GENERAL INTRODUCTION

In Virginia, some black bears (*Ursus americanus)* are hunted while others (those on National Parks or refuges) are protected. During the 1980s and early 1990s the protected bear populations in Virginia were intensively studied (Carney 1986, Comly 1993, Garner 1986, Hellgren 1988, Kasbohm 1994, and Schrage 1994). However, information on the hunted populations of bears in Virginia is limited to harvest records. During 1994, the Cooperative Alleghany Bear Study (CABS), a study directed at the hunted bear population, was initiated in the former George Washington National Forest of northwestern Virginia; in 1995, the study was expanded south to the former Jefferson National Forest. Because the dynamics of the hunted bear population in Virginia is unknown, the effects of hunting on the population are unknown, and thus management of the bear population is compromised. Current black bear management in Virginia is based on demographic parameters derived from harvest data. In Virginia, bears can be harvested during specified weeks of the fall hunting seasons. Bears can be harvested during one week of the deer archery season (October), the second week of the deer rifle season (late November), and during the bear firearm season (December). Bears can be taken with hounds or by stillhunting or shotgun or in the last week of the bear firearm season a bear can be killed with a muzzleloader.

The bear harvest in Virginia, which had been essentially level during the 1970s and early 1980s, steadily increased from 1983 to 1989 (VDGIF, unpubl. reports). Since 1989, the bear harvest in Virginia has fluctuated severely for unknown reasons. Potential causes of harvest fluctuations include varying hunter effort or hunter reporting rate, changing activity of bears (i.e. fall food trips, weather, etc.), or variation in the bear population.

Hunting bears with dogs is a controversial issue (Elowe 1990). Many nonhunters perceive hunting with dogs to be inhumane and a method that gives the hunter an unfair advantage. As a result, animal rights groups have made hunting with hounds an issue in several states where it is practiced. The issue is not entirely a hunting/anti-hunting issue; rather it is an ethical issue that involves public sentiment (Decker et. al. 1993). In Colorado, Utah, Massachusetts, Washington and Oregon, hunting with hounds was stopped by public vote; in California bear hunting was stopped by court order. However, in 1996, Michigan and Idaho voted to continue to hunt bears with hounds. In addition, Michigan voters passed a counter initiative, giving the Natural Resource Commission the authority to regulate game management. Oregon had a similar initiative, but voters did not return the management of bears and cougars to the Oregon Fish and Wildlife Commission (IAFWA 1996 Ballot Initiatives document). The use of hounds to hunt bears in Virginia is contraversial and may be challenged at some future date by the same groups (PETA, etc.) that have challenged bear hunting in other states.

Knowledge and understanding of each method of hunting is a significant aspect in the management of any hunted wildlife population. There is not a separate bear hunting

license in Virginia. Instead, by purchasing a big game license, a turkey hunter, deer hunter, or bear hunter that uses hounds or stillhunts can harvest a bear. Due to the licensing structure in Virginia, there is no method to determine statewide hunter effort and success for each method of hunt used by bear hunters. A goal of this study was to document hunter effort and success so that the impact of the use of hounds as a method of hunting on the bear population is better understood.

In 1992, bear hunters in Virginia gained a bear-dog training season during the month of September. An apparent increase in the number of bears killed on highways that year (VDGIF, unpub. records) coincided with the opening of the bear-dog training season. As a result, a number of citizens expressed concern to the Board of Commissioners of the Virginia Department of Game and Inland Fisheries that the bear-dog training season contributed to the increasing number of bears killed by vehicles. This concern provided the impetus that led to the initiation of the CABS.

The effects of chase by hounds on bears is unknown, but it may influence such factors as energetic demands and movements outside established home ranges. How the use of hounds to hunt bears affects reproductive and survival rates of bears, or their physical condition, or the movement patterns of bears, is poorly understood. In 8 chases in Wisconsin, only one bear moved out of its home range (Massopust 1984). Allen (1984) found that 53% of chased bears in Maine stayed within their home range. Bears that left their home range traveled less than 2 km outside of their home range.

It is important to understand the effect of hunting and the bear-dog training season on the bear population. This information may prove valuable in management of the population for hunting and for its intrinsic value. The specific objectives of this study were

1. Document hunter effort (number of hunters and dogs in each hunting party) and success (whether a bear was chased, treed, and/or harvested) of houndsmen groups that chase or hunt black bears with dogs in western Virginia.
2. Determine the proportion of black bears harvested in Virginia by opportunistic hunters vs. hunters that hunt specifically and exclusively for black bears.
3. Evaluate the impact of the bear-dog training season and hunting bears with hounds on black bear reproduction and survival.
4. Test and evaluate the applicability of the physical condition ratio (weight/body length) as an indicator of stress in chased bears.
5. Determine the effects of the bear-dog training season on black bear movements in relation to home range.

GENERAL METHODS

Bears were trapped from June through August with modified Aldrich foot snares. Trap lines were prebaited for 2 weeks, run for two weeks, then rotated to new areas.

Captured bears were immobilized with an intramuscular injection of a 2:1 mixture of ketamine hydrochloride / xylazine hydrochloride. Drugs were administered by blow-gun dart syringe (Lochmiller and Grant 1983), jabstick, or Cap-chur gun (Palmer Chemical Company; Douglasville, GA). Once a bear was immobilized, it was marked with black perma-flex ear tags and tattooed with the corresponding ear tag number. All adult females that were trapped, and no more than 5 adult males, were radio-collared in the 1995 and 1996 trapping seasons (Wildlife Materials Inc., Carbondale, IL; 150-151 Mhz. and AVM Instrument Company, Champaign, IL; 150-151 Mhz). Cotton breakaway devices were placed on each radio-collar (Hellgren et. al. 1989). Radio collars had a motion sensitive mortality mode (2 beats/sec) with a 30-minute delay.

Various morphological measurements (total body length, zoological length [length of profiled bear], zygomatic arch, foot width and length, canine breadth and width, ear and tail length, etc.) and weight were taken from all captured bears. The chest girth measurement was taken snugly when exhaling and inhaling (Payne 1976). The physical condition of each bear was subjectively estimated and ranked from poor to excellent condition. The reproductive status of each female was noted based on lactation or signs of estrus (e.g. swollen vulva). In addition, blood and hair were collected for future genetic and physiology studies (Vaughan, pers. comm.)

Bears were administered LA 200, an antibiotic and tetracycline marker, which leaves a mark or ring on the cementum annuli of teeth for the year it was administered. This marker aids in identifying year of capture. The tetracycline marker is visible on premolars taken from harvested bears for age determination, thus the information can later be used in a marked-to-total estimate of population size (Garshelis 1997).

Collared bears were handled again during the winter denning season. Dens were visited to readjust radio collars and to change the cotton spacer breakaway device. In addition, the reproductive status and success of each female was determined and cubs greater than 2 kg were fitted with expandable, cub radio collars (J. Higgins 1997). Cubs also were tagged with roto-eartags. T-tags (Floy Tag Co, Seattle, WA) were tested to see if tag loss rate might be reduced; however, cubs found these easier to pull out than the roto-tag. Handling techniques in the den were similar to those of the trap season. The same morphological measurements that were taken during the summer trapping season were taken on adults and cubs in the den. Weights were taken from those bears that could be removed from and replaced back into their dens. Again, LA 200, was administered to each adult and yearling. Some bears were not handled due to the inaccessibility of some tree dens or if bears prematurely abandoned den sites.

STUDY AREA

Southwest study area

The 1,544 sq km southwest study area of CABS is in the Blacksburg Ranger District and a portion of the New Castle Ranger District of the George Washington and

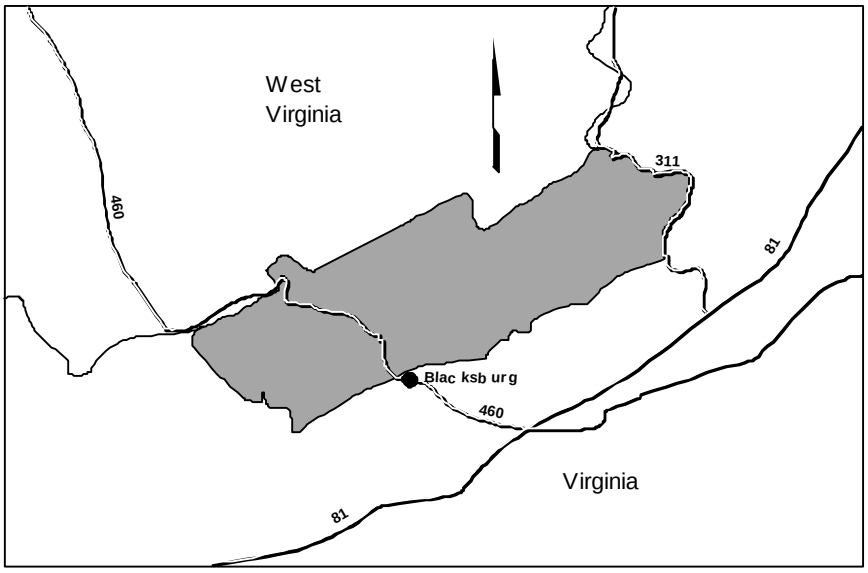

Figure 2. Southwestern study area of the Cooperative Alleghany Bear Study,

Jefferson National Forests (GW & JNF) in Giles, Craig and Montgomery Counties (Figure 1). This portion of the GW & JNF is not continuous public land, but heavily fragmented by private land. The GW & JNF lands are located primarily on the ridges, while the valleys consist of private agricultural lands. The highest elevation is on Mountain Lake (1,378 m) and the lowest elevation is along Craig Creek (492 m). The average annual temperature in Blacksburg, VA for 1996 was 10.4° C. Precipitation averaged 131.43 cm. in 1996 (The National Weather Service, Blacksburg, VA, pers. commun.).

The dominant tree species were white oak (*Quercus alba),* scarlet oak (*Q. coccinea*), chestnut oak (*Q. prinus*), black oak (*Q. velutina*), and northern red oak (*Q. rubra*). Other important overstory species were pignut hickory (*Carya glabraI*), bitternut hickory (*C. cordiformis*), red maple (*Acer rubrum*), pitch pine (*Pinus rigida*), eastern white pine (*P. strobus*) and table mountain pine (*P. pungens*). Common intermediate and codominate trees included black gum (*Nyssa sylvatica*), sourwood (*Oxydendrum arboreum*), black locust (*Robinia pseudoacacia*), and american chestnut *(Castanea dentata*). Important understory trees were sassafras (*Sassafras albidum*), mountain laurel (*Kalmia latifolia*), flowering dogwood (*Cornus florida*), downy serviceberry (*Amelanchier arborea*), witch hazel (*Hamamelis virginia*), Allegheny chinkapin (*Castanea pumila*), and along streams, great rhododendron (*Rhododendron maximum*) and eastern hemlock (*Tsuga canadensis*) were common (Jesse Overcash, USFS, pers. comm.).

Northwest study area

Data collected by other CABS graduate students during May 1995 through April 1997 in the northwest study area of CABS also were used. The 860 sq. km northwest study area was on the Dry River and Deerfield Ranger Districts of the GW & JNF in western Rockingham and Augusta counties (Figure 2). Like the SW study area, the NW study area is in the ridge and valley region of the Appalachian mountain range (Bailey 1976); however, the national forest lands there are not as fragmented by private land. The highest elevation is Elliott Knob (1,360m), while the lowest elevation is at the base of Little North Mountain (488 m; Kozak 1970). The average temperature in the NW study area was 0.3° C in the winter and 22.9° C in the summer. The average snowfall is ≥ 71 cm (J. Higgins 1997).

Important tree species are eastern hemlock, sugar maple (*A. saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula allegheniensis*), chestnut oak, pitch pine, white oak, black oak, northern red oak, yellow poplar (*Liriodendron tulipifera*), and eastern white pine. Common understory trees and shrubs are barren and brush cover (*Q. ilicifolia*; C. Godfrey 1996 and J. Higgins 1997).

Figure 2. Northwest and Southwest study areas of the Cooperative Alleghany Bear Study, VA

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Chapter 1: Dynamics of hunting bears with hounds

The black bear is a valued game species in Virginia, and may be hunted with the purchase of a big game hunting license, which allows hunters to harvest deer, bears and wild turkeys. Bears can be harvested in the deer archery season, the last week of the deer firearm season, and the bear firearm season. In addition, deer hunters can take bears in the last week of the late deer muzzleloader season, which occurs during the bear firearm season. In 1995, 13 % of 602 bears harvested were killed by bow hunters, 34 % were killed by deer hunters during the rifle season and the deer muzzle loader season, and 52 % were killed by houndsmen and still hunters in the bear firearm season. In 1996, 9 % of 623 bears were killed by bow hunters, 28 % were killed by deer hunters during the rifle season and the deer muzzle loader season, and 63 % were killed by houndsmen and still hunters during the bear firearm season.

Although harvest data provides information on the age and sex ratios of harvested bears, the number and density of bears in Virginia, as well as the proportion of the population being harvested, is unknown. Consequently, it is difficult to determine the effect of hunting on the population.

Hunting bears with hounds is controversial in some parts of the United States (Elowe 1990). Many of those opposed to this type of hunting are not anti-hunters, rather, they believe that hunting bears with hounds is not fair chase. Thus, the issue is primarily one of ethics. In Colorado, Decker et al. (1993) conducted a survey to evaluate public concerns on the issues of hunting bears with hounds and hunting bears over bait. They found that the public was concerned with the welfare of the bear population and individual bears, concerned with the ethics of some hunting practices, felt hunting bears with hounds or over bait was an issue of animal rights, or felt voters should make wildlife management decisions rather than the wildlife agencies (Decker et. al. 1993).

Animal rights advocates have found some success in closing bear hunting seasons and outlawing hunting bears over bait and/or with hounds, and hunting bears in the spring when sows are accompanied by small cubs. In 1989, an animal protection group successfully sued the California Department of Fish and Game (DFG) to stop black bear hunting, arguing that the DFG did not have adequate documentation to support bear hunting. In 1990, the DFG prepared a document that met the standards of the California Environmental Quality Act (CEQA), and regained the privilege to hunt black bears with rifles and pistols only (Koch 1994) and in 1991 California regained archery hunting when new documents met the CEQA (Burton et al. 1994). In Massachusetts, Utah, Oregon,

Washington, and Colorado, bear management was in essence taken out of the hands of wildlife agencies and turned over to the public through ballot initiatives. In 1996, the Oregon Fish and Wildlife Commission attempted to regain the right to manage wildlife, but voters failed to pass this initiative.

In Michigan and Idaho, where bear hunting was an issue on a ballot initiative in 1996, animal protectionists presented bear hunting to the public as unfair chase. However, hunters organized early and portrayed animal protectionists as anti-hunters opposed to hunting in general rather than particular hunting methods. Hunters gained voter support by pointing out that data existed to support the contention that bear populations were healthy in both states (John Beecham, Idaho Game Biologist and Tim Rice, Furbearer biologist, Michigan Department of Natural Resources, pers. comm.). As a result, Michigan and Idaho voters elected to continue to hunt bears with hounds and over bait. A legislative initiative was also on Michigan's 1996 ballot to allow the Natural Resource Commission to continue to regulate the taking of game. This initiative also passed (IAFWA 1996 Ballot Initiative Document).

Hunter surveys are a common means of documenting hunter characteristics. Virginia, Michigan, and New Hampshire sent surveys to bear hunters to compare hunter characteristics for each method of take (DuBrock et al. 1978, Peyton 1989, and Litvaitis and Kane 1994). These surveys were designed to document harvest rates and hunter selectivity in harvest. Peyton (1989) found that 17% of houndsmen in Michigan harvested a bear and Litvaitis and Kane (1994) found that 18.6% harvested a bear in New Hampshire. Vermont, Virginia, Michigan, and New Hampshire surveys found that houndsmen were more likely to selectively harvest male bears than stillhunters or hunters who use bait (Willey 1972, DuBrock et al. 1978, Peyton 1989 and Litvaitis and Kane 1994). In addition, Litvaitis and Kane (1994) concluded that because hounds can cover greater distances in hunts, houndsmen should have greater access to female bears than stillhunters. However, Litvaitis and Kane (1994) reported that only 28.6% of the bears harvested by houndsmen were females, while 50.0% of bears harvested by still hunters were females. Bunnel and Tait (1980) suggested that with increased mobility of hunters (such as houndsmen), vulnerability of both sexes of prey would become equal, regardless of home range size of the prey. Further evidence for hunter selectivity was documented in a telephone survey conducted in Washington state (Kohlmann 1996). He found that houndsmen harvested more older bears than hunters who hunted bears over bait or by stalking. All hunting methods harvested proportionately more males than females (Kohlmann 1996). Bunnel and Tait (1985) compared black bear kill data in Michigan, Washington, Montana, Minnesota, Idaho, Pennsylvania, and Alberta and found that males were more vulnerable to hunting mortality than females. Most studies of bear hunting are primarily interested in documenting harvest rates and sex ratios in the harvest and have limited documentation on effort and success rates of houndsmen.

Hunting bears with hounds is the traditional method of hunt for Virginia hunters who exclusively hunt bears. In Virginia, houndsmen have a bear-dog training season during the month of September, during which time hunters are not allowed to carry a firearm or harvest a bear. Traditionally, hunting seasons are not open on Sundays; however, the bear-dog training season (a non hunting season) is open on Sundays. In addition, hunters are not allowed to hunt bears over bait in any of the seasons when bears can be legally harvested.

This chapter documents hunter effort and success of Virginia's houndsmen during the September bear-dog training season and the December bear firearm season.

METHODS

Bear hunters were surveyed in the field in both the southwest (SW) and northwest (NW) study areas of the Cooperative Alleghany Bear Study. Graduate students and undergraduate volunteers accompanied 7 different hunting parties in the NW study area during both the 1995 and 1996 bear-dog training seasons and 6 hunting parties in the SW study area during both the 1995 and 1996 bear-dog training seasons. During the 1995 bear firearm season we accompanied 6 hunting parties in the NW study area and 4 hunting parties in the SW study area. During the 1996 bear firearm season CABS personnel on the SW and NW study areas accompanied 3 different hunting parties each. Hunters were accompanied on Saturdays and Sundays only during the 1995 and 1996 bear-dog training seasons on the NW study area, and during 1995 on the SW study area. In 1996, I accompanied hunters on the SW study area on the weekends and on weekdays during the bear-dog training season. During the 1995 and 1996 bear firearm seasons, hunters were accompanied during the week and on Saturdays.

Hunters were accompanied throughout the entirety of their hunt. Hunter success was documented in terms of bears chased, bears treed, and, in the bear firearm season, bears harvested. Hunter effort was documented as the number of hunters participating in the hunt, the number of hounds involved in each chase, and the length of each chase. Additional data on the sex of bears that were treed and/or harvested, and whether or not the bear was marked (i.e. radio-collared, ear tagged, and/or tattooed) was collected. During any given hunt, when a bear was chased more than once or more than one bear was chased, the successive chases were referred to as the 2nd and 3rd chase of the hunt.

In 1995, to complement the data collected while accompanying hunters, a hunter survey was sent to 762 bear hunters. Hunters were selected from the 1993 and 1994 bear harvest data (stillhunters and opportunistic hunters were included in the harvest data), the Virginia Bear Hunters Association (VBHA) membership, and hunters that CABS personnel accompanied during the bear-dog training season and the bear firearm season.

Surveys were sent out during, the 1st, 3rd, and 5th weeks of the bear firearm season. In each wave, 254 surveys were mailed. Reminders were mailed 2 weeks after each mailing to nonrespondents (Dillman 1978). Hunters were asked to describe their

most recent hunt and asked for the same information that was collected in the field surveys. To encourage participation, participants in the bear hunter survey could request a copy of the results.

The purpose of mailing surveys in 3 waves was to measure effort throughout the season, but most hunters documented hunts in the 4th and 5th weeks of the season. This tendency was most likely a result of hunters waiting to complete their survey at the end of the season. Thus, in 1996, a bear hunter diary was prepared for the bear firearm season in an effort to better document hunter effort throughout the season.

In 1996, in an attempt to select only houndsmen for the bear hunter diary, only bear hunters that harvested a bear in December of 1995 were sampled. In addition, the VBHA members, and hunters that CABS personnel accompanied during the bear-dog training season and bear firearm season were sampled. Letters were mailed to 611 hunters asking them to volunteer to complete a Bear-dog Hunter Diary. Diaries were mailed one week before the start of the bear firearm season to the 102 hunters that volunteered to participate in the bear hunter diary. A reminder letter was sent to those hunters that had not returned their diaries 1 week after the season closed. The Bear-dog Hunter Diary was returned to each hunter after the data was analyzed and participating hunters received a copy of a summary of the results.

The Wilcoxon Rank Sum test was used to test for differences in hunter effort between the NW and SW study areas, between 1995 and 1996 seasons, and between the bear-dog training season and bear firearm season. The Chi Square and Fisher's Exact test were used to test for differences in hunter success. The Chi Square test also was used to test for difference in the distribution of weekly hunting effort during the 1996 bear firearm season (Bear Hunter Diaries).

RESULTS

1995 AND 1996 BEAR HUNTER FIELD SURVEYS

Hunter Effort from Field Surveys

Hunter effort was measured as the number of hunters, the number of hounds on each chase, and length of each chase. The average number of hunters in each hunt ranged from 4.5 to 12.3. The average number of hounds used in each hunt range from 2.5 to 20.5, and the average length of a chase ranged from 0.1 to 3.5 hours (Tables 1-6).

During 1995 in the southwest study area, the mean number of hounds used, and the lengths of the 1st and 2nd chases in the bear-dog training season and the bear firearm season were not different ($\underline{P} > 0.1$; Table 1). However, more hunters hunted during the kill season ($\underline{P} = 0.05$; Table 1). On the northwest study area, all measures of effort for the bear-dog training season were similar to those for the bear firearm season ($\underline{P} > 0.1$; Table 1).

More hunters participated in hunts on the northwest study area during both the 1995 bear-dog training season and 1995 bear firearm season ($\underline{P} < 0.01$; Table 2) and more hounds ($\chi^2 = 5.26$, $\underline{P} = 0.03$) participated in the 3rd hunt on the NW study area. However, there was no difference in the number of hounds participating in the first and second chase or in the length of each chase between the two study areas ($\underline{P} > 0.1$; Table 2).

In 1996, hunting effort in the bear-dog training season was similar to that in the bear firearm season on the southwest study area ($\underline{P} > 0.1$) and the northwest study area ($\underline{P} > 0.1$; Table 3). Similarly, hunting effort within seasons, between study areas did not differ ($\underline{P} > 0.1$; Table 4). In both the northwest and southwest study areas, hunting effort during the bear-dog training season was the same in 1995 and 1996 ($\underline{P} > 0.1$), with the exception that more hunters participated in hunts on the southwest study area during the 1996 bear-dog training season ($\chi^2 = 6.07$, $\underline{P} < 0.01$; Table 5). I detected no between year differences in hunting effort during the bear firearm seasons of 1995 and 1996 ($\underline{P} > 0.1$; Table 6). Hunter effort in 1995 and 1996 was not combined because we were interested in documenting any between year differences in effort.

Hunter Success from Field Surveys

Hunting success, measured in terms of bears chased or treed, during the bear-dog training season was not different from hunting success during the bear firearm season in 1995 or in 1996, ($\underline{P} > 0.10$; Tables 7 & 9). In the 1995 bear- dog training season, hunting success on the 2 study areas was similar ($\underline{P} > 0.20$), with the exception of higher success in chasing the 1st bear on the NW study area, ($\chi^2 = 4.22$, $\underline{P} < 0.04$; Table 8). In the 1995 bear firearm season, hunting success on the 2 study areas was similar ($\underline{P} > 0.20$; Table 8), with the exception of percent that treed a bear ($\underline{P} = 0.008$; Table 8). In the 1996 bear-dog training season and bear firearm season, hunting success between study areas was not different ($\underline{P} > 0.10$; Table 10). I found no between year differences in hunting success during the bear-dog training season (Table 11) or the bear firearm season (Table 12) on either study area ($\underline{P} > 0.10$).

Overall hunting success was determined for every chase that was attempted. In the 1995 bear-dog training season, on the southwest study area, 55% of hunts resulted in a chase, and a bear was treed in 28% of all attempted chases (Table 7). In the 1995 bear firearm season, 60% of hunts resulted in a chase and a bear was treed in 10% of all attempted chases. A bear was harvested in 5% of all chases that were attempted on the SW study area in 1995 (Table 7). During the 1995 bear-dog training season on the northwest study area, 77% of hunts resulted in a chase and a bear was treed in 25% of all attempted chases. During the bear firearm season, 71% of hunts resulted in a chase and a bear was treed in 50% of all attempted chases. A bear was harvested in 18% of all chases that were attempted on the NW study area in 1995 (Table 7). In 1996, on the southwest study area, a bear was chased in 56% of attempts during the bear-dog training season; a bear was treed in 24% of all attempted chases (Table 9). During the bear firearm season, a bear was chased 76% of the time, treed 47% of the time, and harvested in 18% of all

Table 1. Comparison of hunting effort between the bear-dog training season (chase) and the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1995.

Measures of hunter effort	Southwest study area					Northwest study area				
	n[1]	chase season[3]	n[1]	kill season[3]	P[2]	n[1]	chase season[3]	n[1]	kill season[3]	P[2]
number of hunters	24	4.5	15	6.6	0.05	44	10.0	21	11.7	0.24
number of hounds 1st chase	25	6.6	16	8.4	0.13	44	7.9	21	6.2	0.13
number of hounds 2nd chase[4]	9	7.4	2	2.5	-	25	7.2	9	9.8	0.50
number of hounds 3rd chase[4]	5	4.8	1	6.0	-	6	12.3	2	10.5	-
length of 1st chase(hrs)	25	1.0	14	1.9	0.12	44	1.5	21	1.6	0.65
length of 2nd chase(hrs)[4]	8	1.3	2	-	-	24	1.9	8	0.9	0.20
length of 3rd chase(hrs)[4]	5	2.0	1	3.5	-	5	0.8	2	0.1	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 2. Comparison of hunting effort during the bear-dog training season (chase) and the bear firearm season (kill) between the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1995.

Measures of Hunter effort	Bear-dog training season					Bear firearm season				
	n[1]	SW study area[3]	n[1]	NW study area[3]	P[2]	n[1]	SW study area[3]	n[1]	NW study area[3]	P[2]
number of hunters	24	4.5	44	10.0	0.0001	15	6.6	21	11.7	0.006
number of hounds 1st chase	25	6.6	44	7.9	0.32	16	8.4	21	6.2	0.15
number of hounds 2nd chase[4]	9	7.4	25	7.2	0.74	2	2.5	9	9.8	-
number of hounds 3rd chase[4]	5	4.8	6	12.3	0.03	1	6.0	2	10.5	-
length of 1st chase(hrs)	25	1.0	44	1.5	0.11	14	1.9	21	1.6	0.49
length of 2nd chase(hrs)[4]	8	1.3	24	1.9	0.42	2	-	8	0.9	-
length of 3rd chase(hrs)[4]	5	2.0	5	0.8	0.60	1	3.5	2	0.1	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 3. Comparison of hunting effort between the bear-dog training season (chase) and the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1996.

Measures of hunter effort	Southwest study area					Northwest study area				
	n[1]	chase season[3]	n[1]	kill season[3]	P[2]	n[1]	chase season[3]	n[1]	kill season[3]	P[2]
number of hunters	29	6.7	12	6.8	0.97	34	8.5	9	12.3	0.35
number of hounds 1st chase	29	8.0	12	12.3	0.07	34	9.3	9	8.1	0.62
number of hounds 2nd chase[4]	8	11.4	5	9.6	1.0	8	9.0	5	7.0	0.88
number of hounds 3rd chase[4]	3	5.0	-	-	-	2	20.5	3	3.0	-
length of 1st chase(hrs)	29	1.9	12	1.3	0.94	34	1.5	9	1.6	0.72
length of 2nd chase(hrs) [4]	8	0.8	5	0.8	0.82	8	1.1	5	0.7	0.87
length of 3rd chase(hrs) [4]	3	0.5	-	-	-	2	0.5	3	0	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 4. Comparison of hunting effort during the bear-dog training season and the bear firearm season between the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1996.

	Bear-dog training season					Bear firearm season				
Effort	n[1]	SW study area	n[1]	NW study area	P[2]	n[1]	SW study area	n[1]	NW study area	P[2]
number of hunters	29	6.7[3]	34	8.5[3]	0.11	12	6.8[3]	9	12.3[3]	0.15
number of hounds 1st chase	29	8.0	34	9.3	0.92	12	12.3	9	8.1	0.20
number of hounds 2nd chase[4]	8	11.4	8	9.0	0.49	5	9.6	5	7.0	0.35
number of hounds 3rd chase[4]	3	5.0	2	20.5	-	-	-	3	3.0	-
length of 1st chase(hrs)	29	1.9	34	1.5	0.67	12	1.3	9	1.6	0.97
length of 2nd chase(hrs)[4]	8	0.8	8	1.1	0.55	5	0.8	5	0.7	0.82
length of 3rd chase(hrs)[4]	3	0.5	2	0.5	-	-	-	3	-	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 5. Comparison of hunting effort during the bear-dog training season (chase) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, between 1995 and 1996.

Measures of hunting effort	Southwest study area					Northwest study area				
	n[1]	1995[3]	n[1]	1996[3]	P[2]	n[1]	1995[3]	n[1]	1996[3]	P[2]
number of hunters	24	4.5	29	6.7	0.01	44	10.0	34	8.5	0.46
number of hounds 1st chase	25	6.6	29	8.0	0.25	44	7.9	34	9.3	0.93
number of hounds 2nd chase	9	7.4	8	11.4	0.27	25	7.2	8	9.0	0.40
number of hounds 3rd chase[5]	5	4.8	3	5.0	-	6	12.3	2	20.5	-
length of 1st chase(hrs)	25	1.0	29	1.9	0.27	44	1.5	34	1.5	0.45
length of 2nd chase(hrs)[4]	8	1.3	8	0.8	0.63	24	1.9	8	1.1	0.10
length of 3rd chase(hrs)[4]	5	2.0	3	0.5	-	5	0.8	2	0.5	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 6. Comparison of hunting effort during the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, between 1995 and 1996.

Measure of hunting effort	Southwest study area					Northwest study area				
	n[1]	1995[3]	n[1]	1996[3]	P[2]	n[1]	1995[3]	n[1]	1996[3]	P[2]
number of hunters	15	6.6	12	6.8	0.94	21	11.7	9	12.3	0.67
number of hounds 1st chase	16	8.4	12	12.3	0.27	21	6.2	9	8.1	0.68
number of hounds 2nd chase	2	2.5	5	9.6	-	9	9.8	5	7.0	1.00
number of hounds 3rd chase[5]	1	6.0	-	-	-	2	10.5	3	3.0	-
length of 1st chase(hrs)	14	1.9	12	1.3	0.55	21	1.6	9	1.6	0.89
length of 2nd chase(hrs)[4]	2	-	5	0.8	-	8	0.9	5	0.7	0.45
length of 3rd chase(hrs)[4]	1	3.5	-	-	-	2	0.1	3	-	-

[1] number of hunts.
[2] Wilcoxon Rank Sum test.
[3] average value.
[4] 2nd and 3rd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 7. Comparison of hunting success between the bear-dog training season(chase) and the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1995.

Measures of hunter success	Southwest study area					Northwest study area				
	n[1]	chase season[2]	n[1]	kill season[2]	P	n[1]	chase season[2]	n[1]	kill season[2]	P
Percent Chased[3]										
1st bear	25	48	16	63	0.36[6]	44	73	21	67	0.62[6]
2nd bear	10	60	3	33	0.56[7]	24	83	8	63	0.33[7]
3rd bear	5	80	1	100	-	5	80	5	100	1.00[7]
Percent Treed[3]										
1st bear	25	28	16	13	0.44[7]	44	23	21	33	0.36[6]
2nd bear	10	30	3	0	0.53[7]	24	29	8	63	0.12[7]
3rd bear	5	20	1	0	-	5	20	5	100	0.14[7]
Percent Harvested[3]										
1st bear	-	-	16	6	-	-	-	21	5	-
2nd bear	-	-	3	0	-	-	-	3	0	-
3rd bear	-	-	1	0	-	-	-			-
% chased a bear[4]	40[5]	55	20[5]	60	0.71[6]	73[5]	77	34[5]	71	0.29[6]
% treed a bear[4]	40[5]	28	20[5]	10	0.19[7]	73[5]	25	34[5]	50	0.06[6]
% harvest a bear[4]	-	-	20[5]	5	-	-	-	34[5]	18	-

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 8. Comparison of hunting success during the bear-dog training season (chase) and the bear firearm season (kill) between the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1995.

Measures of hunter success	Bear-dog training season					Bear firearm season				
	n[1]	SW study area[2]	n[1]	NW study area[2]	P	n[1]	SW study area[2]	n[1]	NW study area[2]	P
Percent Chased[3]										
1st bear	25	48	44	73	0.04[6]	16	63	21	67	0.79[6]
2nd bear	10	60	24	83	0.20[7]	3	33	8	63	-
3rd bear	5	80	5	80	1.00[7]	1	100	2	100	-
Percent Treed[3]										
1st bear	25	28	44	23	0.63[6]	16	13	21	33	0.25[7]
2nd bear	10	30	24	29	1.00[7]	3	0	8	63	-
3rd bear	5	20	5	20	1.00[7]	1	0	2	100	-
Percent Harvested[3]										
1st bear	-	-	-	-	-	16	6	21	5	1.00[7]
2nd bear	-	-	-	-	-	3	0	8	25	-
3rd bear	-	-	-	-	-	1	0	2	0	-
% chased a bear[4]	40[5]	55	73[5]	77	0.02[6]	20[5]	60	34[5]	71	0.57[6]
% treed a bear[4]	40[5]	28	73[5]	25	0.74[6]	20[5]	10	34[5]	50	0.008[6]
% harvest a bear[4]	-	-	-	-	-	20[5]	5	34[5]	18	1.00[7]

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 9. Comparison of hunting success between the bear-dog training season (chase) and the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1996.

Measures of hunter success	Southwest study area					Northwest study area				
	n[1]	chase season[2]	n[1]	kill season[2]	P	n[1]	chase season[2]	n[1]	kill season[2]	P
Percent Chased[3]										
1st bear	29	62	12	75	0.49[7]	34	71	9	56	0.44[7]
2nd bear	8	63	5	80	1.00[7]	8	75	5	40	0.29[7]
3rd bear	3	67	0	-	-	2	100	3	0	-
Percent Treed[3]										
1st bear	29	24	12	42	0.29[7]	34	9	9	56	0.95[7]
2nd bear	8	38	5	60	0.59[7]	8	13	5	0	1.00[7]
3rd bear	3	33	0	-	-	2	50	3	0	-
Percent Harvested[3]										
1st bear	-	-	12	8	-	-	-	9	0	-
2nd bear	-	-	5	40	-	-	-	5	0	-
3rd bear	-	-	0	0	-	-	-	3	0	-
% chased a bear[4]	40[5]	56	17[5]	76	0.31[6]	44[5]	73	17[5]	41	0.02[6]
% treed a bear[4]	40[5]	24	17[5]	47	0.15[6]	44[5]	11	17[5]	29	0.12[6]
% harvest a bear[4]	-	-	17[5]	18	-	-	-	17[5]	0	

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 10. Comparison of hunting success during the bear-dog training season and the bear firearm season between the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, 1996.

Measures of hunter success	Bear-dog training season					Bear firearm season				
	n[1]	SW study area[2]	n[1]	NW study area[2]	P	n[1]	SW study area[2]	n[1]	NW study area[2]	P
Percent Chased[3]										
1st bear	29	62	34	71	0.48[6]	12	75	9	56	0.40[7]
2nd bear	8	63	8	75	1.00[7]	5	80	5	40	0.52[7]
3rd bear	3	67	2	100	-	0	-	3	0	-
Percent Treed[3]										
1st bear	29	24	34	9	0.17[7]	12	42	9	56	0.67[7]
2nd bear	8	38	8	13	0.57[7]	5	60	5	0	0.17[7]
3rd bear	3	33	2	50	-	0	-	3	0	-
Percent Harvested[3]										
1st bear	-	-	-	-	-	12	8	9	0	1.00[7]
2nd bear	-	-	-	-	-	5	40	5	0	0.44[7]
3rd bear	-	-	-	-	-	0	0	3	0	-
% chased a bear[4]	40[5]	56	44[5]	73	0.32[6]	17[5]	76	17[5]	41	0.04[6]
% treed a bear[4]	40[5]	24	44[5]	11	0.06[6]	17[5]	47	17[5]	29	0.29[6]
% harvest a bear[4]	-	-	-	-	-	17[5]	18	17[5]	0	0.23[6]

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 11. Comparison of hunting success during the bear-dog training season (chase) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, between 1995 and 1996.

Measures of hunter success	Southwest study area					Northwest study area				
	n[1]	1995[2]	n[1]	1996[2]	P	n[1]	1995[2]	n[1]	1996[2]	P
Percent Chased[3]										
1st bear	25	48	29	62	0.30[6]	44	73	34	71	0.84[6]
2nd bear	10	60	8	63	1.00[7]	24	83	8	75	0.63[7]
3rd bear	5	80	3	67	-	5	80	2	100	-
Percent Treed[3]										
1st bear	25	28	29	24	0.77[6]	44	23	34	9	0.13[6]
2nd bear	10	30	8	38	1.00[7]	24	29	8	13	0.54[7]
3rd bear	5	20	3	33	-	5	20	2	50	-
Percent Harvested[3]										
1st bear	-	-	-	-	-	-	-	-	-	-
2nd bear	-	-	-	-	-	-	-	-	-	-
3rd bear	-	-	-	-	-	-	-	-	-	-
% chased a bear[4]	40[5]	55	40[5]	56	0.50[6]	73[5]	77	44[5]	73	0.63[6]
% treed a bear[4]	40[5]	28	40[5]	24	1.00[6]	73[5]	25	44[5]	11	0.08[6]
% harvest a bear[4]	-	-	-	-		-	-	-	-	

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 12. Comparison of hunting success during the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, between 1995 and 1996.

Measures of hunter success	Southwest study area					Northwest study area				
	n[1]	1995[2]	n[1]	1996[2]	P	n[1]	1995[2]	n[1]	1996[2]	P
Percent Chased[3]										
1st bear	16	63	12	75	0.69[7]	21	67	9	56	0.69[7]
2nd bear	3	33	5	80	0.46[7]	8	63	5	40	0.59[7]
3rd bear	1	100	0	-	-	2	100	3	0	-
Percent Treed[3]										
1st bear	16	13	12	42	0.10[7]	21	33	9	56	0.42[7]
2nd bear	3	0	5	60	0.20[7]	8	63	5	0	0.08[7]
3rd bear	1	0	0	-	-	2	100	3	0	-
Percent Harvested[3]										
1st bear	16	6	12	8	1.00[7]	21	5	9	0	1.00[7]
2nd bear	3	0	5	40	0.46[7]	8	25	5	0	0.49[7]
3rd bear	1	0	0	0	-	2	0	3	0	-
% chased a bear[4]	20[5]	60	17[5]	76	0.29[6]	34[5]	71	17[5]	41	0.07[6]
% treed a bear[4]	20[5]	10	17[5]	47	0.02[6]	34[5]	50	17[5]	29	0.29[6]
% harvest a bear[4]	20[5]	5	17[5]	18	0.32[6]	34[5]	9	17[5]	0	0.54[7]

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st, 2nd, or 3rd chase of the day), the % success.
[4] for every chase attempted (1st, 2nd, & 3rd chase of the day) throughout the season, the % success.
[5] overall chance of having a successful hunt.
[6] Chi-square goodness of fit test.
[7] Fisher's exact test.

Table 13. Characteristics of bears harvested during the bear firearm season (kill) in the southwest and northwest study areas of the Cooperative Alleghany Bear Study, Virginia, in 1995 and 1996.[4]

Characteristics of harvested bears	Southwest study area				Northwest study area			
	1995 season		1996 season		1995 season		1996 season	
	n[1]	%[2]	n[1]	%[3]	n[1]	%[2]	n[1]	%[3]
% Males	1	100	3	67	3	100	-	-
% Females	1	0	3	33	3	0	-	-
% ear tagged	1	100	3	100	3	67	-	-
% radio-collared	1	0	3	0	3	0	-	-
Average weight	1	170	3	224	3	191	-	-

[1] number of bears harvested.
[2] percent or average value in 1995.
[3] percent or average value in 1996.
[4] includes only bears observed being harvested by a research team member.

attempted chases. A bear was chased in 73% of attempts and treed 11% of the time during the northwest's bear-dog training season (Table 9). During the bear firearm season in the northwest, a bear was chased 41% of the time and treed 29% of the time. None of the hunts we accompanied harvested a bear in the 1996 bear firearm season in the northwest study area (Table 9).

Characteristics Of Harvested Bears From Field Surveys

In the 1995 bear firearm season, all 3 bears harvested during our field surveys in the NW study area were males; harvested bears averaged 191 lbs., and 2 of the 3 harvested bears were marked with an ear tag. In the SW study area, the single bear harvested was a male, marked with an eartag and weighing 170 lbs. In the 1996 bear firearm season, no bears were harvested when we accompanied hunters in the NW, but in the SW, 2 of the 3 bears harvested were ear-tagged males, averaging 224 lbs. (Table 13). The one female that was harvested was 8 years old, weighed 158 lbs., and had 4 cubs in 1995. This bear was radio collared in the 1995 trapping season and dropped her collar in September of 1996. The hunters did not observe cubs with the bear.

1995 BEAR HUNTER SURVEY

I mailed 762 surveys to bear hunters in 1995. Thirty were undeliverable and 532 (73%) hunters returned their surveys. Two hundred and forty-one of the 532 respondents (45%) were bear hunters who used hounds to hunt bears in the 1995 bear firearm season.

Response rates from each of the 3 categories of hunters sampled were as follows: 75% of the members of the Virginia Bear Hunters Association, 100% of bear hunters that CABS personnel accompanied during the bear-dog training season and the bear firearm season, and 20% of the hunters that were randomly selected from the list of hunters who harvested a bear in 1993 and 1994. Three percent of the respondents' association was not known. Only hunters who used hounds (N=241) were included in the following analyses.

Most of the hunts (33.5%) occurred on the northwest study area even though the survey was sent to hunters throughout Virginia: 23.4% hunted in Rockingham County and 10.1 % in Augusta County. Fewer survey respondents hunted in the southwest study area: 5.4% hunted in Giles County, 4.8% in Craig County, and < 4% in Montgomery County.

The average hunting party consisted of 10.4 hunters and on average, 8.4 hounds participated in the 1st chase. Bears were chased 53.1% of the time and 30.7% of bears chased were treed. During these chases, a bear was treed 2 times 20.0% of the time and 4.7% treed a bear 3 and 4 times. The average length of the 1st chase was 4.6 hours. Forty-four percent of treed bears were males, 16% were females, and 40% could not be identified by sex. A tag or

radio collar was not visible on 86.5% of bears treed, 11.5% were eartagged, and 2% were radio-collared. In 14% of all hunts, a bear was harvested (Table 14).

A second chase occurred in 27 of the 241 hunts (11.2%) with an average of 9 hounds involved in each chase. The average length of chase was 3.7 hours and the bear treed 8.7% of the time. Less than 1% of the second chases resulted in a bear treeing 3 times. When a 2nd bear was chased, 27% that treed were males, 15% were females and the sex of 58% was unknown. An eartag or radio collar was not visible to 96% of the houndsmen; 4% saw an ear tag. During the second chase a bear was harvested 19% of the time (Table 14).

Bears were harvested by members of all 3 categories of hunters sampled in the hunter survey. Houndsmen selected from the 1993 and 1994 harvest data, harvested 22 of the 34 bears (64.7%) that were involved in the 1st chase, and 4 of the 5 bears (80%) involved in the 2nd chase of the day. Members of the VBHA harvested 10 of the 34 bears (29.4%) that were harvested by the surveyed hunters during the 1st chase and 1 of the 5 bears (20%) harvested in the 2nd chase. Houndsmen that cooperated with CABS personnel did not harvest a bear, and 2 houndsmen whose association was unknown harvested the 1st bear they chased (Table 15).

1996 BEAR HUNTER DIARY

A letter asking houndsmen to volunteer to complete a bear hunter diary was sent to 611 houndsmen; 294 were members of the VBHA and 317 were randomly selected in the 1995 bear firearm season. Houndsmen that were found on both lists were sampled only once. Twenty-three percent of VBHA members (N=67) and 11% of houndsmen (N=35) that harvested a bear in 1995 volunteered to complete a diary, and thus received bear hunter diaries. The response rate was 59% or 60 diaries. Five were not used, because the hunters were unable to hunt this year. Thirty three (55%) of the diaries returned were completed by VBHA members, 21 (35%) were completed by hunters who harvested a bear in 1995 and were not members of the VBHA, and 6 (10%) were completed by hunters who were both members of the VBHA and harvested a bear in 1995. Diaries were not returned by 42 hunters; 25 (60%) were members of the VBHA, 14 (33%) harvested a bear in 1995, and 3 (7%) were members of the VBHA and harvested a bear in 1995.

The majority of hunts reported (N=829) in the bear hunter diary occurred on the southwest and northwest study areas of CABS, even though this diary was mailed to hunters throughout Virginia. Rockingham and Augusta County (NW study area) represented 32% of the hunts reported in the 1996-97 bear hunter diary. Craig, Giles, and Montgomery Counties (SW study area) represented 18.5% of the hunts reported in the bear hunter diary (Table 20). These findings were similar to the 1995 hunter survey.

The average hunting party in 1996 consisted of 10.5 hunters, and on average 7.5 hounds were used in the 1st chase (Table 16). Hunters spent, on average, 8 hours a day on each hunt, and hounds were involved in a chase or tracking a bear 4.2 hours (Table 16). The average time

the 1st bear was actively from a list of hunters that harvested a bear pursued by hounds was 2.4 hours. A bear was chased 73.9% of the time and 43.6% of all hunts treed a bear (Table 17). The 1st bear chased was treed more than once in 13.3% of the hunts and the 2nd bear was treed twice in 8.3% of the hunts (Table 17). When sex could be identified in 243 hunts, 65% of bears treed

Table 14. Summary of the results of the bear-dog hunter survey, in Virginia, 1995.

Characteristics of the 1995 bear firearm season	n[1]	mean	percent
number of hunters in each hunting party	241	10.4	-
number of hounds involved in the 1st chase	241	8.4	-
percent of times the 1st bear was chased	241	-	53.1
percent that treed			
the 1st bear	241	-	30.7
the 1st bear 2 times	127	-	20.0
the 1st bear 3 times	127	-	4.7
the 1st bear 4 times	127	-	4.7
length of 1st chase (hours)	241	4.6	-
percent of hunts that harvested the 1st bear	241	-	14.0
number of hounds involved in the 2nd chase	27	9.0	-
harvested			
percent of times a 2nd bear was chased	241	-	11.2
percent that treed			
a 2nd bear	241	-	8.7
the 2nd bear 2 times	241		0.8
the 2nd bear 3 times	241		0.8
length of 2nd chase (hours)	26	3.7	-
percent of hunts that harvested the 2nd bear	26	-	19.0
harvested			
percent of 1st bears that were			
male	113	-	44.0
female	113	-	16.0
ear tagged	113	-	11.5
radio collared	113	-	2.0
percent of 2nd bears that were			
male	26	-	27.0
female	26	-	15.0
ear tagged	26	-	4.0
radio collared	26	-	0

[1] number of hunters responding to each question.

Table 15. Number of bears killed by each group surveyed in the bear-dog hunter survey in Virginia, 1995.

Group	Number of hunters[1]	Number of bears harvested	
		1st chase[2]	2nd chase[2]
Hunters who killed a bear in 1993 or 1994	127	22	4
VBHA[3]	69	10	1
Cooperators[4]	15	0	0
Unknown	30	2	0
Number of bears chased that were harvested		Total =34	Total=5
Percent of bears chased that were harvested		27%	19%

[1] number of hunters that had the opportunity to harvest a bear.
[2] number of bears harvested.
[3] members of the Virginia Bear Hunters Association.
[4] hunters that CABS accompanies on bear hunts.

Table 16. Summary of hunting effort during the bear firearm season from the 1996-97 Bear Hunter Diary, Cooperative Alleghany Bear Study, Virginia, 1996.

Measure of effort	n[1]	mean[2]	SE
Number of hours hunters spent hunting	820	8.	0.09
Number of hours hounds spent hunting	792	4.2	0.11
Number of hunters in 1st chase	761	10.5	0.24
Number of hounds 1st chase	821	7.5	0.21
Number of hunters in 2nd chase	140	10.2	0.50
Number of hounds 2nd chase	138	8.0	0.44
Hours 1st bear pursued			
1st time chased (hrs)	796	2.4	0.09
2nd time chased (hrs)	103	0.56	0.12
3rd time chased (hrs)	33	0.35	0.11
Hours 2nd bear pursued			
1st time chased (hrs)	132	2.6	0.16
2nd time chased (hrs)	9	1.9	1.2
3rd time chased (hrs)	4	0.27	0.16

[1] number of hunters responding to each question.
[2] average value.

Table 17. Summary of hunting success during the bear firearm season from the 1996-97 Bear Hunter Diary, Cooperative Alleghany Bear Study, Virginia, 1996.

Measure of success	n[1]	percent
% chased 1st bear	828	73.9
% chased 2nd bear	139	96.4
% treed 1st bear	828	43.6
% treed 2nd bear	138	49.3
% harvested 1st bear	828	16.5
% harvested 2nd bear	140	21.4
% harvested 1st or 2nd bear	829	20.0
% treed the 1st bear once	828	30.4
% treed the 1st bear twice	828	8.5
% treed the 1st bear 3 times	828	3.0
% treed the 1st bear 4 times	828	1.8
% treed the 2nd bear once	829	8.2
% treed the 2nd bear twice	829	8.3

[1] number of hunts.

Table 18. Characteristics of bears that were treed during the 1996 bear firearm season, Cooperative Alleghany Bear Study, Virginia.[2]

Characteristics of the 1996 bear firearm season	n[1]	percent
percent of 1st bears of the day that treed and were male	243	65.0
percent of 1st bears of the day that treed and were female	243	35.0
percent of 2nd bears of the day that treed and were male	46	71.7
percent of 2nd bears of the day that treed and were female	46	28.3
percent of bears that were ear tagged	821	5.8
percent of bears that were radio collared	821	1.1
percent of harvested bears that were male (1st bear chased)	140	76.4
percent of harvested bears that were male (2nd bear chased)	34	79.4

[1] number of hunters responding to each question.
[2] data from the 1996-97 Bear Hunter Diary.

Table 19. Distribution of hunting effort throughout the bear firearm season from the 1996-97 Bear Hunter Diary, Cooperative Alleghany Bear Study, Virginia, 1996.

Distribution of effort	Number of hunts	Percent of Total	mean
Number of hunts 1st week of the season	226	27.3	-
Number of hunts 2nd week of the season	162	19.5	-
Number of hunts 3rd week of the season	136	16.4	-
Number of hunts 4th week of the season	133	16.0	-
Number of hunts 5th week of the season	172	20.7	-
Number of hunts	829	100	-
Average number of days hunters spent hunting during the season	-	-	13.8

Table 20. Distribution of hunting pressure by county during the bear firearm season from the 1996-97 Bear Hunter Diary, Cooperative Alleghany Bear Study, Virginia, 1996.

County	n[1]	percent
Rockingham[3]	205	24.7
Rockbridge County or WV	95	11.4
Botetourt	77	9.3
Craig[2]	75	9.1
Giles[2]	68	8.2
Augusta[3]	61	7.3
Alleghany	46	5.6
Page	40	4.8
Bedford	39	4.7
Bath[3]	33	4.0
Amherst, Bland, Highland, Madison, Nelson,	90	> 4.0
Montgomery[2], Roanoke, Tazewell, & Wythe	Total = 829	100
Nelson		

[1] Number of hunts.
[2] Counties within the SW study area of CABS.
[3] Counties within the NW study area of CABS.

Table 21. Comparison of hunting effort between field surveys, mail surveys, and bear hunter diary, Virginia, 1995 and 1996.

Measures of hunter effort	Field Surveys		Mail Surveys		Hunter Diary	
	n[1]	Mean[2]	n[1]	Mean[2]	n[1]	Mean[2]
number of hunters	188	8.3	241	10.4	761	10.6
number of hounds 1st chase	190	11.3	241	8.4	821	7.5
number of hounds 2nd chase[3]	188	8.0	27	9.0	140	10.2
length of 1st chase(hrs)	187	1.5	241	4.6	796	2.4
length of 2nd chase(hrs) [3]	69	3.0	26	3.7	132	2.6

[1] number of hunts.
[2] average value.
[3] 2nd chase starts after the bear trees and is chased again, or a different bear is chased.

Table 22. Comparison of hunting success between field surveys, mail surveys, and bear hunter diary, Virginia, 1995 and 1996.

Measures of hunter success	Field Surveys		Mail Surveys		Hunter Diary	
	n[1]	Percent[2]	n[1]	Percent[2]	n[1]	Percent[2]
Percent Chase[3]						
1st bear	190	65	241	53	828	74
2nd bear	71	69	241	11	139	96
Percent Treed[3]						
1st bear	190	24	241	31	828	44
2nd bear	71	31	241	9	138	49
Percent Harvested[3]						
1st bear	58	5	241	14	828	17
2nd bear	21	19	26	19	140	21

[1] number of hunts.
[2] percent value.
[3] for each separate chase attempted (1st or 2nd chase of the day), the % success.
[4] for every chase attempted (1st & 2nd chase of the day) throughout the season, the percent success.
[5] overall chance of having a successful hunt.

were males (Table 18). A bear was harvested by 16.5% of those that attempted a 1st chase and by 21.4% of those that attempted a 2nd chase (Table 17). Overall, a bear was harvested in 20% of all hunts (includes 1st and 2nd chases); males comprised 76.4% of the bears harvested from the first chase and 79.4% of the bears harvested from the second chase (Tables 17 &18). A treed bear's ear tag was visible in 5.8% of the hunts and a radio-collar was visible on 1.1% of the hunts (Table 18).

Hunter effort during the 5-week, bear-firearm season was distributed fairly evenly among weeks. However, when testing for differences(Chi Square Goodness of Fit test) among the 5 weeks of the harvest season, more effort was evident in the 1st, 2nd, and 5th A second chase occurred in 132 of the 829 (16%) hunts documented. Ten hunters and 8 hounds on average were involved in the 2nd chase (Table 16). The average time a 2nd bear was actively pursued by hounds was 2.6 hours (Table 16). A bear was chased 96.4% of the time that a 2nd chase was attempted and 49.3% of all hunts treed a bear (Table 17). When sex could be identified, 71.7% of bears treed were males (Table 18).weeks (P=0.001; Table 19). The average number of days hunters spent hunting during the 1996 bear firearm season was 13.8 days (Table 19).

COMPARISON OF 3 SURVEY METHODS

Reports of hunter effort were consistent in the 3 different surveys, with the exception of length of 1st chase; houndsmen that completed a bear hunter survey appeared to over estimate the length of their 1st chase (Table 21). However, reported hunter success rates were less consistent (Table 22). Fewer bears were reported harvested in field surveys than in the mail surveys or the hunter diaries, and fewer 2nd bears were reported chased and treed in mail surveys.

DISCUSSION

Field surveys indicated there were virtually no differences in hunting effort or hunting success between seasons, study areas, and years, although in some instances, this may be a function of sample size. We found some limitations in documenting effort through field surveys and the 1995 bear hunter survey. For instance, we were unable to determine hunter effort in terms of the length of time hunters spent hunting because the time bears were chased was different than the time hunters spent in the woods. The length of time each hunter was actually involved in the hunt varied and was nearly impossible to document. In addition, the length of chase should be considered as a measure of hound effort and not a measure of the actual length of time a bear was chased. Bears are rarely "jumped" immediately after the hounds are released on a track. Therefore, it can be hard to estimate exactly when a bear was "jumped", as hounds may go beyond hearing distance. Additionally, the use of hounds' barks as a method of determining when a bear has been "jumped" is subjective. "Length of chase" may be an index to how long a bear was chased, but it is likely an overestimate. Allen (1984), in Maine, found chases initiated by hounds locating a track lasted 3.5 hours. This was consistent with the estimates from the 1995 bear hunter survey, but longer than chases documented in the field surveys and the 1996 bear hunter diary.

DuBrock et al. (1978) surveyed bear hunters in Virginia to characterize bear hunting with hounds. They found that, on average, each hunter that owned hounds owned 4 hounds, had 11 hunters in their hunting party, and used between 2 and 35 hounds in a bear chase. Marchinton et. al. (1970) documented that the average number of hounds used in legal hunting of deer in the southeast, was 4. DuBrock's et al. (1978) and Marchinton's et. al. (1970) findings were consistent with the data in this study.

Houndsmen harvested a bear in the southwest study area in 5% and 18% of hunts and in the northwest study area in 9% and 0% of hunts in 1995 and 1996, respectfully. These houndsmen harvested 14% of the bears that they successfully chased and 24% of the bears that treed. Thus, the harvest rates of houndsmen that were accompanied by CABS personnel were consistent with the harvest rates reported in Michigan (17%) and New Hampshire's (18.6%) harvest surveys (Peyton 1989, Litvaitis and Kane 1994). However, harvest rates documented in the 1995 hunter survey and 1996 hunter diary were higher than in Michigan and New Hampshire. Houndsmen in mail surveys harvested 25% of the bears they chased and 40% of the bears that treed and houndsmen in the hunter diary harvested 23% of the bears they chased and 39% of the bears that treed. The low success rate (percent of bears chased that were harvested) in terms of harvest may reflect the selectivity of houndsmen (Litvaitis and Kane 1994, Peyton 1989, DuBrock et al. 1978, Hardy 1974, Poelker and Hartwell 1973, Willey 1972, and K. Higgins, pers. obs.). However, in order to harvest a bear when using hounds, a bear must be chased and most often a bear must be treed. Elowe (1990) reported that hounds in Massachusetts and Maine successfully treed a bear 30% of the time. Hounds released on radio collared bears in Wisconsin were unable to tree a single bear in 8 chases (Massopust 1984). In Maine, bears were treed in 9 of 22 chases

(41%) when first located by radio telemetry. When chased from baits, they were treed in 4 of 16 chases (25%), and when chased from tracking they were treed in 14 of 43 chases (32%; Allen 1984). Willey (1980) used hounds in Vermont to capture bears, and in 38 days of chasing only 10 bears were treed. These treeing rates were consistent with those observed in this study (Range = 5 to 63%).

To better document effort, the 1996 bear hunter diary specifically asked hunters what time they started hunting and what time they finished hunting, what time hounds were released and what time hounds finished chasing or tracking a bear, and length of time a bear was chased. Although these estimates are the best we have documented, they are still subjective. Hunters exerted the most effort (8 hrs.) in terms of time spent in the woods (looking for tracks before releasing hounds and looking for hounds once the chase finished), and hounds were actively hunting (4.2 hrs.) half as many hours as hunters. Bears were chased by hounds for only half as many hours as hounds were actually hunting (2.4 hrs; hounds may be released on a bear's track hours after the bear had walked there).

Response rate in the 1995 bear hunter survey was high (73%) and may indicate hunters' interest in the management of bears. Seventy-five percent to 85 % of bear hunters in Arkansas, 75% in Michigan, and 72% in New Hampshire responded to hunter surveys (Pharris and Clark 1987, Peyton 1989, and Litvaitis and Kane 1994). The lower response rate of the 1996-97 bear hunter diary (59%) may be due to the extra time and commitment that a hunter diary requires (S. McMullin, Va. Tech., pers. comm). The majority of respondents from the 1995 bear hunter survey and 1996 bear hunter diary, came from hunters who hunted within the NW and SW study areas, and/or were members of the VBHA. The high response rate of these hunters may be a result of the effort CABS personnel made in establishing a working relationship with the members of the VBHA and with hunters who hunt within the study areas of CABS.

Since Virginia does not have a separate bear hunting license, we were unable to target only bear hunters who used hounds. Under the current licensing structure, Virginia is able only to estimate the number of bear hunters within the state. In addition, check station check cards do not ask if hounds are used as a method of take in the bear firearm season. In 1995, the Virginia Department of Game and Inland Fisheries (VDGIF) included a check box for bear hunting with hounds as a method of kill on the bear tooth envelopes. However, mailing addresses for these hunters were not available, thus we were unable to sample only those hunters who used hounds as a method of take in the 1995 bear firearm season. Therefore, only bear hunters who used hounds, still hunted, or harvested a bear in the January deer muzzleloader season in 1995 were sampled in the 1996 Bear Hunter Diary.

The bear hunter diary appeared to be a reliable means of documenting hunter effort and success. It had the largest sample size of the 3 methods used and it documented distribution of effort throughout the season. However, it had a lower response rate than the hunter survey. Seventeen percent of houndsmen asked to complete a hunter diary volunteered to do so and only 60% of these houndsmen returned completed diaries. Therefore, < 10% of Virginia's houndsmen

were represented in the results of the hunter diary. The success rates documented in field surveys and the hunter diary were more consistent than in the mail survey, again lending greater reliability to field surveys and the diary. Field surveys were valuable as well, and they avoided hunter bias because CABS personnel collected the data. Additionally, the field survey allowed biologists to interact with hunters and experience hunting bears with hounds.

Currently, the VDGIF includes all bears harvested in the month of December in their estimate for hound hunter harvest rates. In December, bears can be taken with the use of hounds, stillhunting during late deer muzzleloader, and during the turkey season. Thus, the percent of bears taken by houndsmen in Virginia each year is likely over estimated. For Virginia to more clearly and accurately depict the impact of hunting bears with the use of hounds, the actual number of bears harvested each year by houndsmen should be determined. This could be accomplished by including this method of take on game check station check cards. To avoid errors made at check stations, hunters could be required to purchase a separate hunting license to hunt bears. This would also aid in identifying the number of bear hunters who use hounds in Virginia.

Hunting bears with hounds is a tradition in Virginia. Virginia may eventually be targeted by groups opposed to this method of hunting to close bear hunting with the use of hounds; thus, knowledge of houndsmen effort and success rates, as presented in this chapter, could help clarify issues related to this method of hunting should it become necessary. Although Virginia houndsmen were moderately successful in harvesting bears (≥ 11%), field surveys in 1995 and 1996, the 1995 bear hunter survey, and the 1996 bear hunter diary documented houndsmen harvesting a bear in ≤ 20% of their hunts. Houndsmen successfully chased a bear in approximately 60% of all hunts, treed approximately half of these bears, and harvested half of the bears that were treed. Since houndsmen were relatively successful in chasing a bear, it appears that using hounds is a distinct advantage. However, the low harvest rates demonstrate that hunters may be selective and that hounds are not used strictly to ensure that a bear is harvested. It is more likely that houndsmen enjoy working with their hounds similarily to duck hunters, upland game bird hunters, and rabbit hunters. Similar harvest rates have been documented in other states that use hounds to hunt bears (Peyton 1989 and Litvaitis and Kane 1994). If these harvest rates and the estimates of the proportion of males in the harvest are accurate, hunting bears with hounds likely has a minimal impact on the growth rate of Virginia's black bear population. Michigan and Idaho were successful in keeping game management in the hands of the game agencies in part because they possessed vital demographic data for bear populations in their states (Rice and Beecham pers. comm.). Data presented by other graduate students of CABS will aid VDGIF in gaining knowledge of the hunted bear population in Virginia.

RECOMMENDATIONS

We did not attempt to use hunter surveys to estimate hunter bias in harvest rates. Future surveys should ask houndsmen if they would harvest a bear if the bear had ear-tags and/or a radio-collar. In addition, hunter selectivity could be better estimated if we specifically asked hunters if they would harvest a female, if sex could be determined.

In addition, the VDGIF should be encouraged to investigate the idea of requiring bear hunters to purchase a separate bear hunting license. This would allow VDGIF to determine the number of bear hunters in Virginia and to have more control over the harvest. Also, check station check cards should document method of take, thus success of bear hunters can be determined by method of take. By altering the licensing and check card structure, the VDGIF will be able to document the number of bear hunters in the state and give the most accurate estimate of hunter effort and success rates. The VDGIF will then be able to provide scientific evidence to support the bear hunting practices in Virginia and assert their ability to manage bears for their continued existence for their intrinsic value as well as their value as a big game species.

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Chapter 2: Physical condition estimates for hunted and nonhunted black bear populations in Virginia.

The physical condition of individual black bears (*Ursus americanus*) can be an indicator of the health of bear populations, the quality of habitat bears use, or the impact of human induced stressors such as the use of hounds to hunt bears. Biologists have attempted to estimate physical condition of bears with external morphological measurements, physiological measurements, blood characteristics, and body fat and bone marrow fat measures (Poelker and Hartwell 1973, Schroeder 1987, Franzmann and Schwartz 1988, Hellgren et. al 1989, Cattet 1990, Farley and Robbins 1993, and Noyce and Garshelis 1994).

Schroeder (1987) and Cattet (1990) used external morphological measurements to estimate physical condition of live black bears in the field. However, the prediction equations developed by each have limitations. Schroeder (1987) used the ratio of body weight to total body length to estimate physical condition in black bears in California, but Cattet (1990) argued that Schroeder's index failed to account for differences in individual body shape. To account for differences in body shape, Cattet (1990) used a fat to non-fat ratio (FNF) to predict body weight. External morphological measurements from black and polar bears in Canada were used to calculate FNF. His equation included a measure of foreleg circumference, total body length, and age. However, he found that this ratio may not be a reliable estimate of physical condition in black bears because the observed and predicted FNF ratios differed (Cattet 1990). Noyce and Garshelis (1994) suggested that body weight alone may be a better morphological predictor of physical condition.

Estimating physical condition may be complicated by the extreme seasonal weight changes exhibited by bears. Bears gain weight rapidly in the fall by increasing their intake of carbohydrates and fat in preparation for denning (Brody and Pelton 1988). Fat utilization accounts for most of the body mass loss in hibernating black bears, and bears have been documented to lose 16 to 37% of their fall body weight (Nelson et al. 1973, Tietje and Ruff 1980, Hellgren et al. 1990). To better understand the utilization of fat and protein, biologists have used blood characteristics and fat deposition as indicators of physical condition. The use of serum chemistry (e.g. hematocrit (HCT), hemoglobin (Hb), and red blood cells (RBC) values) and hematological parameters (serum urea nitrogen (SUN), mean corpuscular volume (MCV), alkaline phosphatase (ALP), Phosphorus, and uric acid) were considered a reliable means of estimating physical condition when included with other measures of condition such as body weight or body fat indices (Schroeder 1987, Hellgren et al. 1993, Noyce and Garshelis 1994). However, in hibernating black bears, blood values may be unreliable because of the physiological and metabolic changes occurring during this period (Franzmann and Schwartz 1988 and DelGiudice et al. 1991). Therefore, blood characteristics in the fall may be the most appropriate

measure of condition (Franzmann and Schwartz 1988 and Hellgren et al. 1989). In addition, Harlow et al. (1990) found that serum progeseterone, cortisol, and serum glucose in black bears did not respond to handling stress, but responded to differences in the female reproductive state and fat utilization. Bioelectrical impedance analysis and isotopic water dilution were equally accurate measures of physical condition (Farley and Robbins 1993), but depth of anesthesia, inexperience of personnel using equipment, rainfall and extreme temperatures, hydration of bears, and any form of minor tissue trauma, can cause errors in these estimates (Farley and Robbins 1993).

We were interested in determining the physical condition of bears in the hunted population in Virginia as a means of assessing the direct physical effects of chasing bears with hounds. In Virginia, black bears are pursued by hounds as a method of hunting in December; they also are pursued in a separate nonlethal bear-dog training season in September. Some animal rights groups consider such methods of hunt unfair and unethical, and imply that chasing of bears may reduce physiological condition and/or reproduction and survival. Ballot initiatives have been used in some states to challenge the use of hounds to harvest bears. Knowledge of the physical condition of pursued bears may be useful in addressing the concerns of animal rights groups and the public. More importantly, this knowledge will be beneficial to the continued management of bear populations hunted in this manner.

Although available data do not support the notion that morphological measurements accurately depict physical condition (Dr. Charles Robbins, U. of Washington, pers. comm.), external morphological measurements often are the only form of data available for predicting physical condition. We measured physical condition ratios of hibernating female bears, because in most bear studies adult female bears are handled during the denning season, and because bears handled in the den are measured over a shorter time interval than those handled during a trapping season when bears are continually gaining weight.

In this chapter, I compare the physical condition of bears in hunted populations in Virginia to bears in nonhunted populations in Virginia (Shenandoah National Park and Great Dismal Swamp National Wildlife Refuge). I also compared reproductive success and survival rates of hunted bears(this study) to nonhunted bears (previous studies) in Virginia to give greater insight into the possible effects of using hounds to pursue bears.

Bears in SNP, in western Virginia, and GDS, in eastern Virginia, are considered nonhunted bear populations. Within both areas it is illegal to hunt bears by any method. However, hounds are unable to detect boundaries and occasionally enter these restricted areas. Thus, it can be argued that even though protected by law, bears in SNP and GDS are subject to chase. Hounds found within the boundaries of SNP may be confiscated by park rangers, and since houndsmen invest large amounts of money and time in their hounds, confiscation of hounds is likely a deterrent to releasing hounds near park boundaries. GDS harbors the only bear population in eastern Virginia where the harvest is about 10 bears per year. Thus, hound activities near GDS is at a much lower level than in western Virginia. In addition, physical

condition was determined for adult female bears, only and all adult female bears in SNP had entered dens by mid December (Carney 1985), and were unavailable to be chased for half of the bear firearm season. Morphological measurements used from SNP and GDS bears were taken prior to1992 when the bear-dog training season was initiated; thus these bears were not exposed to chases in September.

METHODS

Bears were trapped in Aldrich foot snares during June-August in 1995 and 1996 and immobilized with a intramuscular injection of a 2:1 mixture of ketamine hydrochloride/xylazine hydrochloride. Females >1 year old and males >100 lbs. and < 300 lbs. were radio-collared. In the southwest study area, radio collars were 150-151 MHz. (Wildlife Materials Inc., Carbondale, IL; and AVM Instrument Company, Champaign, IL). In the northwest study area, bears were equipped with either a 150-151 MHz or 164-165 MHz radio transmitter (Telonics, Inc., Mesa Az.). Each collar was attached with a cotton spacer breakaway device (Hellgren et al. 1989). An upper premolar was extracted from each bear to determine age from cementum annuli (Willey 1974).

Female bears with radio collars were handled again in March to determine reproductive success and to refit radio collars and replace cotton spacers. Various morphological measurements were taken on all bears handled during the den season. In the northwest study area where >80% of bears den in trees (Godfrey 1996), only bears that could be safely removed from tree dens and bears that denned on the ground were handled. Important measurements for physical condition estimation were body weight and total length (tip of nose to tip of tail bone, measured along the back).

We tested Schroeder's (1987) physical condition estimate [PCR-A = body wt. (kg)/ total body length (cm); tip of nose to tip of the tail bone measured along the back] with 42 adult female bears ≥ 7 years old from Maine's black bear study (McLaughlin et al. 1994). Most female bears in northern Maine do not produce cubs until they are 6 years old. Therefore, only females greater than 7 years old were considered adults (McLaughlin 1994). Bears in Maine are exposed to alternating years of fall hard-mast availability. We would expect PCRs in poor mast years to differ from those in good mast years and for this reason we used Maine's black bear study data to test the applicability of Schroeder's PCR as an indicator of condition. Female bears were separated into poor fall hard-mast crop years (N=10) and high fall hard-mast crop years (N=32; bears in Maine feed on beech, which is an alternate year crop). Body weights and total length measurements were taken during each den season. ANCOVA (adjusted for age) was not used to test for differences in PCRs and body weights because these data violated the assumption that the slopes are not different (slope of age vs. slope of PCR/wt; $\underline{P} = 0.03$). ANOVA was used on Schroeder's PCR-A equation and on body weight alone to determine if either accurately described the physical condition of northern Maine bears judged to be in either poor (low mast crop years) or good condition (high mast crop years) based on weight and prominence of ribs, backbone, and pelvis.

PCR and body weight of CABS bears were considered along with their survival rates (J. Higgins 1997) and reproductive rates (Godfrey 1996; northwest study area only) to aid in determining physical condition. Data on survival and reproductive rates of bears in the southwest study area were not available at the time of this analysis and so were not included in the hunted bear population estimates. Physical condition estimates of CABS bears were compared to bears in SNP (Carney 1985, Kasbohm 1994, and Schrage 1994) and GDS (Hellgren 1989), both nonhunted populations, to test for possible effects of hounds on the physical condition of hunted bear populations. Bears in the nonhunted bear populations were studied in different years and in different areas, and data were collected by different biologists than those in the hunted population. Thus, the reader should be aware that these comparisons have limitations and should be interpreted with caution.

Virginia bears were separated into 3 age groups for PCR analysis; yearlings, subadults (2 & 3 yrs. old), and adults (≥ 4 yrs. old). Most female bears in Virginia produce their first litter at 4 years of age and so bears ≥ 4 yrs. old were considered adults. The PCR in 1996 and 1997 for the NW and SW study areas were pooled after the Wilcoxon Rank Sum test found no differences in PCR between years or between study areas. The Wilcoxon Rank Sum test was used, instead of ANOVA, because the sample size of bears handled in dens each year and on each study area was small. Shenandoah National Park and Great Dismal Swamp National Wildlife Refuge PCR's were pooled based on the same analysis. The ANCOVA (adjusted for age) was not used to test for differences between the hunted and nonhunted bear populations' PCRs and body weights because these data violated the assumption that the slopes are not different (slope of age vs. slope of PCR/wt; $\underline{P} = 0.01$). A signifigance level of 0.05 for the above test was selected apriori .

In addition, during the 1996 bear-dog training season, 5 radio collared female bears were randomly selected from the southwest study area to be experimentally pursued by hounds. The bear-dog training season is a nonlethal season that occurs during the month of September. The main purpose of these experimental chases was to document movements of bears that are pursued by hounds (see Chapter 3). Three of the 5 females intentionally pursued by hounds were handled in March of 1997. One female dropped her collar in September and the other female left her den prior to our den handling season. The PCR and body weights of these 3 females are included in the average PCR and body weights of the hunted bear population estimates. The average PCR and body weights of these 3 bears also are listed in tables 25 & 27; however the sample size was too small for meaningful comparisons to the nonhunted bear populations of Virginia.

RESULTS

Test Of Schroeder's PCR

Adult female black bears from Maine (≥ 7 years old) exposed to poor fall mast crops had lower PCR's than those exposed to high fall mast crops ($F = 7.66$, $\underline{P} = 0.009$; Table 23). Den weights of adult females following good fall mast crops were higher ($F = 16.89$, $\underline{P} = 0.0002$; Table 23) than den weights of adult females following years of poor fall mast crops.

Table 23. A comparison of Schroeder's (1987) physical condition estimate and body weight for adult female bears[2] in poor fall mast crop years (even years) and high fall mast crop years (odd years) in Spectacle Pond study area, Maine[1], 1982-91.

	high fall mast			poor fall mast			
measure	Mean	SD	n	Mean	SD	n	P[3]
PCR	0.45	0.06	31	0.38	0.08	10	0.009
weight (kg)	69.84	9.69	32	53.78	12.8	10	0.0002

[1] data from Maine Dept. Inland Fish. & Wildlife bear study (McLaughlin et al. 1994).
[2] potential breeding females ≥ 7 years old.
[3] ANOVA.

Table 24. A comparison of physical condition ratios[1] of black bears in hunted (SW & NW study areas of CABS) and nonhunted populations (Great Dismal Swamp and Shenandoah National Park) of Virginia.

	Hunted pop.[2]			Nonhunted pop.[3]			
Age class & sex	$\bar{X}$ PCR[1]	SD	n	$\bar{X}$ PCR[1]	SD	n	P[4]
Yearling females	0.18	-	2	0.20	-	1	-
subadult females	0.25	-	2	-	-	-	-
adult females[5]	0.41	0.09	20	0.48	0.10	13	0.09
Yearling males	0.19	0.04	9	0.24	-	2	-
subadult males	0.24	-	1	0.35	-	1	-
adult males	0.45	-	1	0.37	-	1	-

1 Schroeder's (1987) PCR-A equation.
[2] physical condition ratios from 1995 & 1996 SW study area & 1994-96 NW study area.
[3] physical condition ratios only from females handled in dens; Carney (1985) 1982-85, Kasbohm (1994) 1988-90 Schrage (1994) 1990-93, and Hellgren (1989).
[4] Wilcoxon Rank Sum Procedure.
5 adults ≥ 4 years old.

Table 25. A comparison of physical condition ratios[1] of black bears intentionally pursued by hounds (SW study area of CABS) and nonhunted bears in Great Dismal Swamp and Shenandoah National Park,Virginia.

	Nonhunted pop.[2]			pursued bears[3]		
Age class & sex	$\bar{x}$ PCR[1]	SD	n	$\bar{x}$ PCR[1]	SD	n
adult females[5]	0.48	0.10	13	0.46	0.13	3

[1] Schroeder's (1987) PCR-A equation.
[2] physical condition ratios only from females handled in dens; Carney (1985) 1982-85, Kasbohm (1994) 1988-90 Schrage (1994) 1990-93, and Hellgren (1989).
[3] bears intentionally pursued by hounds in the SW study area of CABS in the 1996 September Bear-dog Training Season.
[4] Wilcoxon Rank Sum Procedure.
[5] adults ≥ 4 years old.

Table 26. A comparison of body weights of black bears in hunted (NW study area of CABS) and nonhunted regions (Great Dismal Swamp and Shenandoah National Park) of Virginia.

	Hunted pop.[1]			Nonhunted pop.[2]			
Age class &	$\bar{x}$ wt(kg)	SD	n	$\bar{x}$ wt(kg)	SD	n	P[3]
Yearling	18.83	-	2	19.95	-	1	-
subadult females	33.11	-	2	-	-	-	-
adult females[4]	63.13	14.38	20	75.43	18.31	13	0.09
Yearling males	21.21	5.75	9	25.85	-	2	-
subadult males	33.56	-	1	45.35	-	1	-
adult males	74.83	-	1	48.98	-	1	-

1 body weights from 1995 & 1996 SW study area & 1994-96 NW study area.
[2] body weights from Carney (1985) 1982-85, Kasbohm (1994) 1988-90 Schrage (1994) 1990-93, and Hellgren (1989).
[3] Wilcoxon Rank Sum Procedure.
[4] adults ≥ 4 years old.

Table 27. A comparison of body weights of adult female black bears[4] intentionally pursued by hounds (SW study area of CABS) and adult females from nonhunted populations (Great Dismal Swamp and Shenandoah National Park) of Virginia.

Nonhunted pop.[1]			Pursued bears[2]		
$\bar{x}$ wt(kg)	SD	n	$\bar{x}$ wt(kg)	SD	n
75.43	18.31	13	64.70	12.14	3

[1] physical condition ratios from Carney (1985) 1982-85, Kasbohm (1994) 1988-90 Schrage (1994) 1990-93, and Hellgren (1989).

[2] bears intentionally pursued by hounds in the SW study area of CABS in the 1996 September Bear-dog Training Season.

[3] Wilcoxon Rank Sum Procedure.

[4] adults ≥ 4 years old.

Table 28. Survival rates of black bears in hunted (NW study area of CABS) and nonhunted regions (Great Dismal Swamp and Shenandoah National Park) of Virginia.

	NW CABS[1]		Great		Shenandoah[5]		Shenandoah[6]		Shenandoah[7]	
Sex and age	Survival[2]	n[3]	Survival[2]	n	Survival[8]	n	Survival[8]	n	Survival[8]	n
Female adult	0.95	21-37	0.84	24	0.95	24	0.90	44	1.00	27
Female juvenile	0.90	9-14	-	-	-	-	-	-	-	-
Male adult	1.00	3-5	0.58	22	0.60	22	0.36	8	1.00	8
Male Juvenile	0.50	1-3	-	-	-	-	-	-	-	-
Cub (male & female)	0.64	5-18	75.4	14	-	-	0.73	40	0.65	17

[1] J. Higgins (1997) survival estimates for 1994 & 1995 NW study area based on Kaplan Meier and Heisey Fuller.
[2] average annual survival rate.
[3] sample size given as a range due to staggered entry of animals.
[4] Hellgren (1989) survival estimates for 1984-87 based on Heisey Fuller (1985) method for adults and juveniles, cub survival estimated from reduction in mean litter size from birth.
[5] Carney (1985) survival estimates for 1982-84 based Heisey Fuller (1985) method.
[6] Kasbohm (1994) survival estimates for 1985-90 of bears in defoliated areas based on Heisey Fuller (1985) method. Cub survival was estimated from reduction in mean litter size from birth for 1988-90 litters.
[7] Schrage (1994) survival estimates for 1990-93 based on Heisey Fuller (1985) method cub survival estimated from reduction in mean litter size from birth.
[8] maximum annual survival rates.

Table 29. Reproductive rates of black bears in hunted (NW study area of CABS) and nonhunted regions (Great Dismal Swamp and Shenandoah National Park) of Virginia.

Studies	litter size	n[6]	Age of 1st breeding	% breeding	% available breeders producing	n[7]
NW CABS[1]	2.0	21	2.5	67	82.6	46
Great Dismal[2]	2.1	12	3.5	67	-	-
Shenandoah[3]	2.0	21	2.5	33	-	
Shenandoah[4]	2.3	26	2.5	33	89.5	19
Shenandoah[5]	2.3	12	-	-	-	

[1] Godfrey (1996) reproductive estimates for 1994 & 1995 NW study area.
[2] Hellgren (1989) reproductive estimates for 1984-86.
[3] Carney (1985) reproductive estimates for 1982-85.
[4] Kasbohm (1994) reproductive estimates for 1988-90.
[5] Schrage (1994) reproductive estimates for 1990-93.
[6] number of litters.
[7] number of females available for breeding.

Physical Condition Estimates Of Hunted vs. Nonhunted Bears

The physical condition ratio ($Z = 1.72$, $\underline{P} = 0.09$) and weights ($Z = 1.70$, $\underline{P} = 0.09$) of adult female bears from Virginia exposed to hunting (N=20) did not differ from those not hunted (N=13;Tables 24 & 26). Although not statistically different at the 0.05 probability level, the calculated P values of 0.09 suggest these differences could be biologically meaningful. Due to the small sample size of all age classes of males, and yearling and subadult females, physical condition estimates for these sex and age classes were not compared between the hunted and nonhunted populations of Virginia's black bears.

Only 3 of the 5 bears pursued by hounds were visited in their dens, because one dropped her collar and another abandoned her den early and did not reden. Sample sizes were too small for statistical tests, but the PCR of these 3 adult female bears did not appear to differ from the PCR of the nonhunted population (Tables 25 & 27). Body weights, on the other hand, were 11kg less in hunted bears. Each of these bears was successfully chased only once. Two of the females produced litters of 4 and 2 cubs and the 3rd female had 2 yearlings with her.

Survival Rates

Survival rates of adult female bears in the northwest study area of CABS was numerically similar to adult female survival in the Great Dismal Swamp (GDS) and Shenandoah National Park (SNP;Table 28). Adult male survival in the northwest study area of CABS was numerically larger than survival of adult males in the GDS and SNP (Table 28), but the sample size in the CABS was very small ($n = 6$). Cub survival in the NW study area of CABS was numerically similar to the 1985-90 cub survival estimate in SNP, but was numerically smaller than the GDS's cub survival estimate and smaller than the SNP's 1990-93 cub survival estimate (Table 28).

Reproductive Rates

Godfrey (1996) found no difference in litter size between the northwest study area and Great Dismal Swamp or Shenandoah National Park (Table 29). Age of first breeding in the northwest study area also was numerically similar to the Great Dismal Swamp and Shenandoah National Park (Table 29). The percent of available breeding females that actually produced cubs each year was highest in SNP (Table 29).

DISCUSSION

Bears are legally hunted with hounds in many states, but despite the long tradition and popularity of this method of hunting, many animal rights groups and individuals believe pursuing bears with hounds is unethical and unfair. Few scientific studies have addressed the biological implications of pursuing wildlife species with hounds (Gavitt 1973; Harlow et al. 1990), and most of these studies have been concerned primarily with the effect of hounds on the movements of the species pursued (Progulske and Baskett 1958, Marchinton et al. 1970, Corbett et al. 1971, Sweeney et al. 1971, Allen 1984, Massopust and Anderson 1984). Although some suspect that chasing bears in the fall affects their reproductive and survival rates, none have investigated this possibility.

We tested Schroeder's (1987) physical condition equation with data from adult female bears in northern Maine and found that during years of abundant hard-mast, adult females, on average, had PCR values ≥ 0.40 ($\bar{x}$ = 0.45; range = 0.27 to 0.51) whereas in years of scarce hard-mast adult females, on average, had PCR values < 0.40 ($\bar{x}$ = 0.38; range = 0.35 to 0.59). During years of scarce beechnut abundance, bears in dens weighed significantly less than in years when beechnuts were abundant; thus we would expect these bears to have a lower PCR. Likewise, Elowe and Dodge (1989) reported a 25-40% decline in individual body weights of bears in years when fall mast was scarce.

Schroeder's PCR appeared to accurately depict differences in physical condition of bears in Maine between years of high and low food abundance. Although most would like to assign a numerical value to represent poor and good physical condition, it may be more accurate to use Schroeder's PCR as a means of comparing physical condition estimates between 2 or more populations, differing years and habitats, etc. When comparing PCR of northern Maine black bears during alternating years of fall food mast availability, we were able to detect a difference in PCR and body weight between good and poor food years. Reproductive data collected on northern Maine bears, after years of poor fall hard-mast exhibited low reproductive output (McLaughlin et al. 1994), which further supports the applicability of Schroeder's PCR.

Schroeder's PCR, however, may be somewhat insensitive since only bears that appeared close to starvation, based on the visibility of the rib cage, hips, and back bone (as in the case of some of the bears in northern Maine, in low hard-mast years), exhibited lower PCRs. Thus, external morphological measurements should be used cautiously and not as absolute estimates of physical condition. Instead, Schroeder's PCR and body weight may be used best as a means of comparing physical condition of 2 or more populations or the same population under differing conditions. The use of PCRs may be helpful in indicating the physical condition of the population studied.

Statistical comparisons of PCR and body weights, indicated that the physical condition of bears from the hunted population in Virginia was not different from the physical condition of bears in the nonhunted bear population. However, statistical comparisons of the physical condtion estimates had relatively low power, sample size was small (n < 25). Also, the p-values of 0.09 suggest that these comparisons may have some biologically meaningful differences. Body weights, in particular, were quite disparate with nonhunted bears 16% heavier than hunted bears. In addition, data on the hunted and nonhunted populations of bears were collected in different years and in different habitats, so these comparisons have limitations and should be viewed carefully.

The small sample size of all age classes of males, and subadult and yearling females was due to our inability to extract bears from tree dens, and in some years, male bears and adult females accompanied by yearlings did not use permanent winter dens.

Survival Rates

There may be many confounding factors that affect bear survival; however, survival rates of adult female black bears in Virginia seemed to be unaffected by hunting. Survival rates of adult females in the hunted population in Virginia were approximately the same as in the nonhunted bear populations (sources of mortality were vechile collisions and poaching) in Virginia. Hunting mortality is thought to be additive, and it is the major source of mortality in hunted populations (Rogers 1976, LeCount 1982, Schwartz and Franzmann, and J. Higgins 1997). But, in this study the high adult female survival rates may not truly reflect the additive nature of hunting and may instead, be a function of houndsmens'reluctance to harvest females. Survival estimates for juvenile and adult black bears in Virginia's hunted bear population (CABS NW study area) were either numerically similar to or numerically higher than the survival estimates in the nonhunted populations (GDS & SNP). Only the GDS and 1985-90 SNP cub survival estimates were numerically higher than cub survival estimates in the NW study area of CABS. It is difficult to make inferences regarding survival from CABS data because houndsmen are known to avoid harvesting females and radio collared bears. However, it appears that hunting may not be an additive source of mortality for adult females on our study areas.

It also may be that food availability plays a greater role in survival. Noyce and Garshelis (1994) suggested that March weights of lactating females should be $\geq$ 65kg for cubs to reach weights high enough to ensure their survival. Elowe and Dodge (1989), however, found highest cub mortality in years following abundant fall hard-mast crops and high cub production; in low mast years, only females feeding on corn produced litters, and cub mortality was low. McLaughlin et. al. (1994) found litter loss (absence of yearlings in sow's den) to be unrelated to fall hard-mast abundance. CABS has not investigated habitat quality or soft and hard mast availability, thus it is unknown if survival of CABS bears is influenced by the availability of mast crops.

Reproductive Rates

Reproductive parameters of the hunted bear population in George Washington-Jefferson National Forests in Virginia were similar to those in SNP and GDS, where bears are not hunted. It appeared that, regardless of any stress brought about by hunting, reproductive parameters were unaffected. More likely, habitat may have a greater influence on reproductive success. McLaughlin et al. (1994) in Maine found that only 4 of 30 adult females available to breed in years following scarce beechnut crops, produced litters. Elowe and Dodge (1989) in Massachusetts and Rogers (1976) in Minnesota also reported that few available breeders produced litters in years of scarce fall hard-mast.

We found no difference in mean litter size between the hunted bear population and the nonhunted bear population. However, litter size may not be an appropriate indicator of physical condition; McLaughlin et al. (1994) and Noyce and Garshelis (1994) reported that litter size was not affected by a female's body weight.

Age of first breeding may be related to physical condition. Some female black bears in the hunted population bred at 2.5 years of age and produced cubs at 3 years of age. In the nonhunted population, females were either 2.5 or 3.5 years old when they bred for the first time. Therefore, it would appear that hunting does not negatively influence the age of first breeding. In addition, hunters in Virginia feed bears an undetermined amount of supplemental food and this too may influence the age at which females first breed. McLaughlin et al. (1994) reported that age of first reproduction was later in northern Maine and may be due to lower body weights there as a result of the alternating years of hard-mast availability. In addition, Noyce and Garshelis (1994) found that bears weighing < 41 kg in March did not produce cubs the following year. Rogers (1976) suggested that adult females must be ≥ 67 kg in the fall in order to produce cubs that year.

Survival and reproductive parameters of the hunted bear populations in Virginia were consistent with those of the nonhunted bear populations in Virginia. However, we are reluctant to draw strong conclusions based on physical condition estimate comparisons ($\underline{P} = 0.09$); while not statistically significant at the 0.05 probability level (chosen a priori) there is still a 91 % chance that there is a real difference in physical condition estimates between the 2 populations. The differences may also have important biological significance. In additon, the small data set also suggests that caution should be used when drawing conclusions based on these comparisons. Survival and reproductive rates of the hunted and nonhunted bear populations may, along with body weights and PCR, be used to augment physical condition estimates of these populations.

Physical Condition Estimates Of Pursued Bears

It is likely that individual bears are repeatedly chased while others are seldom chased and may be unaffected by hounds. Harlow et al. (1992) found this to be true for cougars (*Felis concolor*). When CABS bears were intentionally pursued by hounds, hounds often had some difficulty in pursuing the intended bear; only 7 of 10 experimental chases resulted in the radio collared bear being chased. Thus, chasing bears with hounds likely impacts individual bears rather than the population. Even so, we found that winter body weights and PCRs of bears intentionally pursued by hounds, were not different from those of the nonhunted bear populations. However, the sample size of bears intentionally pursued by hounds, that were later handled in their dens, was small (N = 3). Data from the 1996 Bear Hunter Diary showed that bears were actively pursued by hounds for an average of 2.4 hours. In a typical chase, between 6 and 12 hounds were used (see Chapter 1).

Based on the results of the physical condition indices from external morphological measurements, reproductive rates, and survival rates, bears pursued by hounds appear in similar condition as those populations not pursued by hounds (SNP & GDS). It is likely that when individual bears are actively pursued by hounds they are stressed; however, the extent of chases or frequency of chases may be small enough to have marginal effects on the physical condition of these bears. Harlow et al. (1990) studied stress levels of black bears by collecting blood samples from bears trapped during the summer and from bears handled in the den. Harlow et al. (1990) investigated levels of serum progesterone because Plotka et al. (1983 reported that stress can

cause progesterone to be released into the blood stream. Serum progesterone levels in black bears during the summer trapping period (0.9 ng/ml; Harlow et al. 1990) were well below the levels indicative of stress in white-tailed deer (7.6 ng/ml; Plotka et al. 1983). These numbers suggest that bears do not respond to trap-related stress in the same manner as deer (Harlow et al. 1990). Serum glucose, cortisol, and progesterone in black bears in Colorado were similar in the den season and summer trapping period (Harlow et al. 1990), indicating that serum progesterone may not be a good measure of stress in bears. In addition, progesterone levels may not be a good indicator of pregnancy in female black bears. Progestrone levels did not reach the peak when the blastocyst implants as reported in other studies (Harlow et al. 1990). Cougars exhibit higher plasma cortisol levels than most mammals, but suprisingly, adrenal response was depressed when they were pursued by hounds (Harlow et al. 1992). Cougars exhibit higher plasma cortisol levels than most mammals, but suprisingly, adrenal response was depressed when they were pursued by hounds (Harlow et al. 1992). Results of these studies, plus the similarity of the physical condition estimates of Virginia's hunted bear populations to those of the nonhunted bear population suggest that the effect of pursuing bears with hounds may be negligible. However, documentation on the adrenal response of pursued bears would give greater insight into the effects of hounds on bears.

It is also important to consider that habitat conditions differed between the hunted and nonhunted bear populations and data were collected in different years and by different personnel. Comparisons of physical condition may be affected by differences in data collection and habitat, as well as by the differences in hunting pressure between the NW and SW study areas of CABS. Results from the 1995 bear hunter survey and the 1996 bear hunter diary (see Chapter 1), showed that approximately twice as many houndsmen hunted in the NW study area of CABS as in the SW study area. Simultaneous data collection on hunted and nonhunted bear populations and the addition of blood analysis and body fat indices would better demonstrate the effects of hounds on bear populations.

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CHAPTER 3: Short-term movements of black bears pursued by hounds

Few studies have determined movements of animals pursued by hounds in relation to their home ranges. In the southeastern United States, deer, intentionally pursued by hounds, were forced out of their home ranges, but normally returned within a day (Progulske and Baskett 1958, Marchinton et al. 1970, Corbett et al. 1971, Sweeney et al. 1971, Gavitt 1973). Sealander et al. reported that 69% of deer pursued by hounds in mountainous terrain of Arkansas left their home range for 1 to 3 days. All of these studies, except Progulske and Baskett's (1958) in Missouri, released hounds near radio collared deer. Similarly, hounds have been used to pursue radio collared black bears. In Wisconsin, 13% (n=8) of black bears pursued by hounds, moved out of their home range (Massopust 1984), while 53% (n=28) of black bears in Maine left their home range when pursued by hounds (Allen 1984).

Hunting bears with hounds is a tradition in Virginia, and 40-50% of bears harvested in Virginia each year are shot after being treed by hounds during the bear firearm season in December. Black bears also may be pursued by hounds from the 1st Saturday in September to the 1st Saturday in October during the bear-dog training season. During the bear-dog training season, hunters can not carry a gun or harvest a bear. It is strictly a season in which hunters can legally train their dogs to "run" bears.

Virginia's first bear-dog training season in 1992 coincided with an apparent increase in the incidence of bears killed by automobiles. Many conservationists in Virginia believed this was a direct result of the initiation of the bear-dog training season and voiced their concern to the Virginia Department of Game and Inland Fisheries. Consequently, when CABS was initiated, one objective of the study was to examine the impact of hunting bears with hounds. To accomplish the objective, we documented movements of radio collared bears during the bear-dog training season.

Reiffenberger (1974) in West Virginia, Hamilton (1978) in North Carolina, Brown (1980) in West Virginia, and Villarrubia (1982) in Tennessee studied the effects of roads on hunted populations of bears and all concluded that bears avoided roads. However, Brody and Pelton (1989) determined that hunted bears in North Carolina did not avoid roads. Instead, the low hunter success rate they observed may have been a result of bears avoidance of humans (who commonly use roads). Brad Allen (Wildlife biologist, Maine Dept. Fish. & Wildl., pers. comm.) suggested that bears that are forced out of their home range, into unfamiliar territory, are more easily treed by hounds and may cross roads and may be more vulnerable to other forms of mortality. This chapter discusses the movements of 5 radio collared female bears that were intentionally pursued by hounds during the bear-dog training season.

METHODS

Radio collared bears were located 1 to 3 times a week from the ground with hand- held H-antennas and receivers (Telonics Inc., Mesa, AZ.). Telemetry locations were taken between 0600 and 2400 hours. At least 3 bearings were taken within a 30 minute period from fixed points (telemetry stations) along roads within the study area. Telemetry stations were assigned Universal Transverse Mercator (UTM) coordinates using a self-correcting Global Positioning System (GPS). Telemetry bearings were plotted on USGS 7.5 minute maps and assigned UTM coordinates. Locations used in home range analysis required that 2 of the 3 bisecting angles formed by the 3 bearings be at least 30° and 1 of the bisecting angles to be greater than 35°(White and Garrott 1990). Aerial locations were attempted 1 to 2 times per month from fixed-wing aircraft with directional H- antennas mounted on each wing.

Five female black bears were selected randomly from the southwest study area of CABS to be pursued by hounds during the 1996 bear-dog training season. Two bears were 2.5 year old females with the potential to produce their 1st litters in January, 1 was a 7.5 year old lone female, and 2 bears, 5.5 and 17.5 year old females, were accompanied by cubs. The experimental design called for chasing each bear twice during the month of September, but only 2 bears were chased twice; 2 were chased once and 1 was never chased.

Ground telemetry was used to walk hunters and their hounds (usually English crosses) to the vicinity of the radio collared bear. When the strike dog(s) picked up the bear's trail, telemetry was used to verify that the track belonged to the intended bear. Hounds were not released until the track was verified. Hunters were asked to hunt in the manner they would hunt if this bear had not been located by telemetry. I , along with the hunters, followed the hounds and the bear using ground telemetry, and the sounds of hounds barking to map the route of the bear and hounds. A technician positioned along the nearest road, used telemetry to monitor and record the movements of the pursued bear. Hunter effort and success was estimated for each of the experimental chases.

Telemetry error for ground and aerial locations was calculated from radio locations of known den sites and from locations of test radio collars placed throughout the study area. Error ellipses were determined for ground telemetry using Andrew's maximum likelihood estimator (Lenth 1981; White and Garrott 1990). Error ellipses of ≤ 75 ha were considered acceptable for home range analysis (J. Higgins 1997).

Home range was estimated from non chase telemetry locations for 4 of the 5 experimentally chased bears using the bivariate normal ellipse method (Jennrich and Turner 1969) with the computer program RANGES V (Institute of Terrestrial Ecology, Dorset, England). Although the minimium convex polygon method (MCP) is the most common method used for home range analysis, it often requires 30 or more locations (Institute of Terrestrial Ecology, Dorset, England). Only 1 of the 5 bears monitored had 30 or more locations. Instead, the bivariate normal ellipse method was used to estimate home range because it is stable with few locations. Due to the limited number of radio locations, seasonal home ranges could not be calculated; instead, total home ranges were estimated. Incremental area analysis (Ranges V)

determined if the total home range estimate for each bear had an adequate number of locations. Only 4 of the bears chased had the adequate amount of locations necessary for home range analysis.

Locations taken during experimental chases were analyzed separately using the bivariate normal ellipse method. Movements were plotted for each chase and then were overlayed on each bear's original home range estimate to determine how much of a bear's home range was used by each bear pursued by hounds.

Due to the small sample size of telemetry data, differences in home range estimates between years was tested using the Kruskal-Wallis test with the protected LSD option to determine if data could be pooled. No difference ($P > 0.05$) was found between the 1995 and 1996 home range estimates for the 5 study bears, so telemetry data were pooled.

The multiple rate permutation procedure (MRPP; Mielke and Berry 1982) using program BLOSSOM (Midcontinent Ecological Science Center) was used to determine if the sets of locations taken during the experimental chases came from the same distribution as locations taken for home range estimation. In addition, the distance bears moved was calculated by using error ellipse's to estimate coordinates for each radio location taken. The sum of the distances between each location was used to determine the total distance each bear moved while being pursued by hounds.

RESULTS

Characteristics of chases of radio located bears

Bears located by us for houndsmen were successfully pursued by hounds in 7 of 10 attempted chases. Two bears were experimentally chased once and 2 bears were experimentally pursued twice; 1 bear was never pursued. Bear S1 was pursued only once before she dropped her radio collar. Bear S87 was never directly pursued by hounds (hounds pursued another bear's track), but she did move when the hounds began pursuit of another bear in her vicinity. The average number of hunters and hounds involved in the experimental chases was 6.0, and 9.9, respectively. The average chase lasted 0.9 hours (Table 30). Bears were chased in 5 of 7 first chases of the day and bears treed in 3 of these chases. When a 2nd or 3rd chase was attempted, (ie. the bear left the 1st tree before hounds could be collected, and bear treed again) hounds were successful in chasing and treeing these bears ($n = 3$, $n = 2$, respectively; Table 31).

Home Range Estimation

The average error calculated for ground locations was ±10.8 degrees and aerial locations was 1,570 m. Aerial locations, which normally were used to verify the status of a bear rather than give an accurate location, were not included in home range analysis because the error was large.

One bear, ID # S112, was not included in the analysis. Bear S112, used an unroaded area consisting of steep mountainous terrain and was never accurately located from the ground during experimental chases or for home range determination. The average total home range determined

Table 30. Summary of hunting effort of experimentally pursued adult female black bears in the southwest study area of the Cooperative Alleghany Bear Study, Virginia, 1996.

Measures of hunter effort	n[1]	Mean	SD
# of hunters[2]	7	6	3.3
# of dogs 1st chase[2]	7	13.1	6.9
# of dogs 2nd chase[2]	3	10	3.5
# of dogs 3rd chase[2]	2	6.5	0.7
length of 1st chase(hrs)[2]	7	1.1	1.0
length of 2nd chase(hrs)[2]	3	1.4	1.8
length of 3rd chase(hrs)[2]	2	0.1	0.04
# of dogs in all chases[3]	12[4]	9.9	6.4
length of all chases(hrs)[3]	12[5]	0.9	1.2

[1] number of hunts.

[2] effort rate for each chase attempted.

[3] overall effort rate.

[4] overall number of attempts at having a successful hunt.

[5] length of chase is measured in hours.

Table 31. Summary of hunting success of experimentally pursued adult female black bears in the southwest study area of the Cooperative Alleghany Bear Study, Virginia, 1996.

Measures of hunter success	n[1]	Percent
Proportion chased on 1st attempt[2]	7	71
Proportion chased on 2nd attempt[2]	3	100
Proportion chased on 3rd attempt[2]	2	100
Proportion treed on 1st attempt[2]	7	43
Proportion treed on 2nd attempt[2]	3	100
Proportion treed on 3rd attempt[2]	2	100
Proportion of chases that were successful[3]	12[4]	83
Proportion of chased bears that treed[3]	12[4]	67

[1] number of hunts.

[2] chance of finding success if a chase is attempted.

[3] overall chance of success.

[4] overall number of attempts at having a successful hunt.

Table 32. Comparison of home range estimates and movements of experimentally pursued adult female black bears in the SW study area of CABS, Virginia, 1996.

Bear ID	Bear age	Repro. status[4]	N[1]	Total HR[2]	N[1]	Area traversed during chases[3]	Distance moved (km)	Time pursued (hrs.)
S1	5.5	yearlings (?)	19	13.6 km^2	3	2.1 km^2	1.4	0.5
S25	17.5	yearlings (2)	5	31.0 km^2	5	5.0 km^2	4.1	1.8[5]
S25	17.5	yearlings (2)	5	31.0 km^2	-	-	-	1.0
S41	7.5	cubs (4)	31	8.6 km^2	3	21.4 km^2	3.1	2.8
S87	2.5	cubs (2)	6	18.2 km^2	-	-	-	0.8[6]
S112	2.5	unknown	-	-	-	-	-	2.8
S112	2.5	unknown	-	-	-	-	-	3.5

[1] Number of fixes.
[2] Bivariate Normal Ellipse method (HR = home range).
[3] area traveled when bears were experimentally pursued, bivariate normal ellipse method.
[4] in 1997 den.
[5] S25's male cub was chased and treed.
[6] disturbed by hounds, thus length of time is estimate based on time of telemetry locations.

Table 33. Home range stability of 3 experimentally pursued adult female black bears in the SW study area of the Cooperative Alleghany Bear Study, Virginia, 1996.

				MRPP	
Bear ID	Bear Age	Repro. status[3]	% Overlap[2]	N[1]	P[4]
S1	5.5	yearlings (?)	5.6	22	0.0007
S25	17.5	yearlings (2)	11.8	10	0.21
S41	7.5	cubs (4)	79.7	34	0.81

[1] Number of fixes.
[2] Bivariate Normal Ellipse method.
[3] in 1997 den.
[4] The probability of no difference in total home range and area traversed when pursued.

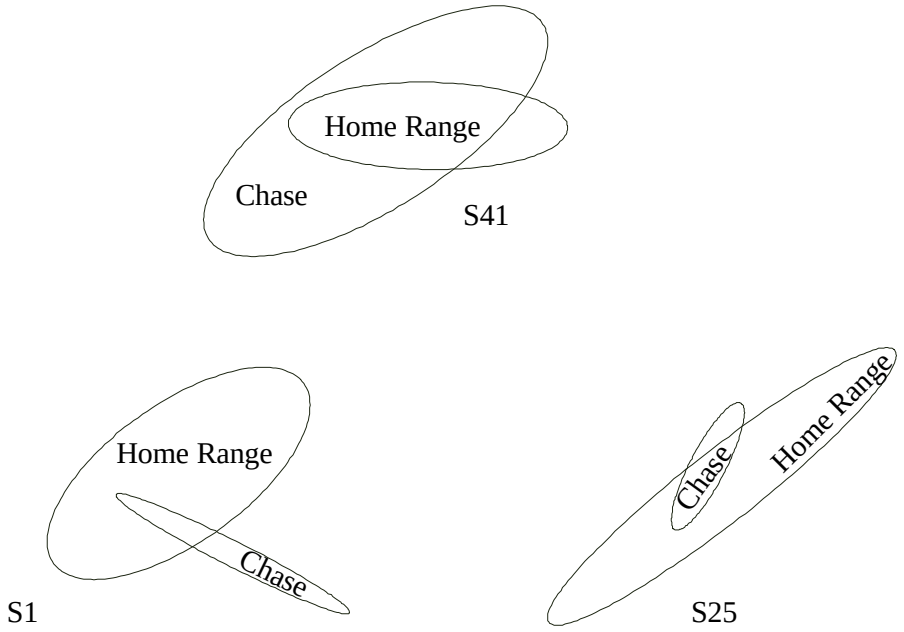

Figure 3. Degree of overlap between the total home ranges of bears S1, S25, and S41 and the area used by these bears during experimental chases, George Washingion-Jefferson National Forest, VA 1996. Home range estimated with the bivariate normal ellipse (Jennrich and Turner 1969).

by the bivariate normal ellipse for 4 (adult females) of the 5 pursued bears was 17.8 km^2 (Table 32). When these bears were intentionally pursued by hounds, bears used an average area of 9.4 km^2(N=3; Table 32).

Home Range Overlap and Stability

Chases were monitored for only 3 of the 5 adult females experimentally chased. Bear S1, used only 5.6% of her home range when pursued by hounds whereas bear S25 and S41, used 11.8% and 79.7% of their home range, respectively ($P > 0.20$; Table 33 & Figure 3). Only one of the 3 female black bear's total home range differed from the area used when experimentally pursued by hounds ($\underline{P} \leq 0.05$) based on the MRPP test (Table 33).

Movements

The 5 randomly selected female bears were chased by hounds in 6 of 10 attempted chases. These bears traveled an average of 2.9 km when pursued by hounds (Table 32). In 4 of 7 chases (57%), bears traveled in straight routes; 43% were circuitous. Three of 7 chases (43%) resulted in a bear crossing a road. Two bears (S41 and S112) crossed seldom used U.S. Forest Service dirt roads, and 1 bear (S1) crossed a paved road with a 45 mph speed limit (not within her home range).

DISCUSSION

Characteristics of experimental chases

Radio collared bears intentionally pursued by hounds in Maine treed 41% of the time. Chases lasted 2.5 hours for bears that failed to tree and 1.4 hours for bears that treed (Allen 1984). This study's treeing rate (3 of 7 bears treed) and estimate for length of chase (range from 0.1 to 1.4 hours) was consistent with Allen's findings.

Home Range Estimation

It is difficult to compare home range estimates from other states and studies because of between area differences in home range estimators, sample size, habitat, bear densities, and food abundance and distribution. Average total home range estimates of adult female bears in this study ($\bar{x}$ = 17.8 km^2) fell within the range of home range estimates from Alberta, Shenandoah National Park, VA, Manitoba and Great Dismal Swamp, VA, Great Smoky Mountains National Park, TN, and Arkansas (range 12.0 to 29.1 km^2; Young and Ruff 1982, Garner 1986, Klenner 1987, Hellgren 1988, Garshellis and Pelton 1981, Smith and Pelton 1990). Adult female home range estimates in other states in the southeastern United States were numerically smaller (not tested statistically) than estimates in the hunted regions of Virginia. For instance, adult females in the Great Smoky Mountains National Park, Tennessee occupied 15 km^2 (Garshelis and Pelton 1981) whereas adult females in Arkansas occupied 12 km^2 (Smith and Pelton 1990). Adult females' home ranges were greatest in Idaho and Pennsylvania (range 37 to 49 km^2; Amstrup and

Beecham 1976, and Alt et al. 1976). The average total home range estimate found in this study falls between these estimates. However, due to the small sample sizes of telemetry locations and the number of adult females used to estimate home range, it is likely that home range size estimated for the 5 study bears may not be a true representation of adult female bear's home range in this study area. Also, the bivariate normal ellipse method, (although more accurate for small sample size) tends to overestimate home range sizes (White and Garrott 1990). Adult females in the northwest study area of CABS, and in Montana, Washington, and Minnesota, occupied the smallest home ranges (range 5.2 to 9.6 km^2; J. Higgins 1997, Jonkel and Cowan 1971, Poelker and Hartwell 1973, Rogers 1977), and may be the most consistent with bears in the southwestern study areas of CABS. However, until home range estimation becomes a primary goal of CABS, the home range estimate of the 3 female black bears in this study can not be validated.

Movements in Relation to Home Range

Home range overlap analysis (Bivariate Normal Ellipse) and the MRPP test found that in 2 of 3 chases (67%), bears used most of their home range when experimentally pursued by hounds. Corbett et. al (1971) in North Carolina and Sweeney et al. (1971) in South Carolina, Florida, and Alabama found 70% and 78%, respectively, of deer pursued experimentally, left their home range. In observed chases of deer in Missouri, hounds appeared to move deer out of their home range (Progulske and Baskett 1958). In 53% of chases in Maine, bears pursued intentionally remained within their home range (Allen 1984). Only 1 of 9 bears that left their home range did not return the same day.

When deer were experimentally pursued by hounds, deer ran approximately 3.8 km (Marchinton et al.1970, Corbett et al. 1971). In 3 experimental chases of 2 female bears in Wisconsin, bears ran an average distance of 6.2 km (Massopust and Anderson 1984). The 3 female bears chased in this study ran an average distance of 2.9 km, almost half as far as the 2 Wisconsin bears. This difference in the length of chase may be a result of a 5 dog limit in Wisconsin. Virginia doesn't have a limit on the number of hounds and this likely puts more pressure on the bear to tree. Also, in the areas where these chases occurred in Virginia, steep mountainous terrain is prevalent. Allen (1984) observed that bears pursued by hounds were twice as likely to run in a straight line as in a circuitous manner; we observed similar results.

Adult female bears pursued by hounds in this study moved over 2 times as far as the normal daily movements reported for female black bears in Idaho and Manitoba (0.9 km and 1.2 km, respectively; Amstrup and Beecham 1976, Klenner 1987). Adult males in Alberta, on average, moved 1.7 km/day (Young and Ruff 1982).

Results of 7 experimental chases of 5 different female black bears suggests that bears in southwest Virginia avoid heavily traveled roads. On 2 of 3 occasions where bears crossed Forest Service roads while being pursued, they crossed roads that were crossed in their normal daily movements (K. Higgins, pers. obs.). While pursued bears traveled at a faster rate and covered a greater distance than in their normal daily movements, these bears did not cross roads

of heavy traffic volume. Route 460, a heavy traffic volume road was 4 to 12 miles from the start of each chase. However, none of the bears chased even attempted to run in the direction of Rt. 460.

It is important to note, that only female black bears were experimentally pursued by hounds in this study. Male black bears tend to occupy larger home ranges (Amstrup and Beecham 1976; Reynolds and Beecham 1980; Alt et al. 1980; Garshellis and Pelton 1981; Smith and Pelton 1990) and thus, travel greater distances than females. Therefore, when males are pursued by hounds they may have a greater risk of encountering roads with heavy traffic volume than the 5 female bears that were experimentally pursued in this study.

A radio collared male bear from this study was killed by an automobile during the 1995 bear firearm season. This bear appeared to move out of its home range during a time hounds were used to hunt bears. We did not monitor this particular chase and can not say for certain that hounds caused this movement.

Although 6 bears were chase, the number of chases we were able to monitor with radio telemetry (n=3) was very small. In addition, the number of radio locations for home range estimation also was small (range = 5 to 31). To more accurately depict movements of bears pursued by hounds and to determine more accurate home range estimates, greater effort should be spent on radio tracking bears during experimental pursuits and non chase months.

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