 1983). Road kills also take a disproportionate number of male bears (Wooding and Brady 1987, Warburton et al. 1993, Wooding and Maddrey 1994). Female bears with cubs are protected by law as are cubs weighing <21.2 kg (50 lbs). Only 1 cub was harvested during the two-year period and it weighed 28.2 kg. Most cubs of the year weigh more than 21.2 kg by the November hunting season but few are harvested due to hunter selectivity (Maddrey, unpublished data). Several females with swollen mammary glands (indicative of having reared

Table 7. Trapping sex ratios for coastal black bear studies in the southeastern United States.

STUDY AREA	MALE	FEMALE	REFERENCE
Dare County, NC	4	0	Hardy (1974)
Bladen County, NC	15	6	Hamilton (1978)
Okefenokee, GA	15	14	Abler (1985)
White River, AR	37	25	Smith (1985)
Dismal Swamp, VA	71	30	Hellgren (1988)
Camp LeJeune, NC	6	18	Lombardo (1993)
Atchafalaya, LA	22	12	Pace et al. (1993)
Ocala/Osceola, FL	18	15	Wooding & Hardisky(1993)
Appalachicola, FL	18	4	Siebert (1993)
Gum Swamp, NC	27	24	This Study
Big Pocosin, NC	19	19	This Study

cubs) were harvested both years. The tendency of older cubs to leave their mother's side for only short periods could impact whether the mother is harvested.

The combinations of higher male mortality (which should decrease male trap response), increased male movements (which should increase male trap response) and smaller home range size and movement of females (which would decrease trap response) make interpretation of sex ratios and their application to the real population impossible.

Body Size

In comparing bear sizes between study areas, total length is probably the best parameter because it changed very little on a seasonal basis. Weight and chest girth were good indicators of size but comparisons were difficult due to large weight and chest circumference variations between seasons. Comparisons with results from other bear studies reveal that NPP bears grew faster and attained heavier weights and larger body sizes as adults. McClean (1991) compared morphological data between wild and panhandler bears from the Smoky Mountains with those from the surrounding national forests. Total length

measurements from adults from all these populations was considerably smaller than from NPP bears.

Comparisons within individual age classes provides an indication of yearly growth. Total length measurements from Neuse-Pamlico, Great Dismal Swamp (Hellgren 1988), and northeastern Pennsylvania (Alt 1980b) show nearly identical growth patterns (Table 8). Bears from the Great Smoky Mountains (McLean 1991) were generally smaller as sub-adults and adults. Weights of bears are comparable between populations if measurements are taken during the same season. The Great Dismal Swamp (GDS) is approximately 145 km north of the NPP and represents the northern end of the bear range in coastal North Carolina and Virginia. Bears in the GDS eat considerably less agricultural foods than Neuse-Pamlico bears on a seasonal basis (Hellgren 1988). The GDS is an approximation of the habitat at NPP before commercial forestry and agriculture changed the landscape. Comparing weights of GDS and NPP bears should give an indication of the nutritional level of the two macro-habitats. Table 9 shows age-class summer weight comparisons between the 2 populations. Weights of NPP bears and GDS bears are very similar in all age classes.

Table 8. Mean total length (cm) comparison among black bears captured at Great Dismal Swamp (GDS) (Hellgren 1988), northeastern Pennsylvania (NEP) (Alt 1980), and the Neuse-Pamlico peninsula (NPP).

	GDS		NPP		NEP	
Age	Male	Female	Male	Female	Male	Female
1	122.7	127.1	124.7	121.4	137.2	121.9
2	155.3	129.7	159.6	143.4	160.0	137.2
3	167.3	146.6	163.9	150.2	170.2	147.3
4	167.9	150.0	183.6	151.4	177.8	154.9
5	181.4	151.0	183.9	155.8	182.9	149.8
6	189.6	148.7	180.0	155.9	188.0	157.5
7+	188.0	145.4	192.5	155.9	186.7	157.0

Table 9. Mean weight (kg) comparison between black bears captured at Great Dismal Swamp (GDS) (Hellgren 1988) and the Neuse-Pamlico peninsula (NPP).

Age	GDS		NPP	
	Male	Female	Male	Female
1	40.4 (7.7, 5)[a]	37.8 (4.1, 8)	33.3 (3.7, 6)	28.4 (1.5, 4)
2	63.6 (4.8, 14)	35.7 (4.4, 3)	77.4 (5.7, 15)	49.4 (2.7, 11)
3	82.0 (6.0, 14)	52.8 (6.5, 6)	85.8 (1.9, 4)	55.5 (1.4, 6)
4	82.0 (3.9, 15)	51.8 (1.2, 4)	129.9 (7.6, 7)	62.7 (5.6, 6)
5	111.5 (9.4, 10)	65.0 (3.5, 2)	135.5 (8.4, 8)	65.9 (2.9, 4)
6	127.3 (5.3, 6)	60.2 (3.7, 5)	147.2 (8.1, 4)	67.6 (3.8, 4)
7+	146.6 (7.4, 11)	62.8 (2.2, 12)	151.2 (8.0, 2)	73.9 (4.8, 6)

[a](SE, n)

We can conclude from this comparison that the current habitat supplies the nutritional elements needed to maintain healthy animals.

The addition of artificial food sources such as crop foods probably elevates the nutritional level of NPP bears and enhances growth. Panhandler bears in the Great Smoky Mountains are larger and grow faster than their wild counterparts due to the consumption of high energy human foods (Eiler 1981, McLean 1991). Bears in Minnesota which regularly fed at dumps attained greater size and grew faster than those which did not (Rogers 1976, 1987).

Results of this study show that the extensive use of grain crops probably provides the needed nourishment for coastal North Carolina bears to become large and have high growth rates. Grain crops are high quality foods, being high in both crude protein and starch (Mattson 1989).

Bears in Pennsylvania may be the largest in North America due to their high nutritional level (Alt 1980a). Fall weight comparisons between bears of northeastern Pennsylvania and the NPP show that Pennsylvania bears of both sexes are consistently larger than NPP bears (Table 10). However, adult males of both areas attain similar weights. The large amounts of crop foods eaten by adult

Table 10. Mean weight (kg) comparison between black bears of northeastern Pennsylvania (NEP)(Alt 1980) and the Neuse-Pamlico peninsula (NPP).

Age	NEP Male	NEP Female	NPP Male	NPP Female
		SUMMER		
Cub	22.7	19.1	-	-
1	38.6	42.7	33.1	28.4
2	85.5	75.0	82.9	49.4
3	117.3	78.2	85.8	55.5
4	135.5	77.7	126.9	62.7
5+	174.5	89.1	144.1	69.8
		FALL		
Cub	44.1	37.3	29.5	-
1	78.2	65.5	59.3	55.0
2	109.1	93.2	90.1	75.1
3	154.1	86.4	128.4	77.8
4	179.5	90.9	131.8	75.0
5+	220.5	113.2	220.7	89.0

male bears on the NPP allows them to grow to very large size in the fall. Bears of coastal North Carolina may be genetically smaller than those from Pennsylvania and only with the addition of large amounts of crop foods are they able to attain similar sizes. Since adult males dominate the best feeding sites, large weight gains of sub-adults and females are not as likely to occur.

The heaviest known bear in North Carolina was harvested on the Neuse-Pamlico peninsula in 1990 and weighed 327.3 kg. Several bears are harvested each year that exceed 250 kg in weight.

Breeding

The estrous period found in this study was consistent with that found in other bear studies indicating that the timing of breeding activity is relatively analogous between regions (Table 11). Rogers (1987) and Eiler et al. (1989) speculated that food availability the previous fall and during the breeding season may play a part in the timing and duration of the breeding season, especially in sub-adults. A fall mast failure or a late summer berry crop may be sufficient to delay the breeding season for females in poor condition. Due to the presence of agricultural

Table 11. Breeding dates for female black bears in North America from observations of vulval swelling.

Area	Dates	Reference
Pennsylvania	18 May - 12 September	Alt 1989
Tennessee	5 June - 12 September	Eiler 1981
Arizona	28 May - 22 July	LeCount 1990
Montana	25 May - 10 August	Jonkel and Cowan 1971
Minnesota	30 March - 5 August	Rogers 1987
N. Carolina	2 June - 4 August	This study

foods in this study area, no shortages are likely to occur and females should remain in good condition. The end result should be a stable breeding season and high reproductive success.

Weight of female bears plays an important role in onset of puberty and reproductive output (Alt 1989). Black bears in colder climates typically have a slower growth rate than bears in warmer climates where the growing season is longer and food availability is greater (Rogers 1976, Rogers 1987). This slower growth rate of females may delay primiparity in cold climates. Rogers (1987) and Jonkel and Cowan (1971) reported that females did not have first successful litters until 6.0 years old. In Pennsylvania, where food is plentiful, bears generally had their first litters at 3-4 years of age (Alt 1989). In Florida, 75% of 2.5 year olds were found to have corpora lutea, however only 20% of 3.5 year olds had placental scars (Wooding, unpublished data). Results of this study showed that age of primiparity was similar to that of Florida and Pennsylvania and that first time mothers were unlikely to be successful with first litters. According to the presence of corpora lutea, 70% of 2.5 year old bears in this study bred. However, only 25% of 3.5 year old bears had placental scars, indicating that younger females may

not be successful in producing first litters. Elowe and Dodge (1989) reported that 4 of 7 first-time mothers and 0 of 15 females which had raised a previous litter, lost entire litters. Of 3 lost litters in Shenandoah National Park, 2 were to first-time mothers (Carney 1985). Eiler (1981) found that only 5% of 3 year old females in the Great Smoky Mountains had cubs, indicating reproductive maturity at this age to be uncommon.

Alt (1989) reported that the mean age of first successful breeding in Pennsylvania was 2.7 years and attributed this to the high growth rates of bears in that area. The majority of bears in the present study were 3-4 years of age at the time of their first successful litter. As in Pennsylvania, this early reproductive success can be attributed to high nutritional status and growth rates.

Female body weight in late fall is a factor in successful reproduction. In Minnesota, Rogers (1976) found that females that did not gain sufficient weight prior to denning usually failed to produce cubs. Adult females in the Great Smoky Mountains failed to produce cubs after fall mast failures (Eiler et al 1981, Pozzanghera 1990). In Massachusetts, females subsisting on poor quality fall diets failed to produce cubs (Elowe and Dodge 1989). The availability of crop foods on the Neuse-Pamlico peninsula

gives females a reliable source of high energy foods during the fall. Skipping years of cub production due to poor nutrition probably does not occur.

Litter Size

Litters of younger females tend to be smaller than those of older females (Kordek and Lindsey 1980, Elowe 1987, Alt 1989). Results from this study followed this pattern. Bears 6.75 years or older (n=17) averaged 2.7 corpora lutea and 2.6 placental scars. Younger females (n=17) averaged 2.0 corpora lutea and 2.0 placental scars. Only 2 of 17 litters from females 5.75 years old or younger had 3 cubs, whereas 11 of 16 litters 6.75 years old or older had 3 cubs. Although no litters of 4 cubs were found in this study, reports from hunters indicate that it is not uncommon. The average litter sizes found in this study were smaller than was expected considering the potential influence of agricultural foods. Females in areas with abundant foods tend to be heavier and produce larger litters (Rogers 1987, Eiler et al. 1989, Alt 1989). The average litter sizes on the NPP approximated other areas in the Southeast, but was smaller than many litter sizes from western and northern locales (Table 12). If nutritional

Table 12. Litter sizes of black bears in the United States based on corpora lutea and placental scar counts.

Area	Number	Average Litter Size	Reference
Coastal N.C.	51	2.1	Warburton 1993
Western N.C.	49	2.4	Warburton 1993
Neuse-Pamlico	37	2.3	This study
West Virgina	33	2.4	Reiffenberger 1993
Vermont	58	2.2	Willey 1978
Michigan	24	2.7	Erickson et al. 1964
Pennsylvania	23	2.8	Kordek & Lindzey 1980
Maine	51	2.3	Hugie 1982
Florida	81	2.6	Wooding (unpublished data)

status is the main determinant in litter size other than age, then larger average litter sizes should have been found in this study. Factors other than age and nutrition must also play a part in determining litter sizes but are unknown.

Reproductive Histories

Although cemental layering was not as pronounced as in teeth from Minnesota (Coy and Garshelis 1992), paired annuli were readable in most samples and gave a good indication of age of first litter and years of cub production.

The initial ages of reproduction found with this method reflected the results obtained through corpora lutea/placental scar analysis and female/cub observations in that most female bears of the NPP have initial litters at ages 3 or 4.

Alternate year cub production is the norm for bears in areas of good nutrition (Rogers 1976). The high nutritional level provided by readily available natural and crop foods should preclude any skipping of potential reproductive years.

The most important information available from the analysis of annuli was the information on previous litters.

Analysis of reproductive tracts containing corpora lutea and placental scars does not give an accurate account of actual cub production because it includes cubs which were never born and ones that died shortly after birth (Coy and Garshelis 1992). Annuli pairing only occurs if a litter survives for several months. Reproductive tracts also only give indications of the previous and current year's births.

Two 14-year old harvested females each produced 6 litters during their lifetimes and were both again pregnant. Without tooth analysis we would only have known the current reproductive history of these bears. The combination of tooth and reproductive tract examination for female bears should enhance the reproductive information available about a population.

Birthing Dates

In Arkansas, Smith (1985) reported birth dates between mid-January and late February. Carney (1985) reported that dates of litter births ranged from 21 January to 17 February in Virginia. Alt (1989) reported litter birthing dates in Pennsylvania to fall between 16 December - 27 January. No conclusions can be drawn from the single litter encountered on the NPP other than birth dates are

consistent with those reported from other studies in the Southeast.

CHAPTER V

FOOD HABITS

RESULTS

Scat and Stomach Sample Analyses

A total of 364 scats was collected during the project, 296 from the Gum Swamp and 68 from the Big Pocosin. The difference in scat numbers between the two areas is a reflection of the heavier road use by bears in the Gum Swamp. Big Pocosin bears rarely used roads and, therefore, very few scats were deposited there. Road traffic was much greater in the Big Pocosin during all seasons because of forest management activities and high hunting pressure. Due to the small number of scats from the Big Pocosin, all food item analyses was pooled.

Seasonal shifts in food items were evident (Figs. 13, 14, 15, Table 13). The spring season (1 April - 30 June) coincided with the growth and development of the winter wheat (*Triticum aestivum*) crop. Winter wheat dominated the diet of bears in the early spring. As bears exited denning areas in early March, winter wheat was 8"-12" tall. Bears grazed this young wheat extensively. As the wheat stalks matured, bears switched to eating the young seed heads. They continued using wheat as their primary food until the

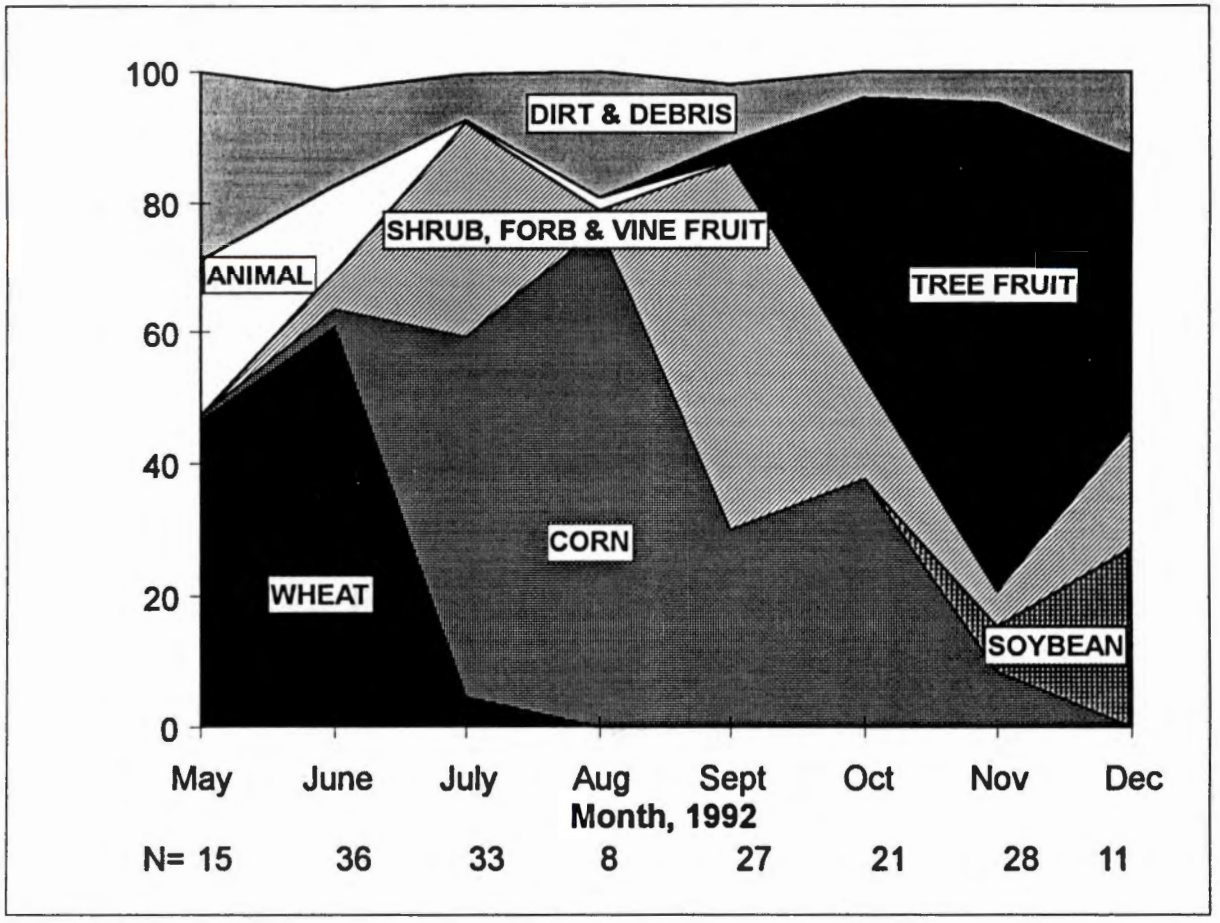


Figure 13. Seasonal variation in major components of black bear diet on the Neuse-Pamlico peninsula, 1992.

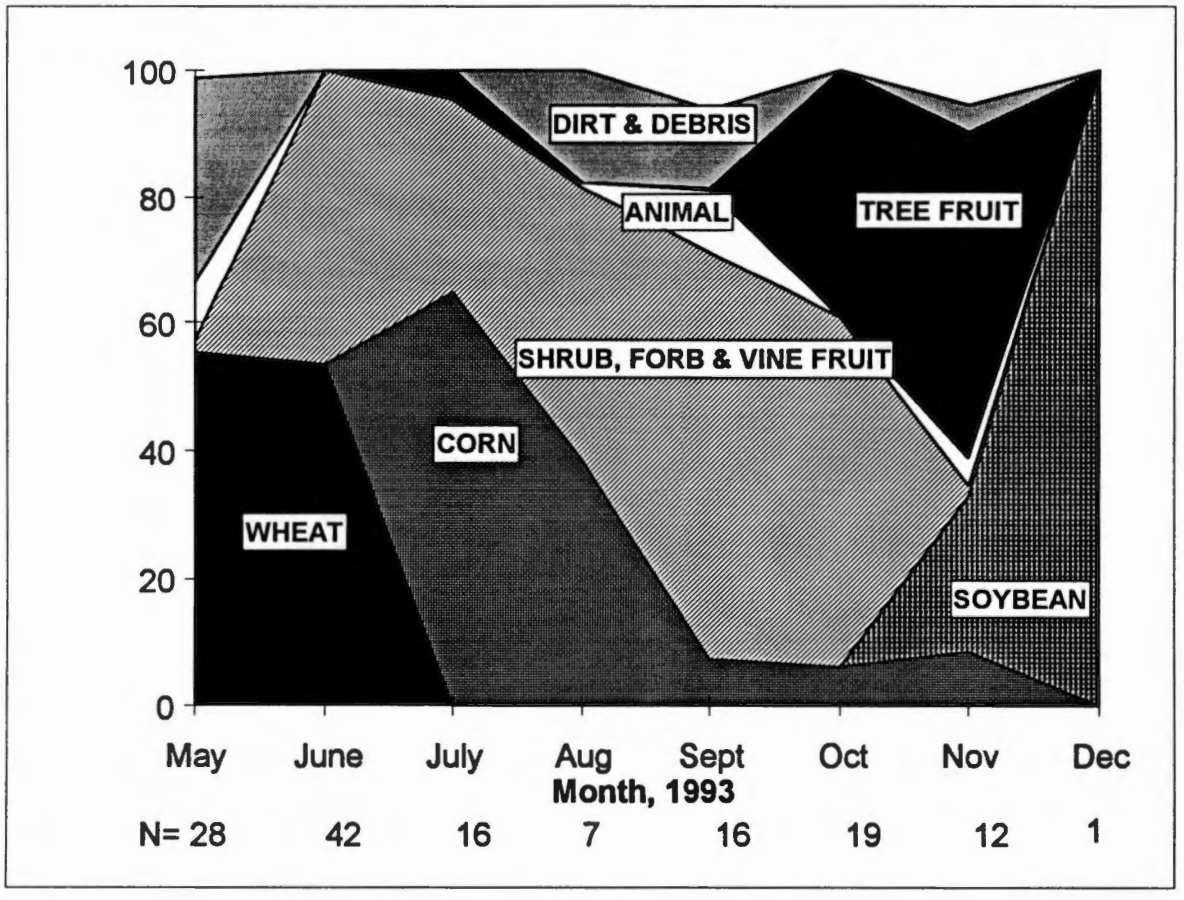


Figure 14. Seasonal variation in major components of black bear diet on the Neuse-Pamlico peninsula, 1993.

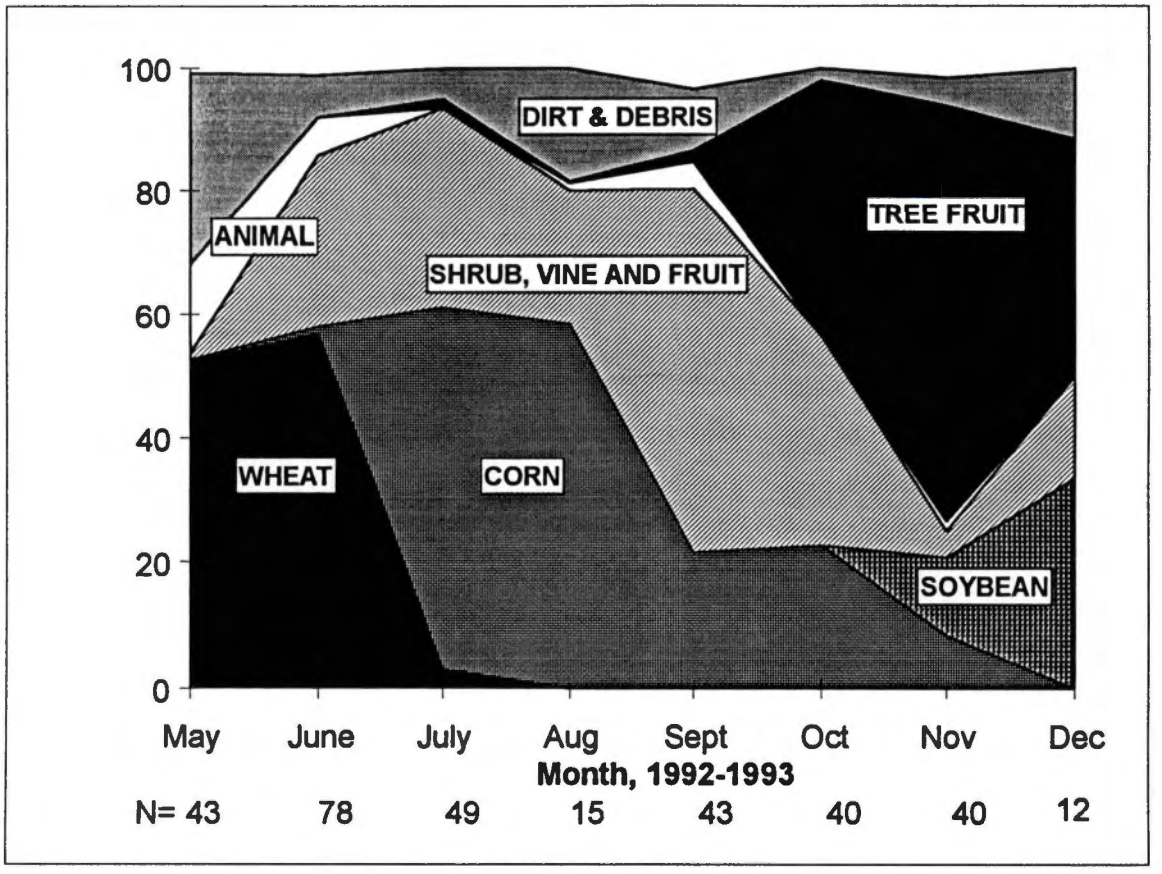


Figure 15. Seasonal variation in major components of black bear diet on the Neuse-Pamlico peninsula, 1992-1993.

Table 13. Major foods of black bears on the Neuse-Pamlico peninsula as revealed by analysis of 364 scats collected during 1992-1994.

Food Items	Aggregate Percentage Volumes Spring	Summer	Fall	Winter
	(n=143)	(n=111)	(n=93)	(n=17)
Crop Foods				
Triticum aestivum	59.59	1.45		78.57
Zea Mays	0.82	43.32	13.51	0.71
Glycine Max			9.66	
Tree Fruits				
Nyssa sylvatica		0.60	50.04	
Symplocus tinctoria		0.18	2.20	
Aralia spinosa		0.92	3.65	
Persea borbonia			T	T
Prunus serotina		0.71		
Forb fruits				
Phytolacca americana		19.22	7.17	
Rubus sp.	15.47	12.67		
Sambucus canadensis		T		
Vine fruits				
Vitis rotundifolia		0.06	2.50	
Smilax sp.	0.37	0.93	3.75	7.14
Parthenocissus quinquefolia			0.93	
Shrub fruits				
Ilex coriacea		6.62	1.67	
Ilex glabra				T
Animal matter				
Odocoileus virginianus	T	0.46	0.71	
Other mammals	1.56	0.18		
Coleoptera	0.06	0.07	T	0.08
Formicidae	6.70	0.20		
Maggots		0.83		
Vegetation and Debris				
Unknown vegetation	0.95	1.43	0.72	6.36
Dirt and Debris	14.45	9.02	4.35	7.14

stripped of bark and cambium by bears were found on both study areas and included atlantic white cedar (*Chamaecyparis thyoides*), sweet gum(*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), and yellow poplar (*Liriodendron tulipifera*). Sapwood feeding activity could not be determined from scat samples but was obvious from examination of affected trees. Tree stripping occurred in late spring and early summer.

The ripening of blackberries (*Rubus* spp.) in early to mid-June coincided with the winter wheat harvest and bears readily switched to this abundant food source. Blackberries were numerous on roadsides and in cutovers and were heavily utilized. Blackberries were especially numerous in 1993, thus scat samples showed a large increase. Black cherry (*Prunus serotina*) was utilized as a short-lived food source in late spring-early summer but was not very abundant in either study area. The few trees that were large enough to produce fruit were usually heavily damaged by feeding bears.

Summer diets (1 July - 30 September) were dominated by field corn (*Zea mays*) and soft mast. Blackberries continued to produce until mid-July but were abandoned as soon as field corn entered the milk stage about the second week in July. Corn dominated the summer diet of bears until mid-August although feeding was heaviest during the milk stage. As corn dried in the late summer heat, the

bears switched to the ripening fruits of elderberry (*Sambucus canadensis*), pokeweed (*Phytolacca americana*), sweet gallberry (*Ilex coriacea*), horse sugar (*Symplocus tinctoria*), and devil's walking stick (*Aralia spinosa*). These fruits were utilized extensively until mid-fall. A summer drought during 1993 had a severe effect on the area corn crop. Not only were there fewer ears on the stalks but the corn dried much quicker. Bears switched to pokeweed and the other summer berries much earlier. The harvesting of the corn crop in late August and early September did not deter the bears from utilizing this food source. As soft mast waned in October, bears reverted back to the harvested fields and fed on waste corn.

During fall (1 October - 31 December) bears continued to feed in corn fields that were not planted to winter wheat. Observations by hunters and substantiation by stomach sample analysis revealed that bears would "root" through the plowed fields to obtain a few kernels of corn. Several stomachs from harvested bears contained a mixture of soil and corn kernels. Black gum (*Nyssa sylvativa*) fruits were the most important natural food during this time period, especially in 1992. The 1993 black gum crop was much less than in 1992 although it was still a substantial food source. Swamp chestnut oaks (*Quercus michauxii*) were common in some parts of the study areas and

are a major food source when acorns are present; however, acorns were almost non-existent during both years. No scats were found to contain acorns; however, 5 stomachs from hunter-harvested bears contained water oak (*Quercus nigra*) acorns. Muscadine grapes (*Vitis rotundifolia*) were also an erratic food source, being rare in 1992 but very abundant in 1993. Utilization of grapes corresponded with their abundance. In 1992, grapes were found in very few scats and stomachs, whereas in 1993 grapes were a major component of the fall diet. Devil's walking stick fruits were also extremely abundant in 1993 and were utilized heavily. During late fall, as black gum fruit waned, bears began feeding heavily on soybeans (*Glycine max*). Soybeans are the primary fall agricultural crop in the coastal plain of North Carolina and are usually harvested in late November and early December (ASCS pers. commun.) Soybeans were dry in the fields by late October and provided an easily obtainable, high protein food source. Bears utilized this widespread food source even after harvest. White-tailed deer entrails left from field-dressed hunter kills were also utilized. Few scats were found with deer remains although 16% of stomachs collected at the hunter check stations contained deer entrails.

As denning time approached in December, bears consumed a wide variety of shrub and vine fruits including red bay

(*Persea borbonia*), privet (*Ligustrum sinense*), greenbriar (*Smilax* sp.) and yaupon (*Ilex vomitoria*). Rough vegetation such as switchcane (*Arundinaria gigantea*) and pine straw was seen in a few scats in late December and may have been eaten to make fecal plugs for hibernation.

Very few scats were collected during late winter because most bears denned or decreased their movements. Greenbriar leaves and berries and bitter gallberry (*Ilex glabra*) fruits were found in scats during this time period.

Eighty-one stomachs were collected from hunter-harvested bears on the NPP. Five of these were empty, leaving 76 stomachs for food analysis. Stomach food item analysis was separated by year (Table 14), sex and age (Fig. 16). Differences in food habits were noted between adult males and other segments of the population. Corn and soybeans comprised nearly the entire diet of adult males (87%) and the percentage of crop foods eaten was significantly different from those of adult females (X^2=6.37, p=0.012) or sub-adults. Sub-adults of both sexes showed similar food habits with crops being much less utilized than either adult segment. Although corn was the major food eaten, black gum and other natural foods were important to sub-adults.

Table 14. Major fall foods of black bears on the Neuse-Pamlico peninsula as revealed by analysis of 76 stomachs collected during 1992-1993.

Food Item	Aggregate Volume 1992	Aggregate Volume 1993	Percentage Frequency 1992	Percentage Frequency 1993
Crop Foods				
Zea Mays	38.7	43.5	58.6	57.4
Glycine Max	12.4	16.3	24.1	27.7
Sorghum vulgare	1.8	2.1	3.4	2.1
Tree Fruits				
Nyssa sylvatica	20.9	5.1	31.0	19.1
Symplocus tinctoria	2.7	2.7	6.9	12.8
Quercus nigra	10.4		17.2	
Aralia spinosa	2.4	6.0	6.9	10.6
Persea borbonia	0.6	0.1	6.9	4.3
Albizia julibrissin		T		2.1
Forb fruits				
Phytolacca americana		0.2		2.1
Vine fruits				
Vitis rotundifolia		1.2		2.1
Smilax sp.		0.5		8.5
Parthenocissus quinquefolia		T		2.1
Shrub fruits				
Ilex coriacea	2.2	T	6.9	4.3
Ilex vomitoria		T		2.1
Sorbus arbutifolia		0.2		2.1
Animal matter				
Odocoileus virginianus	6.9	8.8	13.8	17.0
Ondontotaenius disjunctus		T		8.5
Vegetation and Debris				
Arundinaria gigantea	0.9	2.1	3.4	2.1
Dirt and Debris	1.9	7.3	10.3	19.1

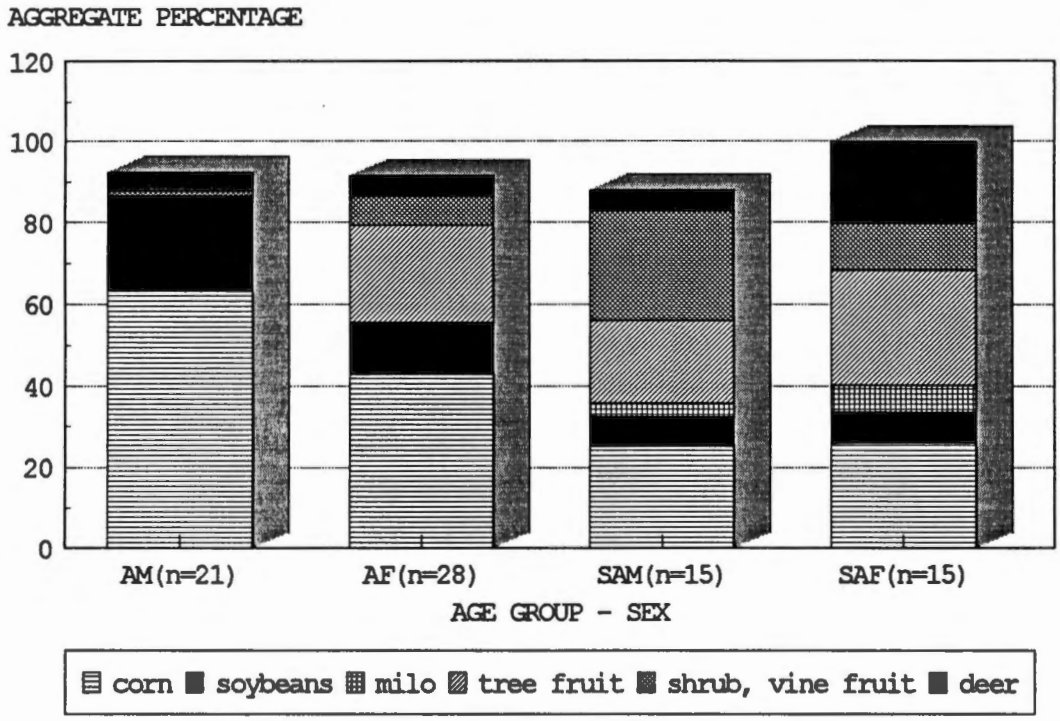


Figure 16. Fall diet variation among black bear sex and age groups on the Neuse-Pamlico peninsula, 1992-1993.

FOOD HABITS

DISCUSSION

Scat and Stomach Sample Analyses

Although variable, the majority of the diet of black bears on the NPP was plant foods (86%). Other researchers in North America have found similar dietary patterns (Bennett et al. 1943, Jonkel and Cowan 1971, Juniper 1978, Beeman and Pelton 1980, Hugie 1982, Maehr and Brady 1984, Clapp 1990, Hellgren 1988). The major distinction in this study was the reliance on agricultural crops during all seasons. Smith (1985) reported on the use of a wheat field in Arkansas by a single male bear; however, the use of winter wheat as a major food source is unique in the literature. Hellgren (1988) also reported on the minor use of wheat in Great Dismal Swamp. Mattson (1990) reported that bear use of wheat was rare even though it was the most widespread of grain crops in the northern hemisphere. He attributed this to the fact that wheat was usually not grown in areas adjacent to bear cover and not to any inherent nutritional deficiency in the wheat. The heavy use of wheat in this study supports that conclusion. Major food sources of other bear populations in early spring were herbaceous plant materials and usually corresponded to

local abundance of particular plant species (Hatler 1972, Landers et al. 1979, Smith 1985, Maehr 1984, Maehr and Brady 1984, Irwin and Hammond 1985, Hellgren and Vaughan 1988). Wheat is the major winter cover crop in northeastern and central eastern North Carolina and is grown adjacent to areas of high bear densities.

Spring has been categorized as a "negative foraging season" for bears because they tend to lose weight during this period (Poelker and Hartwell 1973, Beeman and Pelton 1977, Eagle and Pelton 1983, Hellgren 1988). The bear's stomach and digestive tract are inefficient at digesting and extracting nutrients from plant cellulose (Rogers 1976) and, thus, may not be able to process enough leaves and stems to meet energy requirements (Landers et al. 1979, Hellgren 1988). The extensive use of winter wheat is probably an adaptation of the bear population to an easily obtainable and abundant food source which approximates the vegetative type of foods they ate historically. However, the maturation of winter wheat seed heads occurs about a month prior to ripening of early summer natural fruits. Consumption of this highly nutritious food should shorten the "negative foraging period" for NPP bears. The good condition of early summer trapped bears supports this conclusion.

The switch from herbaceous material to berries corresponded with results from other southeastern studies where fruits became the dominant component of the early summer diet. The major difference in this study was the minor use of blueberries (*Vaccinium* sp.) and huckleberries (*Gaylussacia* sp.). Hardy (1974) in Dare County, North Carolina found blueberries to be the major summer food. Landers et al. (1979) found blueberries and huckleberries to be major spring/summer foods in southeastern North Carolina with blackberries being a minor food. Hellgren (1988) found blackberries and blueberries to be equally important late spring-early summer foods in Great Dismal Swamp. Although black cherry was a small component of the diet of Neuse-Pamlico bears, it was a major food source in several other southeastern bear studies (Beeman and Pelton 1977, Eagle and Pelton 1983, Garner 1986).

The heavy use of corn from agricultural fields has been seen in most areas of the eastern United States and usually leads to conflicts with farmers (Warburton and Maddrey 1994). Corn was found to be a major dietary component of summer diets by Landers et al. (1979) and Hellgren and Vaughan (1988). Hamilton (1978) noted a high reliance on corn in Bladen County, North Carolina but a large percentage of it came from bait piles maintained by

hunters. Hellgren (1988) also noted use of corn fields by bears in the Great Dismal Swamp; however, the time frame of heavy use was restricted to late summer.

Plants associated with disturbed areas made up the bulk of the remaining diet. Blackberries, elderberries, devil's walking stick, black cherry, pokeweed and horse sugar are all associated with roadsides and cutovers. Horse sugar has not been reported previously in southeastern coastal plain bear studies, although it was noted to be a minor food item in the Southern Appalachians (Carlock et al. 1983). Hellgren and Vaughan (1988) noted the use of devil's walking stick on roadsides in Great Dismal Swamp. Neither Hardy (1974) nor Hamilton (1978), reported the utilization of this plant in coastal North Carolina.

Black gum and sweet gallberry were the only major foods associated with undisturbed areas. Black gum is probably the most important natural fall food in the southeastern coastal plain due to its consistency in producing fruit year after year. Hardy (1974), Landers et al. (1979), Hellgren and Vaughan (1988), Wooding and Hardisky (1992) and Seibert (1993) all indicated that black gum was a highly dependable, preferred and utilized fall

food. Black gum consistently produces fruit, unlike oaks which are prone to have years of poor acorn production. Bears in this study relied on black gum to a great extent during fall, feeding on the dropped fruits and also climbing trees to break out branches containing fruits. Oak mast is the predominant fall food of many bear populations in the eastern United States (Cottam et al. 1939, Bennett et al. 1943, Harlowe 1961, Beeman and Pelton 1977, Carlock et al. 1983, Clark et al. 1987, Kasbohm 1994).

Soybean use by bears has not been reported previously in the literature and is a relatively new bear food in eastern North Carolina. Farmers have only noted bear use of soybean fields for a few years. Soybeans may become the major fall food source as stands of black gum continue to be harvested and replaced with loblolly pine plantations. Soybeans were used to a greater extent in 1993 than 1992 when the black gum fruits were less abundant. Soybean use was probably underestimated through scat analysis. Much less time was spent along field edges in fall, especially during deer hunting season, and therefore few scats were collected along soybean fields. Hunters reported substantial use of soybeans fields by bears from late September until harvest.

Bear utilization of hunter-killed deer and deer entrails have been noted from several areas (Landers et al. 1979, Smith 1985, Hellgren and Vaughan 1988). The large number of stomach samples containing deer remains as opposed to scats led us to believe that animal remains were probably under-represented in scats due to their high digestibility. Hewitt (1989) made correction factors for brown bear foods found in scats and surmised that animal matter found in scats represented a small percentage of the actual amount eaten whereas vegetation remains were a much larger percentage. Schwartz and Franzmann (1990) found that moose calf remains were greatly underestimated in scat samples and only through telemetry were they able to determine that bears were a major predator of moose calves. Andelt and Andelt (1984) postulated that coyotes would excrete many more scats when eating low digestibility vegetation as opposed to highly digestible animal diets. Johnson and Hansen (1979) found that coyotes would produce 4 times as many scats when eating grasshoppers as opposed to mammals. This reasoning probably explains the small numbers of scats in this study that contained animal remains, especially during fall when stomach samples contained a large percentage of deer remains.

The use of insects by bears in this study was consistent with findings from other locales. Insects were consistently eaten during all seasons although only ants (Formicidae) contributed significantly to the diet. Bess bugs (*Odontotaenius disjunctus*) were found in a number of scats throughout the year and appeared to be a preferred food if found. Maehr and Brady (1982) noted a similar attraction for bess bugs and yellow jackets in Florida. No remains of bees or wasps were found in any scats in this study. Hair from grey fox (*Urocyon cinereoargenteus*) and eastern cottontail rabbit (*Sylvilagus floridanus*) were also found in scats. It could not be determined if these were from carrion or live-caught. The ingestion of animal and insect remains may be important sources of protein for bears (Beeman and Pelton 1977, Eagle and Pelton 1983) because protein in fruits is generally located in the seeds (Wanio and Forbes 1941). The lack of seed digestion by bears makes seed protein unavailable.

Large amounts of dirt, bark and debris were also noted in scats which contained ants or beetles and were most likely associated with extraction of the insects from their nests (Hardy 1974, Landers et al. 1979). Another explanation for bark and debris fragments in scats could be bear feeding on sapwood. Sapwood feeding by bears is a

relatively unknown phenomenon in the Southeast. Hellgren and Vaughan (1988) reported the presence of atlantic white cedar which was stripped of bark from the base up to 2 m. They postulated that bears were feeding on sapwood as reported from several northern and western locales (Lutz 1951, Glover 1955, Zeedyk 1957, Poelker and Hartwell 1973, LeCount 1986). Hamilton (1978) listed "inner bark of trees" as a food item in Bladen County, North Carolina. Tree damage on the study areas was not extensive and was usually limited to scattered trees. Atlantic white cedar was an exception in that almost every tree found had been partially or completely stripped.

Because both study areas are highly roaded and in some stage of forest management or conversion, the bear population has been forced to rely on foods produced in these disturbed areas. Campo and Hurst (1980) reported that soft mast production in loblolly pine plantations was greatest at age 5 and declined thereafter until the first commercial thinning. Stransky and Roese (1984) also found that soft mast production quickly declined in young pine plantations. Although no vegetative analysis was done of the study areas, cursory observations revealed plentiful natural and artificial foods throughout the year. Although generally not considered bear habitat, young pine

plantations contained good supplies of soft mast during spring and summer.

Many bear populations are subjected to periods of scarce food availability, especially oak mast failures. Oak mast is the primary fall food source for bears in the southern Appalachians (Beeman and Pelton 1977) and is the primary source of fat deposition in the fall (Beeman 1971). Periodic mast failures can decrease cub and yearling survival through starvation and impair reproductive success of pregnant sows due to inadequate fall weight gain (Rogers 1976, Rogers 1987, Eiler 1981).

Stomach sample analysis also revealed a strong reliance on agricultural crops during both 1992 and 1993. Corn was the major dietary component for both years. Black gum was the major natural food both years but the smaller berry crop in 1993 was evident in the 1993 stomach samples. Soybeans were more heavily utilized in 1993 possibly as a result of the smaller black gum crop or due to late harvesting which made the beans available for a longer period.

Although crop foods were the major foods eaten, they were not used equally between adult males and other sex and age groups. Clapp (1990) reported on diet differences between sexes in Arkansas and concluded that diets did not

differ significantly between sexes. His samples were taken from scats picked up at trapping sites from known sex bears. Age and sex difference in diets have also been reported in white-tailed deer (Beier 1987, McCullough et al. 1989) and bighorn sheep (Shank 1982). Fall diets were different between sex and age groups in this study. The unequal utilization of crop food resources in this study probably reflects the temporal exclusion of sub-adults from agricultural areas in the fall by adult animals, especially males. Pelton (1982) and Rogers (1987) both alluded to temporal spacing and a dominance hierarchy at certain times of the year. Garshelis and Pelton (1981) noted that adult males occupied the best fall feeding sites in the Great Smoky Mountains. Adult females, especially those fattening in preparation of birthing cubs, would need large quantities of highly nutritious foods and would be more likely to defend feeding areas. No evidence was seen of disproportionate use of agricultural crops by certain age classes of bears during spring and summer before crops were harvested. Trapping activities were conducted adjacent to agricultural fields in most instances and sex and age ratios were not skewed towards adult animals, especially adult males. The plenitude of standing crop food available in the summer compared to the substantially smaller amounts

of waste grain after harvest would make adult animals more likely to defend feeding areas from other bears in the fall when there is a greater need for high energy food to fatten up for denning and when these foods are in shorter supply.

Stomach samples and scat samples showed similar results for the fall period in that crop foods and black gum were very important. Although this study only covered a 2-year period, agricultural crops in the wheat-corn-soybean rotation are standard for coastal North Carolina and provide a year round food source and therefore should preclude any concerns with natural mast failures. The only problem with relying on unnatural food sources is the possibility of changes in agricultural practices in the future. A switch to agricultural crops which are not bear foods or a large-scale change in land use could be detrimental to bear populations in coastal North Carolina. The loss of remaining black gum stands would also be detrimental because bears rely on this stable fall food source, especially when crop foods are in short supply. If the remaining black gum stands are harvested and converted to pines and agricultural fields are taken out of production, bear populations would likely decrease dramatically due to a lack of fall foods. Bears in this study essentially used agricultural fields from den

emergence to early December. The only break was a 2 to 3 week period between wheat harvest in late June and corn ripening in early July. This steady diet of heavily fertilized, high carbohydrate foods may explain the heavy weights and healthy condition of coastal North Carolina black bears. However, the reliance on artificial food sources to support the currently healthy population may prove disastrous in the future unless key remaining natural habitats are protected.

CHAPTER VI

CROP DEPREDATION

RESULTS

Aerial Corn Damage Surveys

Nine survey flights were conducted to map corn damage in 1802 ha of corn fields in the Gum Swamp study area. The initial flight took place on 15 July 1993. Corn damage was seen from the ground for the first time the previous week as were scats consisting of fresh corn fragments. Surveys were flown once per week thereafter until the corn was harvested, except for the first week in September when military flight scheduling in the restricted zone did not allow other air flights. Corn acreage damage was highest on the second flight and declined gradually thereafter (Fig. 17). The last flight took place 15 September 1993. Total corn stalk damage amounted to 10.4 ha., representing 0.6% of the total corn crop acreage.

Farmer Mail Survey

Neuse-Pamlico farm operators returned 113 of 256 (44%) surveys. First mailings produced 91 (81%) of the returns. Second mailings produced the remaining 22 returns. The third mailing produced no returns. Soybeans (11,945 ha)

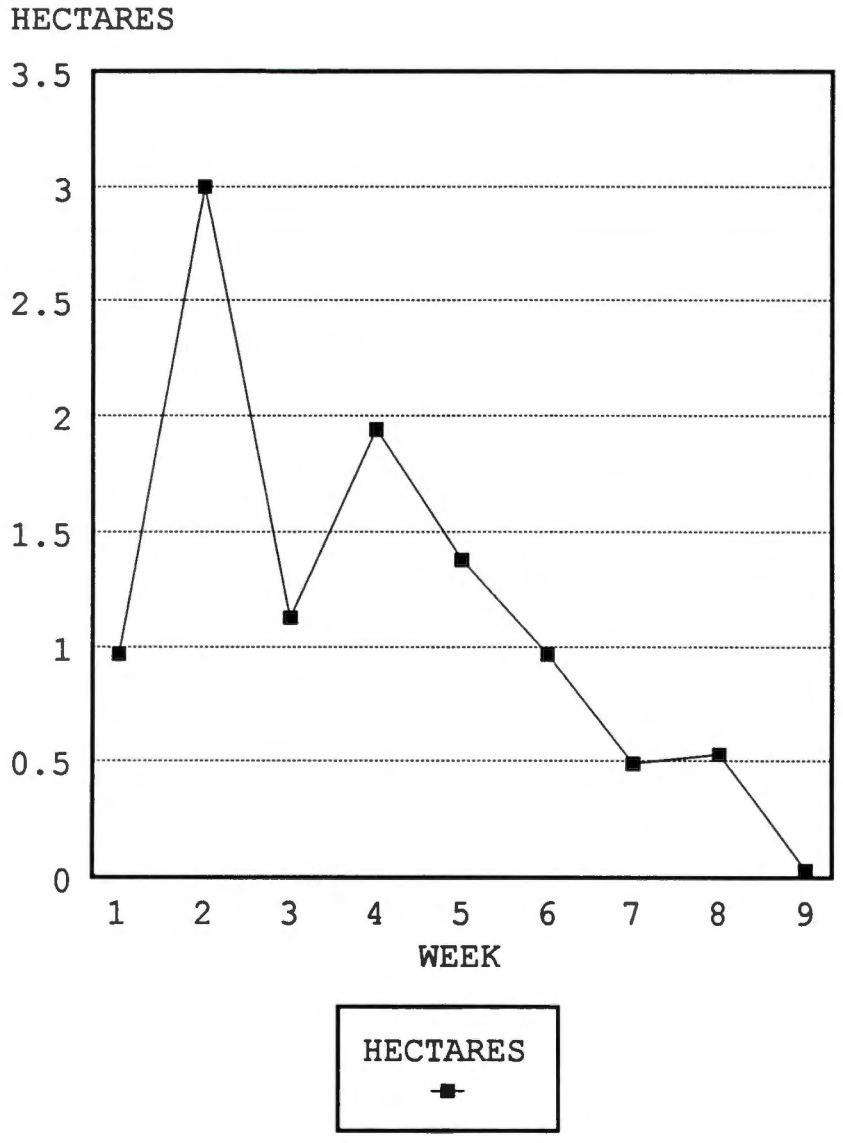


Figure 17. Weekly corn damage caused by black bears on the Gum Swamp study area in 1993.

were the major crop planted by respondents, followed by corn (7,500 ha) and winter wheat (5,260 ha).

Sixty-seven percent of farm operators had seen a bear on their farm in 1993. Bears were most often seen in summer (45.9%), followed by spring (39.5%) and fall (36.7%). Only 22% of farm operators reported seeing bears in winter. When asked how they felt about having bears on their farms, 32.4% responded that they enjoyed seeing them. An additional 45.4% said they enjoyed seeing them but worried about crop damage. Only 12% considered bears to be a nuisance. Attitudes were different between farmers who had sustained damage and those who had not. Only 6 of 46 (13%) farmers reporting bear damage said they enjoyed seeing bears on their farm compared to 29 of 63 (46.8%) of those farmers with no damage (X^2=18.25, 1 df, p=0.00001). Larger percentages also worried about crop damage (60.9% to 33.9%)(X^2=7.13, 1df, p=0.0008) and considered bears nuisances (21.7% to 4.8%)(X^2=9.54, 1df, p=0.002). Eighty-eight percent of farm operators felt that bear activity on their farm was stable (32%) or had increased (56%) in the last five years. Farmers with damage felt more strongly that bears had increased (82.6%) than those with no damage (36.5%)(X^2=17.08, 1df, p=0.00001). Even with the perceived increases, 37% felt that the bear population was about right in the area of their farm. Twenty-four percent felt

that the population was too high and 18% felt it was too low. Twenty-one percent had no opinion. Farmers with damage were much more likely to think bear populations were too high near their farms (50%) than those with no damage (6.8%) (X^2=31.35, 1df, p=0.00001). Farms with no damage were more likely to think populations were too low (27.1%) compared to only 7.1% of farmers with damage (X^2=10.6, 1df, p=0.011). Thirty-one percent of farmers with damage felt the population levels were about right compared to 44.1% of farmers without damage. Interestingly, 21.4% of farmers with damage had no opinion of local bear population levels.

Nearly half (49.5%) of the respondents reported they had bear damage to crops in 1993. Deer were listed as the major cause of crop depredation by 85.5% of respondents. Bear were listed by 15.6%. Raccoons were listed by 3.6% and birds by 5.5%. Beavers were the only other animal implicated. A few landowners listed more than one animal as being equally damaging to crops. Nearly half of the respondents (50.5%) reported that their crops were damaged by bears in 1993.

Corn was the major crop damaged in terms of number of farms, acreage, and dollar loss (Table 15). Thirty-five farmers reported that 92.5 ha of corn crops had been damaged by bears in 1993 with a loss of $27,825. Wheat was

Table 15. 1993 black bear crop damage as reported by farm operators on the Neuse-Pamlico peninsula.

Crop	Total Hectares	Damage Total (ha)	%Crop Loss	#Farms w/ Damage	Total $Loss	$Loss/ Hectare
Wheat	5,260	60.9	1.16%	23	$14,250	$234.18
Corn	7,500	92.5	1.23%	35	$27,825	$300.85
Beans	11,945	32.8	0.26%	11	$8,075	$250.88
Total	24,705	186.2	0.75%	69	$50,150	$269.33

second with 23 farms reporting damage to 60.9 ha and a loss of $14,250. Damage to soybeans was reported by 11 farms totaling 32.8 ha and a loss of $8,075. Bear damage to crops was considered intolerable by only 10.3% of those farmers who had received damage. Damage was considered moderate by 41.4% and light by 39.7%. Forty-three respondents (69.7%) felt that crop damage had increased on their farm within the past 5 years. Asked about causes of increased bear damage, "more bears" (40%) was the number one answer, followed by "bears have adapted to eating crop foods" (28.8%), "loss of mast producing trees" (16.3%), and "no natural foods available" (13.8%).

Few farmers (18.1%) try to prevent damage to crops. Of those that do, shooting is the method of choice (42.9%) with scare devices (23.8%) the only other method tried by more than 2 respondents. Fencing, chemicals and lure crops were also listed. Results were about equal when asked about deterrent effectiveness with 52.4% thinking they had helped reduce damage. Farmers believed longer hunting seasons (33.2%) and compensation for crop losses (26.8%) were the best solutions to crop damage. Relocation (13%) and special permit season (4.9%) received lesser consideration.

The final 5 questions on the survey were farmer personal characteristics. The Neuse-Pamlico farmer is most

likely to be a 46+ years old (66%) white (100%) male (100%) with a high school education (50.5%), who receives 76-100% of his income from farming (52.4%). No significant differences ($P>0.05$) were noted between responses from different age, education or income groups.

DISCUSSION

Aerial Corn Damage Survey

Animal damage to agricultural crops is a major concern to agricultural and wildlife agencies in the United States (Conover and Decker 1991). Techniques to survey crop damage are varied but usually include exclosure plots (Torbit et al. 1993, Vecellio et al. 1994), visual observations (Lyon and Scanlon 1987), or landowner surveys (Gabrey et al. 1993). Damage done to crops by bears has been examined in several locales including Virginia (Davenport 1955, Vaughan et al. 1989), Minnesota (Garshelis 1989), New Hampshire (Calvert et al. 1992), Wisconsin (Hyngstrom and Hauge 1989, Stowell and Willging 1992), Massachusetts (Robinson 1992) and Louisiana (Irvine et al. 1983). Row crops damaged include corn, wheat, oats, soybeans, watermelons, sugarcane, peanuts, and sorghum (Warburton and Maddrey 1994). A combination of aerial and mail surveys was used in this study to examine the extent and duration of crop damage, the feelings of the affected farmers towards the bear resource and to see if crop damage

and duration of crop damage, the feelings of the affected farmers towards the bear resource and to see if crop damage estimates of farm operators was comparable to actual damage.

Aerial photography has been used extensively in recent years to do wildlife and agricultural habitat work. Sidle and Ziewitz (1990) used aerial videography to map piping plover and least tern habitat in Nebraska. The expense of their equipment ($12,000+) made it cost prohibitive for a one season flight. The use of hand-held video equipment was more than adequate to survey corn damage in the Gum Swamp study area during the two-month season in which corn was being damaged. The only problems encountered were eye fatigue from filming, haze caused by high air temperatures and air turbulence.

Aerial videography of corn damage has been tried in Massachusetts (J. McDonald, Jr. Pers. Comm.), but their corn fields are generally small and scattered compared to the extensive contiguous fields of coastal North Carolina. Although wheat probably receives the most bear damage in coastal North Carolina, it is not as evident as damage done to corn, especially from the air. Corn damage is characterized by trampled stalks pulled into a central feeding area. The bear rakes in all the corn within reach and destroys much more than it eats. Single damaged areas may be up to a hectare in size. The trampled areas are

easily seen from the air and are easily distinguished from bare spots in the fields.

Bears will also strip ears from stalks and carry an "armfull" out of the field to eat in the woods. Davenport (1955) reported this type of damage in eastern Virginia. Ear stripping damage is impossible to see from the air and is hard to detect in the fields other than by finding the pile of cobs in the adjacent woods. Therefore, the actual damage seen from the air should be considered a minimum estimate.

Bears damaged corn randomly. Although the same trails were used to cross into the fields, bears usually did not enlarge existing damage "spots" but created new ones on each foray. Damaged fields could have dozens of damaged areas. Corn damage adjacent to the field entry point did not follow this pattern and was usually greatly enlarged prior to harvest.

Bears switched readily to corn fields which were just ripening. Fields which had substantial damage one week would have no new damage the next week due to bears switching to adjacent fields which had corn in the milk stage. Davenport (1955) reported that bears near the Great Dismal Swamp ate corn from the time it reached the milk stage until harvest time, although they preferred it in the roasting ear stage. According to the aerial survey, this

was not the case in the Gum Swamp as corn in the milk stage was preferred. In Wisconsin, Stowell and Willging (1992) reported corn was most vulnerable to bear damage while in the milk stage. Spencer (1955) also found corn to be damaged during the milk stage in Maine.

Although bear damage amounted to only 0.6% of the total corn acreage, it is not an insignificant loss in the eyes of the local farmers. Bear damage to corn is different from other types of crop damage in that it is very visible. The damage is also not randomly distributed throughout the field but is clumped along the edges, making the damage appear to be greater than it actually is.

Farmer Mail Survey

Returns from farm operators were lower than might be expected since this study was so well known in the region. The cause of this was the definition of farm operator used by the local ASCS offices. The number of farm operators was much larger than the actual number of farmers, which would tend to decrease the percentage of returns. Only 2 surveys were returned which stated they did not farm. Consultation with area farmers indicated that many names listed as farm operators did not farm but only picked up subsidy checks from the government.

Overall, bears were characterized as a welcome member of the local fauna. The great majority of farmers had seen bears on their farms and enjoyed seeing them, although they did worry about possible crop damage. Farmers who had sustained previous crop damage were more likely to be worried about crop damage, but still were unlikely to consider bears nuisances.

Most farmers thought bear populations had increased within the past five years which echoed sentiments of area biologists (Warburton et al. 1993). Most still did not believe that bears were reaching levels which were too high and 18% felt bear population were still too low. As would be expected, farmers who had crops damaged were more likely to feel bears were nuisances and that populations were too high. Clark et al. (1991) found that landowners in Arkansas who had experienced bear damage were also more likely to view bears negatively than those who had not.

Deer were implicated as the primary crop damage problem, being named by 85.5% of respondents. Conover and Decker (1991) found deer to be the number one wildlife agricultural problem in a nationwide survey. Bear were implicated as the major crop depredation problem by only 15.6% of the area farmers. This can be partially explained by the heavy losses farmers suffer from deer and also from the high regard many farmers hold for bears.

Corn was listed as the number one crop damaged by bears amounting to losses of over $27,000. Damage to corn by bears is highly visible and unmistakable (Davenport 1955) and this characteristic may have inflated its damage ranking. Winter wheat is eaten for a longer period of time than is corn and is a source of food in early spring when few natural foods are available. Damage to wheat is not very visible until the stalks are dry and easily broken. Deer also feed extensively in wheat and bed in the fields, crushing the stalks, thus making identification of the damaging species difficult. For these reasons, wheat damage caused by bears is probably underestimated. Bear damage to soybeans is also probably underestimated because it is a relatively new phenomenon and is also hard to distinguish from deer damage.

Farmers felt that increased population levels were the main reason for increased crop damage. Loss of or absence of natural foods was named by only 30% of the respondents indicating that they did not perceive habitat loss to be a major factor in crop depredation. In Minnesota, Garshelis (1989) and Rogers (1987) felt that natural food availability was directly related to numbers of nuisance complaints. Bears on the NPP include crops as part of their normal diet and therefore the number of nuisance

complaints is not related to local natural food abundance but to the tolerance level of the farmers.

Although damage to crops is widespread, few farmers attempted to prevent damage. Lack of reliable and inexpensive methods to prevent bears from entering large fields was the probable reasoning behind the lack of effort. North Carolina law allows farmer to shoot animals in the act of destroying personal property. Shooting was the number one method listed by farmers to alleviate damage problems, although farmers are usually reluctant to shoot bears for crop depredation problems. "Longer hunting seasons" was the top choice for alleviating crop problem with "compensation for losses" a close second. Longer hunting seasons is a much more viable option in North Carolina than crop compensation. Five states currently compensate landowners for bear damage and the costs can run upwards of $2 million per year (Warburton and Maddrey 1994). The extent of agricultural damage done in coastal North Carolina could easily cost several hundred thousand dollars per year. Since the state wildlife agency has jurisdiction over the bear resource, many farmers feel they should make reparations for losses sustained. Compensation, however, does not address or correct the problem of depredation (Robinson 1992). The lack of an adequate deterrent to bear damage to large scale

agricultural interests is a major problem. Some of the larger farms may have 50+ bears which are causing damage in a single season. Deterrents such as propane cannons, electric fences, shooting and chasing with bear dogs may work on smaller farms where a single bear is doing damage but none of these have been effective in the larger fields.

At the present, farmer attitudes concerning bears and crop damage in coastal North Carolina can be separated into two categories; those who have experienced damage and those who have not. The fact that bear populations were at such a low level a few years ago plays a large part in how farmers feel about bears and how much crop loss they are willing to withstand. If farmers continue to absorb crop losses over a number of years, attitudes will probably change. Results of this study show that bears eat crop foods regardless of natural food availability and that all segments of the bear population use crop fields. The bear population must be managed at a socially acceptable level wherein crop losses are kept to a tolerable level. Hunting seasons must allow an adequate harvest to maintain populations at this social tolerance level. Until an easy to use, inexpensive method can be found to prevent bears from damaging field crops, population management is the only tool available to wildlife managers.

CHAPTER VII

MORTALITY

RESULTS

Hunting

A total of 110 bears were known to have been harvested from the NPP in 1992 (n=55) and 1993 (n=55) (Table 16). In 1992, 38 bears were brought to the bear hunter check stations. Data from an additional 17 bears was collected via phone to hunters after checking North Carolina Wildlife Resources Commission kill cards. All known harvested bears in 1993 were brought to the check stations.

Four (7.2%) tagged bears were harvested in 1992 and 7 (12.7%) in 1993, including 4 radio-collared animals (Table 17). Bear #46, captured and tagged in 1993 in the Gum Swamp study area, was harvested approximately 53.3 km west of the study area. The marked sample was skewed toward males (n=7) and toward younger animals. Nine of the 11 marked bears harvested were 3.75 years old or younger.

Hunting methods on the peninsula were similar between years with still hunting accounting for the great majority (96%) of the harvest. Rifles were used to take 97.2% of the total harvest. In 1992, 25% of the harvest occurred on the opening day of the bear season and in 1993, 22%.

Table 16. Daily harvest totals for bears killed on the Neuse-Pamlico peninsula, 1992-1993.

1992 SEASON			
Date	Male	Female	Total
09 November	6	6	12
10 November	2	6	8
11 November	6	2	8
12 November	3	4	7
13 November	6	3	9
14 November	2	9	11
Totals	25	30	55

1993 SEASON			
Date	Male	Female	Total
08 November	4	10	14
09 November	4	5	9
10 November	5	4	9
11 November	2	5	7
12 November	3	2	5
13 November	6	5	11
Totals	24	31	55

Table 17. Marked bears harvested during the 1992 and 1993 bear hunting seasons on the Neuse-Pamlico peninsula.

BEAR#	AREA[a]	SEX	AGE	YEAR CAUGHT	YEAR HARVESTED	DISTANCE FROM CAPT. POINT (km)
09	BP	M	3.5	1992	1993	<1.0
11	BP	M	3.5	1992	1993	12.9
12	BP	M	2.5	1992	1992	1.5
14	BP	M	3.5	1992	1993	4.8
15	GS	M	1.5	1992	1992	1.5
24	GS	F	9.5	1992	1992	1.0
29	GS	F	3.5	1992	1993	1.5
33	BP	M	2.5	1992	1992	<1.0
46	GS	M	2.5	1993	1993	53.3
47	GS	F	3.5	1993	1993	1.5
51	GS	M	4.5	1993	1993	<1.0

[a]BP - Big Pocosin
GS Gum Swamp

Similar harvest levels were recorded for each remaining season day (Table 16). Harvests for each county of the NPP are given in Table 18.

Time of harvest was recorded for each bear brought to the check stations and from those hunters contacted by phone (Tables 19, 20). Still hunted males harvested before 1000 hours averaged 174.3 kg in weight and 6.7 years of age. Those harvested after 1400 averaged 74.2 kg and 2.6 years of age. Significant differences were noted between weight ($p=0.0001$) and age ($p=0.0006$). Still hunted females harvested before 1000 hours had an average weight of 86.9 kg and averaged 9.1 years of age. Those harvested after 1400 hours averaged 69.6 kg and 5.3 years of age. There were no significant differences noted between weight ($p=0.092$) and age ($p=0.135$). Only 5 still-hunted bears were harvested between 1000 and 1400 hours. Dog hunters accounted for only 4 bears (3M:1F) taken during 1992 and 1993. All bears taken by dog hunters were harvested before 1030 hours.

Successful Bear Hunters Questionnaire

All hunters (n=55) who brought in a harvested bear to the check stations in 1993 responded to the questionnaire. Fifty-six percent (n=31) killed a bear on their initial hunting day. Of those 31 hunters, 48% (n=15) took one hour

Table 18. Black bear harvest totals by county on the Neuse-Pamlico peninsula, 1992-1993.

YEAR	COUNTY	MALE	FEMALE	TOTAL
1992	Beaufort	13	16	29
1992	Craven	1	5	6
1992	Pamlico	11	9	20
1993	Beaufort	12	19	31
1993	Craven	5	4	9
1993	Pamlico	7	8	15
TOTALS		49	61	110

Table 19. Time of harvest/weight relationships for black bears harvested during the 1992 and 1993 hunting seasons on the Neuse-Pamlico peninsula.

TIME OF HARVEST[a]	#MALES	AVERAGE WEIGHT (kg)	#FEMALES	AVERAGE WEIGHT (kg)
1992 AM	9	190.9 (n=6)	2	85.2 (n=2)
1992 Midday	2	193.2 (n=1)	0	
1992 PM	13	73.3 (n=11)	26	71.5 (n=19)
1993 AM	11	165.2 (n=11)	10	87.1 (n=10)
1993 Midday	1	254.5 (n=1)	2	70.5 (n=2)
1993 PM	13	74.2 (n=26)	16	66.8 (n=13)
CUM AM	20	174.3 (n=17)	12	86.9 (n=12)
CUM Midday	3	213.6 (n=3)	2	70.5 (n=2)
CUM PM	26	74.2 (n=26)	42	69.6 (n=32)

[a] AM Sunrise - 0959 hours
Midday 1000 - 1400 hours
PM 1401 - Sunset

Table 20. Time of harvest/age relationships for black bears harvested during the 1992 and 1993 hunting seasons on the Neuse-Pamlico peninsula.

TIME OF HARVEST[a]	#MALES	AVERAGE AGE	#FEMALES	AVERAGE AGE
1992 AM	9	6.25 (n=8)	2	11.75 (n=2)
1992 Midday	2	16.75 (n=1)	0	
1992 PM	13	2.58 (n=6)	26	4.20 (n=20)
1993 AM	11	6.48 (n=11)	10	8.23 (n=10)
1993 Midday	1	9.75 (n=1)	2	8.75 (n=2)
1993 PM	13	2.67 (n=12)	16	6.44 (n=16)
CUM AM	20	6.38 (n=19)	12	8.81 (n=12)
CUM Midday	3	13.25 (n=2)	2	8.75 (n=2)
CUM PM	26	2.64 (n=18)	42	5.19 (n=36)

[a] AM Sunrise - 0959 hours
Midday 1000 - 1400 hours
PM 1401 - Sunset

or less to harvest their bear. The average number of days to harvest a bear was 1.65 (range 1-6).

Forty-one bears (74%) were harvested adjacent to agricultural fields. Fourteen bears (34%) were harvested adjacent to corn fields, 12 bears (29%) were harvested next to soybean fields and 9 (21%) were harvested adjacent to corn and soybean fields. Sixteen percent did not specify the type of field.

Questioned about their quarry, only 37% (n=20) said they were hunting only for bear. The remaining 63% (n=35) responded that they were hunting for both bear and white-tailed deer. No hunter responded that he was primarily just deer hunting.

When asked about season length, no hunters responded that the season should be shorter. Nearly half (45% n=25) thought the season should be longer. Nineteen respondents thought the season should stay 6 days. Twelve percent (n=7) had no opinion.

Questioned concerning season timing, most hunters (78%) would prefer the season to remain in November. Of these 47% (n=26) would prefer the season in early November, 23% (n=13) would prefer the season in late November, 7% (n=4) would prefer the season anytime in November, 7% (n=4) would prefer the season in early December, 1% (n=1) would prefer the season in later December, 3% (n=2) would prefer

the season anytime in December, and 7% (n=4) had no opinion.

Given a choice between a shorter season in November versus a longer season in December, the majority (40%) said they would prefer the longer season. Only 23% preferred the November season option. Seven percent (n=4) said they wanted a separate bow season even though it was not one of the choices. Twenty-nine percent (n=16) had no opinion.

Non-Harvest Mortality

Twenty-seven bears were killed by means other than hunting during the study period (Table 21). Road kills accounted for 15 (55.6%) of these deaths. Sex ratios of road-killed bears was 1:1. Younger age classes predominated with the average age of both males and females being 2.1 years old. Ages of road kills were significantly lower than those from capture ($p=0.0002$) or harvest ($p=0.0002$) samples. In addition to the road-kills, 9 additional bear-vehicle collisions were investigated wherein the bear was able to absorb the blow and leave the roadway area. The fate of these bears is unknown. Dates

Table 21. Non-harvest black bear mortality on the Neuse-Pamlico peninsula, 1992-1994.

DATE	SEX	AGE	COUNTY	TYPE OF MORTALITY
06 May 92	F	4.25	Beaufort	Vehicle
06 May 92	F	1.25	Craven	Vehicle
09 June 92	M	2.25	Beaufort	Research
18 June 92	F	3.50	Beaufort	Vehicle
29 June 92	M	6.50	Pamlico	Research
Summer 92			Beaufort	Depredation
Summer 92			Beaufort	Depredation
Summer 92			Beaufort	Depredation
Summer 92			Beaufort	Depredation
02 Nov. 92	M	0.75	Beaufort	Vehicle
?? Jan. 93	M	3.00	Beaufort	Poaching
?? Jan. 93	M	5.00	Beaufort	Unknown
?? Jan. 93	F	4.00	Beaufort	Unknown
06 Feb. 93	M	0.25	Beaufort	Research
06 Feb. 93	F	0.25	Beaufort	Research
08 April 93			Beaufort	Vehicle
02 June 93	M	2.50	Beaufort	Vehicle
03 June 93	M	4.50	Beaufort	Vehicle
10 June 93		1.50	Pamlico	Vehicle
29 Aug. 93	F	2.50	Beaufort	Vehicle
19 Nov. 93	F	0.75	Beaufort	Vehicle
03 Dec. 93	M		Beaufort	Vehicle
07 Dec. 93	M	0.75	Beaufort	Vehicle
23 Dec. 93	M	0.75	Beaufort	Vehicle
05 Jan. 94			Beaufort	Vehicle
01 May 94	M	11.25	Beaufort	Poaching
01 June 94	F	2.50	Beaufort	Vehicle

of road kills was variable but late spring/early summer and late fall/winter predominated. Females were more likely to be hit in the spring/summer and males in the fall/winter. All road-killed cubs were hit in the fall after November 1.

Four bears were killed by research related activities, 2 while trapping and 2 cubs which were abandoned during den research. The initial death was of a 2.5 year old male who sustained serious foot injuries in the snare and was euthanized by project personnel. The other trapping related death involved a snared 6.5 year old male who was found dead by the anchor tree. Fresh wounds on his face and hindquarters indicated he had been in a fight with another bear and had climbed the tree in an effort to escape. This occurred on 29 June and was during the breeding season when large males were fighting over potential mates. Several large males had been captured in the immediate vicinity of the anchor tree.

Two cubs (1M:1F) were abandoned by bear #08 during den research activities. This female was captured in early June and was lactating, indicating she had cubs of the year. She was picked for den location work because she should not have had newborn cubs. It is not known if her previous cubs died during the summer or if she had cubs in successive years.

Four cases of animals shot for depredating crops in 1992 were reported by a farmer on the Neuse-Pamlico Farmer Survey. No other information is available on these animals.

Four additional bears (3M:1F) were suspected of being poached. Two radio-collard bears, #18 and #32 were found dead after their radio signals remained in an inactive mode for an extended period of time during denning. Both of these bears were found dead in the Gum Swamp Bear Sanctuary within 200m of each other. Another untagged male bear was found dead near bear #18. He had been shot in the back of the head. In May of 1994, a large male bear was found washed up on the Pamlico River shore near South Creek. A necropsy revealed that he had been shot in the forehead.

DISCUSSION

Hunting

Bear hunting in coastal North Carolina has undergone a metamorphosis in the last 10 years. Until the mid-1980's, most counties were closed to bear hunting. Bear hunting was closed in the 1970's in response to habitat destruction and low population levels Pamlico County was the only area of the NPP to remain open, however hunting was restricted to still hunting. Beaufort County was reopened in 1987 and Craven in 1989 in response to increased bear populations, depredation complaints and road kills. By 1990, most counties in coastal North Carolina had been reopened to hunting. Weyerhaeuser Company Lands remained closed to bear hunting until 1990 when a few clubs adjacent to farms experiencing severe depredation problems were opened to limited hunting. In 1991, Weyerhaeuser lands were opened to bear hunting through a quota system which allowed a tightly controlled limited harvest (Maddrey et al. 1991). The 5935.2 ha Gum Swamp Bear Sanctuary on the eastern end of the Gum Swamp study area remained closed to hunting. The opening of Weyerhaeuser lands greatly increased bear hunting opportunities on the Neuse-Pamlico peninsula.

The harvest in coastal North Carolina has exhibited tremendous growth since establishment of the new seasons and usually exceeds that of the mountains. The 1993 statewide harvest total was 825 with 524 being harvested from the coast (Warburton 1994).

Hunting with bear dogs is a tradition in North Carolina and historically about 90% of the kill resulted from this method (Carlock et al. 1983); however, still hunting is becoming increasingly popular especially in coastal bear range. Bear behavior and hunting methods (still vs. dog) play a part in determining the sex and age structure of the harvest; however, there has not been a consensus as to how.

Males are generally thought to be more susceptible to mortality than females because of their larger home ranges and greater movements (Bunnell and Tait 1980, Bunnell and Tait 1985). Older bears are also less vulnerable due to their increased wariness and more nocturnal habits (Alt 1980a). Willey (1978) felt that differences in feeding patterns and behavior made males more vulnerable. Changes in hunting pressure can also alter the age/sex ratios of the harvest. Fraser et al. (1982) determined that as hunting pressure increased to high levels, females became a greater percentage of the harvest. Kolenosky (1983) found

that females in his study area in Ontario became increasingly vulnerable as hunting pressure increased. Hunting methods can also determine the sex ratio of the harvest although there has been no clear consensus on the issue. Still hunters have been attributed to harvesting higher percentages of females (Harger 1978, Carlock 1990, Abler 1985), and dog hunters a higher percentage of males (Collins 1973, Poelker and Hartwell 1973, Willey 1978). By contrast, Allen (1985) felt that dog hunting was more selective towards females and Elowe (1990) reported that sex ratios of dog hunted bears in Maine were usually close to 1:1. In Tennessee (Carlock et al. 1983), still hunters harvested more males than females over an 18 year period.

On the NPP, still hunting was the major hunting method and females predominated in the harvest in 1992 and 1993. Most bear hunting was done adjacent to agricultural fields in tree stands or by sitting at road intersections near bear crossings. Hunting with bear dogs was almost non-existent. Hunting methods were not the determining factor in the sex and age of harvested animals. The time of day when hunters were afield determined the sex and age of the harvest. Hunters in the afternoon took considerably more females, younger and smaller bears than hunters in the morning because the younger and smaller bears which are usually females are using the agricultural fields in the afternoons. Adult males were only seen in the fields at

sunrise and thus they were only harvested early in the morning by hunters sitting at agricultural fields.

Although there was no way to accurately measure hunter effort in each of these time periods, afternoon hunting pressure appeared to be much higher than that in the morning. Many hunters did not have enough time to hunt before work in the morning but there was enough time to go after work in the afternoon.

Hunting at the current level does not appear to be a limiting factor to expansion of the bear population. The percentage of tagged animals shot during the hunting seasons (10%) was low when compared to results from studies of hunted populations. Kohn (1982) reported that 20% of adult bears were killed in the same year they were tagged in Wisconsin. McCaffrey et al. (1976) reported that 91% of tagged bears were killed by hunters within 3 years in the Catskills of New York. Hunting mortality in Pennsylvania averaged 20% of tagged animals (Alt 1980b).

Seven of the 11 tagged bears harvested were young males. Only 2 had ventured far from the area where they had been captured. Bear #46 was captured in the Gum Swamp area in the summer of 1993 and radio collared. Contact was lost within a few weeks and it was thought that he had dispersed. Subsequent air flights failed to find this bear. He was harvested off the Peninsula in an area west

of the Neuse River near Dover approximately 53.3 km from his capture point. The only other bear who made any significant movement was bear #11 who was caught in the Big Pocosin in 1992. He moved to an area known as the Bay Bush Pocosin approximately 12.9 km west of the Big Pocosin and remained there until harvested the following year.

Successful Bear Hunters Questionnaire

Since the bear season runs concurrent with the deer season, the bear is seen as a bonus animal to many hunters. Most hunters (63%) were hunting both deer and bear when they harvested their bear. Agricultural fields are usually the best place to hunt deer and bear in the late afternoon so more hunters chose to hunt adjacent to these areas. The results of the questions concerning season length were not surprising. The majority would like a longer season no matter what time of year it is held.

Non-Harvest Mortality

Non-harvest mortality of bears may represent a substantial portion of the annual mortality. Road kills generally account for approximately 9-12% of the annual coastal black bear mortality in North Carolina (Warburton et al. 1993). On the NPP, non-harvest mortality accounted

for 24.5% of the total mortality with road kills represented 11.3% of the total. Although small sample sizes limit analysis, seasonal deaths of males and females were opposite of those reported by Warburton et al. (1993). Males are usually more vulnerable to road kills in the summer due to breeding activities and dispersal of sub-adults and females are generally more vulnerable in the fall due to their increased feeding activities. Small sample sizes were probably the reason for the unusual data. None of the road-killed bears examined by project personnel were tagged or radio-collared.

Mortality due to crop depredation and poaching are hard to quantify. Although animals shot by farmers are supposed to be reported to the NCWRC within 24 hours, this rarely occurs. Many farmers are also secretive about shooting bears in their crops since bears are held in such high regard by hunters. Crop depredation losses were not thought to be very high during the 2 years of the study, however actual numbers are impossible to determine. Many farmers said they had shot bears in the past but it did not solve their problem. The re-opening of the bear hunting season and the opening of Weyerhaeuser lands to bear hunting made many farmers wait until hunting season to shoot bears under "normal" circumstances.

Similarly, poaching losses are hard to quantify and would be impossible to detect unless radio collared animals began disappearing mysteriously. Poaching has been documented during other bear studies in North Carolina, especially those in the mountains (Pozzanghera 1990, Powell et al. 1992).

CHAPTER VIII

SUMMARY AND CONCLUSIONS

1. Research was conducted on the Neuse-Pamlico peninsula in coastal North Carolina from May 1992 to June 1994.

2. Eighty-nine black bears were captured 102 times during the study period including 38 from the Big Pocosin and 51 from the Gum Swamp.

3. The overall trapping success rate was one capture per 10.4 trap nights. Trapping success in the Gum Swamp was one capture per 6.9 trap nights and in the Big Pocosin it was one capture per 15.9 trap nights.

4. The sex ratio of initial captures was 46M:43F and did not differ from 1:1.

5. Ages of captured bears ranged from 1.5 - 10.5 years. The average age was 4.0. Males averaged 3.7 and females 4.3.

6. Adults (3.5+ years) comprised 58.6% of the captured bears. Gum Swamp bears were 58.6% adults vs. 50.0% for those of the Big Pocosin.

7. The average age of harvested bears was 5.2 years old (n=90). Harvested females averaged 6.2 and males 4.8. Harvested bears were significantly older than captured bears (p=0.036)

8. Neuse-Pamlico bears grew faster and attained greater weights than bears from the Great Smoky Mountains. The heavy diet of crop foods consumed by adult males allowed large fall weight gains which made these bears comparable in size to those from Pennsylvania.

9. Eight of 46 (17.4%) captured females were in estrus. Ages of bears in estrus range from 2.5 -9.5 years. Thirty-six percent of 2.5 year old captured females (n=11) were found to be in estrus. Two of 6 captured 3.5 year old sows had cubs present indicating breeding at 2.5 years. The breeding period spanned from 2 July - 4 August.

10. According to the presence of corpora lutea and placental scars, most (70%) female bears first breed at age 2.5, however, only 40% are successful at producing cubs.

11. Litter sizes observed from captured females (n=12) averaed 1.9 cubs. Litter sizes obtained from corpora lutea and placental scar counts averaged 2.4. Litters of older females (6.5+ years) averaged 2.7 whereas younger females averaged 2.0. Litter sizes were less than expected

given the nutritional element provided by the agricultural crops and were parallel with most other bear populations. Causes for this lack of response to added nutrition are unknown.

12. Reproductive histories obtained from examination of cementum annuli spacing indicated that most bears had first litters at 3-4 years of age and every other year thereafter. Skipping years of reproduction was found in only 1 sample. Although, it will not replace examination of reproductive tracts, examination of reproductive histories from tooth cementum gives the wildlife manager a more complete picture of reproductive success.

13. The early age of primiparity ($\underline{x}$=2.7 years), the lack of skipped years of reproduction and remaining productive for many years gives NPP bears high reproductive potential and explains in part the increasing population levels of recent years. Nutrition is also a part of reproductive success and the crop food influence certainly gives young females and pregnant females the needed nourishment.

14. Seasonal diets of black bears are heavily dependent on agricultural crops. Winter wheat makes up the bulk of the spring diet. Bears ate berries as they ripened in early summer and then switched to corn for the remainder of the summer. Corn, soybeans, black gum and shrub fruits made up the fall diet. Soybean use appears to increase

indicator of what to expect if black gum stands are harvested.

15. NPP bears have replaced many of their natural foods with crop foods. Black gum is a preferred fall food and is critical to coastal bear populations if crop foods are not available. The continued loss of black gum stands to harvesting will probably be detrimental to bear populations in the future, especially if agricultural foods diminish through the use of different crops or overall land use change. The loss of black gum and the loss of agricultural crops would be very detrimental to local bear populations.

16. Adult males consumed significantly more crop foods than adult females or sub-adults during fall. Adult males probably temporally exclude other age and sex groups from prime feeding areas such as agricultural crops in fall. This heavy feeding during fall on highly nutritious crop food explains the large weights attained by these bears.

17. Corn damage caused by bears in the Gum Swamp amounted to 10.4 ha representing 0.6% of the total corn acreage. Most corn damage is done during the milk stage of development and damage is done by all age and sex classes. The use of aerial videography to measure corn crop damage was an accurate method for comparing to farmer's estimated crop damage.

18. Most farmers on the Neuse-Pamlico peninsula enjoy seeing bears on their farms but 45% worry about crop damage. A majority of farmers felt that the bear population had increased in the last 5 years. Farmers who had sustained damage were more likely to feel that bears had increased than those with no damage.

19. Deer were listed as the major cause of crop damage although over half the farmers who returned surveys had crops damaged by bears in 1993.

20. Crop damage in 1993 was estimated at 186.2 ha with a monetary loss of $50,150. Corn was the crop most damaged with 92.5 ha and a loss of $27,825. Although bears damage a small fraction of the agricultural crops on the NPP, damage can be severe in localized areas. The high visibility of this damage leads to many of the complaints from area farmers. No successful means exist for alleviating bear crop damage other than through population management.

21. A total of 110 bears were harvested on the Neuse-Pamlico peninsula during the study period including 11 tagged bears. Most bears were harvest adjacent to agricultural fields (74%) by still hunting (96%).

22. Still hunters harvested adult males only during early morning hours. No adult males were harvested in the afternoon. Ages of all bears harvested in the morning by still hunters were older and heavier than those harvested

in the afternoon. Adult males may have been excluding females and younger bears from crop fields during night-time and early morning. The other bears were forced to feed during late afternoon which left them more vulnerable to hunters.

23. Bear behavior and hunting methods must be taken into account before setting or changing hunting seasons. The female harvest was slightly higher than the male harvest during the study and care must be taken to protect the female segment of the population, especially the older females. The high female harvest can be directly tied to their use of agricultural fields in late afternoon. Extension of the hunting season in early November would probably be detrimental to the female segment because they would still be using crop fields during this time frame. If additional hunting days are added, the season should be shifted later into early December or split the season and add the extra days in December when female movements will diminish.

24. Non-harvest mortality (24.5%) was relatively high. Twenty-seven bears were lost to other mortality factors including 15 road kills, 4 depredation kills, 4 research losses, 2 poaching deaths and 2 unknown kills. Means to reduce these mortality factors could include education of hunters, farmers and landowners. Reducing road kills will

be hard to accomplish due to the large numbers of highways in coastal North Carolina which bisect bear range.

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APPENDICES

APPENDIX A

CAPTURE AND REPRODUCTIVE DATA

Table A1. Information on Black Bears captured on the Big Pocosin study area, 1992-1993.

Bear #	Date Captured	Sex	Age	Weight(kg)
1	26 MAY 92	M	2.25	52.3
2	28 MAY 92	F	2.25	40.9
3	2 JUNE 92	F	2.50	48.6
4	3 JUNE 92	M	4.50	143.2
5	4 JUNE 92	F		40.9
6	7 JUNE 92	M	8.50	159.1
7	9 JUNE 92	M	2.50	75.0
8	9 JUNE 92	F		68.2
9	9 JUNE 92	M	2.50	105.4
10	13 JUNE 92	M	2.50	61.4
11	14 JUNE 92	M	2.50	84.1
12	17 JUNE 92	M	2.50	77.3
13	18 JUNE 92	M	2.50	102.3
14	18 JUNE 92	M	2.50	71.4
33	21 JULY 92	M	2.50	81.8
34	22 JULY 92	F	8.50	90.9
35	25 JULY 92	F	5.50	63.6
36	25 JULY 92	M	5.50	104.5
37	26 JULY 92	F	6.50	59.1
38	30 JULY 92	M	6.50	163.6
39	4 AUGUST 92	F	4.50	75.0
41	13 AUGUST 92	F	4.50	90.9
61	11 JUNE 93	F	4.50	65.9
62	15 JUNE 93	M	4.50	147.7
63	17 JUNE 93	F	1.50	25.0
64	23 JUNE 93	M	5.50	182.7
76	21 JULY 93	F	6.50	75.0
77	21 JULY 93	F	2.50	52.3
78	23 JULY 93	F	2.50	56.8
79	28 JULY 93	F	2.50	59.1
80	28 JULY 93	F	4.50	59.1
81	29 JULY 93	F	5.50	72.7
82	29 JULY 93	M	4.50	118.2
83	29 JULY 93	M	2.50	90.9
84	3 AUGUST 93	M	3.50	81.8
85	3 AUGUST 93	M	1.50	38.6
86	4 AUGUST 93	F	2.50	66.7
87	13 AUGUST 93	F	7.50	63.6

Table A2. Information on Black Bears captured on the Gum Swamp study area, 1992-1993.

Bear #	Date Captured	Sex	Age	Weight (kg)
15	24 JUNE 92	M	1.50	40.9
16	24 JUNE 92	M	6.50	147.7
17	26 JUNE 92	F	9.50	68.2
18	27 JUNE 92	M	3.50	90.9
19	27 JUNE 92	F	1.50	29.5
20	27 JUNE 92	M	4.50	143.2
21	29 JUNE 92	M	5.50	131.8
22	29 JUNE 92	M	6.50	125.0
23	1 JULY 92	F	3.50	59.1
24	2 JULY 92	F	9.50	68.2
25	2 JULY 92	F	10.50	65.9
26	5 JULY 92	M	5.50	122.7
27	5 JULY 92	M	5.50	138.6
28	12 JULY 92	F	2.50	38.6
29	13 JULY 92	F	2.50	43.2
30	15 JULY 92	M	1.50	22.7
31	15 JULY 92	M	5.50	113.6
32	18 JULY 92	F	3.50	50.0
40	4 AUGUST 92	M	1.50	22.7
42	11 SEPT 92	F	5.50	68.2
44	13 MAY 93	F	2.25	40.9
45	18 MAY 93	F	3.25	56.8
46	18 MAY 93	M	2.25	53.1
47	19 MAY 93	F	3.25	59.1
48	19 MAY 93	M	2.25	113.6
49	19 MAY 93	M	3.25	86.4
50	19 MAY 93	M	2.25	47.7
51	19 MAY 93	M	4.25	106.8
52	20 MAY 93	F	4.25	52.3
53	21 MAY 93	F	2.25	50.0
54	27 MAY 93	F	3.25	56.8
55	27 MAY 93	M	1.25	31.8
56	28 MAY 93	M	3.25	84.1
57	1 JUNE 93	F	3.50	56.8
58	4 JUNE 93	F	6.50	72.7
60	10 JUNE 93	M	5.50	157.5

Table A2. Continued.

Bear #	Date Captured	Sex	Age	Weight (kg)
65	25 JUNE 93	M	2.50	65.9
66	29 JUNE 93	F	5.50	59.1
67	1 JULY 93	M	4.50	147.7
68	7 JULY 93	M	7.50	143.2
69	7 JULY 93	M	4.50	65.9
70	7 JULY 93	M	6.50	59.1
71	8 JULY 93	M	5.50	157.5
72	8 JULY 93	F	4.50	61.4
73	15 JULY 93	M	1.50	43.2
74	16 JULY 93	F	6.50	63.6
75	16 JULY 93	F	1.50	27.3
88	24 AUGUST 93	M	2.50	48.6
89	27 AUGUST 93	F	7.50	86.4
90	2 SEPT 93	F	1.50	31.8
91	3 SEPT 93	F	2.50	45.5

Table A3. Weights of tagged bears captured or harvested on the Neuse-Pamlico peninsula, 1992-1993.

GAIN/ #	SEX	AGE	RECAP/HARV. DATE	ORIGINAL CAPTURE	ORIGINAL WGT. (Kg)	RECAP/HARV. WGT. (Kg)	WEIGHT GAIN (Kg)	WEIGHT DAY (KG)
09	M	2.5	08 Nov 93	09 June 92	104.5	165.9	61.9	-
11	M	2.5	09 Nov 93	14 June 92	84.1	159.1	75.0	-
12	M	2.5	11 Nov 92	17 June 92	77.3	104.5	27.2	0.18
14	M	2.5	11 Nov 93	18 June 92	71.4	131.8	60.4	-
25	F	10.5	16 July 93	02 July 92	65.9	71.4	6.5	0.39
25	F	10.5	03 Sept 93	02 July 92	65.9	90.9	25.0	-
28	F	2.5	07 June 93	12 July 92	38.6	54.5	15.9	-
29	F	2.5	09 June 93	13 July 92	43.2	54.5	11.3	0.15
29	F	2.5	08 Nov 93	13 July 92	43.2	75.0	31.8	-
30	M	1.5	04 June 93	15 July 92	22.7	47.7	25.0	-
33	M	2.5	11 Nov 92	21 July 92	81.8	113.6	31.8	0.28
46	M	2.5	09 Nov 93	18 May 93	53.2	89.5	46.3	0.26
47	F	3.5	13 Nov 93	19 May 93	59.1	95.5	36.4	0.20
48	M	2.5	08 July 93	19 May 93	113.6	106.8	-6.8	-0.14
51	M	4.5	10 Nov 93	19 May 93	106.8	127.3	20.5	0.12
56	M	3.5	16 July 93	28 May 93	84.1	90.9	6.8	0.14
88	M	2.5	10 Sept 93	24 Aug 93	48.6	52.3	3.7	0.21

Table A4. Cub observations from captured female black bears on the Neuse-Pamlico peninsula, 1992-1994.

Bear#	Age	# Cubs Observed
08	-	2
25	10.5	2
28	4.5	2
32	3.5	2
39	4.5	2
41	4.5	2
42	5.5	1
52	5.5	2
66	6.5	2
79	3.5	2
80	5.5	3
81	5.5	1
AVERAGE		1.9

APPENDIX B

FARMER CROP DAMAGE AND ATTITUDE SURVEY

SURVEY OF FARMER'S ATTITUDES TOWARD BEARS & CROP DAMAGE

Please include only those farms located North of the Neuse River in Craven County, South of the Pamlico River in Beaufort County and all of Pamlico County.

1. How many acres of the following crops did you farm in 1993?

CORN	_____	POTATOES	_____
SOYBEANS	_____	TOBACCO	_____
WHEAT	_____	OTHER	_____
COTTON	_____		

2. Did you see a bear on your farm during 1993?

[] YES
[] NO -> (Go to question 3)

2(a). If so, what time of year did you see bears. Please check all that apply.

[] SPRING
[] SUMMER
[] FALL
[] WINTER

3. Which of the following <u>BEST</u> describes how you feel about bears on your farm?

[] I ENJOY SEEING THEM
[] I ENJOY SEEING THEM BUT WORRY ABOUT CROP DAMAGE.
[] BEARS ARE A NUISANCE
[] NO OPINION

4. In the past 5 years, do you think the bear activity on your farm has.....

[] INCREASED
[] REMAINED ABOUT THE SAME.
[] DECREASED
[] NO OPINION

5. Do you think the bear population around your farm is...

[] TOO HIGH
[] ABOUT RIGHT
[] TOO LOW
[] NO OPINION

6.. Which animal species does the MOST damage to your crops?

[] WHITE-TAILED DEER
[] BLACK BEAR
[] RACCOON
[] BIRDS
[] OTHER (please list) _____

7. Were your crops damaged by bears in 1993?

[] YES
[] NO (Go to question 8)

7(a). Estimate the acreage amount of bear damage to each of your crops in 1993.

CORN _____
WHEAT _____
SOYBEANS _____
OTHER (please list) _____

7(b). Estimate the dollar value loss from each crop caused by bears.

CORN _____
WHEAT _____
SOYBEANS _____
OTHER (please list) _____

7(c). Do you consider bear damage to YOUR crops to be.....

[] INTOLERABLE
[] MODERATE
[] LIGHT
[] NO OPINION

7(d). Do you think bear crop damage has increased on your farm in the past 5 years.

[] YES
[] NO (Go to question 8)

7(e). If bear damage on YOUR farm has increased, what do you believe is the MAJOR cause?

[] BEARS HAVE ADAPTED TO EATING EASILY OBTAINABLE CROP FOODS.
[] NO NATURAL FOODS ARE AVAILABLE.
[]. LOSS OF MAST PRODUCING HARDWOOD TREES.
[]. MORE BEARS.
[]. OTHER (please list) _____

8. Do you try to prevent bear damage to your crops?

[] YES
[] NO (Go to question 9)

8(a). What types of deterrents have YOU used to prevent bear damage? (please check all you have used)

[] SCARE DEVICES
[] ELECTRIC FENCES
[] CHEMICALS
[] SHOOTING
[] OTHER (please list)_____

8(b). Do you think any of these deterrents have been effective?

[] YES(please list)_____
[] NO

9. What do you think is the BEST way to alleviate bear crop damage?

[] LONGER BEAR HUNTING SEASON
[] INCREASED BAG LIMIT
[] RELOCATION OF PROBLEM ANIMALS
[] COMPENSATION FOR CROP LOSS
[] SPECIAL PERMIT SEASON
[] OTHER (please explain) ----------

FARMER CHARACTERISTICS

The following information will be helpful in understanding who is being affected by bear damage to crops. All responses, however, are voluntary. Again, your responses will not be associated with your name.

1. Age

   [] 25 OR LESS
   [] 26 - 35
   [] 36 - 45
   [] 46 - 55
   [] 55 OR MORE

2. Sex

   [] MALE
   [] FEMALE

3. Race

   [] BLACK
   [] WHITE
   [] OTHER

4. Education (please check highest level of school completed).

   [] NONE
   [] ELEMENTARY
   [] JR. HIGH
   [] HIGH SCHOOL
   [] 2 YRS. COLLEGE
   [] 4 YRS. COLLEGE
   [] MORE THAN 4 YEARS COLLEGE

5. How much of your household income do you receive from farming.

   [] LESS THAN 10%
   [] 10 - 25%
   [] 26 - 50%
   [] 51 - 75%
   [] 76 - 100%

THANK YOU FOR YOUR COOPERATION

VITA

Robert Calvin Maddrey, son of Rufus Calvin and Patricia Parke Maddrey, was born in Roanoke Rapids, North Carolina, on 09 September 1958. He was raised in the town of Seaboard and graduated from Northampton County High School in Creeksville, North Carolina in 1976. He attended Halifax Community College, North Carolina where he graduated with an Associate of Arts Degree in General Education. He then attended North Carolina State University where he graduated with a Bachelor of Science Degree in Wildlife Biology in 1981. After graduation, he accepted a position with the North Carolina Wildlife Resources Commission with whom he is still employed as a District Wildlife Biologist in New Bern. He was married in 1988 to Mary Renee and has two children, Ryan Christopher and Russell Clayton. He entered the graduate program in the Department of Forestry, Wildlife, and Fisheries at the University of Tennessee, Knoxville in June 1992 and received a Master of Science degree in Wildlife and Fisheries Science in May 1995.