NEW HAMPSHIRE
BLACK BEAR ASSESSMENT
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Executive Summary

New Hampshire's black bears have recovered from a record low during the mid-1800s to a strong, healthy, record statewide population. The state's bear population was driven to low levels due to habitat loss caused by land use changes (e.g., land clearing practices for farming by early settlers) and because they were declared a pest species and persecuted for over 300 years (1600's through 1955) by earlier generations that settled the state. Bears were hunted and killed year round and bountied until 1955. Changes in land use, elimination of the bounty system in 1956 and adoption of regulations regarding bear harvest since 1951 have allowed bears to expand statewide, both in numbers and range. As bear populations grew, so did interest in bear hunting by the public. Bears were declared a big game species in New Hampshire in 1983. The Fish and Game Department was granted permanent authority to regulate the bear harvest and manage the population in 1985.

Since the late 1980s, bear management has been guided via formal management plans with specific population goals and objectives. The Department is currently operating under its third plan in as many decades and in the process of revising this plan for the period 2016-2025. Developing population goals and objectives that are clearly stated in a management plan to guide management actions has been an efficient way to manage bears and allowed for science-based decision making.

Since the mid-1990s, sex and age-at-harvest data from all documented bear mortalities have been used (in a variety of models) to estimate bear abundance and to monitor trends (growth or decline) in the population. Currently, the statewide bear population is estimated at 5,700 and regional populations are consistent with existing objectives in 3 of 6 management regions; two regions require a modest reduction in density and one region requires a slight increase.

The quantity and quality of bear habitat varies by management region. An estimated 88% (7,872 mi^2) of the total land area in the state represents bear habitat. The percentage of available bear habitat tends to decrease from north to south within the state and is inversely proportional to the extent of development. The suitability of land as bear habitat decreases as development increases.

Increased human densities result in the greater likelihood of conflicts between bears and humans and increases bear mortality. Prime black bear habitat is characterized by large,

unfragmented, undeveloped blocks of woodlands. Bear habitat becomes more fragmented from north to south within the state. New Hampshire has experienced rapid human population growth and associated development. Most population growth has, and will continue, to occur in the more southern portion of the state, however no part of the state is immune from this threat. Increased conflicts will lower the public's tolerance of bears which may result in a desire to decrease bear densities. A primary reason for striving to protect and maintain high quality bear habitat is because productive habitat with diverse foods will reduce the need for bears to supplement their diets with human-related food and create space where bears can live with minimized human contact.

A very active, cooperative bear/human conflict mitigation program has helped stabilize bear/human conflicts over the past decade. The key concept of this program is to educate the public on how to be proactive in avoiding conflicts with bears and has been a critical component to increasing public support and willingness to make change in an effort to avoid further conflict. Public attitudes towards bears (i.e., cultural carrying capacity) will dictate future bear population levels and this program will play a significant role in increasing/maintaining the public's willingness to accommodate bears on the landscape.

The core group of constituents that hunt bear (approximately 10,000) has grown over time and is expected to increase in the future, primarily because bear populations are strong and people get more interested in bear hunting when sightings are more frequent. Despite continued demand for bear hunting by various methods, the consumptive use of the bear resource continues to be threatened by social perceptions of the nonhunting community. It is very important that hunters promote a positive image of bear hunting and recognize that the methods they use may have low social acceptance by some segments of society. For example, houndsman, and to a lesser extent bait hunters, may be subject to public scrutiny, although both methods can play a role in bear management. Strong ethics and selectivity will make these hunting methods more defendable to a public that questions these hunting styles.

The ability to manage bear populations across a broad landscape will depend on hunter access and strong public support of hunting. Any activity that promotes commercialization or privatization of this public resource and land base will be detrimental to bear management and hunting. It is essential that bear populations do not exceed cultural carrying capacity; if bears become too numerous on the landscape, they will be less appreciated and devalued.

Introduction

The New Hampshire Fish and Game Department prepared this black bear species assessment to aid in decision-making during the Game Management Planning Process that will guide bear management during 2016-2025. Specifically, this assessment was designed to serve as a technical guide to assist constituents, stakeholders, interested members of the public, Commissioners and Department staff in understanding bear biology and management in New Hampshire, and their implications for formulating bear management goals and objectives for the next decade. This assessment uses the best data available on New Hampshire's black bear population and represents the collective judgment of the Game Management Team.

An Executive Summary summarizes the major points of the assessment. The Natural History section provides biological information on bears pertinent to their successful management. The Management section contains a history of regulations and regulatory authority, past management, past goals and objectives and current management. The Habitat and Population sections summarize past, present and projected conditions for New Hampshire's black bears. The Use and Demand section addresses historic, current and projected use and demand of the bear resource. Bears can be a complicated animal and their management, at times, is no different. Personal opinion can weigh heavy into bear management and decision-making can be clouded by bias. Nonetheless, bears are a valuable resource to the state and many user groups have a keen interest in their future management. It is hoped that the information provided in this species assessment allows well informed and scientifically sound decisions to be made.

Natural History

Description

Three species of bears inhabit North America including black (*Ursus americanus*), brown or grizzly (*Ursus arctos*) and polar (*Ursus maritimus*) bears (Jonkel 1978). The American black bear is the smallest and most widely distributed North American bear, and is the only species found in the eastern United States (Pelton 1982). Bears have a massive skull and a pointed head that is flat in profile (Bray and Barnes 1967, Willey 1978, Kolenosky and Strathearn 1987). The body of the black bear is bulky with short, stout legs and relatively large feet. Both front and back feet have five toes containing five short, narrow, recurved, nonretractile claws approximately one inch in length. Bears are plantigrade, walking flat on the soles of their feet

and are able to move with surprising speed up to 35 miles/hour, and are also strong swimmers (Willey 1978, Kolenosky and Strathearn 1987, Pelton 2003).

Adult black bears are sexually dimorphic in size with females typically smaller than males of the same age class. Adult females typically weigh 150-200 pounds, approach 5 feet in length and measure approximately 30 inches at shoulder height. Males generally weigh 250-350 pounds, reach lengths of 6 feet and average 40 inches at shoulder height. Despite sex-specific average weights, males and females weighing 750 and 300 pounds, respectively, have been documented (Willey 1978). Black bears are typically full-grown at 4 years of age (Pelton 2003).

The typical color phase of black bears in eastern states is black with a brownish muzzle; approximately 25% of bears have a white chest patch that varies between a large, V-shaped patch of white to only a few visible white hairs (Bray and Barnes 1967, Hatler 1980, Willey 1978, Kolenosky and Strathearn 1987, Pelton 2003). Other color phases do exist including variations from brown to almost white. In western states shades of brown, cinnamon and blonde are relatively common (Bray and Barnes 1967, Jonkel 1978, Kolenosky and Strathearn 1987, Pelton 2003). Although phase variations are less common in the east, brown-phase black bears have been reported in Pennsylvania, Maine and New Hampshire (Bray and Barnes 1967, Willey 1978, NHFG file data).

Black bears have acute hearing and well developed sense of smell; they have small, dark brown eyes that can distinguish color and provide detailed near-vision but poor distance vision (Willey 1978, Kolenosky and Strathearn 1987).

Distribution and Status

Historically, American black bears inhabited most of North America with the exception of non-forested areas including the barrens of Canada and the deserts of southwestern United States (Bray and Barnes 1967, Kolenosky and Strathearn 1987). During historic times, widespread eradication of bears by man, coupled with habitat loss due to land clearing and settlement, caused North American bear populations to decline significantly. Populations throughout much of the United States were eliminated or brought to very low levels by the late 19th century (Jonkel 1978, Pelton 1982). During the early twentieth century, farm abandonment perpetuated forest succession creating more ideal bear habitat. During recent decades, regulated harvest coupled with improved human tolerance has provided bear populations with increased

protection. Most bear populations are now considered big game and are closely monitored and regulated (Jonkel 1978).

Today, American black bears are found through much of Canada and the United States and their occupied range has been expanding in recent years (Pelton et al. 1999, Williamson 2002). American black bears presently occupy all provinces and territories of Canada (except Prince Edward Island) and 41 U.S. states (with occasional sightings in at least 3 others). During the past two decades, most American black bear populations have grown both in numbers and range. Sixty percent of jurisdictions report increasing populations, and all other populations appear to be stable or fluctuating (Garshelis and Hristienko 2006). Based on current estimates, the total U.S. population is estimated at 400,000 bears and the Canadian population is estimated at 450,000 for a combined North American population estimate of 850,000 bears (Garshelis et al. 2008).

Reproduction

Breeding among black bears occurs in summer and peaks in the latter part of June and July (Bray and Barnes 1967, Jonkel 1978, Kolenosky and Strathearn 1987, Pelton 2003). Females in estrus have been observed as early as late May and as late as mid-August. Females remain in estrus until bred or until the ovarian follicles begin to regress (Kolenosky and Strathearn 1987, Pelton 2003). During the breeding season, multiple matings may occur for both sexes (Kolenosky and Strathearn 1987, Pelton 2003). Initial breeding is necessary to induce ovulation (Pelton 2003). After breeding, bears exhibit a physiological adaptation where the fertilized egg is retained in the uterus and does not attach to the uterine wall until late November (delayed implantation). Development of the embryo is retained at the blastocyst stage until attachment to the uterine wall (Pelton 1982, Kolenosky and Strathearn 1987, Pelton 2003). Upon attachment of the blastocyst to the wall of the uterus, remaining fetal development occurs over a two-month period with cubs being born in the den during January or early February (Pelton 1982, Alt 1983, Kolenosky and Strathearn 1987, Pelton 2003). Cubs are born hairless, with eyes closed, measuring 6-8 inches in length, and weighting approximately 6-12 ounces (Kolenosky and Strathearn 1987, McLaughlin 1999, Pelton 2003). The sex ratio at birth is typically 50:50 (Pelton 1980, Kolenosky and Strathearn 1987, Elowe and Dodge 1989, Pelton 2003).

The reproductive success of females is related to the availability of high quality fall foods and the nutritional condition of females during that season. Females require fall foods that are high in fat and carbohydrates in order to achieve a minimum body weight that will support fetal development (Elowe 1987, Kolenosky and Strathearn 1987, Rogers 1987, Elowe and Dodge 1989, Pelton 2003). Abundant fall foods promote rapid weight gain as females and males may gain 0.5 and 1.5-2.0 pounds/day, respectively (Kolenosky and Strathearn 1987). If adequate energy reserves are not accumulated, the fertilized egg (blastocyst) may not implant or be reabsorbed, or cubs may be born but consumed by the mother (Sawaya et al. 2013).

When compared to other game animals, the breeding potential and reproductive capacity of black bears is considered relatively low. The age of sexual maturity and litter size is closely associated with habitat richness and food availability. Sexual maturity is typically attained between 2-4 and 2-5 years for females and males, respectively (Bray and Barnes 1967, Kolenosky and Strathearn 1987, McLaughlin 1999, Pelton 2003). In New Hampshire, 16, 34, 59 and 75% of harvested females had birthed cubs at age 2, 3, 4 and 5, respectively (NHFGD file data). Litter sizes range from 1-4 cubs, with 2-3 cubs being most common, and typically increase with age. One cub litters are common for first-time breeders. Females generally breed every other year, although early loss of a litter may allow females to breed and produce cubs in successive years (Bray and Barnes 1967, McLaughlin 1999, Pelton 2003). In New Hampshire, cub loss as late as late July has resulted in breeding and cub production in consecutive years (NHFGD file data). Cubs remain with the sow for about 18 months and disperse during spring-summer as yearlings.

Mortality

Black bear mortality varies by age class and is caused by several factors including, human activities (hunting, lethal removal due to bear/human conflicts, motor vehicle collisions, cub abandonment resulting from den disturbance), malnutrition, cannibalism and disease (Young and Ruff 1982, Pelton 1980, Pelton 1982, Elowe 1987, Kolenosky and Strathearn 1987, Rogers 1987, Elowe and Dodge 1989, Schwartz and Franzmann 1991, McLaughlin 1999, Pelton 2003). Mortality is higher for subadults compared to adults and higher in males than females. Black bears are capable of long life spans approaching 20-25+ years, however few bears in many, particularly hunted, populations reach 10-12 years of age (Pelton 1980, Pelton 1982, Kolenosky

and Strathearn 1987, Pelton 2003). In New Hampshire, the mean age of harvested bears over the past 10 years was 3.8 and 5.5 years for males and females, respectively (NHFGD file data).

Survival of cubs is closely related to the physical condition of the female, as cubs born to malnourished sows have a higher likelihood of mortality compared to cubs of well-nourished sows (Kolenosky and Strathearn 1987). In Ontario, cub mortality averaged 20% during most years but approached 50% during years with poor food production (Kolenosky and Strathearn 1987). Starvation was the leading cause of cub loss in Maine where mortality ranged from 17-42% (McLaughlin 1999). Cub mortality averaged 41% by one year of age in Massachusetts, where abandonment by the sow due to human disturbance at den sites, mostly due to dens located near houses or frequently used snowmobile trails, was the major cause of death for cubs prior to emergence from dens (Elowe 1987, Elowe and Dodge 1989). Cub mortality after den emergence was caused by abandonment due to death of the sow, disease, natural accident, motor vehicle collision and presumed cannibalism by the sow (Elowe 1987, Elowe and Dodge 1989). Human disturbance is likely a more significant cause of cub mortality in areas where bear populations are in close proximity to high human densities compared to bears in remote habitats. A major source of cub abandonment in New Hampshire in more recent years has been caused by sows being shot by homeowners due to conflicts (primarily for raiding unsecured chicken pens). The second leading cause of cub abandonment in New Hampshire is due to motor vehicle strikes (NHFGD file data).

The period of highest mortality (20 to ≥35%) occurs as bears disperse from their mothers as yearlings (Elowe and Dodge 1989, Pelton 2003). Yearling bears, specifically males, experience greater competition with older, more dominant bears as they secure feeding sites. Increased competition forces younger bears to travel more in search of food thereby increasing vulnerability. Additionally, increased movement causes greater contact with humans resulting in higher mortality from motor vehicle collisions, hunting and lethal removal due to conflicts (Elowe 1987, Elowe and Dodge 1989, NHFGD file data). Increased movement and competition results in increased natural mortality, including starvation and predation by dominant bears (Pelton 1980, Pelton 2003).

Subadult bears (2-3 years of age) remain susceptible to the same mortality factors experienced by yearlings including starvation, predation by dominant bears and human related mortality. Adults have higher survival compared to subadults (Elowe and Dodge 1989,

McLaughlin 1999, NHFGD file data). In Maine, survival of adult females approached 100% in the absence of hunting (McLaughlin 1999). Adults are able to survive periods of food scarcity by utilizing fat reserves whereas young bears allocate more food energy for body growth and less to fat storage causing them to be more susceptible to starvation during low food periods. Human-related mortality, specifically hunting, road kills and lethal removal due to conflicts, represent the principle mortality agents for adult bears (Warburton 1984, Pelton 2003, NHFGD file data).

Disease does not represent a major mortality agent in bears (Pelton 2003). Black bears are prone to various parasites but to a lesser extent compared to other mammals (Hatler 1967, Pelton 2003). Parasite infestations are more prevalent in southern portions of the United States, where increased temperature and humidity provide more ideal environments (Pelton 2003). Older bears, generally bears exceeding 15 years of age, may die due to dental problems (worn teeth, abscesses) but this does not appear to represent a major mortality factor (Pelton 1982, Pelton 2003). In New Hampshire, death from lysosomal storage disease, an inherited disease affecting metabolic processes, has been documented in a limited number of bears (NHFGD file data).

Black bears experience differential mortality with rates being higher in males compared to females (Elowe 1987, Pelton 1980, Elowe and Dodge 1989). Males have larger home ranges and are more mobile compared to females causing them to have increased contact with humans which results in greater exposure to mortality risks (Pelton 1980, Pelton 2003). At the time of family breakup, females occupy a portion of their mother's home range whereas males are forced to disperse. This results in young females having smaller home ranges, access to higher quality habitat and higher social status compared to young males. As a result of these factors, males experience higher mortality causing the adult sex ratio to be skewed towards females. In New Hampshire, average harvest rates are typically 2x higher for males (24%) compared to females (12%) and the adult sex ratio is estimated at 0.62 m:f (NHFGD file data).

Denning Behavior

Black bears avoid food shortages and severe winter weather by entering dens and remaining dormant. Black bears are classified as hibernators because they experience a change in both body temperature and heart rate during this process (Kolenosky and Strathearn 1987). However, bears differ from "true" hibernators, as bears may be easily aroused from this state if

disturbed. While bears are in winter dens, body temperature drops 7-8^{o}C, metabolism is reduced 50-60%, heart rate decreases from 40-50 beats/min to 8-19 beats/min and body weight decreases 20-27%; bears do not eat, drink, defecate or urinate during the denning period (Pelton 2003).

Den sites are generally selected in secure areas because birth and early maternal care of cubs occurs in dens. In northern areas, snow cover provides additional concealment and insulates against heat loss. Den types vary ranging between excavated ground nests, excavations under roots of standing trees, wind thrown trees and fallen logs, hollow logs either elevated or at ground level, rock cavities, slash piles and leaf nests at ground level (Lentz 1968, Jonkel 1978, Kolenosky and Strathearn 1987, Elowe 1984, Pelton 2003).

The duration of the denning period varies with latitude from several days in the southern United States to over 7 months in more northern areas. In New Hampshire, bears typically enter dens from mid-October to late November, and emerge during late March/early April (Kane 1989, NHFGD file data). The timing of den entry appears to be mostly dictated by fall food supplies, although local weather conditions (i.e., temperature, snow conditions) appear to have influence (Bray and Barnes 1967, Hatler 1980, Elowe 1984, Kolenosky and Strathearn 1987, Pelton 2003). During years when food is abundant, bears generally enter dens later compared to years when food is scarce. In New Hampshire, some bears are harvested during late November and early December in years with good acorn and/or beechnut production (NHFGD file data). Adult females, particulary those that are pregnant, generally den first, followed by subadults and adult males (Bray and Barnes 1967, Pelton 2003).

Increasing temperatures and day length during spring stimulates den emergence (Lindzey and Meslow 1976). Ambient temperatures ≥ 50 F for several days typically will cause bears to emerge from dens (Kolenosky and Strathearn 1987). Males generally are the first to emerge while females with cubs emerge last (Kolenosky and Strathearn 1987). Bears generally do not feed and maintain low levels of activity during the first 2 weeks following den emergence (Pelton 2003). This represents a physiological and behavioral adaptation by which bears adjust their digestive system from a period of extended inactivity (Pelton 2003).

Habitat

Black bears are highly adaptable and inhabit a variety of habitat types, however they are most closely associated with forested habitats. Forested habitats are necessary to meet various habitat requirements including space, food, water, cover and concealment (Lentz 1968, Miller

1975, Jonkel 1978, Pelton 1980, Kolenosky and Strathearn 1987). Prime black bear habitat is characterized by large, unfragmented, undeveloped blocks of woodlands (Lentz 1968, Miller 1975, Pelton 1980, Warburton 1984, Pelton 2003). Additionally, prime habitat contains terrain with high topographical variation that provides escape cover and security, areas with dense understory vegetation and a diversity of plant species that provide adequate soft and hard mast (Kolenosky and Strathearn 1987, Pelton 2003). Where black bears occur in western and southwestern portions of North America, prime habitat is restricted to vegetated mountainous areas and forested coastal plains (Lentz 1968, Miller 1975, Pelton 1980, Warburton 1984, Pelton 2003).

In several New Hampshire studies, bears exhibiting nuisance activity utilized residential areas for feeding but appeared to require adjacent woodlands within close proximity for travel, security and resting cover (Ellingwood 2003, Callahan 2010, Comeau 2013, Smith 2013). Black bears use a variety of cover types for denning including swamps, spruce-fir thickets and both hardwood and softwood stands under various forest management prescriptions (i.e., clearcuts, partial cuts, and mature stands; Lentz 1968, McLaughlin 1999). In northern New Hampshire, the majority of radio-collared bears denned in spruce/fir thickets located at altitudes ranging from 2,600 to 3,200 feet (Ellingwood 2003).

Food Habits

Food abundance influences black bear populations both directly and indirectly. Direct affects, including age-at-first reproduction, litter size and frequency of litters, are impacted by both quantity and quality of food resources (Pelton 1980). Food availability indirectly affects seasonal movements and mortality rates (Pelton 1980).

Black bears consume a wide variety of foods including both plant and animal matter and therefore are omnivores. The bulk of their diet consists of vegetation, but a small percentage of their diet consists of animal matter (Bray and Barnes 1967, Miller 1975, Hatler 1980, Pelton 1982, Pelton 2003). A large percentage of animal matter is obtained in the form of colonial insects and beetles (a significant source of animal protein), however various species of mammals, birds, amphibians and reptiles are also consumed (Bray and Barnes 1967, Miller 1975, Jonkel 1978, Hatler 1980, Pelton 1982, Kolenosky and Strathearn 1987, Pelton 2003). Black bears are not considered significant predators and likely feed on vertebrates in

opportunistic situations either as prey or carrion (Bray and Barnes 1967, Pelton 1982, Pelton 2003).

In some regions across their range, bears may be recognized as predators of ungulates, specifically the newborn young of deer (*Odocoileus spp*.), moose (*Alces alces*), caribou (*Rangifer tarandus*) and elk (*Cervus elaphus*) (Bray and Barnes 1967, Hatler 1967, Franzmann *et al*. 1980, Ozoga and Verme 1982, Boutin 1992). Currently in Pennsylvania, deer enthusiasts are concerned that bears are having a negative impact on deer recruitment and that state's management agency is implementing a study to assess purported impacts. The impacts of moose calf predation by bears on moose populations likely fluctuate by region due to variations in bear and moose densities (Boutin 1992). Studies from Quebec indicate that bear predation on moose calves averaged 5-15% (Boutin 1992). In New Hampshire, bears likely predate moose calves and deer fawns as opportunity arises. Although the impacts have not been quantified in New Hampshire, predation by bears does not appear to limit the population growth rate of New Hampshire ungulates.

The high percentage of vegetation consumed by bears results in diets that are high in carbohydrates and low in proteins and fats (Pelton 2003). Bears do prefer foods that have high protein and fat content that allows weight gain and enhances fecundity (Pelton 2003). Hard mast represents a protein and fat-rich food source that is available on a seasonal basis and used in high quantities when available. Annual fluctuations in food availability are common and of greater severity in northern areas due to shorter foraging seasons and decreased species diversity compared to southern areas (Kolenosky and Strathearn 1987). In northern New Hampshire, beechnut (*Fagus grandifolia*) crops historically were cyclical with even-numbered years having good nut production and odd years having poor production; during more recent years strong crops seem to occur every 3-4 years (NHFGD file data). Beechnuts represent the primary fall food source in these areas due to a relative lack of alternative sources of mast. When beechnut production is cyclic, and alternative foods are lacking, cub production may become cyclic as well with sows producing cubs in synchronized fashion, following good nut years (McLaughlin 1999). In more southern areas, acorns from Northern red oak (*Quercus rubra*) have a similar influence on reproduction. In New Hampshire, strong cub production has become very evident in years following abundant beechnut and acorn crops (NHFGD file data). In Massachusetts,

females with access to higher fat and carbohydrate mast crops had higher reproductive success compared to females with lower carbohydrate herbaceous fall diets (Elowe 1987).

Seasonal Food Sources and Associated Habitats

Spring represents a period when natural food supplies are low. Following den emergence bears continue to utilize stored body fat from the previous fall. This represents a time when bears may continue to lose weight (Miller 1975, Pelton 2003). Bears feed on the newly emerging herbaceous vegetation, including grasses (*Gramineae*), forbs and sedges (*Cyperaceae*) typically found around seeps, wetlands, clear cuts and agricultural areas. Buds and new leaves of aspen (*Populus spp*.), birch (*Betula spp*.) and maple (*Acer spp*.) are also important spring food sources and are found in both regenerating and mature hardwood stands. In years following good fall mast production, leftover mast including beechnuts, acorns and maple seeds represent important foods found in mature hardwood and mixed stands. Bears also frequent logged over areas, wooded edges and old fields where they feed on the larvae of colonial insects, specifically ants. In spring, bears may also search areas where deer or moose wintered (e.g., low and high elevation softwood stands) to feed on animals that died. Winter-killed moose or deer represent a valuable source of animal protein in early spring. Milk represents the primary food source for cubs until approximately June and becomes of less importance once summer foods become available in July and August (Elowe 1987).

The diet of the black bear becomes more diverse during summer due to vegetative growth and the production of soft mast. Colonial insects continue to represent an import source of animal matter in that season. Openings and early successional habitat types are important feeding areas because they support various fruiting vegetation including blueberries (*Vaccinium spp*.), raspberries and blackberries (*Rubus spp*.), strawberries (*Fragaria spp*.), elderberries (*Sambucus spp*.), serviceberries (*Amelanchier spp*.), dogwoods (*Cornus spp*.) and cherries (*Prunus spp*.). Wetland areas and adjacent shaded woodlands with rich soils remain important during summer due to the herbaceous vegetation found in these sites. Two preferred plant species found in these habitats include jewelweed (*Impatiens capensis*) and Jack-in-the-pulpit (*Arisaema triphyllum*). Bears feed on the stalk and leaves of jewelweed and the tuberous root of Jack-in-the-Pulpit.

Many of the soft mast species consumed during late summer remain an important component of the fall diet. Black and choke cherries are a highly preferred fall food and

typically are found along roadways, overgrown fields, field edges, riparian areas (particularly black cherry) and throughout select forested areas. Early successional habitats, such as regenerating clear cuts, remain important to bears during this time period due to the presence of soft mast including raspberries, blackberries and pin cherries. In high elevation forest stands, bears feed on berries of mountain ash (*Pyrus spp*.) during this season. Bears frequent old farmlands during fall where they feed on apples (*Malus spp*.) and hawthorn (*Crataegus spp*.). Hard mast becomes an important component of the fall diet of bears. Bears will seek mature hardwood stands to feed on beechnuts and acorns and early successional habitats for hazelnuts (*Corylus spp*.). Bears typically begin climbing for beechnuts in September before the nuts fall to the forest floor, however this practice may be delayed if soft mast species are highly available. Regardless of when bears begin to utilize hard mast, it becomes the dominant fall food source when available. Bears may travel up to 50-100 linear miles outside of their normal range during fall to utilize important, localized food sources including soft mast, hard mast and agricultural crops (Miller 1975, Elowe 1984, Kolenosky and Strathearn 1987, Pelton 2003). During years with poor hard mast production, bears may feed on less recognized soft mast including winterberry and mountain holly (*Ilex spp*.) along forested wetlands. In years with extreme mast failures, bears may rely on agricultural crops (i.e., corn, apples) or human-related food sources (i.e., bird seed, garbage, beehives, chickens and poultry feed, etc.) to meet dietary needs.

Behavior

The degree of social contact among black bears varies by season and circumstance. They generally are solitary except for female/cub groups, breeding pairs in summer and congregations at feeding sites (Bray and Barnes 1967, Jonkel 1978, Kolenosky and Strathearn 1987, Pelton 2003). Adult males often dominate food sources but black bears do not actively defend territories (Elowe 1984, McLaughlin 1999). Home ranges overlap and are shared among bears of different age and sex (Elowe 1984, Kolenosky and Strathearn 1987, McLaughlin 1999). When food is abundant, bears may feed in close proximity to one another at feeding sites. However, confrontations between dominant and subdominant bears do occur and larger bears will kill and cannibalize smaller bears (McLaughlin 1999). Fighting among bears is relatively rare as communication prevents the need for attack and young bears generally avoid older bears (Elowe 1984, Kolenosky and Strathearn 1987, Pelton 2003).

Adult females and their offspring have a strong family bond during the first 18 months as cubs den with their mother as yearlings and separate prior to June of the second year. After family breakup, association between cubs and mothers decreases significantly. Siblings often associate with one another for a brief period after breakup and use relatively small home ranges within their mother's range (Bray and Barnes 1967, Elowe 1984, Kolenosky and Strathearn 1987). Between 2-4 years of age, male offspring disperse away from their former range while female offspring typically occupy a subset of the mother's home range (Elowe 1984, Kolenosky and Strathearn 1987). If the mother dies, her female offspring often take over her range (Kolenosky and Strathearn 1987). Subadult males may disperse 50-60 miles (Elowe 1984, McLaughlin 1999). The fact that young females occupy a portion of their mother's range is an important factor regarding the slow rate of population expansion seen in bears. Additionally, dispersal behavior of subadult males is an important contributing factor to their lower survival compared to females.

The degree of tolerance by bears while feeding is largely dictated by food abundance and distribution. During periods when food sources are less abundant, bears exhibit more solitary feeding behavior (Kolenosky and Strathearn 1987). Exclusion between unfamiliar bears during low food situations has been documented (Jonkel 1978). When food resources are abundant, bears tolerate one another in closer proximity at food sites (Elowe 1984, Kolenosky and Strathearn 1987, McLaughlin 1999, Pelton 2003). During periods when more than one adult bear utilizes the same feeding site, they maintain distance from one another (Elowe 1984). Ongoing work by a bear behaviorist in New Hampshire suggests that bears have a complex social structure (more so than once thought) and that reciprocity and food sharing may exist at various levels among related and nonrelated bears (Ben Kilham, Bear Behaviorist, pers. commun., 2014).

The size of a black bear's home range is determined by the ability of an area to meet the animal's needs including food, water, den sites and cover. Home range sizes vary depending on the sex and age of the bear, season, habitat type, habitat quality and population density (Bray and Barnes 1967, Jonkel 1978, Brown 1980, Pelton 1980, Elowe 1984, Kolenosky and Strathearn 1987, Pelton 2003). The home range of an individual bear may fluctuate from year to year due to food availability with ranges being larger during years of food scarcity and smaller during years of food abundance (Pelton 1980).

Home ranges of bears of all sex and age classes overlap one another. Ranges of different adult females may have almost complete overlap, adult male ranges may overlap several adult female ranges, and adult male ranges may partially overlap (Elowe 1984). Annual home ranges of adult males (over 100 mi^2) are typically 3-8x larger than that of adult females (6-19 mi^2; Elowe 1984, Warburton 1984, Kolenosky and Strathearn 1987, Pelton 2003). Ranges of yearling (1-2 years old) and subadult (2-3 years old) females are generally smaller than that of adults and vary from 4-8 mi^2 (Lentz 1980, Kolenosky and Strathearn 1987). Home ranges are more variable between young males and average 7 and 23 mi^2 for yearlings and subadults, respectively (Elowe 1984). Young males tend to use a local site for 2-4 days and then move to another site for a short period of time (Kolenosky and Strathearn 1987, NHFGD file data). This pattern creates more variation in the home ranges of young males and causes them to have larger ranges compared to young females. In New Hampshire home ranges were larger during fall compared to spring/summer for adult females (18 vs. 12 mi^2), subadult females (43 vs. 7 mi^2) and subadult males (116 vs. 19 mi^2; Meddleton and Litvaitis 1990).

Black bears are generally most active at dawn and dusk although this pattern may be altered due to breeding activity, feeding habits and human activity (Brown 1980, Elowe 1984, Warburton 1984, Pelton 2003). Daily movements are influenced by temperature, therefore most activity occurs during cool evening and morning hours (Jonkel 1978). Activity generally decreases above 77^o F and below 32^o F (Pelton 2003). Direct sunlight deters black bears from feeding in more open areas presumably due to heat absorption (Jonkel 1978). During periods of inactivity, bears utilize bedding sites in dense forested habitats for security and thermal cooling (Pelton 2003). Conversely, in a New Hampshire study of nuisance bear activity, bears were more active during the day (6:00-17:59 hours) compared to night (18:00-5:59 hours; Ellingwood 2003). Increased daytime activity by bears in this study may have been influenced by the timing of availability of human-related food sources (i.e., garbage, birdseed) within these communities.

Seasonal movements by black bears are dictated by food availability, breeding activity and movements before and after the denning period (Bray and Barnes 1967, Hatler 1967, Brown 1980, Pelton 2003). Bears move between various habitat types throughout the year depending on food and cover needs. Bears may travel considerable distances outside their normal range to take advantage of seasonally important food sources (Miller 1975, Elowe 1984, Kolenosky and Strathearn 1987, Pelton 2003). Adult male bears have increased movements during breeding

season as they search for receptive females (Elowe 1984). Bears are highly active during early and mid-fall as they increase foraging activity in preparation for den entry. Activity and movement generally decreases and becomes localized around den sites as the denning period approaches during late fall (Elowe 1984, Pelton 2003). In some portions of their range, bears may migrate to and from denning areas during fall and spring, respectively (Bray and Barnes 1967, Pelton 2003).

Management

Regulatory Authority

Legislation was passed in 1985 which gave the New Hampshire Fish and Game Department (NHFGD) authority to regulate the bear season and method and manner of take. In 1988 the State Legislature granted the Department permanent authority to regulate bear harvest. Under the Department's regulatory authority, the Executive Director and the Commission regulate bear harvest by setting season dates and hunting hours, specifying legal methods of take, time when each may occur and bag limits. The Executive Director must hold public hearings as specified in RSA 541A to solicit public input regarding changes in regulations prior to implementation. The State Legislature has retained the authority to set hunting license fees.

In 1990 the State Legislature authorized a bear permit system that required hunters to possess a bear permit in addition to a game hunting license while hunting bears. The cost of a bear permit has increased since its inception from $3 in 1990 to $5 in 1998. The cost of a bear hunting permit increased in 2006 to $16 and $48 for resident and nonresident hunters, respectively. This money has been used to fund various black bear research projects, public outreach and education initiatives, a bear/human conflict mitigation program and bear-related data collection efforts.

Past Management

Bounty System

Early efforts to “manage” the state's bear population occurred when the first settlers arrived on New Hampshire's seacoast in the early 1600s. Bears were declared a nuisance species by early settlers due to concerns over agricultural damage (i.e., crops, livestock) caused by bears. Bear bounties were established at the township level initially and were followed by a state

bounty in 1828. The state bounty system remained in effect until 1955 with bounties ranging from $2 to $40. Typically, less than 100 bears were bountied on an annual basis (Table 1).

First Harvest Restrictions

Over the next 25 years, interest in bears grew considerably and represented a period of dramatic change that brought increased protection for bears. Even once the bounty on bears was lifted, it was legal to harvest bears statewide throughout the year. The first restriction on the harvest of bears occurred in 1951 when a bear dog season was established (April 1-June 1). In 1956, it became mandatory to report all bear kills to the Department. In 1961 a regular fall bear season was established that allowed bears to be harvested from October 1-December 10 and the hound season was changed to May 1-October 31. In 1963 the general bear season was modified and allowed bears to be harvested from September 1-December 10 and the hound season was changed to September 1-November 14. In 1965 a bow with a minimum of 40 pounds pull was approved for taking bear. In 1967 the general bear season was again modified and allowed bears to be taken from September 1 to the end of the regular deer season. The general bear season structure remained unchanged until 1985 (Table 2). In 1971 a bag limit of one bear per licensed hunter per year was established and the hound season was again modified and was open from September 1 through the day before the opening of the regular deer season. In 1979 a federal aid black bear management project was initiated to begin a more intensive population monitoring program by collecting sex and age data from all mortalities. Due to the growing interest in bears since the 1950's, the State Legislature officially classified bears as a big game species in 1983.

Bears Managed as a Big Game Species

During 1965-1985, growing interest in bears as a prized game animal caused an increase in hunter effort with more hunters pursuing bears utilizing all three methods of bear hunting. In 1985, utilizing its newly granted regulatory authority, the Department adopted rules to reduce the female harvest and to allow for bear population increase and natural range expansion. Specific rules were adopted to reduce harvest with guides, reduce take by closing the bear season the day before the regular deer season opened and closing all counties except Coos, Carroll and Grafton. Restrictions were placed on guides in that year allowing only 20 bear guides/year, allowing each guide to assist in the taking of only 3 bear and restricting nonresident bear guides by way of reciprocity laws.

Bear baiting has been regulated by both state law (RSAs 208:22 (IV) and 207:3-d) and Department rule (Fis 307.02) since the 1980s. Prior to 1991, hunters could place bait during the entire general season, a permit was required and individuals were restricted to no more than three bait sites and guides could bait an unlimited number of sites. Beginning in 1991, preseason baiting was prohibited and a formal baiting season was established. Additionally in that year, individuals were restricted to no more than one bait site and guides could bait at no more than 3 sites. In 1995 RSA 207:3-d was amended to provide the Executive Director the authority to adopt rules to govern baiting. Rules related to baiting have been modified several times since 1991. Current rules continue to require a permit and allow individuals to have up to two bait sites, but no more than one in Wildlife Management Units (WMUs) A, B, D1, H1, H2, I2, K, L, and M; guides are allowed six bait sites anywhere in the state.

Prior to 1985, the training of hunting dogs (excluding bear hounds) was regulated by the State Legislature under RSA 207:12-a. Prior to this year, no laws applied to the training of bear hounds therefore training dogs on bear was permitted year round. This law was amended in 1985, and prohibited the training of bear dogs from May 1 - June 30. This law was again amended in 1993 and prohibited the training of bear hounds from March 1 - July 15.

An amendment to the state law in 1995 gave the Executive Director of NHFGD the authority to adopt rules under RSA 541-A relative to the period which dogs could be trained on bear. Since the 1995 amendment to RSA 207:12-a, the Department has set the annual bear dog training season through rule making. In 1996, under Fis 305.02, bear dog training was permitted July 16 - August 31 in WMUs open to bear hunting. In units closed to bear hunting, training was allowed July 16 - last day of the muzzleloader deer season. In that same year, this rule was again amended and prohibited bear dog training from March 1 – July 15 statewide and during the open season in WMUs open to the taking of bear. In 2000, this rule was amended and prohibited bear dog training March 1 – July 14 statewide and during the open season in WMUs open to the taking of bear. This rule has been readopted without change since that time. A New Hampshire bear hunting group introduced a proposal in 2012 to open the bear hound training season earlier (June 1). The Department has opposed opening the hound training season before July 15th due to various social and biological concerns.

Black bear is the only species for which the Executive Director has the authority under RSA 541-A to adopt rules that specify a period (i.e., season) for which dogs may be trained.

Any person who is properly licensed to hunt may be issued a training permit for the training of bird dogs and trail or tree hounds (e.g., raccoon, fox, coyote and fisher) during the closed season on any wildlife except deer, moose, caribou, lynx, cougar, bobcat and turkey.

Restrictions on bear harvest in the six decades since the bounty system was abolished (1955) allowed the black bear population in the state to significantly increase in both size and range. Estimates of the state bear population showed relatively steady growth during the 1990s (Figure 1). As bears reoccupied their former range within the state, southern portions were opened to bear hunting to maintain control of the growing population. Several towns in Merrimack County were opened to bear hunting in 1993. In 1994 the majority of Belknap and Strafford Counties were opened and more towns in Merrimack and Sullivan Counties were opened. In 1998 the entire state was open to the harvest of bears. Additionally, the number of guides allowed to hunt bear per year was increased to 30 in 1999.

Annual variations in the degree of overlap between bear season and deer muzzleloader and rifle seasons were due to specific bear population management objectives, annual bear hunter effort and trends in annual bear harvest. Historically, regions with higher bear densities and regions where bear densities were consistent with or exceeded the goals had a greater degree of overlap between the bear and deer gun seasons. Bear harvest during the deer muzzleloader and rifle seasons varies from year to year and is impacted by food abundance and distribution, timing of den entry and hunter effort. Many hunters pursue deer in New Hampshire during the deer muzzleloader and rifle seasons. Historically, a notable percentage of deer hunters purchased a bear permit so they could harvest a bear if given the opportunity while deer hunting. The price increase of the bear permit in 2006 changed this trend as nearly 5,000 less bear permits were sold in 2006 as compared to 2005 (Figure 2). Presumably, these 5,000 permits holders represented opportunistic deer hunters that occasionally took bears. This decline in permits had no influence on the overall bear harvest; this segment of the bear hunting population had a low success rate and minimal harvest impact.

During years with abundant fall food production (i.e., beechnuts, acorns, apples), bears remain active later into fall resulting in a higher percentage of bears being harvested during the muzzleloader and rifle seasons for deer. During poor food years, bears often enter dens early which results in decreased bear harvest during the muzzleloader and rifle seasons for deer. Certain fall food sources, including beechnuts, acorns and apples, cause bears and deer to feed in

similar areas thereby increasing the opportunity for deer hunters to take bears. Due to these reasons, bear harvest during the deer muzzleloader and rifle seasons is highly variable and less predictable, but generally low. Historically, a greater percentage of the annual bear harvest occurred during the muzzleloader and firearms deer seasons by opportunistic deer hunters. This is no longer the case as the vast majority of the annual bear harvest occurs prior to the opening of deer season. During more recent years, typically less than 50 bears (approximately 8% of total harvest) are taken during the gun portion of the deer season. This is primarily due to a significant increase in participation in hunting bears with bait and hounds (which occurs earlier in the season) and decreased participation in still hunting/stalking. Also, varied degrees of overlap between the late bear and deer season have restricted late season harvest in some regions in some years. In recent times, most (90+%) hunters who take bears are specifically hunting for bear rather than opportunistically taking bear while hunting for deer or other species (Figure 3).

Bear seasons during 1985-1999 varied in length and degree of overlap with the deer gun seasons (Table 2). During 1985-1990 bear seasons overlapped entirely with muzzleloader deer seasons. From 1991-1995 bear seasons overlapped entirely with muzzleloader seasons and some portions of deer rifle seasons. There was no overlap between bear and deer season (muzzleloader or rifle) in 1996 due to an above average harvest in 1995. During 1997-1999 bear seasons again overlapped entirely with muzzleloader deer seasons and various portions of deer firearms seasons. The general trend in season structure during 1985-1999 was a move from more conservative to more liberal bear seasons. This was in response to bear population growth, increased bear complaints and the development of specific regional bear population goals in 1997.

Past Goals and Objectives

1960-1988

Past management goals have focused on population and conflict management. A management plan was adopted in the early 1960s to trap, tag and relocate nuisance bears as opposed to having those bears dispatched. In 1979 the Commission officially adopted this nuisance bear policy.

1988-1996

In 1988 a draft black bear plan was written and revised in 1990 and guided bear management until 1996. The primary goals of the plan were to 1) reduce the kill of female bears

to allow for older females to exist in the population, 2) to maintain bear densities in the northernmost three counties equal to 1990 levels, 3) to allow for range expansion into suitable habitat in the southern half of the state by a season closure, and 4) to provide an annual hunter harvest of 200-300 bears.

Starting in the 1990s, bear management regions were formed (each consisting of 2-4 WMUs) and established the scale at which populations would be estimated, goals would be developed and management decision would be made (Figure 4). Initially there were 5 management regions including the North, White Mountains, Central, Southwest and Southeast regions; the Southwest region was subsequently split in the Southwest-1 and -2 regions. The primary reason for establishing management regions was to allow for pooling of data over a larger geographical area to create more robust data sets from which management decisions could be made. Bear mortality data serves as the primary dataset for management activities and mortality data from an individual WMU is simply too limited to allow for a meaningful assessment of population dynamics and ecology at that level. As a result, bear management regions were established which resulted in larger data sets for a specific geographical area of focus. Individual WMUs were grouped into regions based on similarities in both bear density and habitat.

1997-2005

In 1994 the Department began the process of developing a Big Game Management Plan (BGMP) that spanned the period of 1997 through 2005. This process employed a stakeholder group, public input, historical data, biological data and habitat quality data to formulate desired population levels for bears in New Hampshire. Given an upper and lower limit within which to operate, the stakeholder group set population goals in terms of bear density/mi^2 for each management region. Public input was solicited using public forums, telephone surveys, questionnaires and public meetings.

The BGMP stated four general principles that would govern the Department's bear management through 2005. The four general principles of the plan include: 1) bear management programs will be based on sound science and the season setting process will be based on population goals, biological principles and public input, 2) recreational hunting will be the primary management tool, 3) the bear resource will be managed for multiple-use and the harvest

will be equitably distributed among all hunting interests, and 4) the bear population will be managed on a regional level (Figure 4).

The BGMP (1997-2005) established specific goals and objectives regarding bear management in New Hampshire. The goals and objectives of the plan include: 1) the state's principle bear management objective is to establish and maintain ecologically viable bear populations at levels consistent with diverse public interests, 2) bear management decisions will promote bears as a valuable ecological, aesthetic, recreational and economic resource, 3) bear management efforts will focus on attaining regional population goals, 4) bear management will be based on scientifically sound management standards, and 5) dedicated bear funds will be used for data collection, public education, directed research, conflict mitigation and habitat protection and management.

Population goals in the management plan were expressed in terms of density (bears/mi^2; Table 3a) and the recommended percent change necessary to achieve goals was based on 1996 population estimates. Bear population goals by region for 1997 through 2005 were: 1) maintain the population in the North Region at 1996 levels (0.56 bears/mi^2), 2) decrease the population in the White Mountains Region from 0.82 to 0.72 bears/mi^2, 3) decrease the population in the Central Region from 0.35 to 0.31 bears/mi^2, 4) allow for gradual, controlled increase of the population in the Southwest Region from 0.27 to 0.30 bears/mi^2, and 5) maintain low bear densities in the Southeast Region. In 1998 the Southwest Region was split into two separate bear management regions, each containing two wildlife management units (Figure 2). The management goals for both Southwest-1 and -2 (0.3 bears/mi^2) remained consistent with previous regional goals.

To meet the objectives of 1997-2005 bear management plan, season structure was designed to maximize hunting opportunity for all three methods of bear harvest including still, bait and hound hunting. During 2000-2003, season length varied by management region and averaged 3-13 weeks for still hunting, 3-4 weeks for bait hunting and approximately 8 weeks (54 days) for hound hunting (Table 2). In regions where bear densities were over goal, there was complete overlap with the deer gun season. During that period there was 1 week of overlap between the bait and hound hunting seasons. The season structure for the 2004/2005 hunting season represented a more conservative approach in response to a high overall and female harvest during 2003. In those years, the still, bait and hound hunting seasons ran 5-10, 3-4 and

approximately 7 weeks (51 days), respectively (season length varied by management region). Despite more restrictive seasons in most of the state compared to previous years, the still hunting season was increased from 3 to 5 weeks in the Southwest-2 Region. The annual harvest of females had been low in that region therefore additional hunting opportunity was offered without deviating from regional population goals. There was limited overlap between the bear and deer firearms season, with overlap occurring only during the muzzleloader deer season in select management regions. This change was made to reduce the number of bears taken incidentally to deer hunting during the late bear season. The hound hunting season began 13 days prior to that of previous seasons creating more overlap between the bait and hound season. The hound season was opened earlier to allow hound hunters to target bears causing corn damage and to provide hound hunters with a similar season length as previous. Additionally, this season change was necessary in order to close the hound season prior to the opening of the deer muzzleloader season. The number of guides allowed to hunt bear per year was increased from 30 to 35 in 2004 and the number of bears they could assist in taking increased from 3 to 6.

In the final year of this management plan, the estimated population was at goal in 4 of 6 regions (Table 3a). Bear populations were above goal in the White Mountains and Southwest-1 regions and required a density reduction of 0.38 and 0.31 bears/mi^2, respectively, to reach goal.

Current Management

The state's black bear population is currently managed under the direction of the BGMP (2006-2015). The concept and process of formulating this plan was very similar to the previous plan that directed management during 1997-2005. For this plan, a group of 30 key wildlife stakeholders (aka Public Working Group) identified by the Department utilized baseline information (generated via a public survey, provided through species assessments and presentations) to identify and rank key management issues and to formulate regional species goals and objectives. Department staff provided comments, considerations and concerns related to the biology and management of each species to the working group for their consideration. Draft goals and objectives were presented to the public at several open houses sessions and ultimately approved by the NHFG Commission.

The primary goal of this plan was to "regionally manage bear populations by balancing and incorporating social, economic, public safety and ecological factors, using the best available science." While population goals and objectives changed from the previous plan, the

overarching management approach and season structure have remained relatively consistent. Bears continue to be managed at a regional level with harvest regulations formulated for 6 management regions (Figure 4). Regional bear populations continue to be managed in terms of bear density (bears/mi^2) by comparing annual estimates of regional abundance to the goals defined in the management plan (Table 3b). Hunting seasons (strategies used to achieve population goals) are set biennially based on population and biological data and subject to public input under RSA 541A.

Season structures are designed to achieve population goals while at the same time maximizing hunting opportunity for all three methods of bear harvest including still, bait and hound hunting. Historical trends in harvest data are used to predict the harvest impact of the different hunting methods, specifically the length and timing. Method-specific seasons are manipulated biennially to achieve the desired level of harvest to meet population goals. There have been efforts over the past decade to maintain relatively similar seasons (in terms of length and timing) when possible as hunters tend to appreciate consistency. The season structure for the various hunting methods over the past decade represents an effort to satisfy both population goals and hunter interest.

During the period of this plan (2006-2015), hunting seasons have been fairly consistent averaging 3-12.5 weeks for still hunting, 3-4 weeks for bait hunting and 7.3 weeks (51 days) for hound hunting (Table 2). There has been no change in the length of the hound season in any region over the last decade. The bait hunting season has been the same in all regions except the Central; the bait season was reduced from 4 weeks during 2006-2007 to 3 weeks during 2008-2015. The still hunting season has seen the greatest variability by region between years. The still hunting season in the Southwest-2 was 5 weeks long in 2006-2007, truncated to 3 weeks during 2008-2013, and increased to 4 weeks in 2014-2015. In the Southeast, this season averaged 10 weeks in 2006-2007, was reduced to 3 weeks in 2008-2013, and increased to 4 weeks in 2014-2015. In the Southwest-1 region, this season was approximately 11 weeks in 2006-2007 and decreased to 10 weeks during 2008-2015. The White Mountains has seen the most liberal still hunting seasons (due to long-term effort to reduce bear density) which ran approximately 11 weeks during 2006-2007 and 12+ weeks during 2008-2015. The still hunting season in the Central region ran 10 weeks during 2006-2013 and was extended to 12 weeks in 2014-2015. Still hunting seasons that are 12+ weeks in length overlap the entire deer

muzzleloader season as well as the first two weeks of deer firearms season. A 10-week still hunting season would overlap with the deer muzzleloader season but not the firearms season.

In addition to population levels, there were several additional goals stated in the plan related to bear/human conflict abatement and habitat protection. These goals included: 1) the Department will implement public education efforts so that residents and visitors understand and appreciate black bears, and are familiar with methods to minimize bear/human conflicts, 2) New Hampshire residents and visitors will strive to minimize conflicts between bears and humans, using widely recognized practices endorsed and recommended by the Department, and 3) the department will work alone and in partnership with state, federal, public and private partners to minimize loss of critical bear habitat and to conserve, protect and enhance bear habitat on state, federal and private lands, through education and the expenditure of technical and financial resources.

In the first year (2006) of the current management plan, the statewide population was estimated at 4,588 bears and the overall goal was to stabilize the statewide population at 5,100 (0.55 bears/mi^2). Regionally, estimated densities were at goal (see Table 3b for goals) in the North and Southwest-1 regions, above goal in the White Mountains (by 0.32 bears/mi^2), below goal in the Central (by 0.26 bears/mi^2), Southwest-2 (by 0.25 bears/mi^2) and Southeast (by 0.14 bears/mi^2) regions (Figure 5). For comparison, in year 8 of the plan (2013; most recent year for which population estimate available at time of writing), the population had increased to an estimated 5,728 bears representing a 24% increase (approximately 3% annual growth). Current management strategies are to decrease the statewide density from 0.63 to 0.55 bears/ mi^2 (- 0.13 bears/mi^2; Table 3b). Regional prescriptions (Figure 5) include to stabilize the population in the North and Southwest-1 and -2, decrease density in the White Mountains (by 0.17 bears/mi^2) and Central (by 0.16 bears/mi^2) regions and increase density in the Southeast (by 0.13 bears/mi^2).

Other Management Issues

From a management perspective, several other changes/issues have occurred in recent years that are noteworthy. In 2006, the Department established a rule (Fis 310.01) that stated "no person shall use, place, provide, give, expose, deposit, scatter or distribute any material that results in attracting black bears after being noticed by the executive director or his designee to cease the activity because the activity might result in injury to a person, damage to property or

create a public nuisance." Since that time under this rule, approximately 50 residents in 25 towns have been required to stop feeding bears.

In addition to bear feeding, hunters who bait have been asked to voluntarily stop using chocolate as a type of bait. Concerns have been raised in recent years regarding the use of chocolate as bear bait which stems from the fact that chocolate contains the ingredient theobromine that can, at high doses, be toxic to bears and other species that consume it. Theobromine poisoning of black bear cubs and raccoons has been documented in Michigan, Pennsylvania, and recently New Hampshire. In the New Hampshire case, two adult females and two cubs died due to confirmed chocolate toxicosis in 2014. This most recent incident likely represents the most significant case of chocolate-induced mortality ever documented in bears due to the number of bears found dead at on location and the fact that adult bears, in addition to cubs, died. Additionally, it is assumed that other mammals may be susceptible to chocolate toxicosis if enough of the material is ingested. While theobromine poisoning has been studied and documented in dogs, cats, rodents and humans, per-pound toxicity levels for bears and other wildlife species remain unknown at this time. The type of chocolate used as bait is an important factor as the concentration of theobromine varies considerably between types. The concentration of theobromine is a significant factor because it heavily influences the quantity of chocolate that can be consumed before toxicosis occurs. Unsweetened baker's chocolate has the highest concentration of theobromine, followed by dark chocolate and milk chocolate. The size of the animal ingesting the chocolate is also an important factor. Smaller animals are more susceptible to poisoning compared to larger animals, because they do not have to eat as much to be impacted.

In regards to state laws, two bills were introduced during the 2013 legislative session that directly related to bear management in New Hampshire. The first bill (SB 56-FN) would have prohibited the taking of bear from baited areas. The Department opposed this bill as bear baiting for hunting is viewed as an important tool for obtaining desired harvest levels necessary to keep the bear population at a level that is consistent with management goals. This bill was killed in committee. A second bill (HB 276) would have required owners of solid waste containers which are attracting wildlife to store or dispose of such solid waste in a wildlife resistant manner (i.e., bear-proof dumpsters and garbage cans). The Department supported this bill but fully recognized that passage of a state law may not have been the most effective way to address this

issue. This bill was also killed in committee. This remains an important issue in bear management given that accessible garbage at businesses and residences continues to be the root of a large percentage of annual bear/human conflicts. A resolution to this problem will require a working partnership between commercial trash companies, the public, law enforcement and the Department. Such dialog and partnership among these groups has been attempted in the past without success.

The number of registered hunting guides allowed to guide for bear per year has continued to be closely regulated by the Department. The initial cap was set on this activity in 1985 when 20 guides were permitted to guide for bear. This cap was increased to 30 in 1999 and 35 in 2004. The cap has remained at 35 since 2004 and each guide is allowed to assist in the take of 6 bear annually. This issue will be discussed in more detail in the section on use and demand in this assessment.

Research

Research has become an integral part of the Department's bear management program allowing for science-based decisions to be made on issues that would have been difficult to address in the absence of supporting data. The Department has been fortunate in that 7 research projects have been conducted on bears in the past 14 years (Table 4). While the Department has implemented a couple projects on its own, projects have been most feasible and successful by cooperating with in-state universities, specifically the University of New Hampshire and Plymouth State University. Research has been funded through the annual sale of bear hunting permits and the New Hampshire Wildlife Restoration Program grant in cooperation with the U.S. Fish and Wildlife Service, Wildlife and Sport Fish Restoration Program.

The varied research over the past 14 years has focused on multiple objectives including: 1) estimating bear abundance via mark/recapture (using genetic tagging and a tetracycline biomarker), 2) the effectiveness of multiple conflict abatement tools (e.g., wildlife ordinances, aversive conditioning, translocation) at reducing anthropogenic food attractants and/or conflict behavior, 3) an assessment of nuisance bear seasonal home range and vulnerability to hunting, 4) an evaluation of fine-scale movement patterns of bears within residential communities using GPS telemetry, and 5) the success of rehabilitating orphaned cubs for subsequent release into the wild.

Conflict Management

Mitigating conflicts between bears and humans is a critical component of the Department's bear management program. Bear density goals depend largely on human attitudes toward bears, specifically the willingness of people to accommodate bears and the Department's ability to mitigate bear/human conflicts. Bears have the ability to generate considerable controversy as they may cause property damage when consuming human-related food sources (i.e., bird feeders, garbage, pet/livestock food, barbeque grills). People often misunderstand or misinterpret bear behavior causing unnecessary fear of and intimidation by bears. In 1996 the Department initiated a bear education campaign ("*Something's Bruin in New Hampshire-Learn to Live with Bears*") to enhance public tolerance towards bears, promote the need for increased human responsibility in minimizing conflicts and reduce the level of anthropogenic food attractants on the landscape. Since approximately 2002, biologists from NHFGD and the United States Department of Agriculture – Wildlife Services (USDAWS) have cooperated on a bear/human conflict mitigation program. The key concept of this program is to educate the public on how to be proactive in avoiding conflicts with bears. Staff from both agencies interact with and provide technical assistance to a large number of residents and tourists through routine site visits. The USDAWS annually employs two full time technicians during May-August as this coincides with the period when bear/human conflicts are most frequent. These technicians allow for a very timely and more efficient complaint resolution which has been critical to increased public support and willingness to make changes in an effort to avoid further conflict. In addition to technical assistance and educational messaging, this program loans conflict mitigation equipment (e.g., electric fences, bear-proof garbage containers, etc.) to the public to demonstrate successful techniques in deterring bears with the ultimate goal of changing human behavior as it relates to securing/managing residential food attractants.

Bear/Human Conflicts

Nuisance bear complaints are documented by USDAWS as part of the conflict mitigation program and categorized as agricultural (crop damage, loss of livestock or poultry, damage to bee hives, etc.), property damage (bird feeder damage, trashcan/dumpster raiding, etc.) or public safety concerns (campground bears and/or bears that demonstrate a lack of human fear). Nuisance bear complaints are factored into both management decision-making and long-term management planning efforts. Additionally, complaint data is used to identify communities with

public outreach needs regarding bear/human conflicts. Bear complaint data serve as an index to human tolerance of bears and is useful in assessing the success of the cooperative bear education campaign.

Annual documented bear complaints in New Hampshire increased steadily during 1990-2003, but have stabilized over the past decade averaging 635 complaints/year (Figure 6). Given the highly varied nature of annual complaint trends, interpreting trends over time can be challenging. Based on this 10-year mean of 635 complaints, slightly over half (332) are the result of bears causing property damage while foraging for residential foods; agricultural complaints (134) and concerns over public safety (168) account for a lower and more stable number of annual complaints. Because bears are such food-motivated animals, annual food availability and distribution directly influence the level of nuisance bear complaints with complaints typically lower during years of abundant natural foods (e.g., 2008 and 2013) and higher during years of food scarcity (e.g., 2004 and 2012; Figure 6). During an average year, 37% (235 complaints) of annual complaints are the direct result of bears raiding birdfeeders (10%) and unsecured garbage (27%). Interestingly, the primary educational message of the campaign places heavy emphasis on these common attractants. If these attractants could be eliminated (e.g., voluntary compliance, town ordinances, state dumpster law), annual bear/human conflicts could be immediately reduced by nearly 40%.

Annual levels of nuisance bear activity are not directly correlated with bear population levels, however this remains a commonly held belief by a large percentage of the public. Department research indicates that a relatively small percentage of bears become chronic nuisance animals and a small number of nuisance bears within a community can generate substantial complaints (Ellingwood 2003, Smith 2013). The human population density and corresponding anthropogenic food sources (i.e., bear attractants) in a given area serve as the primary driver of bear/human conflict levels. Despite the lack of a close relationship between complaint frequencies and population levels, it is intuitive that nuisance complaints will increase as both bear and human populations grow. Recent trends in annual bear complaints suggest that the cooperative bear/human conflict mitigation program is having a positive influence. The state's human population has grown significantly and the bear population has experienced modest growth (approximately 1.5% annually) over the past decade. The fact that complaints

have stabilized is viewed as a success; in the absence of this cooperative program, bear/human conflict levels would have likely increased dramatically.

Bear Damage/Compensation

An additional segment to the cooperative mitigation program includes an Animal Damage Control Program. A key component of this program includes formal bear damage assessments to agricultural-related resources for the purpose of compensation as required by state law (RSA 207:23-a). Under this law, any person who receives loss or damage by bears to livestock, bees, orchards or growing crops may be eligible for compensation upon inspection by a NHFG department agent. Compensation for bear damage is paid out by the New Hampshire Department of Agriculture. Damage to hives, corn and livestock/poultry, constitutes the vast majority of agricultural damage by bears and accounts for the majority of compensation paid. Annual compensation as a result of bear damage has been generally less than $6,000/year (Figure 7). Similarly to the frequency of bear/human conflicts, annual agricultural damage is directly related to the distribution and abundance of natural foods (e.g., beechnuts, acorns, apples, various fruit crops). Natural food crops fluctuate significantly from one year to the next and therefore the degree to which bears utilize agricultural foods does the same. Over the past decade, annual compensation has averaged $9,318 with most payment resulting from corn damage ($6,377), followed by hive damage ($2,019) and loss of livestock/poultry ($923). During poor food years, bears have a tendency to congregate in cornfields, particularly in the Connecticut River Valley. In those years (e.g., 2003, 2009 and 2012), corn damage can be high resulting in compensation that may approach $20,000. Compensation related to hives and livestock/poultry loss has remained relatively low and stable over time; corn damage varies and drives the overall level of damage payments. The use of electric fence (which is an item loaned as part of the conflict mitigation program) can eliminate a large percentage of agricultural damage by bears thereby lowering compensation payments.

One of the more challenging conflict situations to manage in recent years involves bears raiding coops and predating chickens. The number of people raising chickens in backyards has grown considerably and poultry conflicts have steadily increased over time (Figure 8). This activity has become a notable source of mortality for bears, particularly during the summer months. Homeowners are legally allowed to protect property by shooting bears (and other wildlife) under state law (RSAs 207:26 and 207:30). Electric fence around coops/pens will

adequately protect chickens from bears but convincing homeowners to make that investment has been difficult. This may be partially due to a liberal state law that allows lethal action prior to any mitigation attempts. The loaning of electric fencing has been beneficial in convincing some chicken owners to invest in this type of protective equipment, as it is viewed as the most effective long-term option to protect chickens from bears. Changing the state law to require some level of preventative measures to be taken prior to lethal action would result in more long-term solutions to conflicts and help minimize human-related, non-hunting mortality of bears.

Translocation and Dispatching of Bears

Translocation is occasionally used to abate conflicts between bears and humans, however, it is a less preferred method compared to education, public awareness and the management of food attractants. This action is often viewed as a "Band-Aid" approach to a conflict as it does little to address the root of the problem (typically a food attractant). In a New Hampshire study, Smith (2013) found that translocated bears had a low rate of return (28%) to the area of capture but had relatively high (55%) nuisance recidivism. Translocation was deemed a viable management strategy in some situations but reducing anthropogenic food attractants would reduce the need. Bears that are trapped and moved in New Hampshire represent bears that are likely going to be ultimately destroyed due to nuisance behavior. Translocation represents a way to offset mortality (from summer to fall) so that a hunter can take and utilize the animal during bear season. During an average year, 5-10 bears are translocated in New Hampshire due to conflict behavior.

In addition to complaint data, the annual frequency of bears dispatched as nuisance animals provides additional insight on levels of human tolerance towards bears (Figure 9). Department staff and private citizens occasionally dispatch nuisance bears, typically after all other mitigation efforts have failed. An average of 4 bears/year were dispatched during 1983-1993. This average increased to 14 bears/year during both 1994-2003 and 2004-2013. While the number has been low during most years, it can reach a high of 30 in poor food years (i.e., 2003). Of greater concern is the fact that a person's willingness to shoot a bear due to conflict represents intolerance, an attitude that will be detrimental to the bear population. While it is recognized that some bears in a population need to be destroyed due to negative behavior, minimizing this loss should be an important component of bear management. Often when female bears are killed, Department biologists and a private rehabilitator find themselves in a position where they need to

capture and care for orphaned cubs. In recent years, a considerable number of cubs were orphaned when landowners shot female bears at chicken pens during late spring and early summer. Regardless of people's opinion on rehabilitation, there are better ways to resolve conflicts.

Habitat Assessment

Past Habitat

Black bears utilize a variety of habitat types but are most closely associated with forested landscapes. A relative trend in black bear habitat in New Hampshire can be seen through historical trends of deforestation due to human settlement and land clearing. Prior to colonial settlement, the state was approximately 95% forested (8,543 mi^2; Sundquist and Stevens 1999). From the time of European settlement until the late 1800s, forestland was rapidly converted to agricultural land. Large-scale land clearing for settlement and agriculture began around 1750 and continued to the mid-1850s when less than half the state (4,496 mi^2) remained forested (Sundquist and Stevens 1999). Land clearing was prevalent in most of the southern half of the state and extended into more northern areas along the major river drainages. Bear habitat was at its lowest level during the mid-1800s when agricultural development and land clearing was highest. Available bear habitat was largely removed from the central and southern counties during this time period. The northern three counties of Carroll, Coos and Grafton retained the greatest percentage of bear habitat.

During the early twentieth century, the Industrial Revolution caused a decline in agriculture allowing abandoned farmland to revert to forests. By 1950, approximately 75% of the state was forested (6,745 mi^2). During this same time period (1942), it was estimated that roughly half of the state was viable bear habitat (4,496 mi^2; Silver 1957).

In 1983 the percentage of forest cover in the state was at its highest level (87%; 7,793 mi^2) since 1700 (Sundquist and Stevens 1999). An analysis of bear harvest data from the period 1956-1982 indicates that the vast majority of bears were taken in the White Mountains (41%), North (32%) and Central (25%) regions. A very low percentage (1% or less) of the historical harvest came from the southern management regions. While there are other factors that influence this trend (most bears had been killed in areas where greatest human population existed), this data suggests that the most viable bear habitat was located in the upper two thirds

of the state. In 1991, the more northern WMUs (WMUs A, B, C1, C2, D1, D2, E, F, G and J1; Figure 4) were considered primary bear range (4,654 mi^2) as these units contained large forested tracts with low human densities (NHFG file data). Units H1, H2, I1, I2, J2, K and L (3,835 mi^2) were considered secondary bear habitat due to increased rates of human development and habitat fragmentation (NHFG file data). Unit M (730 mi^2) was not considered bear range as this unit was highly developed. Bear population estimates during the mid-1990's were: 0.56 bears/ mi^2 in the North (WMUs A, B, C2 and D1), 0.82 bears/ mi^2 in the White Mountains (WMUs C1, D2, E and F), 0.35 bears/ mi^2 in the Central (WMUs G, I1, J1 and J2), 0.27 bears/ mi^2 in the Southwest (WMUs H1, H2, I2 and K) and very low densities in the Southeast regions (NHFG file data).

Black bear habitat for both the 2004 assessment and the 2014 revision were described on a bear management region level using 2001 and 2011 land cover data. The 2004 assessment used New Hampshire Land Cover data (NHLC 2001) by GRANIT (Durham, NH). The 2014 assessment used National Land Cover data (NLCD 2011) by the U.S. Geological Survey (Sioux Falls, SD). These assessments categorized land cover and land use into 23 classes, based primarily on the classification of Landsat Thematic Mapper imagery. This habitat assessment was updated by establishing a crosswalk between the 2011 NLCD and the 2001 NHLC data (raster data layers were combined using ArcGIS 10 software; Catherine Callahan, GIS Specialist, New Hampshire Fish and Game, pers. commun., 2014).

Bear habitat was measured for each WMU and grouped into bear management regions (Appendix I and II). Potential bear habitat was considered to include 8 categories of forestland, 3 categories of active agricultural land, 2 categories of wetlands and a category of barren land (Appendix III).

Statewide, potential bear habitat in 2001 was estimated at 7,982 mi^2 with 1,316 mi^2 in the North, 1,820 mi^2 in the White Mountains, 2,059 mi^2 in the Central, 711 mi^2 in the Southwest-1, 1,189 mi^2 in the Southwest-2 and 886 mi^2 in the Southeast regions (Figure 10, Appendix II). An estimated 89% of the total land area in the state represented bear habitat (Figure 11, Appendix II). The 2001 estimate of statewide bear habitat represented a 6% decline from the 1991 estimate of bear habitat (8,489 mi^2). The differences in methodologies from which these estimates were generated allow only general comparisons between present habitat conditions and those in 1991. The 1991 habitat assessment was formulated on a WMU level and based on the percentage of forestland and trends in human development. The current habitat assessment was based on

estimates of area by various land cover and land use types. Comparison between estimates indicated that those areas considered primary bear range in 1991 (WMUs A, B, C1, C2, D1, D2, E, F, G and J1) currently contain the greatest amount of available bear habitat (Figures 10 and 11) and greater bear densities (Table 3b). Similarly, those areas considered secondary bear range in 1991 (WMUs H1, H2, I1, I2, J2, K and L) continue to contain less bear habitat (Figures 10 and 11) and lower bear densities (Table 3b). Because identical methods were used to assess habitat for both the initial assessment (2004) and this revision (2014), a more specific description of habitat conditions in 2004 will be provided in the section titled "Current Habitat" so that change in habitat over the past 10-year period can be assessed.

Past Influential Factors on Habitat

Historical human use of the land in New Hampshire likely has impacted the quality of bear habitat in the last several decades. Following European settlement, large-scale land clearing removed mature forest cover throughout nearly half of the state. Farm abandonment during the Industrial Revolution allowed farmland to revert to forestland, promoting the growth of early successional habitat. Early successional forest communities increase habitat diversity due to the various plant species that occupy these sites. Stands of mature forest, intermixed with early successional forest communities, create ideal bear habitat. Logging practices over the last 50 years have continued to both promote and maintain early successional habitats, creating a diversity of age classes and species composition across the landscape. Early successional habitats typically produce a variety of fruit producing shrubs and grassland communities that are highly utilized by bears. Historically, New Hampshire's forest contained a high percentage of softwood cover, particularly in the more northern areas. Several factors have served to convert these softwood-dominated forests to hardwood stands. Softwood species were intensively harvested since the 1960s due to an outbreak of spruce budworm and associated salvage cutting, as well as strong softwood markets that promoted harvest of softwood species (Will Staats, Wildlife Biologist, New Hampshire Fish and Game, pers. commun., 2004). Since that time, continued harvest of softwood, coupled with silvicultural practices that promote hardwood regeneration, have resulted in hardwood-dominated stands. Similar trends in land use and timber harvesting have appeared to improve bear habitat quality in Maine (McLaughlin 1999). Timber harvesting also creates log roads and landings that promote fruit producing shrubs providing

important foods for bears. Logging slash resulting from harvest provides areas for bears to feed on colonial insects.

Human Population Growth and Expansions

Rates of human population growth and development have direct impact on the quality, extent, intactness and distribution of bear habitat. New Hampshire has experienced significant human population growth, especially since the 1950's (Sundquist and Stevens 1999). The human population increased an average of 2,507 people/year from 1750 (31,000 people) to 1950 (532,310 people). Since 1950, the human population has increased an average of 13,930 people/year until 2000 (1,228,794). During the period 1990-2005, New Hampshire was recognized as the fastest growing state (in terms of human population) in the Northeast, with a 17.2% increase in population during that time period (Sundquist and Stevens 1999, Sundquist and Hewes 2010). As a result of human population growth and associated development, forest cover in New Hampshire declined for the first time in several decades from a high of 87% (1983) to 83% in 1993 (Sundquist and Stevens 1999).

During the period 2005-2010, the state's human population growth rate declined slightly (6.5%) from previous levels (Sundquist and Hewes 2010). Despite this recent decline in growth, the population is predicted to grow 14% (approximately 180,000 people) in the years ahead to 2030, at which time it is estimated that the population will reach 1.6 million people (Sundquist and Hewes 2010). Approximately 70% of this growth is anticipated to occur in the four southeastern counties (33% of the state's land base). Based on past development patterns, the loss of an additional 225,000 acres of forest cover is predicted through 2030 as a result of population growth and development which would drop the state's forest land to 78.5% of the total land area (Sundquist and Hewes 2010).

Human development represents a direct loss of available bear habitat and serves to lower cultural carrying capacity (aka social carrying capacity) which is the density of bears the public is willing to tolerate in regards to bear/human conflicts. Human population growth and associated development increases the amount of anthropogenic food attractants on the landscape available to bears and puts humans and bears in closer proximity to each other thereby increasing the chance of conflict. This trend is reflected by the overall increase in bear/human conflicts over the past two decades (Figure 6), the period of greatest New Hampshire human population growth. Increased road densities represent an additional source of mortality for bears and may

impact bear behavior, movement and habitat connectivity. Vehicle strikes, although considered generally infrequent during most years, are the second highest cause of bear mortality in New Hampshire and the most prominent source of nonharvest loss. Road density is typically directly proportional to levels of human presence and disturbance. Annual bear mortality by motor vehicles has averaged 34 bears/year since 1983 and has increased in recent years (Figure 9). Additionally, the number of bears dispatched as nuisance animals has increased in recent years due to bear and human population growth (Figure 9). While many factors contribute the number of bears hit on roads or dispatched due to conflicts in a given year, increasing trends over time relate significantly to an increasing human population and related habitat loss. Previous studies have indicated that roads with varying degrees of human disturbance exert negative effects (i.e., avoidance of roads, decreased usage along roadways, mortality agent) on black bears in some areas (Stickley 1957, Miller 1975, Hamilton 1978, Brown 1980, Pelton 1980, Rodger and Allen 1987). In New Hampshire, research suggests that bears honor roads as home range boundaries (Ellingwood 2003, Coster 2008).

The impacts of past human development within the state on bear habitat and populations are not completely known. Given that bears have grown in numbers and expanded their range within the state, it does not appear that human development has served as a limiting factor. The state's human population has doubled since 1950, however 85% of the growth was concentrated on 33% of the land area of the state, most of which occurred in the southeastern counties (Sundquist and Stevens 1999). Bears have proven themselves capable of living in close proximity to humans, particularly in rural environments. These situations cause an increase in bear/human conflicts and serve as a direct measure of people's willingness to coexist with and accommodate bears. Changes in human tolerance and the frequency of bear complaints will continue to provide a useful index of the impacts of human development on bear populations.

Current Habitat

Current Conditions

Statewide, potential bear habitat in 2011 was estimated at 7,872 mi^2 (7,982 in 2001, -1.4%) with 1,324 mi^2 in the North, 1,816 mi^2 in the White Mountains, 2,042 mi^2 in the Central, 707 mi^2 in the Southwest-1, 1,178 mi^2 in the Southwest-2 and 805 mi^2 in the Southeast regions (Figure 10, Appendix II). An estimated 88% (89% in 2001, - 1%) of the total land area in the state represented bear habitat (Figure 11, Appendix II). The percentage of land area considered

bear habitat tends to decrease from north to south within the state with 95% in the North Region compared to 68% in the Southeast region (Figure 11). The percentage of available bear habitat was inversely proportional to the extent of development. Developed land was more abundant in the Southeast Region (25%) compared to northern bear management regions (3-4%; Figure 12, Appendix I).

The transportation cover type was not considered viable bear habitat and included roads classified by New Hampshire Department of Transportation as Class I-V. In addition to these Class I-V roads, land area (regardless of cover type classification) located within a 300-foot buffer (beginning at edge of pavement) of major roads were also not considered viable bear habitat. Major roads, as defined by the United States Department of Transportation and Federal Highway Administration, include all arterials and collectors. Arterial roads provide the highest level of mobility and the highest speeds (e.g., 50-75 mi/h) over the longest uninterrupted distance. Arterial roads include interstates, freeways, multilane highways, and other important roadways that supplement interstates. The roads directly connect urbanized areas, cities and industrial centers. Collectors are major and minor roads that connect local roads and streets with arterials. Collectors provide less mobility than arterials at lower speeds (e.g., 35-55 mi/h) and for shorter distances. Although it is well recognized that bears may utilize habitats within these buffered areas, past research has indicated road avoidance by bears in some areas (Stickley 1957, Miller 1975, Hamilton 1978, Brown 1980, Pelton 1980, Rodger and Allen 1987). Buffered areas along major roads were not considered viable bear habitat because bears that utilize these areas are at higher risk of being struck by motor vehicles. While the overall number of bears hit by vehicle in the state is considered relatively low in most years, it does represent the highest form of nonharvest morality for bears (NHFG file data). Since 1983, the number of bears killed on roads has averaged 34/year, however this mean has increased to 51/year during the past decade. In some years (i.e., 2003 and 2004), 100 bears may die due to collisions with motor vehicles. Additionally, roads and associated buffer zones (on major roads only) were not considered bear habitat in an effort to more accurately reflect the extent of human development. Imagery for this analysis was divided into 30-meter pixels. Pixels were classified into cover types based on the cover type that occupies the majority of each pixel. This would result in some developed areas (i.e., semi-urban areas) being classified as a nondeveloped cover type. Utilizing 300-foot road buffers on select roads presumably allowed for a more meaningful measure of human

development. Developed areas, roads and road buffers account for 9% (8% in 2001, + 1.3%) of the total land area in the state and 3-25% of the land area by region (Figure 12, Appendix I).

Currently, New Hampshire is estimated to be 83% forested, which is identical to estimates from 1999 (Sundquist and Stevens 1999), representing a 6% decline from the 2001 estimate (88%). The percentage of habitat classified as forest declines as you move from north to south ranging between 91 and 67% in the White Mountains and Southeast regions, respectively (Figure 13). The more southern management regions were dominated by mixed forest stands (see Appendix III for description of cover types) while the two northernmost regions contained a higher percentage of stands classified as spruce/fir or other hardwoods (deciduous stands that did not met the beech/oak or paper birch/aspen criteria; Figures 14a and b). Birch/aspen, white/red pine and hemlock accounted for a low percentage of statewide and regional forested habitat (Figures 15a and b).

Cleared and open areas, including clear cut forests and old agricultural fields that were reverting to forest, accounted for an estimated 9% (6% in 2001, + 3%) of statewide bear habitat and were most abundant in the Southeast (14%) and North regions (13%; Figures 16a and b). While the percentage of this habitat is relatively low, it is a very important cover type. These areas contain the highest distribution and diversity of early successional, fruit-producing plants and shrubs (e.g., strawberry, raspberry, blackberry, cherry, blueberry, beaked hazel, etc.) which make up a considerable part of a bear's diet. Bears feed in these areas in multiple seasons, with the greatest use occurring during late summer and early fall. In terms of this habitat type by region, the Southeast likely contained a higher percentage of reverting farmland while the North appeared to have a higher percentage of reverting clear cuts. The amount of land area classified as cleared/open between 2001 and 2011 increased (44%, 206 mi^2). This increase is considered an advantage to bears from a food perspective assuming there was no negative change in land use. Land may be deforested for subsequent building lots which may be categorized under this habitat type (before building construction). If there is a change in land use that resulted in development, then bear habitat would be negatively impacted.

Agricultural areas, including row crops, hayfields, pastures, plowed fields and orchards were considered bear habitat although use of these habitats by bears can create conflicts with farmers. Additionally, bears likely utilize the edge of these habitats, as compared to more interior portions, at a higher degree given their preference for escape cover. Agricultural habitats

generally receive more use by bears during years when typical fall food sources fail (i.e., beechnuts, acorns, cherries and wild apples). Harvest and mast survey data from New Hampshire indicate that corn use by bears is higher during poor beech years and lower during strong beech years. This same trend is evident with acorns in southern regions of the state. Agricultural habitats account for a low percentage of available bear habitat ranging 1-4% by region (similar in 2001, Figures 16a and b).

Habitat Fragmentation

Prime black bear habitat is characterized by large, unfragmented, undeveloped blocks of woodlands (Lentz 1968, Miller 1975, Pelton 1980, Warburton 1984, Pelton 2003). The suitability of land as bear habitat decreases as development increases. Increased human densities result in greater bear/human conflicts and increased bear mortality. Additionally, increased road densities result in higher bear mortality by motor vehicles. People's attitudes towards bears directly impact bear population goals and objectives.

The size of habitat blocks suitable to be considered unfragmented or undeveloped was based on the analysis of home range size of bears from previous studies in New Hampshire (Meddleton and Litvaites 1990, Ellingwood 2003). These studies indicated that male and female bears had an average annual home range of 20 mi^2 and an average core area of 2.5 mi^2. Home range size presumably varies depending on habitat quality with bears requiring smaller areas in more productive habitats with greater diversity. Suitable habitat blocks should include forests with a variety of age classes and species composition to meet cover and food requirements. Fragmentation analysis of habitat blocks was conducted for 2.5 and 20 mi^2 areas. Blocks were considered unfragmented if composed of contiguous land cover types that were considered bear habitat; land cover types that were not considered habitat were considered fragmenting features (Appendix III). Roads defined by New Hampshire Department of Transportation as Class I-V, as well as 300-foot buffers on major roads, were also considered fragmenting habitat features. Class VI roads were not considered fragmenting features and were included in this analysis. Eight categories of forest land, 3 categories of agricultural land, 2 categories of wetlands and cleared/open land were used in this analysis. Data indicate that bears do exist in areas where habitat blocks meeting these criteria are not available. Bears use a variety of smaller forest stands that are fragmented, often in close proximity to human development, to meet their habitat requirements. This analysis was provided as a measure of regional habitat quality and to help

predict the effects of human development on future bear populations. This assumes that a 20-mi^2 area of suitable habitat would provide the necessary habitat requirements with limited human exposure for the average New Hampshire black bear.

Habitat is less fragmented in the North and White Mountains regions compared to more southern regions (Figures 17, 18a and b, Appendix II). Statewide, the majority (87%, similar in 2001, - 0.8%) of bear habitat occurs in blocks ≥ 2.5 mi^2 of contiguous habitat and ranges between 97-46% from north to south (Figure 17, Appendix II). In terms of larger habitat blocks, 62% (same in 2001) of statewide bear habitat occurs in blocks ≥ 20 mi^2 of contiguous habitat and ranges between 86-7% from north to south (Figure 17, Appendix II). Generally, forested blocks are smaller (< 1.6 mi^2) in the southern portion of the state and increase in size (8-16 mi^2) in the central and westcentral part of the state (Sundquist and Stevens 1999). Large blocks (>39 mi^2) are more common in the northern portion of the state (Sundquist and Stevens 1999).

Habitat fragmentation in New Hampshire has been primarily caused by human population growth and associated development including land use change, forest removal for building lots and the construction and expansion of roads and highways. While most of this has occurred in the more southern part of the state, it is also occurring at a more modest level in central and northern areas. The construction of new houses represents the most significant threat to large, intact blocks of habitat. New Hampshire experienced a housing construction boom during 2001-2005 when approximately 9,000 new houses/year were built. This was the largest housing boom that had occurred in the state since the 1980s when nearly 20,000 houses/year were built (Sundquist and Hewes 2010). While most development has been focused on the southern part of the state, central and northern areas are quickly becoming less rural. The state's human population is predicted to grow 180,000 people through 2030 (14% growth), adding approximately 25,100 people to Coos, Carroll and Grafton counties (Sundquist and Hewes 2010).

Critical Bear Habitat

Beech/oak stands and wetlands (forested and 50% of non-forested wetlands) were considered critical black bear habitat as these areas provide important forage and cover. Beech/oak stands accounted for 1,213 mi^2 of bear habitat (15% of total available habitat) in 2011 (1,303 mi^2 in 2001, - 1%). Beech/oak stands were distributed more evenly compared to other cover types, however their abundance was highest in the Central (412 mi^2), Southwest-2 (256

mi^2) and White Mountains (222 mi^2) regions (Figure 19, Appendix II). Beech/oak distribution was low in the north (82 mi^2) as oak is generally absent in that region and only found in select local stands. Beech represents the major nut producing species in that region. Oak is more widely distributed in the remaining management regions and appears dominant compared to beech. Historically, beech crops in New Hampshire cycled every other year with even years being high abundance and use years and odd years being off-years (NHFG file data). That trend is no longer evident in beech production as years with above average crops have become variable, often occurring every 3-4 years. Conversely, there is no consistent pattern between years of good acorn production versus years with poor acorn production. Acorns appear to be a more dependable annual nut crop compared to beechnuts. Oak has produced an above average crop during 7 of the last 10 years while beechnuts were only abundant in 3 years over the same time period.

Wetlands accounted for 484 mi^2 of bear habitat (6% of total available habitat) in 2011 (160 mi^2 in 2001, + 4%, see reason for change below). The availability of wetlands as bear habitat varied by region and were most prevalent in the North, Central, Southwest-2 and Southeast regions (6-15%) as compared to the White Mountains and Southwest-1 regions (2-4%; Figures 16a and b, Appendix I). Forested wetlands and 50% of all non-forested wetlands were considered bear habitat. Non-forested wetlands were considered habitat in order to incorporate 50% of seasonally flooded basins, fresh meadows, shrub swamps and bogs. Forested wetlands comprised the vast majority (93%) of wetland type considered critical bear habitat; non-forested or open wetlands (analysis included only 50% of this wetland type) accounted for a much lower (7%) percentage of wetland habitat.

Carrying Capacity of Habitat

Based on the assessment of habitat availability, New Hampshire's estimated carrying capacity for bears could be as high as 11,808 bears. The majority (66%) of this carrying capacity (7,773 bears) was attributed to the North, White Mountains and Central regions as these areas contained the greatest amount of bear habitat (Figures 10 and 11). The three southern management regions had lower carrying capacity (4,036 bears) and reflected decreased habitat availability in those regions. The lowest acceptable population reflected the Department's best estimate of bear density necessary to maintain a minimum viable population of 1,372 bears. Based on the current estimate of available statewide bear habitat (7,872 mi^2), this minimum

viable population yielded an approximate statewide density of 0.17 bears/mi^2. This minimum viable population size was based on the principles of conservation biology and long-term population viability. The minimum viable population estimate used 2004-2013 harvest age structures to derive estimates of age-specific survival rates. Upper limits of biological carrying capacity assumed that optimal bear habitat in the northeast could support 1.5 bears/mi^2 (McLaughlin 1999). Reported bear densities from 18 jurisdictions in the northeastern United States and eastern Canada range between 0.13-1.10 bears/mi^2 (NHFGD file data). Estimated bear densities (bears/mi^2) on landscapes adjacent and comparable to New Hampshire include: Massachusetts (0.65), Vermont (0.60), Maine (1.10) and Quebec (0.13). Accurate estimates of upper and lower limits of regional carrying capacity would require a more detailed measure of quality and suitability of regional bear habitat.

Habitat Projection

From a habitat perspective, human population growth and associated development continue to represent the primary limiting factor to future bear habitat in New Hampshire. As the human population increases, more land will be converted to house lots, roads will be expanded and/or added, and infrastructure projects will intensify. Habitat will become more fragmented and bears and humans will be forced to live in closer proximity to one another. More people and houses on the landscape will result in an increased level of anthropogenic foods, thereby increasing the likelihood of bear/human conflicts. The state's human population is expected to grow approximately 9,000 people/year during the next two decades (Sundquist and Hewes 2010). As was the case historically, most of this growth will occur in southern New Hampshire with 70% of the growth predicted in the four southeastern counties. The remaining 30% of growth in the central and northern part of the state cannot be ignored and will also impact regional bear habitat. The more northern counties of the state are expected to gain 3,000-12,000 more residents in the next two decades. It has been roughly 10 years since the state experienced its second largest housing boom. As the economy improves, the rate of houses being built will likely mirror population growth.

Forest cover is predicted to decline to 79% of the state's land area by 2030 (Sundquist and Hewes 2010). The majority (83%) of statewide habitat was classified as forested; therefore a loss of forested habitat will impact the availability of overall bear habitat. Based on the habitat analysis done for this assessment for the period 2001 to 2011, overall available bear habitat

declined 1.4% (-110.3 mi^2) and forested habitat declined 7% (-504 mi^2). A continued loss at this rate would be a loss of approximately 110 mi^2 of overall bear habitat every decade. It is difficult to predict what the continued loss of forested habitat will mean in regards to overall bear habitat. Forest habitat can be lost but still provide viable habitat depending on what it is converted into (e.g., cleared, agriculture, etc.). If forested habitat is converted into house lots, then the loss of bear habitat will be accelerated in the future.

In addition to a loss of forested land, agricultural land declined 40% (137 mi^2) between 2001 and 2011. This rate of loss is more accelerated compared to the period 1997-2007 when 30 mi^2 (23%) of farmland was lost or converted to other land use (Sundquist and Hewes 2010). A continued loss at this rate indicates an additional loss of 30-135 mi^2 of bear habitat over the next decade. Loss of agricultural areas would have the greatest impact on bears in the Central, Southwest-1, Southwest-2 and Southeast regions due to the higher percentage of agriculture in these regions (Figures 16a and b). Although bear/human conflicts may occur when bears forage in agricultural areas, this habitat type is highly valuable, particularly during poor food years. Additional loss of land due to road construction and associated road buffers is expected, however it is difficult to determine the degree of bear habitat that will be impacted. Habitat loss will be greatest along major roads with high traffic volume and increased speed limits.

Further human development will likely impact critical bear habitat, including wetlands and beech/oak stands. In addition to direct loss of these habitats to development, human disturbance in close proximity to these habitat types may decrease use of these areas by bears. Beech/oak stands decreased 7% (-90 mi^2) between 2001 and 2011. Given that this cover type accounts for a relatively small percentage (15%) of available habitat, and because of its importance to bears, any loss is assumed to be detrimental to bears. Most management regions are susceptible to loss of beech/oak stands due the relatively even statewide distribution of this habitat type (Figure 19). These species are grouped as one cover type but it is well recognized that beech is more prominent in the North and White Mountains while oak is more dominant in the Central and southern management regions. Timber harvesting will likely cause the greatest percentage of beech/oak loss in all regions. However, removal or disturbance of this habitat type due to development (e.g., house lots) is also a significant concern. The use of these stands tends to decrease as human presence and disturbance increases. Accelerated harvest of hardwood stands that remove mature, nut-producing beech and oak trees may have an impact on bear

productivity, population stability and bear/human conflict trends. Bear productivity is directly associated with food abundance, specifically hard mast species that are high in fat and carbohydrates. A significant loss of this food source may result in decreased cub production and a resulting change in the age structure of the population. Additionally, the loss of this high quality food may cause bears to supplement their diets with human-related foods (which are also high calorie food items). Timber harvesting practices that do not maintain and/or promote more mature timber stands represent the most significant threat to nut bearing hardwood stands. New Hampshire's forests have proven resilient but these hardwood species require several decades before they are mature enough to produce fruit.

Wetlands, which included all forested wetlands and 50% of open wetlands, totaled 484 mi^2 (6%) of available bear habitat. The low percentage of wetland habitat on the landscape represents an important reason why it is considered critical bear habitat. Wetlands provide important food and cover to bears during all seasons but are of particular value during spring due to early emerging vegetation. The majority (93%) of wetland habitat was in the form of forested wetlands; open wetlands (50%) comprised the remaining (7%) wetland habitat. Estimated wetland habitat in the state increased significantly (+324 mi^2) from 2001 (160 mi^2) to 2011. This increase is attributed to the fact that the data sets used to quantify habitat have changed over the past decade. In 2001, the New Hampshire Land Cover (NHLC) data was used but this data set has not been updated since that time. This most recent habitat assessment was based on National Land Cover (NLC) data. The increase in the estimate of forested wetlands between years does not represent an actual increase in wetlands, rather it was due to an improvement in the mapping and delineation of wetlands in 2011 (Catherine Callahan, GIS Specialist, New Hampshire Fish and Game, pers. commun., 2014). The USGS utilized Wetlands Inventory data to produce the NLCD map. Wetlands were underrepresented in the 2001 habitat assessment. Human encroachment that results in decreased use to this cover type by bears represents the greatest habitat-related threat to wetlands.

Increased development will also further fragment parcels of contiguous land reducing bear habitat quality. Large blocks ($\geq$ 20 mi^2) of contiguous bear habitat will likely decline in all regions but are expected to decline the fastest in the Central, Southwest-1, Southwest-2, and Southeast regions. This is due to the fact that most human population growth has and is predicted to continue to occur in the more southern parts of the state (Sundquist and Hewes 2010). New

Hampshire continues to become less rural in nature. In 1950, approximately two-thirds of the state had a human density considered rural; this is predicted to decline to one-third by 2030 as the landscape become more suburban (Sundquist and Hewes 2010). As these larger intact blocks of habitat are lost, there will be less of a buffer between bears and human therefore conflict rates are predicted to increase.

Future bear populations will be directly impacted by the rate of habitat loss to human development and human attitudes towards bears. Despite an effort to remove developed lands from this assessment of available black bear habitat, bears are expected to occasionally occupy these areas. Black bears have shown the ability to live, and do well, in close proximity to humans when adjacent cover is available for security and escape cover, as long as people tolerate their presence. Current bear habitat around the state could likely support higher bear densities (biological carrying capacity), however people's tolerance of and willingness to accommodate bears (cultural carrying capacity) will continue to be a significant limiting factor. As remote habitats are converted to developed land, bear/human conflicts are expected to exceed human tolerance (cultural carrying capacity) in these environments. Public outreach and education aimed at reducing bear/human conflicts and increasing public tolerance will be essential to maximize cultural carrying capacity and allow more bears on the landscape. As bear/human conflicts increase, the current bear management program may need to be adjusted in an effort to achieve desired harvests rates and meet management objectives. Increasing harvest and lowering bear density may not necessarily result in decreased bear/human conflicts (human density has greater influence on conflict trends than does bear density), however manipulating bear density does represent one management option. Possible adjustments to the hunting season may include incentives to harvest more bears in regions with higher human densities as well as the use of techniques designed to remove nuisance bears at the community level.

Future habitat needs include identifying and protecting land through direct ownership or conservation easements. The majority (98%) of land protection in New Hampshire has used this approach (Sundquist and Stevens 1999). In 2010, 29% (2,663 mi^2) of the state's land area was protected from development (Sundquist and Hewes 2010). Additionally, the majority (70%) of protected land in New Hampshire was located in the northern half of the state with slightly less than half (43%; 1,137 mi^2) located within the White Mountain National Forest. In the New Hampshire Wildlife Action Plan 2010 update, 42% of the highest ranked habitat was protected,

33% of the highest ranked habitat in the biological region was protected, and 28% of habitat in the supporting landscapes of the abovementioned habitat classifications was protected (NHFG WAP Plan 2010).

Future habitat protection should focus on several aspects of bear habitat including critical habitat, large blocks of unfragmented land and the regional distribution of bear habitat. Parcels of land containing critical bear habitat (i.e., beech/oak stands, wetlands, and unfragmented blocks of land) should be a priority of land protection efforts. As of 2001, only 22% of all the high-value wetlands in the state were protected (Sundquist and Stevens 1999). The regional percentage and distribution of contiguous blocks of unfragmented land (Figures 17 and 18b) should also be considered. Regions with a lower percentage of large unfragmented blocks (e.g., Central, Southwest-2 and Southeast) should be targeted during protection efforts. Protecting land that provides corridors between larger blocks of habitat would facilitate future movement by bears between blocks and thus enhance block value. This would allow bears to expand their range during years of decreased food availability and maintain genetic diversity among bears. Additionally, this would allow bears to have decreased contact with humans and roads while moving between blocks thereby increasing survival and decreasing conflicts.

Agencies and organizations that own protected land in New Hampshire include the federal and state government, municipalities, private groups and quasi-public groups. Department staff should work closely with these organizations on land protection issues to provide guidance regarding bear habitat priorities. Many town conservation commissions around the state have access to GIS software and cover type maps that allow for more informed decision-making during land protection efforts. Department staff should continue to work with these groups to help direct these efforts. The Department, with the assistance of informed, interested stakeholders, should promote the need and importance of land and wildlife conservation, with a focus on maintaining larger intact and diverse habitats.

Mapping of critical bear habitat is essential to future habitat assessment and directing habitat protection efforts. The GRANIT (2001) and U.S. Geological Survey (2011) Land Cover Assessment has made these initiatives possible and should be replicated periodically to monitor habitat change. Additionally, periodic ground truthing of cover types would be useful to ensure the accuracy of data layers.

Studies designed to improve on current estimates of bear population density on a management region level should be continued on a statewide basis. Future studies may attempt to estimate the carrying capacity by specific habitat (or groups of habitat) types. This would allow for an accurate assessment of carrying capacity based on habitat analysis. Such an assessment would also allow for comparison between bear densities based on habitat/biology and social desire.

Population Assessment

Population Modeling

The mandatory reporting of bear kills established in 1956 represented the first step in maintaining a comprehensive database on the state's bear population. Bear registration provides the opportunity to collect biological information such as sex and age which is the foundation of most widely used techniques for estimating population size. The bear's sex is determined by examination and age is provided by premolar tooth analysis. Currently, sex and age data on nearly all bear mortalities spanning the period 1983 through 2014 are available.

Since the mid-1990s, sex and age data from all documented bear mortalities have been used to model the age and sex structure of the state's bear population and to monitor trend changes (growth or decline). Various approaches have and continue to be used in conjunction with one another to provide the most reliable estimate possible. One model used is that of Paloheimo & Fraser (1981) which utilizes harvest sex and age data to estimate sex-specific harvest rates based on differential vulnerability (determined by sex ratio change by age class). All bears ≥1.5 years old are used in this analysis as this represents the age where differential vulnerability based on sex begins. This model applies an estimated harvest rate (for each sex) to a known harvest level to estimate a prehunt population size.

A second model has been recently used in New Hampshire to estimate bear abundance; collectively, results of these two models are compared to allow for a better estimate of abundance and assessment of trend data, and to serve as a "checks and balances" to one another. This second model also uses age-at-harvest data to estimate population size through population reconstruction. Population reconstruction is a method of using demographic data (sex and age data acquired through harvest) to reproduce the historical trend in animal abundance (Downing 1980, Roseberry and Woolf 1991). This technique is a population estimation method that

utilizes age-at-harvest data and backward addition of cohorts to estimate a minimum population size. Consecutive population estimates (from both models) for different periods of time are then used to assess rate of population change. This rate of change in abundance over time (aka population growth) is the result of birth, death, immigration and emigration on the demography of a population and one of the most important parameters to bear population management (Pollock et al. 1990).

Another approach that has been used to estimate rate of population change over time includes life-table or demographic analysis (e.g., Leslie matrices) which uses data collected on a cohort to monitor trend changes in a population. This type of analysis requires robust estimates for various vital rate statistics including population size, age- and sex-specific survival and fecundity, sex ratios, age structure data and age of primiparity (Clark et al. 2006, Clark et al. 2010). Data needs for demographic analysis are far more intensive compared to models that use age-at-harvest data and often require additional data collection efforts (e.g., radio telemetry work, den surveys, mark-recapture techniques) to ensure that vital rate estimates are appropriate and reflect what is actually going on in the population. The precision of life table-based estimates of population growth are strongly correlated with the precision of age-specific vital rate estimates (Sawaya et al. 2013). Life-table analysis has been used to estimate rate of population change, female all-cause mortality rate and the cub segment of the population.

Life-table analysis focuses on females because female productivity, mortality, age distribution and abundance dictate population status. Males are polygamous with dominant males breeding several females over a large area. Population growth is directly associated with the proportion of breeding females producing litters and with survival of adult females. Male survival rates are lower compared to females and are not strongly correlated with population growth.

The Department also conducts a statewide deer hunter survey each fall, where hunters record their observations of bears (and other wildlife species) along with the amount of time spent hunting. This measure of observation per unit effort is used to calculate regional bear observation rates. Observation rates reflect relative bear densities and are used to allocate the statewide population estimate into regional densities.

Sample sizes (bear mortality data) are not sufficiently large to directly model regional bear populations, nor to rely on mortality data from a single year to model the population. As a

result bear population estimates and population statistics were derived utilizing 5-year blocks of mortality data (e.g., 2009-2013). The statewide population estimate is partitioned into regional density estimates utilizing 3-year blocks (e.g., 2011-2013) of bear observation rates by deer hunters.

In addition to estimating bear abundance using harvest-based mortality data, the Department collaborated on research designed to formulate bear population estimates using genetic tagging and mark-recapture analysis during 2006-2008 (Table 4; Coster 2008). A primary objective of this study was to use the DNA-based population estimates to compare against and validate estimates derived from bear mortality statistics and hunter observation data (technique used by NHFGD described above). Two study areas were established, each approximately 100 mi^2 in size, in the northernmost bear management region. Within each study area, 50 hair traps were established at a density of one hair trap per 2-mi^2. Genetic-based bear density estimates were consistent in both study areas for two consecutive years, suggesting that this technique is a valid method of obtaining reliable estimates of bear abundance in New Hampshire. DNA-based bear population estimates were generally similar and comparable to population estimates derived using bear mortality data/hunter observation rates.

Results from the genetic tagging research suggest that this method represents a valid technique for bear population estimation in New Hampshire. Additionally, results indicated similarity between the two independent methods of estimating densities, therefore it is presumed that mortality/observation data can be used to provide a reliable estimate of regional bear density. The use of mortality/observation data currently represents the most cost-effective method for the Department to formulate regional bear population estimates, and likely will continue to be used for bear population management in New Hampshire.

Past Populations

Bear population trends in New Hampshire are comparable to those across North America. When the first settlers arrived to New Hampshire, bears were found statewide. Land clearing practices by early settlers, year round bear hunting and a bear bounty system caused the population to be at its lowest level during the mid-1800s. Silver (1957) reported that bears were occasionally seen in Rockingham County until 1810, were relatively frequent in Merrimack County during the early 1840s and taken in Hillsboro County until 1824. Bears were occasionally taken in Cheshire and Sullivan Counties until 1880 (Silver 1957). The three

northernmost counties of Grafton, Carroll and Coos always maintained relatively modest bear densities (Silver 1957).

Changes in land use and adoption of regulations regarding bear harvest during the twentieth century allowed for statewide population growth and range expansion. During the early twentieth century, the Industrial Revolution caused a decline in agriculture allowing abandoned farmland to revert to forest creating more ideal habitat. The bear bounty system was eliminated in 1956. During this same period (1951-1963) the first bear hunting seasons were established which represented the first restrictions on bear harvest. Bears were declared big game animals in 1983. The NHFGD was granted authority to regulate season length, method and manner of take in 1985. In 1988 the Department was granted permanent authority to regulate the bear harvest. In 1985 the seven southernmost counties of the state were closed to the taking of bear to allow for range expansion. Harvest data since 1956 indicated a southward range expansion from Coos, Carroll and Grafton Counties into Sullivan, Cheshire and Merrimack Counties (NHFG file data). The entire state was reopened to bear hunting in 1998.

The secretive nature of bears coupled with the heavily forested habitats that they typically occupy, creates challenges when estimating bear populations. A general trend in bear abundance in New Hampshire can be seen by reviewing the numbers reported bountied between 1882 and 1956 (Table 1). This table indicated fluctuations in bear harvest for 70+ years. Periods of high harvest (e.g., 1888-1896) are followed by periods of decreased harvest (e.g., 1897-1902). The state's bear population was estimated by both Harper and Seaton in 1929 at 1,000 (Silver 1957). In 1943 Stevens used data from 1934-1942 to calculate a statewide bear population of 837. Stevens based this calculation on the assumption that one bear occupied every 5 mi^2 area of occupied range and that approximately half of the state contained bear habitat (Silver 1957).

Harvest data collected since 1956 indicated a southward range expansion from Coos, Carroll and Grafton Counties into Sullivan, Cheshire and Merrimack Counties (NHFG file data). The rate of expansion was assumed to be slow because of female bear behavior and periodic high harvest between 1956 and 1985 (Table 5). Female offspring typically occupy a subset of the mother's home range thereby precluding their dispersal (Elowe 1984, Kolenosky and Strathearn 1987). The entire state was open to bear hunting until 1985 and high harvest in some portions of the state likely impeded range expansion. Additionally, age data collected on bears during the early 1980s indicated a decline in the female age structure and generated concern over the lack of

older breeding females in the population. The desire to promote range expansion and allow for older females in the population prompted the need for more conservative bear seasons. Harvest restrictions adopted in 1985 decreased bear harvest and allowed for increased female survival and southward range expansion.

During 1990-2005, the bear population experienced modest growth of approximately 2-3% per year (based on two models; see description in population modeling section) as the population increased from 3,505 to 4,830 bears (Figure 20). The period of greatest growth occurred during 1995-2000 when average annual growth approximated 10%; the population remained stable (-0.7% annual decline) during 2001-2005. It is important to recognize that rate of population change estimates are more precise when obtained over longer time periods; short-term estimates (e.g., 5-year period of time) are useful but should be used with caution.

Regional Goals and Estimated Densities

Previous regional goals (BGMP: 1997-2005) and respective estimated bear densities were described in the Management section of this assessment and displayed in Table 3a and Figure 5. As a recap, during the last year (2005) of the previous management plan, regional bear populations were at goal in the North, Central, Southwest-2 and Southeast regions and above goal in the White Mountains and Southwest-1 regions.

Age Structure

The age structure of harvested bears, particularly females, supports the trends observed in population size and rate of growth. The mean age of harvested females and males during 1990-2005 was 5.7 and 4.6 years, respectively (Figure 21). Female age has been stable over time and has resulted in modest population growth over the past 2+ decades. A decrease in female mean age would likely result in population decline while an increase would suggest growth. The mean age of harvested males was lower than that of females indicating that males experienced higher mortality rates compared to females (Figure 22). Although mean age at harvest provides an important index of population dynamics, it may not always accurately reflect population status. This may be the case when analyzing year-to-year age data and illustrates the importance of using several years of age data for analysis purposes. Additionally, several factors may affect mean harvest age including annual fluctuations in cub production, differential vulnerability to hunter harvest based on age, food availability and variations in hunter effort and selectivity. For example, mean age tends to decline for both sexes during high harvest years. To prevent

misinterpretation of harvest age data, our population assessment utilizes long-term trend data including the age and sex structure of harvested bears, harvest rates and harvest tallies. Trend lines in these data typically coincide with population model results.

Survival and Harvest Rate Estimates

The increased movement exhibited by males increases their vulnerability and causes them to have higher harvest rates compared to females (Figure 22). Decreased vulnerability of females has allowed their harvest rates to be more consistent during 1990-2003 as compared to that of males. Harvest rates for both sexes, but more notable for males, increased the greatest during 1996-2003 and appear to be the result of elevated bear harvest during 1999, 2000, 2001 and 2003. Bear harvest sex ratios during 1990-2005 averaged 1.3 males:female indicating higher vulnerability of males (Table 5). In select years (e.g., 2003), the harvest sex ratio drops below 1.0 and indicated that females accounted for a higher than average percentage of the harvest. Higher mortality rates for males result in females being more abundant than males in the bear population, but this typically is not evident in harvest data. During poor mast years, female harvest tends to increase relative to male harvest, with the result being the females can approach or exceed males in the harvest. During years with abundant mast, males are more vulnerable than females to harvest and therefore account for a larger percentage of the harvest.

Modeling of harvest data from 1994-2003 indicates that mean overall survival for females and males was 82 and 74%, respectively, with a corresponding rate of mortality by all causes (harvest and non-harvest) of 18 and 26%. Harvest mortality rate for males (20%) was twice that of females (10%); estimated non-harvest (natural) mortality was slightly higher for females (9%) than males (7%; Table 6).

Current Populations

Based on population estimates during 2006-2013, the statewide bear population has increased by 1,140 bears representing and estimated annual growth rate of 3% (Figure 20). This increase was presumably caused by multiple biological and management-related factors. In the early stages of the plan, the management called for an increase in bear density in half of the state, specifically in the central and southern bear management regions. This resulted in more restrictive bear hunting seasons compared to prior years in an effort to satisfy goals. Interestingly, there was little difference in the average annual harvest (584 bears/year) during 2006-2013 compared to the eight years prior (1998-2005; 501 bears/year). Additionally, there

have been several years since 2006 where overall mast production (primarily by beech and oak) has been above average (NHFG file data). During these strong food years, bears become less vulnerable and harvest levels decline. Rich habitat and abundant food resources can change the dynamics of a bear population by raising survival of adult females, decreasing the harvest sex ratio, increasing reproductive success (e.g., increased cub survival, larger and/or more frequent litters) and lowering the age of first reproduction. It is difficult to pinpoint which variables had the greatest influence on population growth; it is likely that multiple factors have caused the growth documented in the New Hampshire bear population.

Regional Goals and Estimated Densities

In the first year (2006) of the current bear management plan, the statewide population was estimated at 4,588 bears and the overall goal was to stabilize the statewide population at 5,100 (0.55 bears/mi^2). Regionally, estimated densities were at goal (see Table 3b for goals) in the North and Southwest-1 regions, above goal in the White Mountains (by 0.32 bears/mi^2), below goal in the Central (by 0.26 bears/mi^2), Southwest-2 (by 0.25 bears/mi^2) and Southeast (by 0.14 bears/mi^2) regions. For comparison, in year eight of the plan (2013; most recent year for which population estimate available at time of writing), the population had increased to an estimated 5,728 bears representing a 24% increase (approximately 3% annual growth). Current management strategies are to decrease the statewide density from 0.63 to 0.55 bears/ mi^2 (- 0.08 bears/mi^2; Table 3b). Regional prescriptions include to stabilize the population in the North and Southwest-1 and -2, decrease density in the White Mountains (by 0.17 bears/mi^2) and Central (by 0.16 bears/mi^2) regions and increase density in the Southeast (by 0.13 bears/mi^2).

Age Structure

Female mean age (5.4 years) during 2006-2013 has remained generally consistent with the long-term value (5.7 years); the recent mean age of males (3.8 years) has declined slightly from previous years (4.6 years). The decline in male mean age is primarily due to the increase in male harvest mortality over the past decade (female harvest mortality has remained lower and more constant over time). Female productivity, survival, age distribution and abundance dictate the dynamics of a bear population. Because of the breeding behavior of males, they have less of an influence on overall bear population size and growth rate. Given that the female age structure has changed little from previous years, similarities in past and present population growth rates are expected.

Survival and Harvest Rate Estimates

Bear harvest sex ratios during 2006-2013 averaged 1.3 m:f which was identical to the mean ratio achieved during the prior 16-year period (Table 5). This indicates that the percentage of males to females in the harvest has not changed and that females (during most years) make up a lower percentage of the annual harvest. This factor helps explain the modest growth seen in the bear population over time as females are less prone to mortality than males.

Modeling of harvest data from 2004-2013 indicates that mean overall survival for females and males was 80 and 70%, respectively, with a corresponding rate of mortality by all causes (harvest and non-harvest) of 20 and 30%. Harvest mortality rate for males (24%) was twice that of females (12%); estimated non-harvest (natural) mortality was slightly higher for females (9%) than males (8%). A comparison of this data to the same data reported for 1994-2003 (in Past Populations section) indicates general similarity among most estimates (Table 6). Overall survival rates for both sexes dropped slightly between time periods but remained relatively similar. Harvest mortality rate increased slightly between years and was most notable for males.

Population Projections

The state's bear population is expected to fluctuate by region over time and will be most impacted by changes in human density and land use. As the human population increases, bear/human conflicts will likely follow a similar trend. Increased conflicts will lower the public's tolerance of bears (decreased cultural carrying capacity) and there may be a desire to lower bear population goals which would result in decreased bear densities. Bears have proven to be highly adaptable and can thrive in residential areas with high human presence. The future loss of bear habitat likely will have the greatest impact on bear/human conflict levels; bears are well established in New Hampshire and anticipated moderate habitat loss over time may not significantly reduce bear densities. However, that does not in any way decrease the need to protect and enhance bear habitat in all parts of the state. A primary reason why bears have done so well in the face human population growth and expansion is because human-related foods serve as a buffer to bears when natural foods are limited. All wildlife needs viable habitat and bears are no different. Productive habitat with diverse foods will reduce the need for bears to supplement their diets with human-related food and create space where bears can live with minimized human contact.

The North and White Mountains regions contain the greatest percentage of total land area classified as available bear habitat (Figure 11), the lowest percentage of land area classified as developed or transportation (Figure 12) and less fragmented bear habitat (Figure 17). These regions contain a variety of highly productive habitat types including wetlands, cleared areas containing berry producing herbaceous vegetation and stands of beech, oak and aspen. Habitat loss due to timber harvesting (e.g., beech and oak stands) and human development is expected to occur in these regions and may lower bear population productivity. Continued human development will reduce available bear habitat causing bears and humans to live in closer proximity (greatest issue is the increase of anthropogenic foods) thereby increasing levels of bear/human conflicts. However, the rate of habitat loss and human development is expected to be considerably slower in these regions compared to more southern management regions.

Given the predicted changes in habitat, and assuming harvest regulations, harvest rate, season structures and levels of bear hunter effort remain consistent, bear populations in these regions are expected to fluctuate between periods of stability and modest growth of 2-3% annually. If participation in bear hunting increases in the future, specifically by nonresidents, most of this increased effort will likely take place in these two regions. These regions have higher bear densities and more land open to hunting. For these reasons, the more northern management regions are more attractive to traveling bear hunters. A resulting increase in hunter effort and success may cause a decline in the bear population growth rate and result in the need to adjust hunting seasons depending on population goals. Due to the quantity of very remote land in the White Mountains, the bear population in this region will be less impacted by increased harvest and will be the most difficult to manipulate from a management perspective. Remote land serves as a refuge to bears, particularly during strong food years (beechnuts, acorns and mountains ash berries are important foods in this region), causing bears to be less vulnerable to hunting thereby decreasing harvest rate.

The Central, Soutwest-1 and -2 regions have a slightly lower percentage of total land area classified as available bear habitat (Figure 11), a greater percentage of land area classified as developed or transportation (Figure 12) and more fragmented bear habitat (Figure 17). Although prime bear habitat in these regions is less abundant and more fragmented, the habitat has proven to be highly productive and more diverse due to the quantity of beech and oak (Figure 19), agriculture and wetlands (Figure 16b). The majority of the state's human population growth and

development has and will continue to occur within these regions (Sundquist and Stevens 1999, Sundquist and Hewes 2010).

Anticipated human development and habitat loss in these regions will further increase bear/human conflicts and decrease human tolerance towards bears. Portions of these regions are highly developed and the potential for conflicts are high. As an example, the Central region has one of the highest annual bear/human conflict tallies of any of the management regions. If bear densities remain consistent with current levels or increase, the frequency of complaints are expected to increase significantly as the area becomes more developed. Based on anticipated changes in human population growth and habitat conditions, it is assumed that bear densities will approach or exceed cultural carrying capacity in these regions before doing so in the North and White Mountains. Assuming harvest regulations, season structures and levels of bear hunter effort remain consistent, bear populations in these regions are also expected to fluctuate between periods of stability and slow population growth of 2-3% annually. Predicted growth may be offset to some extent by nonhunting mortality; human population growth and expansion will likely result in more bears being loss to motor vehicle collision and lethal removals.

If regional cultural carrying capacity is met and population goals call for reduced bear densities, harvest opportunity will need to be expanded to increase harvest rate. Populations in these regions have recently reached existing goals, and reduced growth is necessary to stabilize. At the current levels, annual population decline (in the Central and Southwest-2 regions) of approximately 2% should be sufficient to maintain consistency with regional goals. The population in the Southwest-1 region has been stable. If future density goals call for a population reduction, a 2-4% annual decline may be necessary in these central and southern regions. Additionally, private land ownership and decreased hunter access within these regions may create a challenge in future management as it will be necessary to maintain hunter pressure to adequately achieve harvest objectives.

The Southeast region has the lowest percentage of total land area classified as available bear habitat (Figure 11), the greatest percentage of land area classified as developed or transportation (Figure 12) and highly fragmented bear habitat (Figure 17). The goal in this region has been to maintain the population at a low density. This area is not considered to constitute ideal bear range due to its high human density, level of development and fragmented habitat. The potential for bear/human conflicts is high, and the expected tolerance for nuisance

bears is very low. Prior to the current management plan, the Department's approach was to maintain a very low density (no numerical density goal assigned) in this part of the state. Essentially, a few bears may permanently reside in the region while transient bears may move in and out. Bear density in this region is expected to remain low but the public will need to determine a desired level.

Limiting Factors

Human attitudes and habitat conditions represent the most significant limiting factors to future bear populations in New Hampshire. Based on habitat availability alone, New Hampshire could support higher bear densities than what have been previously achieved. Bear density goals will depend largely on human attitudes toward bears, specifically the willingness of people to change their own behavior to accommodate bears and the Department's ability to mitigate bear/human conflicts. The cooperative bear/human conflict mitigation program has been very successful and has helped stabilize conflicts in recent years and presumably has maintained higher tolerance. Bear population management goals outlined in the current plan (BGMP: 2006-2015) were formulated based on the public's input and desires. Future bear population management goals will continue to incorporate public attitudes to ensure goals remain consistent with cultural carrying capacity.

The loss of bear habitat represents a significant limiting factor to future bear populations as habitat conditions influence bear behavior, reproduction and survival. The loss of forested habitats to human development will increase bear/human conflicts and likely result in a decreased bear population. A large percentage of New Hampshire towns are in close proximity to available bear habitat. Further development within these towns will represent a direct loss of forested habitat and put humans in closer proximity to bears. Bears are highly food motivated and have a unique ability to find the highest quality foods within their home range; habitats that maintain diverse, natural foods will minimize the need for bear supplement with human-related foods. Additionally, bears attracted to human-occupied areas will have increased mortality due to bears being dispatched as a result of nuisance complaints and killed by vehicle strikes. A loss of habitat that provides important fall foods (i.e., hard mast producing species) may result in lower productivity, causing decreased recruitment of young bears.

Use and Demand Assessment

Past Use and Demand

Precolonial to 1956

Indians harvested bears with bow and arrows, snares and in pits (Merrill 1888). Bear meat was a common food source used by Indians and early settlers and was often preferred over venison (Wood 1634, Wheeler 1879). Early European settlers viewed bears as competitors that threatened agricultural crops and livestock. Additionally, the process of clearing land for agriculture by the early settlers resulted in the loss of bear habitat and a decline in bear numbers. Because bears were viewed as a nuisance species they were placed on a bounty system until 1956. In the nearly five decades since bounties were abolished, changes in land use and adoption of regulations regarding bear harvest allowed for statewide population growth and expansion. As bear populations have grown statewide, so has interest in bears by both hunters and non-hunters.

1956-1985

Historical annual bear harvest fluctuated considerably and trends in bear harvest between 1882 and 1956 can be seen by reviewing the numbers reported bountied during that time period (Table 1). The average bear mortality from 1956-1965 was 143 bears with an average still and hound hunter harvest of 111 and 17 bears, respectively (Table 5; Figure 23). During that period most bears were harvested incidental to deer hunting.

Interest in bear hunting continued to grow during the next decade, 1966-1975. The average bear mortality increased to 303 bears with an average still and hound hunter harvest of 259 and 21 bears, respectively (Table 5). During that time the majority of the harvest continued to be incidental to deer hunting. The years of 1969 and 1973 were most noteworthy as hunters took a high number of bears in those years (Table 5; Figure 23).

The average bear mortality from 1976-1985 was 208 bears with an average still, bait and hound hunter harvest of 148, 10 and 45 bears, respectively (Table 5). Harvest data from that decade indicated a shift in the manner by which bears were hunted. During the late 1970s and early 1980s, declining deer densities caused a reduction in deer hunter effort. Despite the reduced number of deer hunters, annual bear harvest remained relatively constant during that time. The annual bear harvest changed from an incidental harvest by many deer hunters to a harvest by a select group of bear hunters. The most significant increase in hunter effort was

demonstrated by houndsman as the number of permits issued to take bear with dogs increased from 55 in 1979 (first year data was available) to 122 in 1983. Bait hunter effort was not well documented during this time period but anecdotal and harvest data indicate that interest in baiting also increased. The number of bears taken by houndsman increased 108% from 1978 to 1983 and harvest by bait hunters increased 100% from 1979 to 1983 (bait hunter harvest data not available for 1974-1978 and 1982; Table 5; Figure 23).

The increase in the number of hunters pursuing bears with hounds and over bait was thought to reflect an increase in bear guiding during that period as these methods of harvest are typically used by guides. Reports indicate that there was great demand for a guided bear hunt with hunts costing over $1,500 (NHFG file data). A comprehensive, historical summary of guiding in New Hampshire is not available. There were 65 registered guides in 1976 that were listed as hunting or hunting and fishing guides. Data from 1978 was similar with 69 registered guides. It is unclear as to how many of these registered guides were specifically hunting bears in those years. By 1981, 30 guides were specifically hunting bear in New Hampshire (NHFG file data). In 1983, 61 of 77 (79%) bears harvested using hounds were taken with the aid of a guide (NHFG file data). The percentage of the total bear harvest taken with the use of a registered guide was 32, 13 and 5% in 1983, 1984 and 1985, respectively (Figure 24).

Bear harvest decreased substantially in 1985 due to rules adopted in that year to reduce female harvest and allow for bear population increase and range expansion. Specific restrictions were implemented that limited the number of guides who could operate per year to 20, closed bear season the day before the regular deer season opened and closed all counties to the taking of bear except Coos, Carroll and Grafton. The restrictions placed on guides in 1985 (maximum of 20 bear guides) was the result of an increased number of nonresident houndsman coming to New Hampshire to guide for bear. This increased activity caused social dissatisfaction, and collectively both resident bear hunters and the nonhunting public pushed for restrictions.

1986-1995

The average bear harvest from 1986-1995 was 241 bears with a mean still, bait and hound hunter harvest of 145, 53 and 43 bears, respectively (Table 5; Figure 23). The overall and bait hunter harvest during that period increased 16 and 430%, respectively, compared to the preceding 10-year mean; average harvest by hound and still hunters remained consistent with previous levels. Bear seasons remained relatively restrictive during most of this 10-year period

with varying degrees of overlap between bear and deer season, portions of the state remaining closed to bear harvest, restrictions on bear hunting guides and the elimination of preseason baiting in 1991 (Table 2). Due to the growing interest in bear hunting, it is assumed that harvest levels would have been considerably higher under a more liberal (previous) season structure. A notably high harvest occurred in 1995 that caused the Department to seek a voluntary closure of the bear hunting season that year. The more northern WMUs were open to bear harvest during the entire deer rifle season in 1995, which increased the opportunity for late season harvest by opportunistic deer hunters (Table 2). Mast crops produced very poorly that year and resulted in the increased vulnerability of bears to hunting. The 1995 bear harvest (428 bears) was nearly twice the preceding 5-year average of 231 bears. Additionally, hunters took a higher percentage of females that year (1.1 m:f) as compared to the preceding five years (mean of 1.5 m:f). This time period also saw a considerable decrease in the percentage of bears harvested using a registered guide and averaged 3% (Figure 24). This decrease in harvest was largely due to restrictions placed on bear hunting and guiding in 1985.

Hunters have been required to purchase a separate bear hunting permit (in addition to a hunting license) since 1990 which has allowed the Department to assess bear hunter effort. Bear hunting permit sales increased 235% from 1990 (4,300 permits) to 1995 (14,385 permits; Figure 2). Hound permit issuance increased 39% between 1990 (198 permits) and 1995 (275 permits; Figure 2). Bait hunting permit issuance decreased from 1990 (447 permits) to 1991 (178 permits) but showed steady increase through 1995 (259 permits; Figure 2).

Bear permit costs during this period remained low ranging from $3 in 1990 to $5 from 1998 through 2005. Even with the extra charge, the number of licensed bear hunters has increased since inception of the permit. Due to the importance of this money for funding registration, research and public outreach and education, the Department attempted to increase permit costs in these years without success.

1996-2005

During 1996-2005 interest in bear hunting continued to show steady growth indicating that bears continue to be viewed as a valuable big game species. Bear permit sales increased 42% from 1996 (12,020 permits) to 2001 (17,129 permits which represents and all-time high) but decreased slightly (11%) through 2005 (15,258 permits; Figure 2). The average number of permits issued during this 10-year period was 15,561/year. Trends in the number of method-

specific permits issued during 1996-2005 were similar with hound and bait permits increasing 20% and 104%, respectively. An average of 448 bait and 297 hound permits were issued per year.

The average bear harvest from 1996-2005 was 450 bears with a mean still, bait and hound hunter harvest of 58, 255 and 137 bears, respectively (Table 5; Figure 23). The overall bear harvest increased 87% from the preceding 10-year mean; method-specific changes were considerably more significant with a 381% increase in bait harvest, a 219% increase in hound harvest and a 60% decrease in still hunter harvest. These years represent the period of greatest change in how people hunted bears in the state and are illustrated by changes in the percent harvest by method between time periods (1986-1995 vs. 1996-2005). Proportions of the harvest decreased for still hunters (60% to 13%) and increased for bait (22% to 57%) and hound (18% to 30%) hunters.

The overall annual success rate of bear hunters was low (3%) but rates for bait (31%) and hound (20%) hunters were considerably higher. For that reason, there has been a general shift from still hunting/stalking bears to hunting bears with bait, and to a lesser extent hounds. It should be recognized that estimates of success rates for bait hunters would represent a maximum rate because landowners do not require a baiting permit when on their own land (success rate determined by numbers of permits issued) therefore the number of hunters baiting is somewhat higher than indicated by permit issuance. Still hunter success was difficult to assess because both bait and hound hunters may switch over to this hunting method once their respective seasons end (still hunting season is open later than both bait and hound season in all regions). For data analysis purposes, it was assumed that hunters did not utilize more than one hunting method per year and permit allocation by method truly reflected hunter effort. Based on these assumptions, still hunter success was low and averaged 2%. Success rates could not be assessed prior to 1990 as no specific permit was required to hunt bear (hunters could legally take bear under a general hunting license) and therefore there was no measure of hunter effort. It is assumed that historic success rates of bear hunters were relatively similar to levels reported above. This represents another advantage of the bear permit requirement.

When the price of the bear permit was low during 1990-2005 ($3-$5), opportunistic deer hunters often bought a permit so that they could take a bear inadvertently while deer hunting. As a result, hunters took a modest percentage (19%) of the annual bear harvest while targeting deer

(Figure 3). During years with abundant fall foods, bears remain active later into fall resulting in a higher percentage of bears being harvested incidental to deer hunting in some years (e.g., 2000). Based on this data, as well as the growing participation in bait and hound hunting, it is evident that there historically has been a core group of bear hunters who specifically target bear each year.

This period represents the time in history when unprecedented high bear harvests began to occur in select years, most notably in 2003 and 2004 (Figure 23). These highs in bear harvest reflect: 1) a strong bear population (Figure 1), 2) increased hunting pressure- the number of individuals specifically hunting bears has risen over time (Figure 2), 3) increased hunting opportunity – the entire state was opened to bear hunting beginning in 1998 (Table 2), and 4) changes in method-specific hunter effort- the growing popularity of hunting bears with bait has resulted in higher hunter success rates thereby increasing harvest levels. In addition to these factors, annual food distribution and abundance also dictates the vulnerability of bears and annual harvest rate. Increased baiting during very poor food years can result in atypically high harvest in select years.

The harvest of 803 bears in 2003, followed by 679 bears in 2004, admittedly had managers concerned over the subsequent impact to the bear population. The Department had never experienced such a dramatic increase in harvest; the 2003 harvest was 52% higher than the previous record harvest of 527 bears in 2001. Of particular concern was the elevated female harvest rate, specifically in the more northern portion of the state. The Department implemented an early closure (of 11 days) to the bear season (authority provided to Executive Director under RSA 208:2 and 208:22) in that year in WMUs A, B, C2 and D1. Since that time, the bear harvest has reached a "high" level multiple times, ranging from 600-800+ during 6 of the last 11 years (Figure 23). This trend has become less alarming and it has become evident that the state's robust bear population can withstand occasional periods of increased harvest. Several low harvests have offset the high years resulting in a more reasonable multiyear "average" harvest. Even with intermittent high harvest, the bear population has grown and has remained consistent with population goals.

Bear guiding activity increased slightly in New Hampshire during 1996-2005. The number of registered guides allowed to hunt bear per year was raised to 30 and 35 in 1999 and 2004, respectively. Despite increased guiding activity, the percentage of the annual harvest

taken with the use of a guide has remained consistent and averaged 4% (Figure 24). Most guides utilized hounds (64%) to take bears; baiting (31%) and still hunting (5%) were used to a lesser extent. Additionally, most guided bear hunts occurred in the North (54%) followed by the White Mountain (25%), Central (19%) and Soutwest-1 (2%) regions.

Nonconsumptive use of bears has been difficult to quantify. Anecdotal evidence indicates that open landfills in the state's more northern towns historically attracted large numbers of people due to bear viewing opportunities that these areas provided. Routine bear questions from the general public, as well as attendance at presentations regarding bear biology, management and research, indicate that people have a genuine interest in bears. It remains evident that outdoor enthusiasts continue to relish the opportunity to view bears in New Hampshire.

Current Use and Demand

2006-2013

In 2006, the price of the bear permit increased from $5 (regardless of residency status) to $16 and $48 for residents and nonresidents, respectively. This increase received support from a large percentage of bear hunters as they felt the species had been previously undervalued. This price increase has resulted in the loss of approximately 5,000 licensed bear hunters a year which represented a percentage of opportunistic deer hunters who presumably were previously inclined to purchase a bear tag due to the low cost. The greatest decline in license sales occurred during the first year of the price increase when 5,584 less permits were sold as compared to 2005. Since that time, permit sales have moderated some averaging 9,944/year (Figure 2). Since the initial decline, the sale of bear permits has increased slightly (6%) over the past eight years. The decline in license sales has had little impact on the overall bear harvest; opportunistic deer hunters took a low percentage of the annual harvest in prior years (Figure 3). Trends in the mean number of bait permits issued during 2006-2013 have been much more pronounced, increasing 130% from the previous decade (448 to 1,030). The growth in hound hunting has been more modest with the average number of permits increasing 15% from the previous 10-year period (297 to 341).

The average bear harvest from 2006-2013 was 584 bears with a mean still, bait and hound hunter harvest of 223, 285 and 76 bears, respectively (Table 5; Figure 23). The overall bear harvest increased 30% from the preceding 10-year mean; method-specific changes included

a 284% increase in still hunter harvest, an 11% increase in bait harvest and a 45% decrease in hound harvest. When comparing the percent harvest by method to the previous decade (1996-2005 vs. 2006-2013), the proportion of the harvest taken by bait hunters remained generally similar (57% and 49%), however percentages increased for still hunters (13% to 38%) and decreased for hound hunters (30% to 13%). While participation varied between still and hound hunting, the popularity of baiting bears continued from the previous decade.

The overall annual success rate (6%) of bear hunters during 2006-2013 was twice that achieved during the previous 10-year period (3%). Method-specific success rates changed little from the preceding ten years and averaged 28, 22 and 6% for bait, hound and still hunters, respectively. The ability to assess hunter effort by method continues to be possible because of permit requirements for hunters that utilize bait and hounds. Given the increased success by hunters that use these methods, it is important to be able to both monitor and predict harvest impacts.

Even though the price of a bear permit has increased, some hunters continue to purchase the permit to have a chance to take a bear while hunting deer. This group of still hunters is recognized as an important user group and efforts have been made to increase their opportunity when required management action allows. The still hunting season in the North, White Mountains, Central and Southwest-1 regions have overlapped with the deer muzzleloader season for several years (Table 2). Additionally, the White Mountains, and more recently the Central region, also have a late season that overlaps with the first two weeks of the deer firearms seasons.

Still hunting seasons that are 12+ weeks in length overlap the entire deer muzzleloader season as well as the first two weeks of deer firearms season. The fact that populations are at or above goal in these regions is the primary reason why extended hunting opportunity has been possible. While the harvest by this group (hunters specifically targeting deer) in any given year is low (average of 12%; Figure 3), additional harvest is warranted and does provide an opportunity that some constituents enjoy.

Bear guiding activity has remained generally similar to previous levels in New Hampshire during 2006-2013. This stability is a function of the cap put on guiding starting in 1983; the desire to expand the commercialization of the bear resource is anything but static. The number of registered guides allowed to hunt bear per year has remained at 35 since 2004. The

percentage of the annual harvest taken with the use of a guide has remained generally consistent and averaged 9% during recent years (Figure 24). Most guide's utilized bait (85%) to take bears; hounds (14%) and still hunting (1%) were used to a lesser extent. Most guided bear hunts occurred in the North (52%) followed by the White Mountain (29%) and Central (19%) regions.

This cap has recently been increased to 50 guides but the Department continues to support limits in an effort to: 1) ensure that bear management remains consistent with the Department's mission statement, 2) prevent a dramatic increase in the commercialization of the bear resource, 3) maximize the availability and use of this publically-owned resource for the general hunter and public, 4) prevent the incentive to privatize the bear resource, and 5) ensure that management decisions benefit bears and not an individual's economic agenda. In some states that have widespread bear guiding, outfitters typically lease land from large landowners (e.g., paper companies) and access for the general hunter is limited.

The use of the bear resource by the nonconsumptive public has continued to increase in recent years. Information requests by the general public, as well as attendance at presentations regarding bear biology, management and research, indicate that people have a genuine interest in bears. Calls from the public asking for locations to view bears have become routine. Wildlife photographers are taking great bear pictures in various parts of the state and their pictures appear to be in high demand. While representing a significant source of bear-human conflicts, the number of people intentionally feeding bears in their backyards has grown and indicates some people's desire to frequently see bears.

Use and Demand Projections

Bear hunter effort is expected to increase over the next ten years, primarily because bear populations are strong and people get more interested in bear hunting when sightings are more frequent. Bear permit sales have increased 6% over the past eight years and this trend is expected to continue into the future. Despite continued demand for bear hunting by various methods, the consumptive use of the bear resource continues to be threatened by social perceptions of the nonhunting community. Bait and hound hunting in New Hampshire represent important management tools that enhance the Department's ability to efficiently and effectively control bear population growth and maintain populations at desired levels. These two methods of harvest typically account for approximately 62% of New Hampshire's annual bear harvest; additionally, these methods are useful in targeting specific offending bears. Modifications

designed to increase still hunter success rates, including increased bag limits, season length and overlap with deer hunting seasons, would likely represent the most viable methods of controlling bear population growth in the absence of hounding and baiting, but would likely not be sufficient to compensate for the loss of the other methods. From a behavior perspective, it is assumed that maintaining reasonable harvest pressure on bears will help maintain an increased level of fear of humans by bears. Bears that are more naturally wary of humans are less prone to nuisance activity and human-related mortality.

Bear populations are strong in all regions of the state and estimated densities are relatively consistent with goals. Under past management, the bear population has shown modest growth (2-3% annually) and this growth may continue into the future. If future management actions require that the population be stabilized or reduced, hunting pressure will need to be increased in an effort to increase harvest rate. In the future, bear hunting opportunity will likely increase and bear hunters using various methods will need to share opportunity and access. No one method of bear hunting should monopolize the annual harvest. Bear hunters comprise multiple user groups and all should account for an equitable portion of the resource. Methods such as baiting are useful from a harvest perspective but need to be closely monitored; there are types of bait that may be harmful to bears and other wildlife and therefore should be removed from the woods. It is critically important that hunters promote a positive image of bear hunting and recognize that some methods they use may have lower social acceptance by some segments of society. Strong ethics and selectivity will make these hunting methods more defendable to a public that questions these hunting styles. The ability to manage bear populations across a broad landscape will depend on maintaining or expanding hunter access. It is essential that bear populations do not exceed cultural carrying capacity; if bears become too numerous on the landscape or people fail to minimize the potential for bear-human conflicts, they will be less appreciated and devalued.

Table 1. Summary of bear bounties paid by the state of New Hampshire, 1882-1956.

Bear Bounties Paid by the State of New Hampshire, 1882-1956

Year	No.	Year	No.	Year	No.
1882	80	1907	49	1932	97
1883	68	1908	30	1933	13
1884	100	1909	50	1934	310
1885	132	1910	57	1935	258
1886	91	1911	36	1936	248
1887	58	1912	81	1937	99
1888	100	1913	37	1938	50
1889	116	1914	100 est.	1939	30
1890	102	1915	100 est.	1940	71
1891	110	1916	100 est.	1941	78
1892	200	1917	97	1942	49
1893	179	1918	98	1943	99
1894	129	1919	96	1944	83
1895	105	1920	46	1945	149
1896	121	1921	50	1946	160
1897	83	1922	33	1947	172
1898	29	1923	58	1948	119
1899	36	1924	60	1949	90
1900	51	1925	60	1950	155
1901	29	1926	60	1951	201
1902	55	1927	60	1952	171
1903	114	1928	100	1953	150
1904	80	1929	83	1954	75
1905	74	1930	160	1955	449
1906	55	1931	64	1956	119*****

Source: Silver 1957

***** Bounty was in place until August 5, 1955 and therefore incorporated into fiscal year 1956.

Table 2. Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

YEAR	SEASON	DATES	WMU	DEER SEASON DATES*
2015	General	Sept 1-Nov 10 Sept 1-Nov 24 Sept 1-Sept 28	A,B,C2,D1,H1,I2 C1,D2,E,F,G,I1,J1,J2 H2,K, L,M	Archery - 9/15-12/15 Muzzleloader – 10/31-11/10 Rifle - 11/11-12/6
2015	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2015	Dog	Sept 21-Nov 10	All except WMUs H2,K,L,M	
2014	General	Sept 1-Nov 11 Sept 1-Nov 25 Sept 1-Sept 28	A,B,C2,D1,H1,I2 C1,D2,E,F,G,I1,J1,J2 H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 11/1-11/11 Rifle - 11/12-12/7
2014	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2014	Dog	Sept 22-Nov 11	All except WMUs H2,K,L,M	
2013	General	Sept 1-Nov 12 Sept 1-Nov 26 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader – 11/2-11/12 Rifle - 11/13-12/8
2013	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2013	Dog	Sept 23-Nov 12	All except WMUs H2,K,L,M	
2012	General	Sept 1-Nov 13 Sept 1-Nov 27 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 11/3-11/13 Rifle - 11/14-12/9
2012	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2012	Dog	Sept 24-Nov 13	All except WMUs H2,K,L,M	
2011	General	Sept 1-Nov 8 Sept 1-Nov 22 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 10/29-11/8 Rifle - 11/9-12/4
2011	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2011	Dog	Sept 19-Nov 8	All except WMUs H2,K,L,M	

Table 2 (cont). Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

2010	General	Sept 1-Nov 9 Sept 1-Nov 23 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 10/30-11/9 Rifle - 11/10-12/5
2010	Bait	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2010	Dog	Sept 20-Nov 9	All except WMUs H2,K,L,M	
2009	General	Sept 1-Nov 10 Sept 1-Nov 24 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 10/31-11/10 Rifle - 11/11-12/6
2009	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2009	Dog	Sept 21-Nov 10	All except WMUs H2,K,L,M	
2008	General	Sept 1-Nov 11 Sept 1-Nov 25 Sept 1-Sept 21	A,B,C2,D1,G,H1,I1,I2,J1,J2 C1,D2,E,F H2,K, L,M	Archery - 9/15-12/15 Muzzleloader - 11/1-11/11 Rifle - 11/12-12/7
2008	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	G,H1,H2,I1,I2,J1,J2,K,L,M A,B,C1,C2,D1,D2,E,F	
2008	Dog	Sept 22-Nov 11	All except WMUs H2,K,L,M	
2007	General	Sept 1-Nov 2 Sept 1-Nov 13 Sept 1-Nov 20 Sept 1-Oct 5	A,B,D1 G,I1,J1,J2,L,M C1,C2,D2,E,F,H1,I2 H2,K	Archery - 9/15-12/15 Muzzleloader - 11/3-11/13 Rifle - 11/14-12/9
2007	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	H1,H2,I2,K,L,M A,B,C1,C2,D1,D2,E,F.G,I1,J1,J2	
2007	Dog	Sept 24-Nov 13	All except WMUs H2,K	
2006	General	Sept 1-Oct 27 Sept 1-Nov 7 Sept 1-Nov 14 Sept 1-Oct 5	A,B,D1 G,I1,J1,J2,L,M C1,C2,D2,E,F,H1,I2 H2,K	Archery - 9/15-12/15 Muzzleloader - 10/28-11/7 Rifle - 11/8-12/3
2006	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	H1,H2,I2,K,L,M A,B,C1,C2,D1,D2,E,F.G,I1,J1,J2	
2006	Dog	Sept 18-Nov 7	All except WMUs H2,K	

Table 2 (cont). Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

2005	General	Sept 1-Oct 28 Sept 1-Nov 8 Sept 1-Oct 5	A,B,D1 C1,C2,D2,E,F,G,H1, I1,I2,J1,J2,L,M H2,K	Archery - 9/15-12/15 Muzzleloader - 10/29-11/8 Rifle - 11/9-12/4
2005	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	A,B,D1,H1,H2,I2,K,L,M C1,C2,D2,E,F.G,I1,J1,J2	
2005	Dog	Sept 9-Oct 28	All except WMUs H2,K	
2004	General	Sept 1-Oct 29 Sept 1-Nov 9 Sept 1-Oct 5	A,B,D1 C1,C2,D2,E,F,G,H1, I1,I2,J1,J2,L,M H2,K	Archery -9/15-12/15 Muzzleloader - 10/30-11/9 Rifle - 11/10-12/5
2004	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	A,B,D1,H1,H2,I2,K,L,M C1,C2,D2,E,F.G,I1,J1,J2	
2004	Dog	Sept 9-Oct 29	All except WMUs H2,K	
2003	General	Sept 1-Nov 11 Sept 1-Dec 7 Sept 1-Sept 21	A,B,D1,H1,I2,L,M C1,C2,D2,E,F,G,I1,J1,J2 H2,K	Archery - 9/15-12/15 Muzzleloader - 11/1-11/11 Rifle - 11/12-12/7
2003	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	H1,H2,I2,K,L,M A,B,C1,C2,D1,D2,E,F,G,I1,J1,J2	
2003	Dog	Sept 22-Nov 11	All except WMUs H2,K	
2002	General	Sept 1-Nov 12 Sept 1-Dec 8 Sept 1-Sept 21	A,B,D1,H1,I2,L,M C1,C2,D2,E,F,G,I1,J1,J2 H2,K	Archery - 9/15-12/15 Muzzleloader - 11/2-11/12 Rifle - 11/13-12/8
2002	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	H1,H2,I2,K,L,M A,B,C1,C2,D1,D2,E,F,G,I1,J1,J2	
2002	Dog	Sept 22-Nov 12	All except WMUs H2,K	
2001	General	Sept 1-Nov 13 Sept 1-Dec 9 Sept 1-Sept 21	A,B,D1,H1,I2,L,M C1,C2,D2,E,F,G,I1,J1,J2 H2,K	Archery - 9/15-12/15 Muzzleloader - 11/3-11/13 Rifle - 11/14-12/9
2001	Baiting	Sept 1-Sept 21 Sept 1-Sept 28	A,B,D1,H1,H2,I2,K,L,M C1,C2,D2,E,F,G,I2,J1,J2	
2001	Dog	Sept 22-Nov 13	A,B,C1,C2,D1,D2,E,F,G,H1,I1,I2,J1,J2,L,M	
2000	General	Sept 1-Nov 7 Sept 1-Dec 3 Sept 1-Sept 21	A,B,D1,H1,I2,L,M C1,C2,D2,E,F,G,I1,J1,J2 H2,K	Archery - 9/15-12/15 Muzzleloader - 10/28-11/7 Rifle - 11/8-12/3
2000	Baiting	Sept1-Sept 21 Sept 1-Sept 28	A,B,D1,H1,H2,I2,K,L,M C1,C2,D2,E,F,G,I1,J1,J2	
2000	Dog	Sept 22-Nov 7	A,B,C1,C2,D1,D2,E,F,G,H1,I1,I2,J1,J2,L,M	

Table 2 (cont). Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

1999	Baiting	Sept 1-Sept 28 Sept 1-Sept 21 Sept 1-Sept 7	A,B,C2,D1 C1,D2,E,F,G,H1,I1,I2,J1,J2,L,M H2,K	
1999	Dog	Sept 29-Nov 9 Sept 22-Nov 9 Sept 22-Oct 29	A,B,C2,D1 C1,D2,E,F,G,I1,J1,J2 H1,I2	
1998	General	Sept 1-Nov 15 Sept 1-Dec 6 Sept 1-Nov 13 Sept 1-Sept 7 Sept 1-Oct 30 Sept 1-Nov 10	A,B,C2,D1 C1,D2,E,F G,I1,J1,J2 H2,K H1,I2, L,M	Archery - 9/15-12/15 Muzzleloader - 10/31-11/10 Rifle - 11/11-12/6
1998	Baiting	Sept 1-Sept 28 Sept 1-Sept 21 Sept 1-Sept 7	A,B,C2,D1 C1,D2,E,F,G,H1,I1,I2,J1,J2,L,M, H2,K	
1998	Dog	Sept 29-Nov 10 Sept 22-Nov 10 Sept 22-Oct 30	A,B,C2,D1 C1,D2,E,F,G,I1,J1,J2 H1,I2	
1997	General	Sept 1-Sept 21 Sept 1-Nov 11 Sept 1-Nov 14 Sept 1-Dec 7	H1,I2 I1,J2 A,B,C1,C2,D,G,J1 E,F	Archery - 9/15-12/15 Muzzleloader - 11/1-11/11 Rifle - 11/12-12/7
1997	Baiting	Sept 1-Sept 21	A,B,C1,C2,D,E,F,G,H1,I1,I2,J1,J2	
1997	Dog	Sept 22-Nov 11	A,B,C1,C2,D,E,F,G,I1,J1,J2	
1997	All Methods	Closed	H2,K,L,M	
1996	General	Sept 8-Nov 1	A,B,C1,C2,D,E,F,G1,I1,J1,J2	Archery - 9/15-12/15 Muzzleloader - 11/2-11/12 Rifle - 11/13-12/8
1996	Baiting	Sept 1-Sept 22	A,B,C1,C2,D,E,F,G,I1,J1,J2	
1996	Dog	Sept 23-Nov 1	A,B,C1,C2,D,E,F,G,I1,J1,J2	
1996	All Methods	Closed	H,I2,K,L,M	
1995	General	Sept 1-Dec 3 Sept1- Nov 7	A,B,C1,C2,D,E,F,G,J1 I,J2	Archery - 9/15-12/15 Muzzleloader - 10/28-11/7 Rifle - 11/8-12/3
1995	Baiting	Sept 1-Sept 24	A,B,C1,C2,D,E,F,G,I,J1,J2	
1995	Dog	Sept 25-Nov 7	A,B,C1,C2,D,E,F,G,I,J1,J2	
1995	All Methods	Closed	H,K,L,M	

Table 2 (cont). Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

1994	General	Sept 1-Nov 1 and Nov 7-27 Sept 1-Nov 27 Sept 1-Oct 14	A,B,C1,C2,D,E,F,G.J1 E,F H1, I, J2	Archery - 9/15-12/15 Muzzleloader - 10/22-11/1 Rifle - 11/2-11/27
1994	Baiting	Sept 1-25	A,B,C1,C2,D,E,F,G,J1,E,F,H1,I,J2	
1994	Dog	Sept 26-Nov 1	A,B,C1,C2,D,E,F,G,J1,E,F,H1,I,J2	
1994	All Methods	Closed	H2,K,L,M	
1993	General	Sept 1-Nov 9 and Nov 16- Dec 5 Sept 1-Sept 30	Carroll, Coos, Grafton Counties Belknap, Merrimack, and Sullivan County Towns Remainder of State Closed	Archery - 9/15-12/15 Muzzleloader - 10/30-11/9 Rifle - 11/10-12/5
1993	Baiting	Sept 1-Sept 19	Same as above	
1993	Dog	Sept 20-Nov 9	Same as above	
1992	General	Sept 1-Oct 31 and Nov 16-Dec 1 Sept 1-30	Carroll, Coos, Grafton Counties Merrimack County Towns Remainder of State Closed	Archery -9/12-12/13 Muzzleloader - 10/31-11/10 Rifle - 11/11-12/6
1992	Baiting	Sept 1-Sept 13	Same as above	
1992	Dog	Sept 14-Oct 31	Same as above	
1991	General	Sept 1-Oct 31 and Nov 16-Dec 6 Sept 1-30	Coos, Carroll, and Grafton Counties Merrimack County Towns Remainder of State Closed	Archery -9/14-12/15 Muzzleloader - 10/26-11/5 Rifle - 11/6-12/1
1991	Baiting	Sept 1-10	Same as above	
1991	Dogs	Sept 11-Oct 31	Same as above	

Table 2 (cont). Summary of bear season dates by region and method of harvest, 1963-2015. Deer season dates are provided to indicate the degree of overlap between bear seasons and deer seasons during 1963-2015.

1990	General	Sept 1- Nov 6 Oct 1-Nov 6	Coos, Carroll, and Grafton Counties Merrimack County Towns Remainder of State Closed	Archery - 9/15-12/16 Muzzleloader - 10/27-11/6 Rifle - 11/7-12/2
1990	Baiting	Same as above	Same as above	
1990	Dog	Sept 1-Nov 6	Same as above	
1989	General	Sept 1- Nov 7 Oct 1-Nov 7	Coos, Carroll, and Grafton Counties Merrimack County Towns	Archery -9/16-12/17 Muzzleloader - 10/28-11/7 Rifle - 11/8-12/3
1989	Baiting	Same as above	Same as above	
1989	Dog	Sept 1-Nov 7	Same as above	
1988	General	Sept 1- Nov 8	Coos, Carroll, and Grafton Counties Remainder of State Closed	Rifle - 11/9-12/4 Muzzleloader - 10/29-11/8 Archery - 9/17-12/18
1988	Baiting	Same as above	Same as above	
1988	Dog	Sept 1-Nov 8	Same as above	
1987	General	Sept 1- Nov 3	Coos, Carroll, and Grafton Counties Remainder of State Closed	Archery - 9/19-12/13 Muzzleloader - 10/24-11/3 Rifle - 11/4-11/29
1987	Baiting	Same as above	Same as above	
1987	Dog	Oct 1-Nov 3	Same as above	
1986	General	Sept 1- Start of regular deer season	Coos, Carroll, and Grafton Counties Remainder of State Closed	Archery -9/13-12/14 Muzzleloader - 10/25-11/4 Rifle - 11/5-11/30
1986	Baiting	Same as above	Same as above	
1986	Dog	Oct 1- To start of regular deer season	Same as above	
1985	General	Sept 1- Start of regular deer season	Coos, Carroll, and Grafton Counties Remainder of State Closed	Archery - 9/14-12/15 Muzzleloader - 10/26-11/5 Rifle - 11/8-12/1
1985	Baiting	Same as above	Same as above	
1985	Dog	Oct 1- To start of regular deer season	Same as above	
1963-1984 1963-1970 1971-1984	General/Bait Dog Dog	Sept 1- End of regular deer season 9/1-11/14 9/1-day prior to opening of regular deer season	Statewide Statewide Statewide	Complete overlap between bear and deer season

* Deer season dates vary in some years by sex of deer allowed and area of the state.

Table 3a. Summary of New Hampshire bear population management goals by management region. Bear management decisions were based on the Big Game Management Plan: 1997-2005. Population goals are expressed as density/mi^2. Population estimates provided are for 2005, the last year of the plan.

Region	1997-2005 Management Goal	2005 Population Estimate	Management Required
North	0.56	0.58	Stabilize
White Mountains	0.72	1.10	Decrease
Central	0.31	0.36	Stabilize
Southwest-1	0.30	0.61	Decrease
Southwest-2	0.30	0.30	Stabilize
Southeast	Low	0.12	Stabilize

Table 3b. Summary of New Hampshire bear population management goals by management region. Bear management decisions are based on the existing Big Game Management Plan: 2006-2015. Population goals are expressed as density/mi^2. The population is considered to be "at goal" if the population estimate is +/- 12.5% of the management goal. Population estimates provided are for 2013, the most recent population estimate.

Region	2006-2015 Management Goal	2013 Population Estimate	Management Required
North	0.6	0.55	Stabilize
White Mountains	0.8	0.97	Decrease
Central	0.6	0.76	Decrease
Southwest-1	0.5	0.57	Stabilize
Southwest-2	0.5	0.57	Stabilize
Southeast	0.2	0.07	Increase
Statewide	0.6	0.63	Decrease

Table 4. Summary of research projects conducted on black bears in New Hampshire, 2000-2014. These research projects focused on bear management issues/questions that were pertinent at the time that the research was conducted. Research has been invaluable to the Department's bear management program and has been funded through the sale of bear hunting permits and the New Hampshire Wildlife Restoration Program grant in cooperation with the U.S. Fish and Wildlife Service, Wildlife and Sport Fish Restoration Program.

Title	Cooperators	Principle Researcher(s)	Years
As Assessment of Nuisance Bear Seasonal Home Ranges in New Hampshire	NHFG	Mark Ellingwood Kip Adams Kent Gustafson Andrew Timmins	2000-2003
Estimating Bear Density Using Tetracycline-based Mark/Recapture	NHFG	Kip Adams	2000-2001
Use of Genetic Tagging to Estimate Abundance and Detect Spatial Patterns of Black Bears in New Hampshire	NHFG/UNH	Peter Pekins Adrienne Kovach Stephanie Coster Andrew Timmins	2004, 2006-2008
Estimating Fine-scale Movement Patters of Black Bears Using GPS Telemetry	NHFG/PSU	Catherine Callahan	2007-2009
Evaluation of Two Methods of Aversive Conditioning on Nuisance Activity Levels of New Hampshire Black Bears	NHFG/PSU	Nancy Comeau Andrew Timmins	2007-2009
Assessing the Efficacy of Wildlife Ordinances as a Management Tool for Reducing Human-Bear Conflicts in New Hampshire	NHFG/UNH	Jaclyn Comeau Andrew Timmins	2011-2012
Assessing Translocation of Nuisance and Rehabilitation of Orphan Black Bears in New Hampshire	NHFG/UNH	Wesley Smith Andrew Timmins	2011-2012

Table 5. Summary of New Hampshire black bear harvest by year and method, 1956-2013.

Bear Harvest Summary, 1956-2013								
Year	**Total Harvest**	**Still Hunter Harvest**	**Bait Hunter Harvest**	**Hound Hunter Harvest**	**No. Males**	**No. Females**	**No. Unknown Sex**	**Sex Ratio M:F**
1956	100*	71	-	-	66	33	1	2.0
1957	92*	71	-	8	54	37	1	1.5
1958	126*	113	-	6	81	44	1	1.8
1959	136*	93	-	14	77	54	5	1.4
1960	137*	117	-	13	80	56	1	1.4
1961	166*	133	-	19	97	68	1	1.4
1962	187*	150	-	23	100	84	3	1.2
1963	154*	112	-	30	92	62	-	1.5
1964	116*	97	-	12	77	39	-	2.0
1965	211*	156	-	24	113	97	1	1.2
1966	293*	247	-	17	175	107	11	1.6
1967	245*	202	-	22	142	93	10	1.5
1968	199*	150	-	30	110	89	-	1.2
1969	433*	386	-	21	212	208	12	1.0
1970	293*	241	-	28	156	126	11	1.2
1971	334*	295	-	9	161	154	19	1.0
1972	273*	236	-	16	133	123	17	1.1
1973	356*	310	-	22	198	147	11	1.3
1974	280*	232	-	20	137	134	9	1.0
1975	326*	290	-	25	166	151	9	1.1
1976	209*	176	-	17	113	87	9	1.3
1977	220*	136	-	37	105	105	10	1.0
1978	241*	198	-	37	145	92	4	1.6
1979	272*	202	7	57	179	92	1	1.9
1980	229*	163	3	51	138	89	2	1.6
1981	180*	129	11	43	116	60	4	1.9
1982	182*	117	-	59	110	72	0	1.5
1983	238	147	14	77	139	99	0	1.4
1984	217	160	13	44	130	87	0	1.5
1985	93	54	13	26	54	39	0	1.4
1986	126	77	24	25	79	47	0	1.7
1987	260	179	42	39	165	95	0	1.7
1988	198	114	53	31	138	60	0	2.3
1989	241	118	85	38	146	95	0	1.5
1990	291	105	114	72	179	112	0	1.6
1991	123	79	15	29	77	46	0	1.7
1992	230	157	34	39	139	91	0	1.5
1993	274	171	52	51	162	112	0	1.4

* Includes depredation, car and miscellaneous kills.

Table 5 (cont.). Summary of New Hampshire bear harvest by year and method, 1956-2013.

Bear Harvest Summary, 1956-2013								
Year	**Total Harvest**	**Still Hunter Harvest**	**Bait Hunter Harvest**	**Hound Hunter Harvest**	**No. Males**	**No. Females**	**No. Unknown Sex**	**Sex Ratio M:F**
1994	239	153	39	47	136	103	0	1.3
1995	428	301	72	55	222	206	0	1.1
1996	152	62	52	38	97	55	0	1.8
1997	335	202	69	64	206	127	2	1.6
1998	279	181	53	45	155	124	0	1.3
1999	499	313	117	69	283	216	0	1.3
2000	449	294	118	37	259	190	0	1.4
2001	527	295	169	63	304	223	0	1.4
2002	338	203	92	43	197	141	0	1.4
2003	803	462	274	67	383	419	0	0.9
2004	679	343	244	92	366	313	0	1.2
2005	434	190	179	65	244	190	0	1.3
2006	352	149	152	51	213	139	0	1.5
2007	615	277	278	60	354	262	0	1.4
2008	440	209	176	55	248	192	0	1.3
2009	758	295	372	91	414	344	0	1.2
2010	708	252	373	83	363	345	0	1.1
2011	418	155	193	70	246	172	0	1.4
2012	812	283	430	99	436	376	0	1.2
2013	570	163	309	98	340	230	0	1.5

Table 6. Summary of survival/mortality rates for New Hampshire black bears from harvest and non-harvest causes, 1994-2013. Values represent the 10-year mean rate calculated for two time periods (i.e., 1994-2003 and 2004-2003). Overall survival and all-cause mortality rate estimates were calculated using SAS LifeTest procedure. Estimates of harvest survival and harvest mortality were calculated using the Paloheimo & Fraser (1981) model.

		1994-2003	**2004-2013**
Females	Overall Survival	0.82	0.80
	All-Cause Mortality	0.18	0.20
	Harvest Mortality	0.10	0.12
	Harvest Survival	0.90	0.88
	Non-harvest Mortality	0.09	0.09
	Non-harvest Survival	0.91	0.91
		1994-2003	**2004-2013**
Males	Overall Survival	0.74	0.70
	All-Cause Mortality	0.26	0.30
	Harvest Mortality	0.20	0.24
	Harvest Survival	0.80	0.76
	Non-harvest Mortality	0.07	0.08
	Non-harvest Survival	0.93	0.92

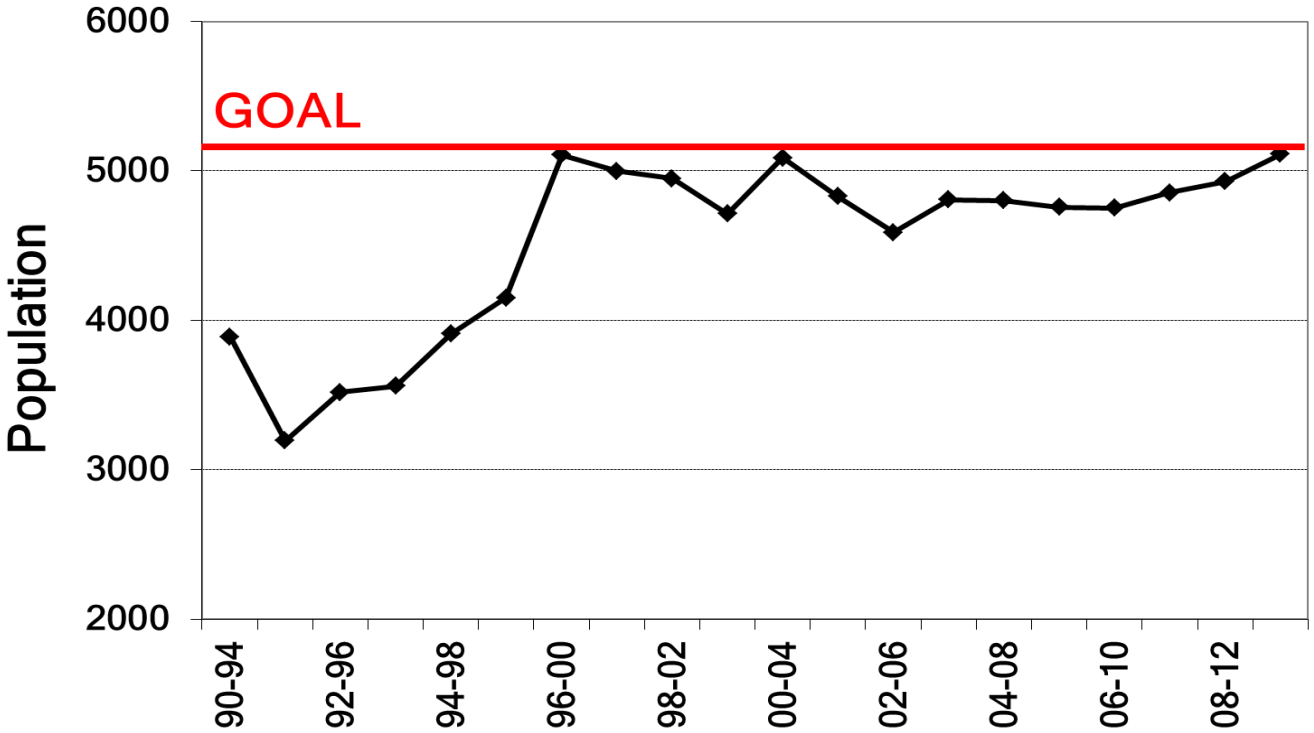

Figure 1. Estimated 5-year running mean New Hampshire statewide black bear population, 1990-2013. Population estimates were based on 5-year periods of age and sex mortality data and 3-year periods of deer hunter observation rates. Red line represents the statewide bear popualtion goal stated in the Department's Big Game Management Plan: 2006-2015. A statewide bear population of 5,100 would equate to a density of 0.55 bears/mi^2.

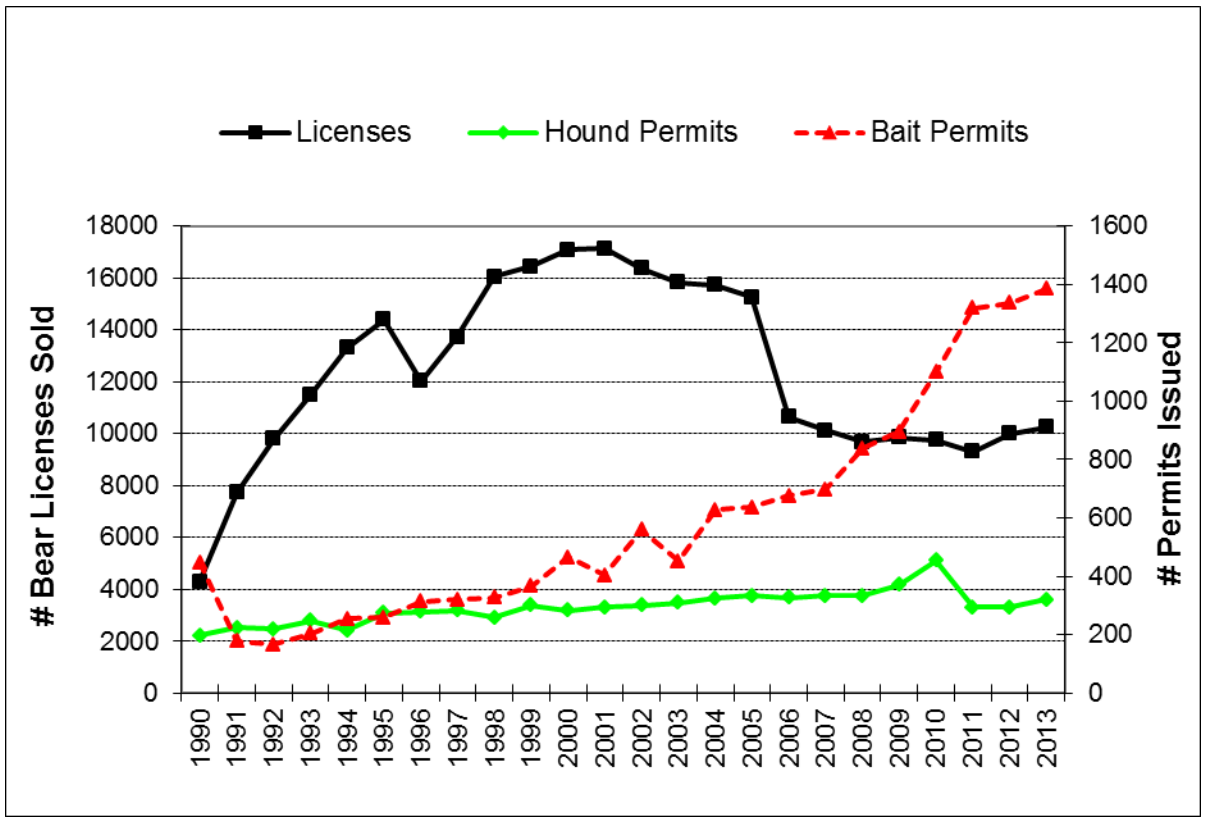

Figure 2. Summary of licenses sold and method-specific permits (i.e., bait and hound) issued to hunt black bear in New Hampshire, 1990-2013. Since 1990, hunters have been required to purchase a separate bear hunting permit. At the time of its inception in 1990, the bear permit cost $3 and increased to $5 from 1998 through 2005. In 2006, this permit increased to $16 and $48 for residents and nonresidents, respectively. The bear hunting community supported and pushed for this permit fee increase.

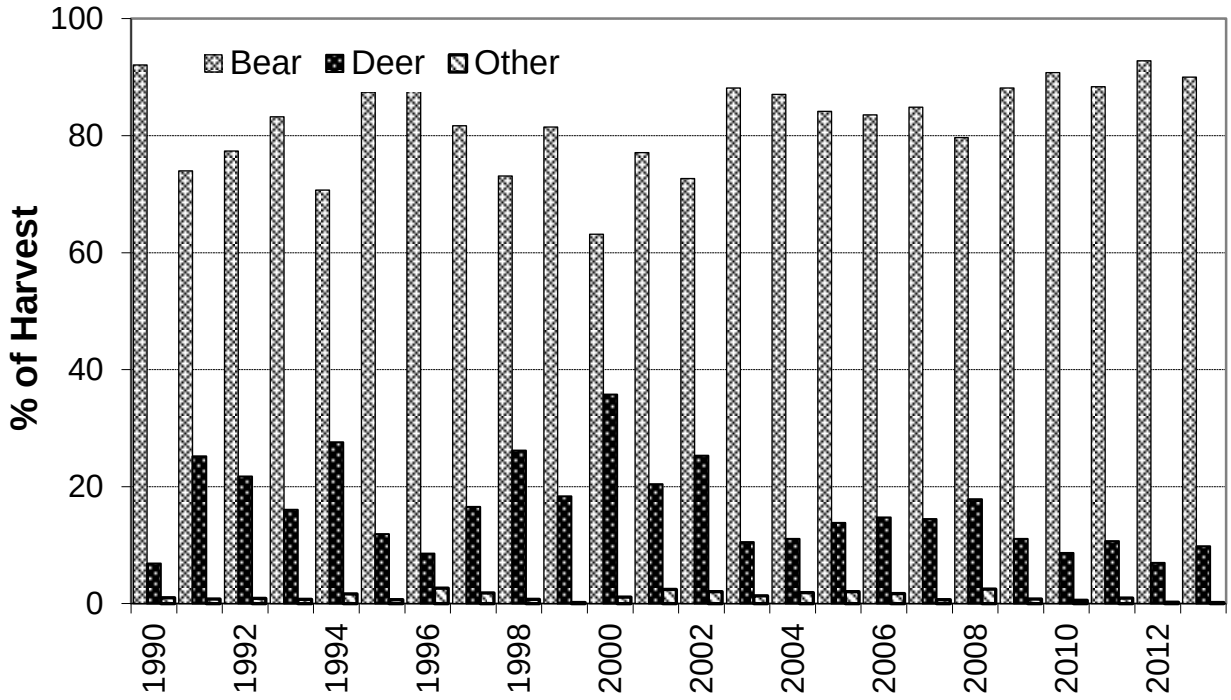

Figure 3. Proportion of the total black bear harvest taken by hunters specifically targeting bear versus deer and other species in New Hampshire, 1990-2013. During mandatory bear registration, hunters are asked the specific species they were targeting at the time the bear was taken.

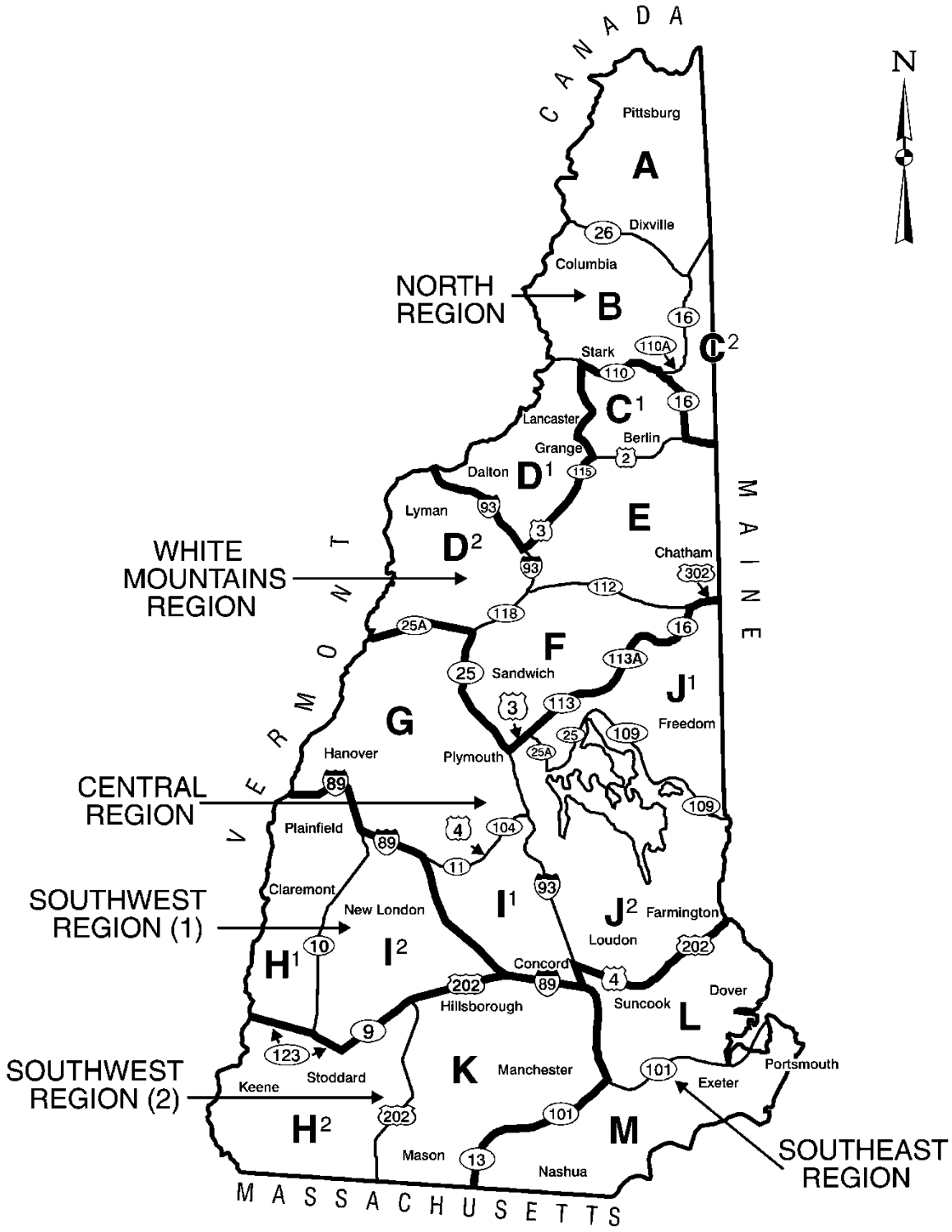

Figure 4. New Hampshire black bear management regions.

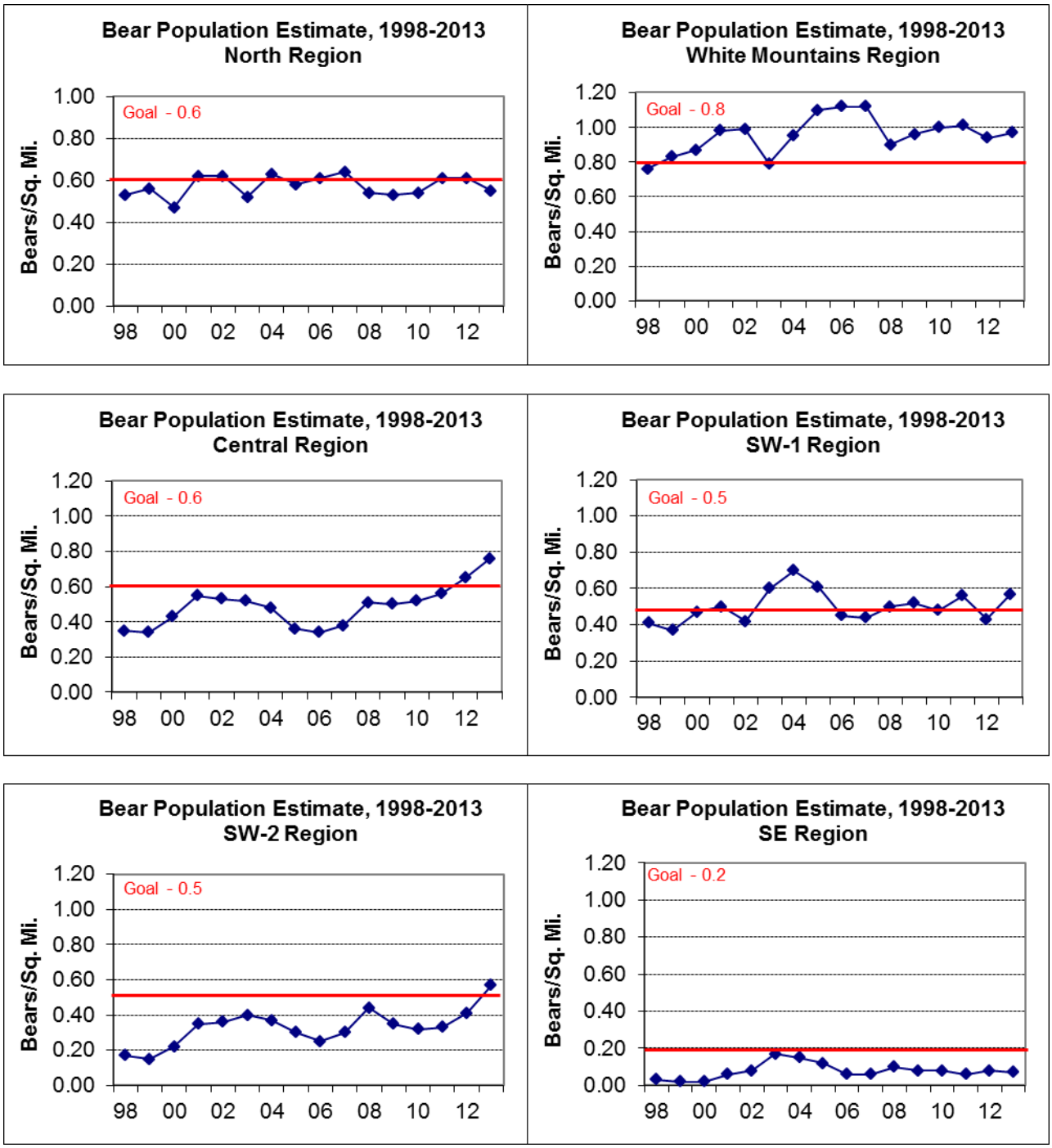

Figure 5. Estimated bear density (expressed as bears/mi^2) for six New Hampshire bear management regions during the period 1998-2013. Density estimates are based on 5-year periods of age and sex mortality data and 3-year periods of deer hunter observation rates. Regional population/density goals are stated in red font and indicated by red lines. These goals were established in 2005 as part of the Department's Big Game Management Plan: 2006-2015.

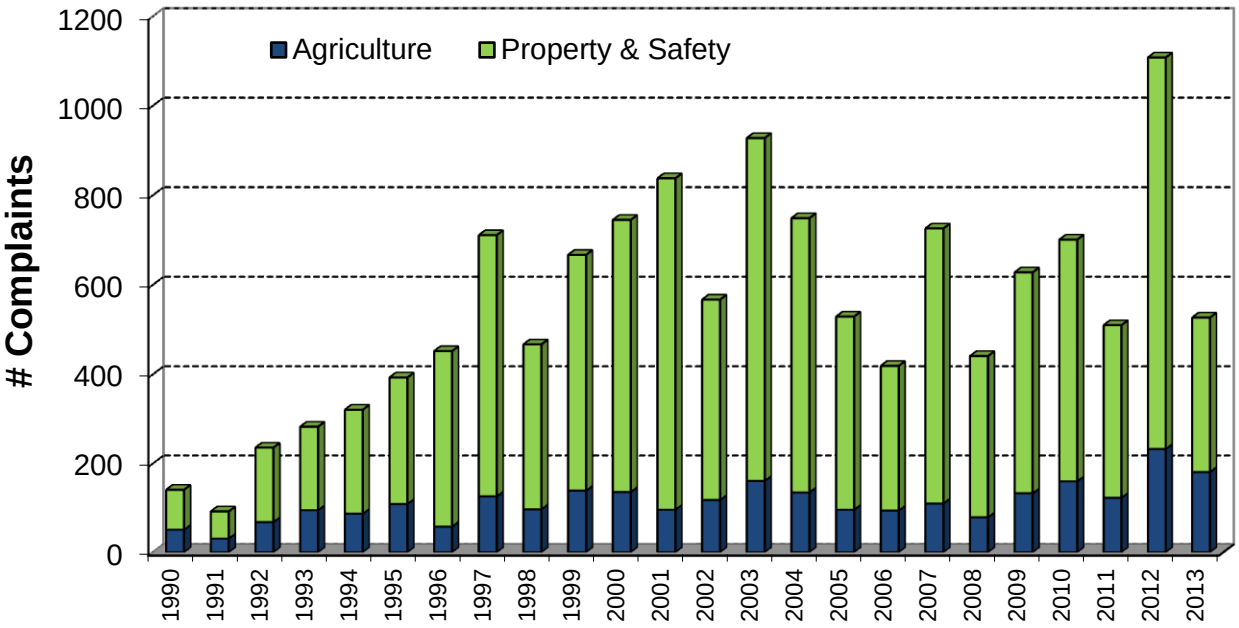

Figure 6. Summary of bear complaints reported to the Animal Damage Control Program in New Hampshire, 1990-2013. The Animal Damage Control Program is a cooperative effort between NHFG and USDAWS. Agricultural complaints include complaints pertaining to chickens, livestock, hives and crops. Non-agricultural complaints include damage to property (i.e., garbage and birdfeeders) and human health and safety concerns.

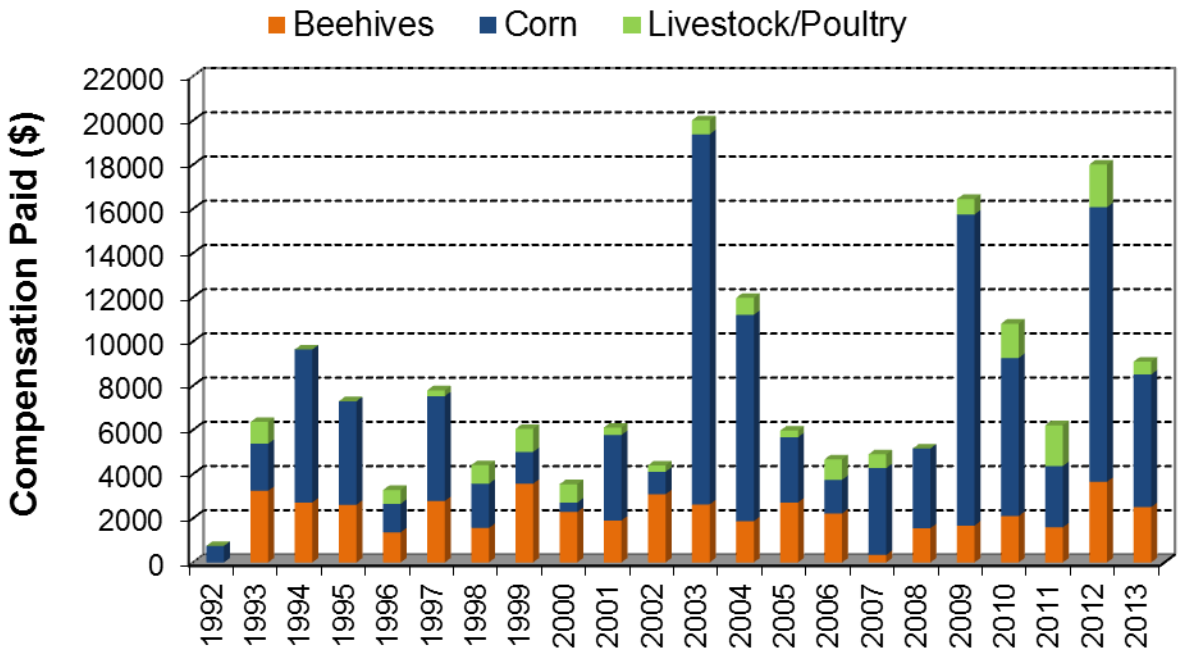

Figure 7. Summary of compensation paid due to agricultural-related damage by bears in New Hampshire, 1992-2013. Under state law (RSA 207:23-a) people who receive loss or damage by bears to livestock, bees, orchards or growing crops may be eligible for compensation.

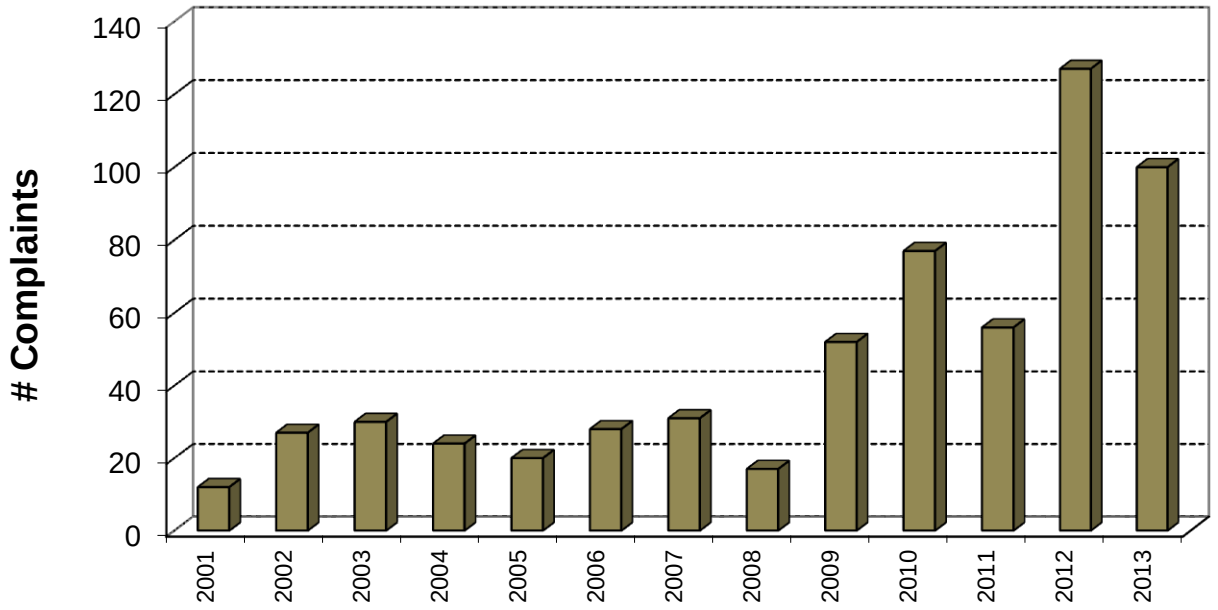

Figure 8. Summary of complaints related to bears raiding coops and predating chickens in New Hampshire, 2001-2013. Complaints were reported to the Animal Damage Control Program which is a cooperative effort between NHFG and USDAWS. Conflicts over poultry have become a challenging management issue in New Hampshire. It is recommended the chicken owners utilize a barrier of electric fence to protect chickens from bears and other wildlife. Chicken conflicts account for an increasing proportion of agricultural-related bear complaints in recent years.

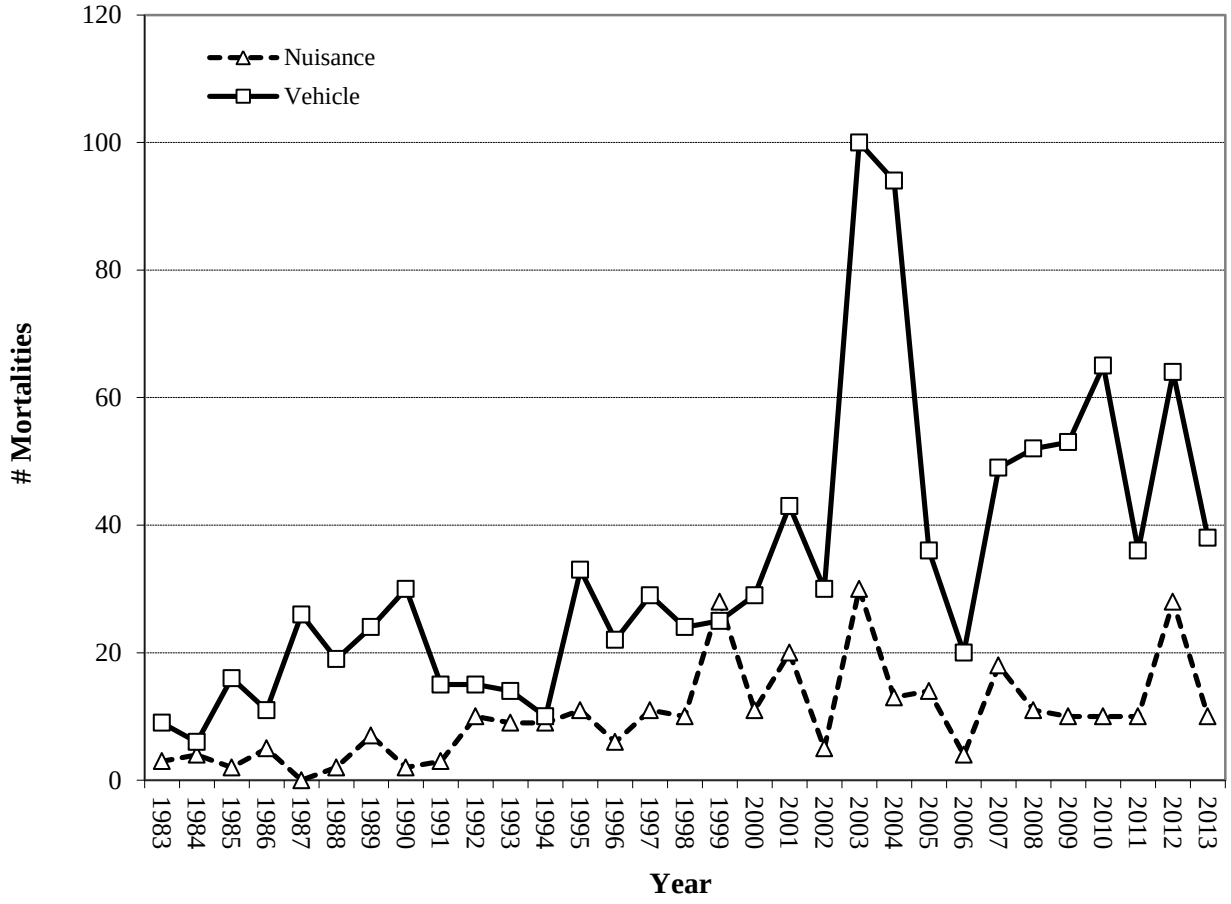

Figure 9. Summary of non-hunting black bear mortality by cause in New Hampshire, 1983-2013.

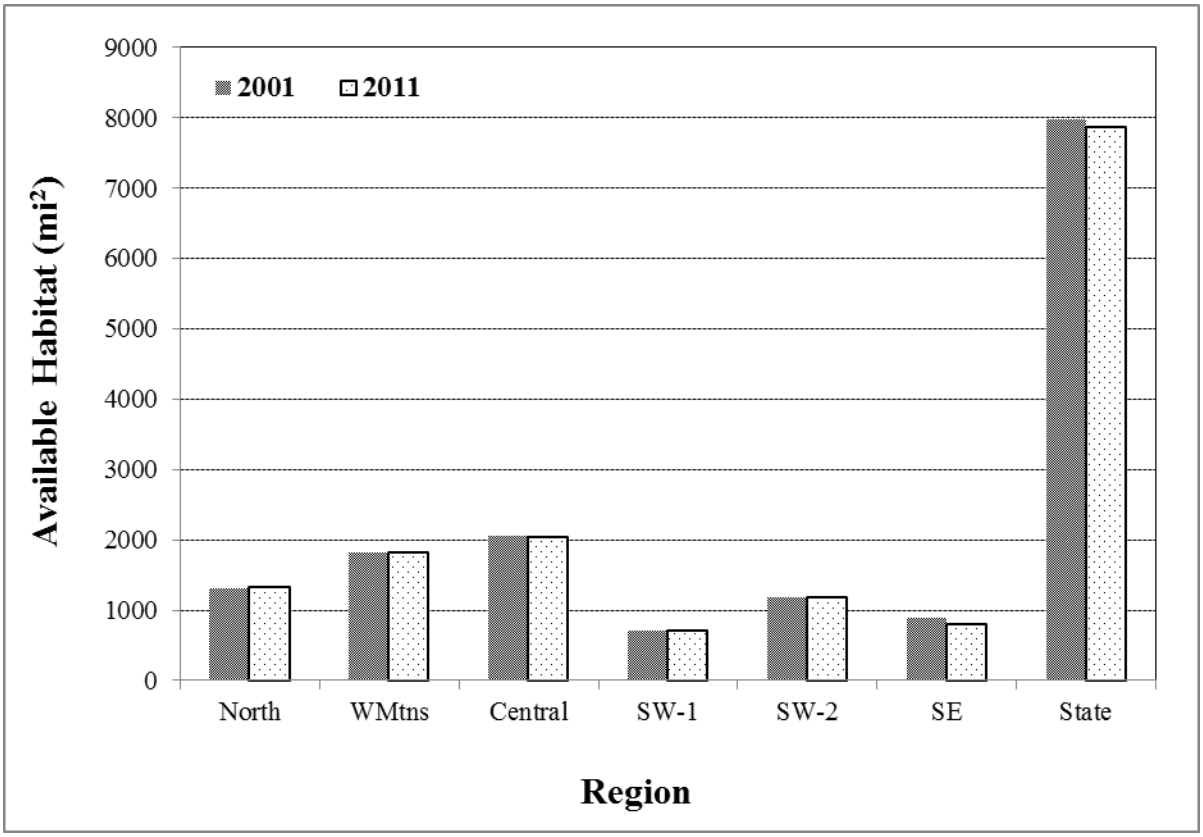

Figure 10. Estimated available black bear habitat on a statewide and bear management region level in New Hampshire. Estimates were derived using 2001and 2011 land cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

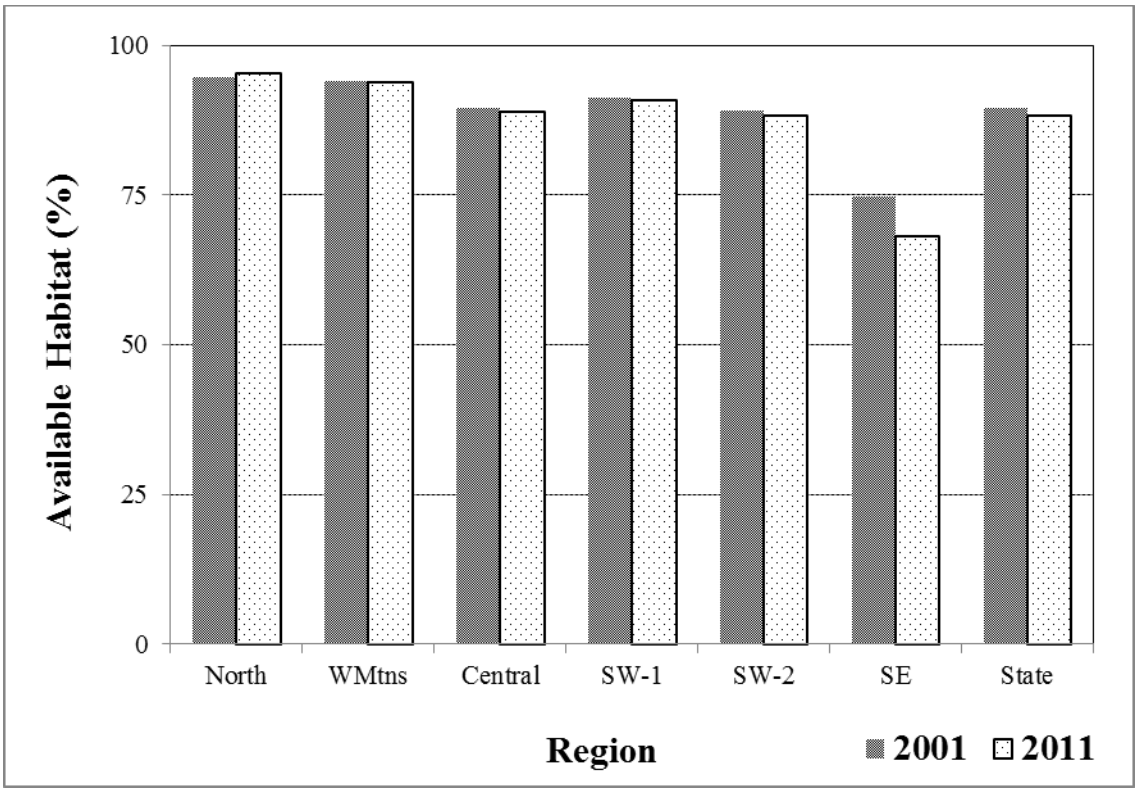

Figure 11. Estimated percentage of total land area considered black bear habitat on a statewide and bear management region level in New Hampshire. Estimates were derived using 2001and 2011 land cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

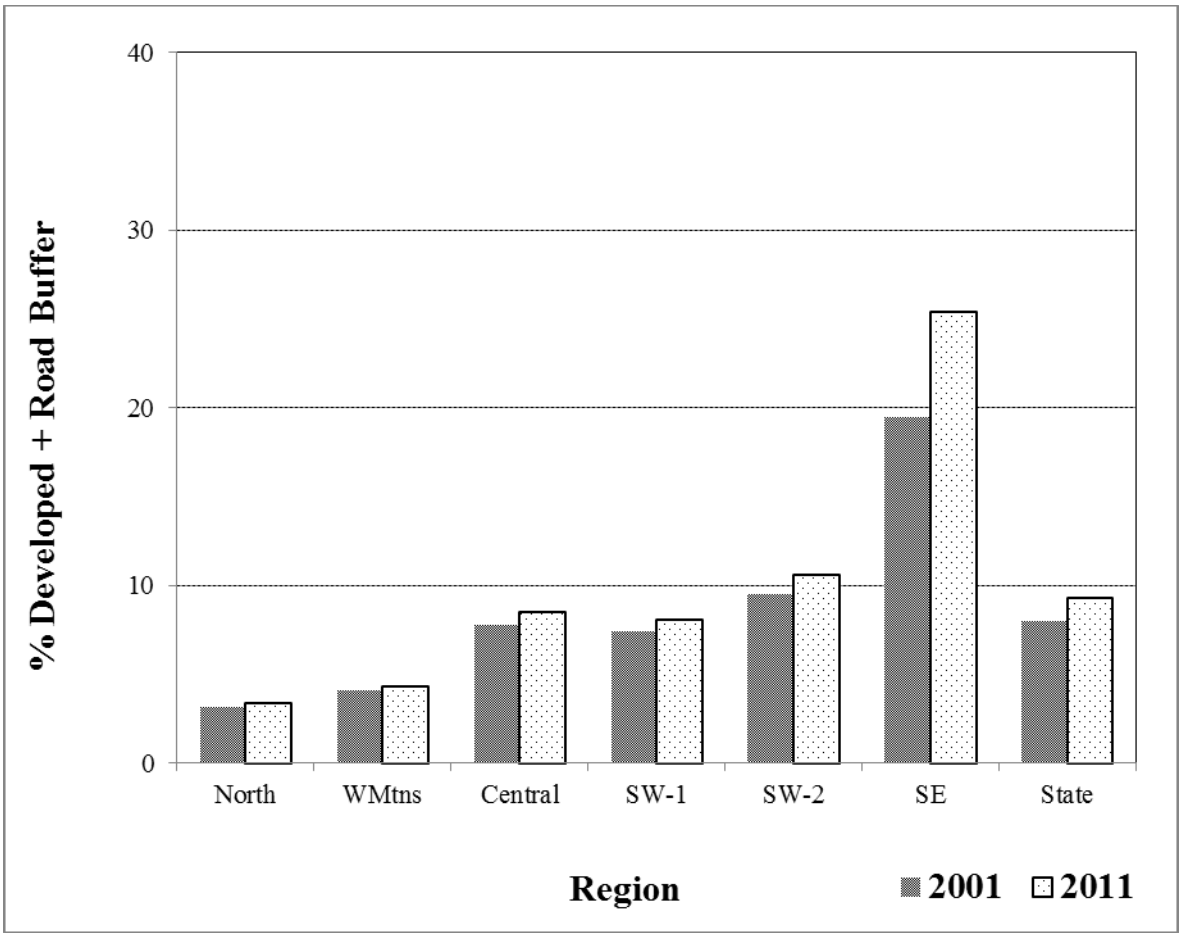

Figure 12. Estimated percentage of total land area classified as developed or transportation including 300-foot buffers on major roads on a statewide and bear management region level in New Hampshire during 2001 and 2011. Major roads, as defined by the United States Department of Transportation and Federal Highway Administration, include arterials and collectors. Arterial roads provide the highest level of mobility and the highest speeds (e.g., 50-75 mi/h) over the longest uninterrupted distance. Arterial roads include interstates, freeways, multilane highways, and other important roadways that supplement interstates. The roads directly connect urbanized areas, cities and industrial centers. Collectors are major and minor roads that connect local roads and streets with arterials. Collectors provide less mobility than arterials at lower speeds (e.g., 35-55 mi/h) and for shorter distances.

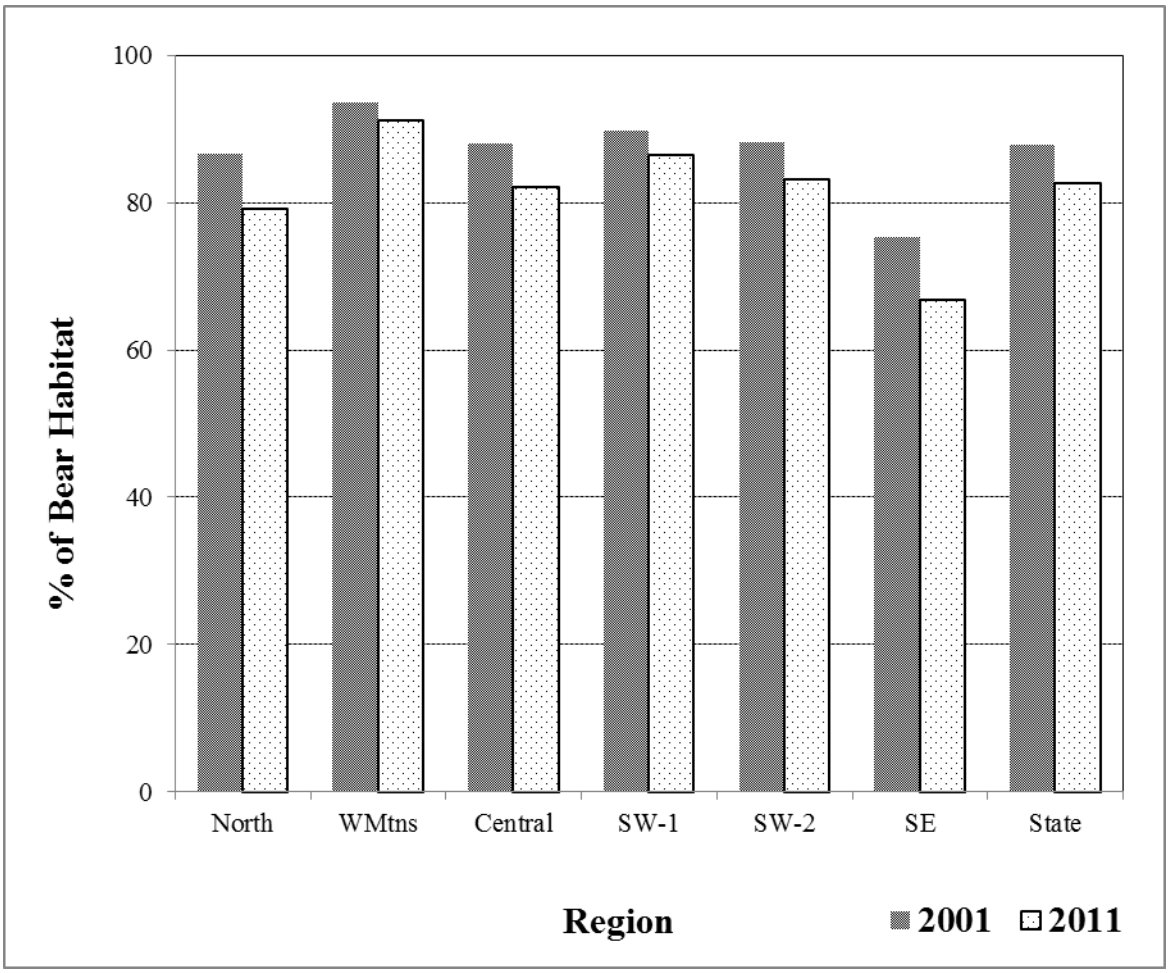

Figure 13. Estimated percentage of available bear habitat classified as forested on a statewide and bear management region level in New Hampshire during 2001 and 2011. Forested black bear habitat included land dominated by various forest cover types including beech/oak, paper birch/aspen, other hardwoods, white/red pine, spruce/fir, hemlock, pitch pine and mixed forest.

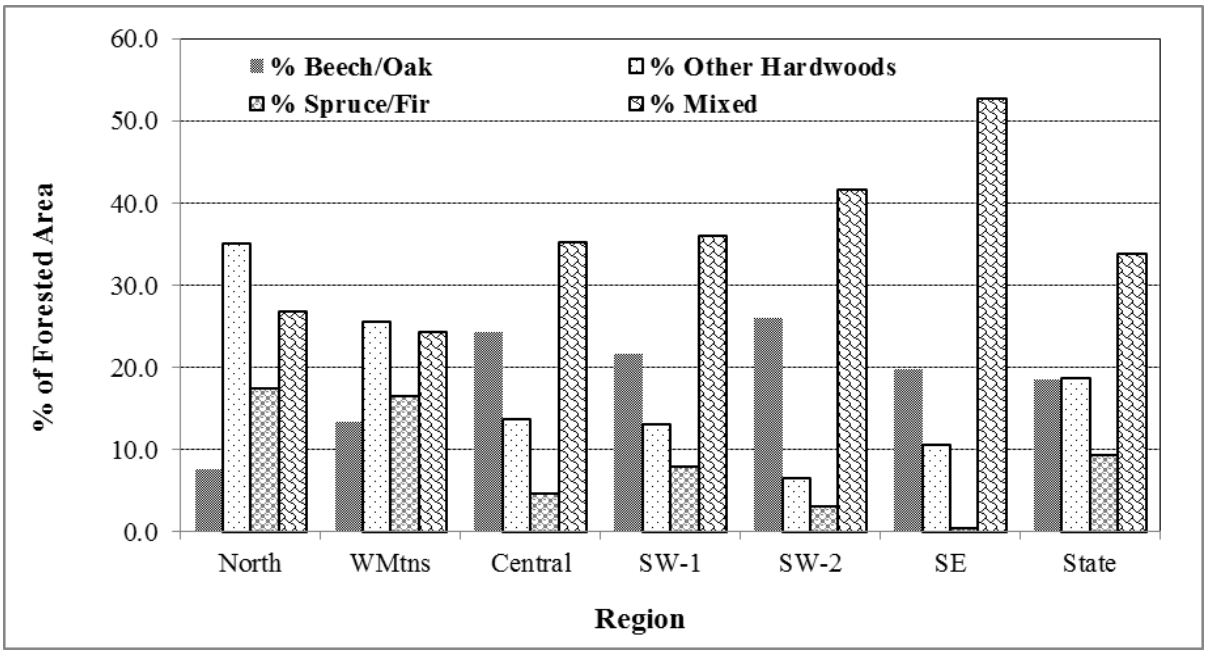

Figure 14a. Estimated percentage of forested area containing more dominant cover types on a statewide and bear management region level in New Hampshire during 2001. Only forested cover types considered black bear habitat were used in analysis.

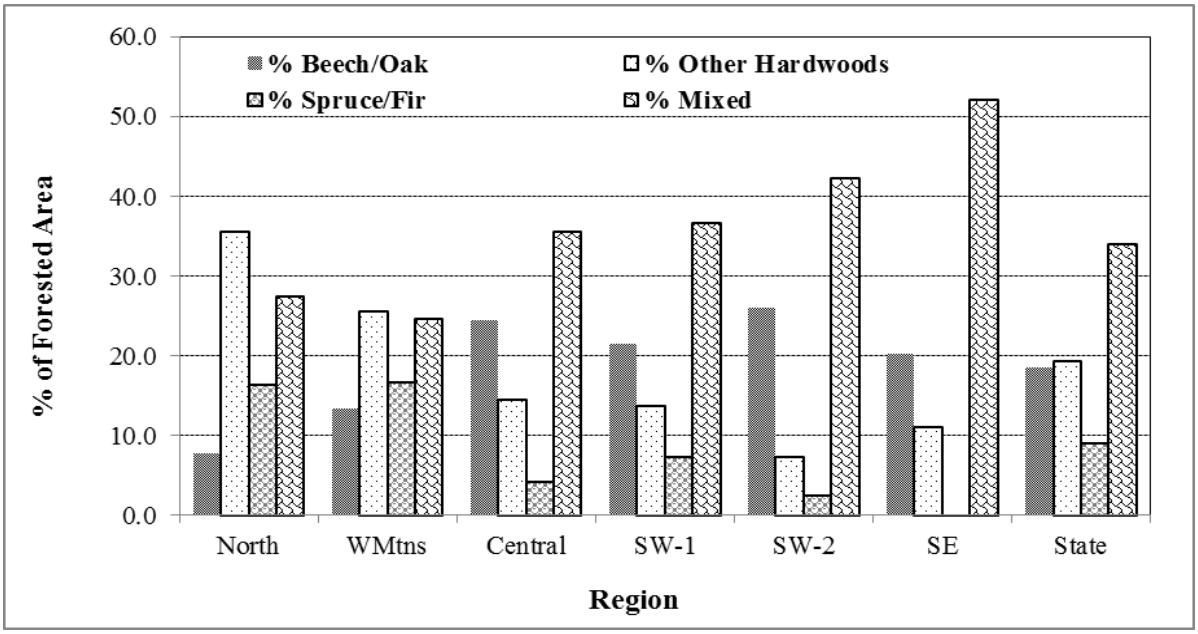

Figure 14b. Estimated percentage of forested area containing more dominant cover types on a statewide and bear management region level in New Hampshire during 2011. Only forested cover types considered black bear habitat were used in analysis.

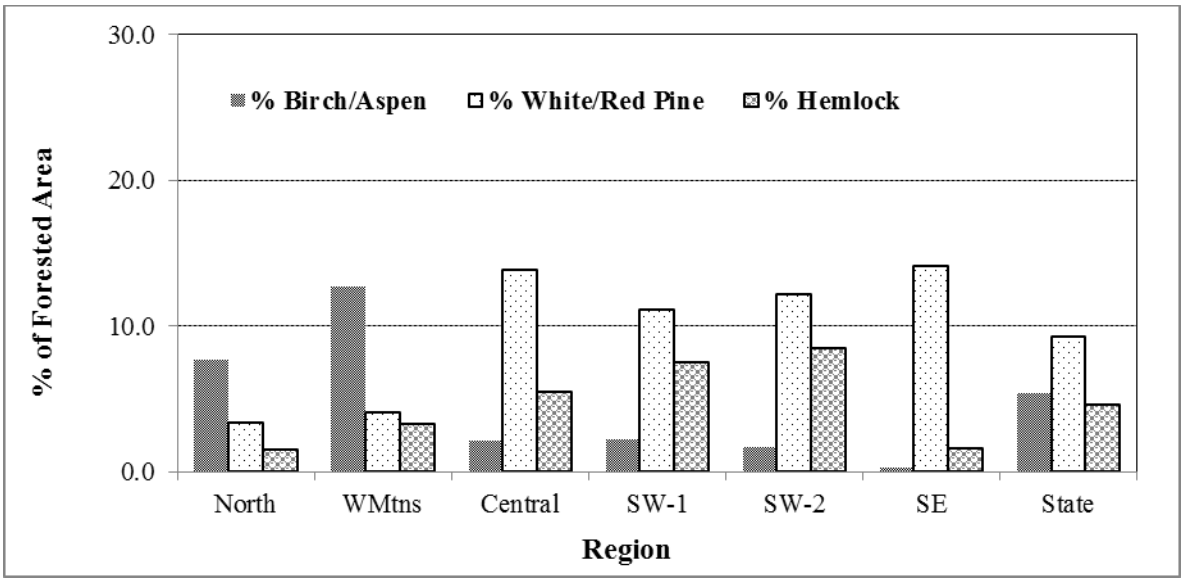

Figure 15a. Estimated percentage of forested area containing less dominant cover types on a statewide and bear management region level in New Hampshire during 2001. Only forested cover types considered black bear habitat were used in analysis. Pitch pine was not included in graph as this forest type had low abundance accounting for <0.5% of forested areas.

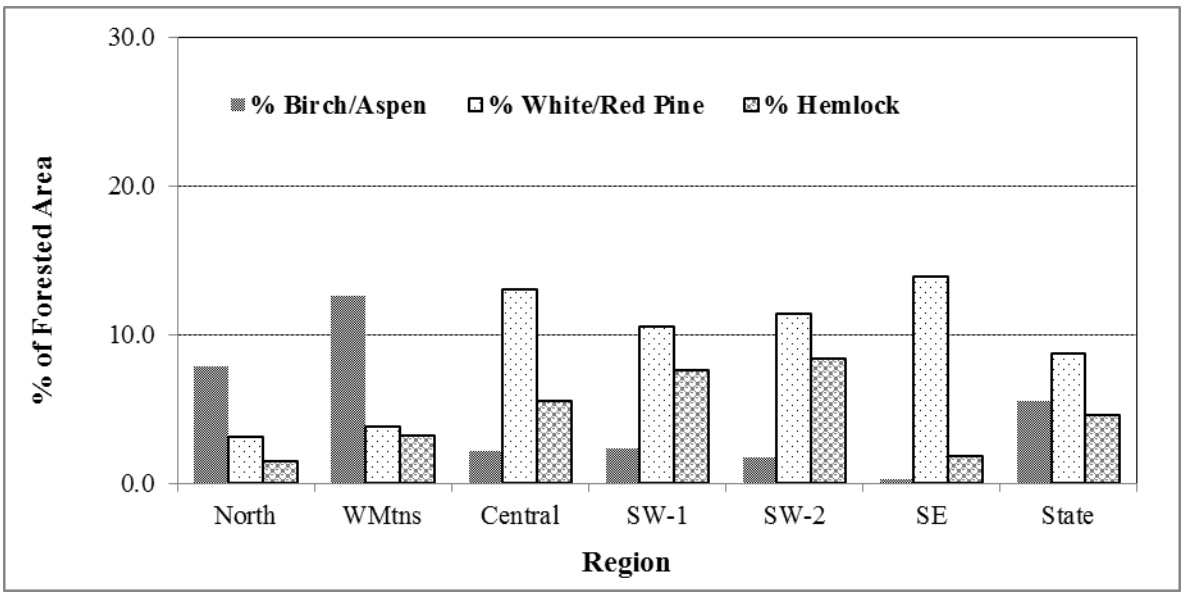

Figure 15b. Estimated percentage of forested area containing less dominant cover types on a statewide and bear management region level in New Hampshire during 2011. Only forested cover types considered black bear habitat were used in analysis. Pitch pine was not included in graph as this forest type had low abundance accounting for <0.5% of forested areas.

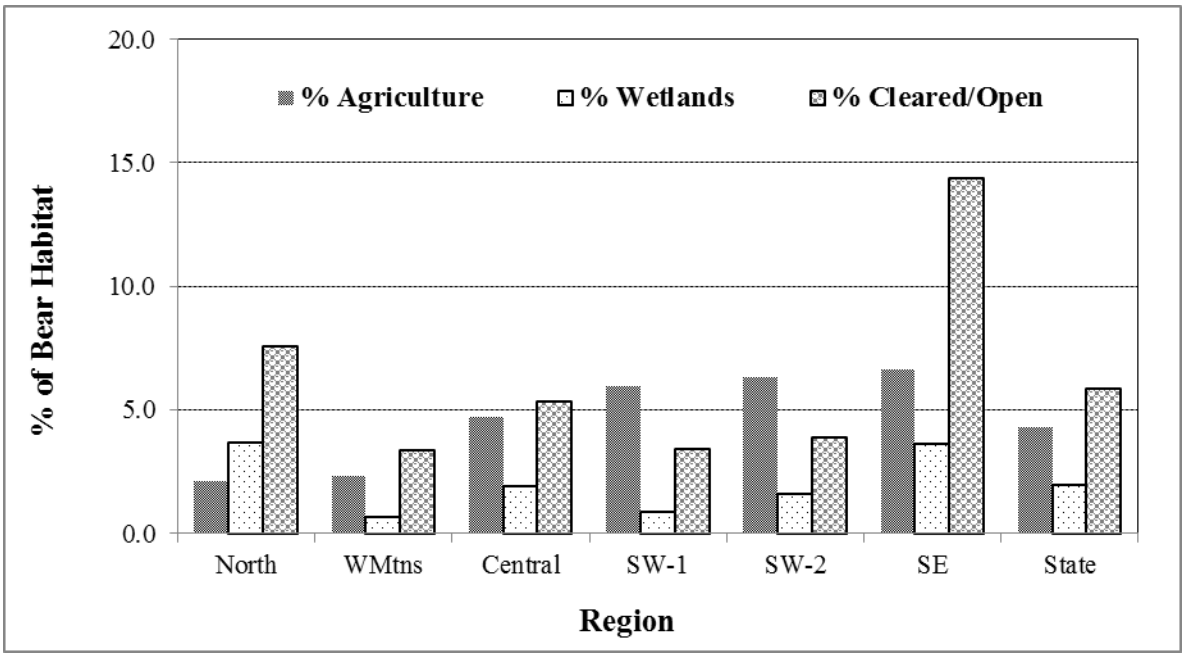

Figure 16a. Estimated percentage of available bear habitat classified as agriculture, wetland or cleared/open on a statewide and bear management region level in New Hampshire during 2001. Agricultural areas included land dominated by hay fields, pastures, row crops, plowed fields and orchards. Wetlands included areas containing wetland characteristics including hydric soils, hydrophytic vegetation and hydrologic conditions that result in water at or near the surface for extended periods of the growing season. Wetlands included forested wetlands and 50% of non-forested wetlands. Non-forested wetlands were considered bear habitat in order to incorporate 50% of seasonally flooded basins, fresh meadows, shrub swamps and bogs. Cleared and open areas included clear cut forests and old agricultural fields that are reverting to forest.

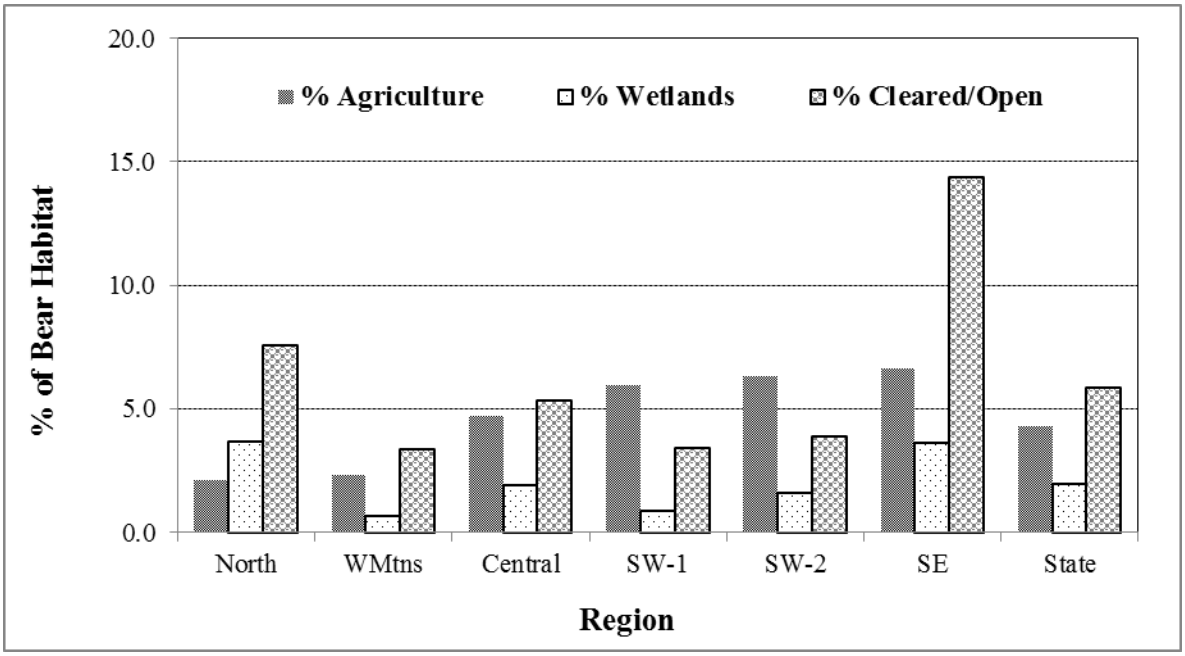

Figure 16b. Estimated percentage of available bear habitat classified as agriculture, wetland or cleared/open on a statewide and bear management region level in New Hampshire during 2011. Agricultural areas included land dominated by hay fields, pastures, row crops, plowed fields and orchards. Wetlands included areas containing wetland characteristics including hydric soils, hydrophytic vegetation and hydrologic conditions that result in water at or near the surface for extended periods of the growing season. Wetlands included forested wetlands and 50% of non-forested wetlands. Non-forested wetlands were considered bear habitat in order to incorporate 50% of seasonally flooded basins, fresh meadows, shrub swamps and bogs. Cleared and open areas included clear cut forests and old agricultural fields that are reverting to forest.

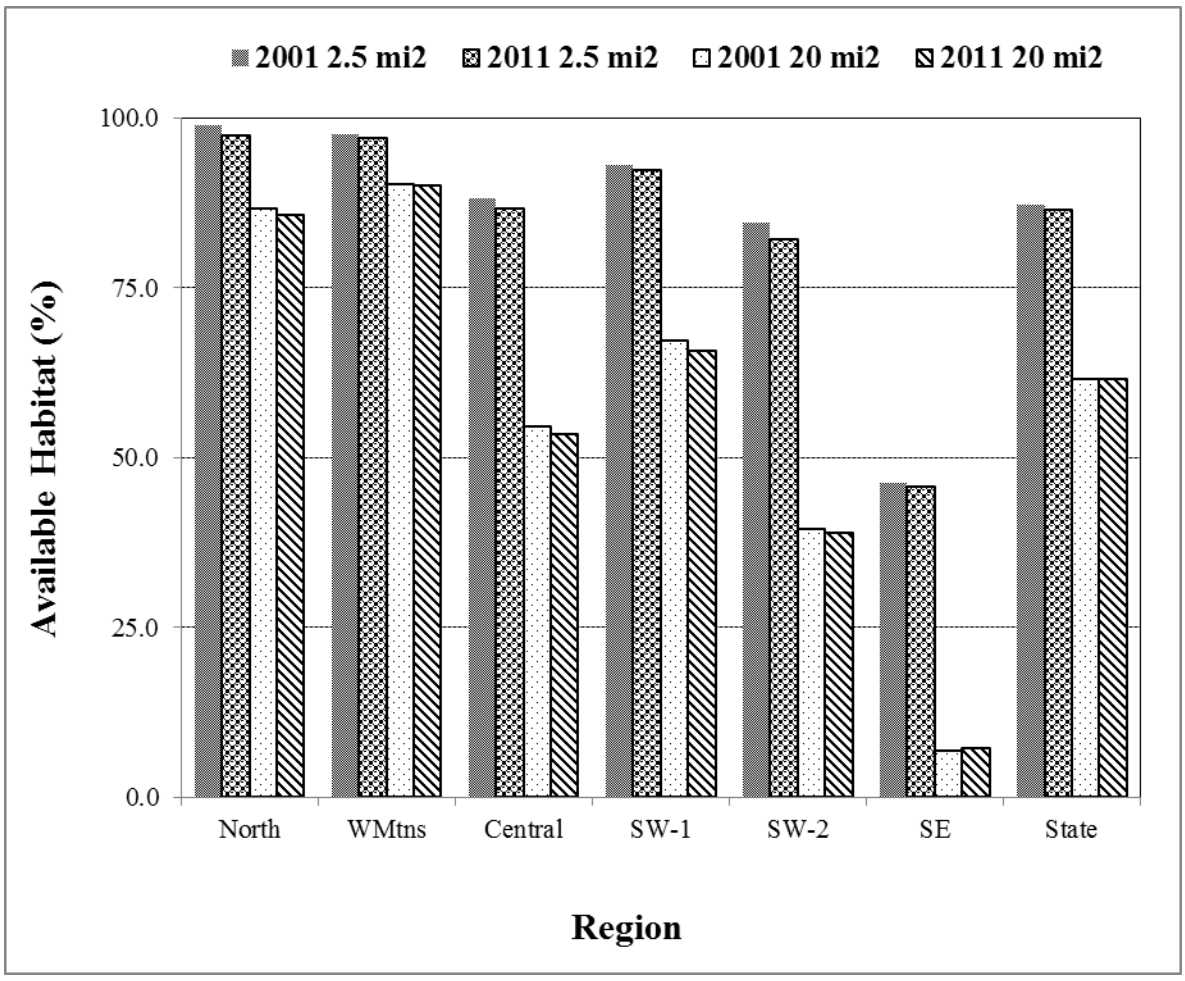

Figure 17. Estimated percentage of contiguous black bear habitat that exceeds certain minimum thresholds (2.5 and 20 mi^2) on a statewide and bear management region level in New Hampshire during 2001 and 2011. Areas are considered contiguous until broken by land classes that are not considered bear habitat, roads and associated buffers.

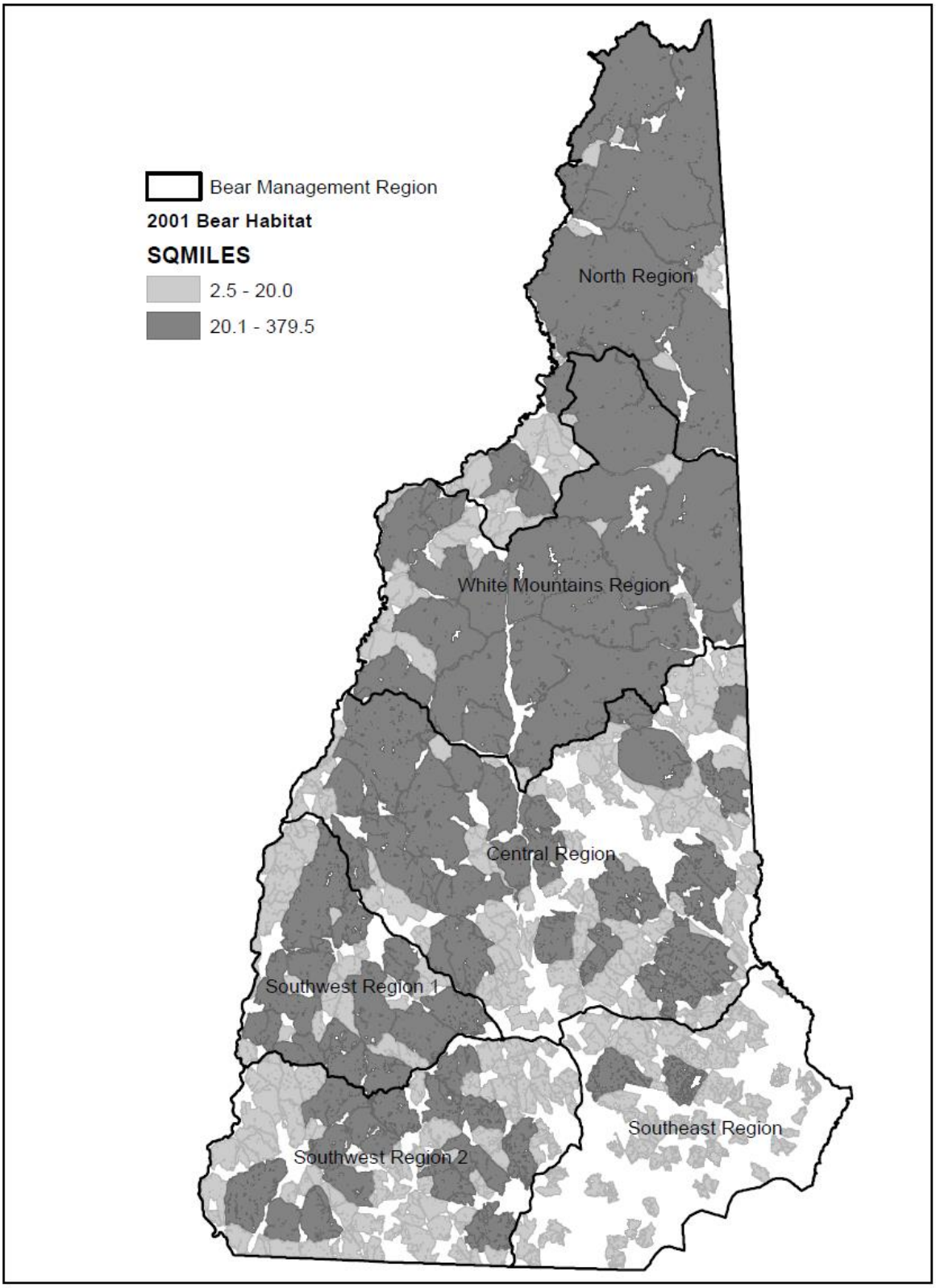

Figure 18a. Distribution of contiguous black bear habitat blocks that exceed 2.5 and 20 mi^2 in area by bear management region in New Hampshire, 2001.

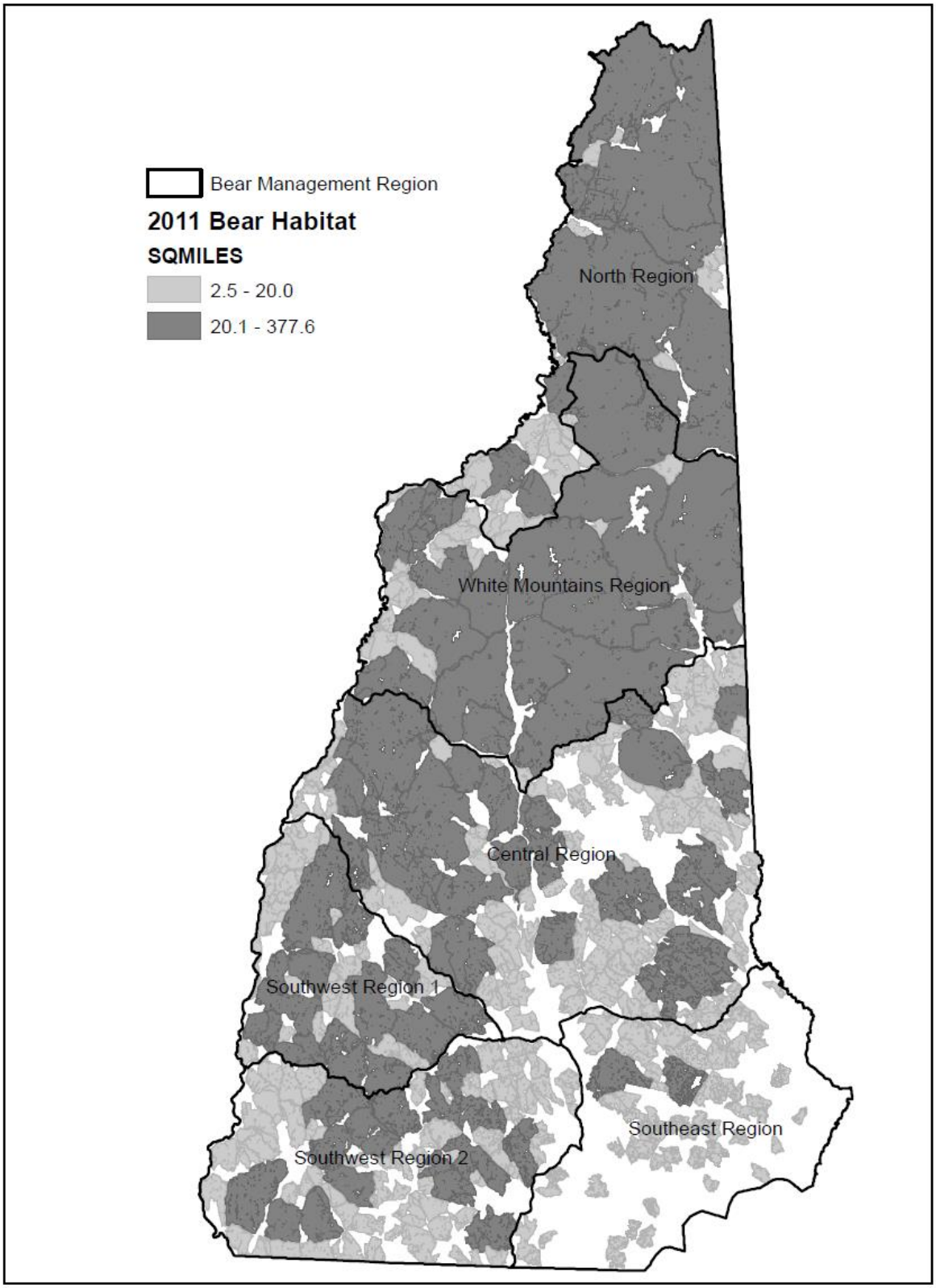

Figure 18b. Distribution of contiguous black bear habitat blocks that exceed 2.5 and 20 mi^2 in area by bear management region in New Hampshire, 2011.

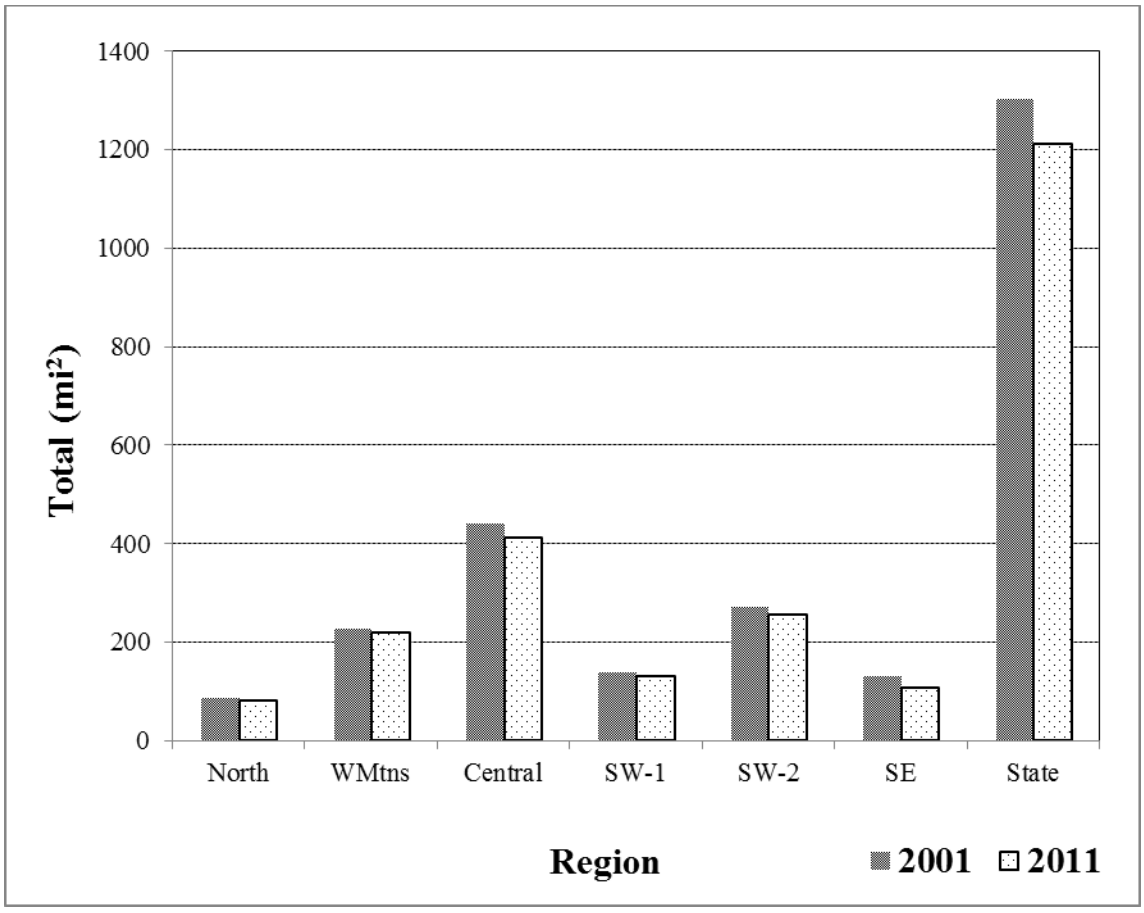

Figure 19. Estimated area of forest cover dominated by American beech and oak species by bear management region within New Hampshire during 2001 and 2011. Beech/oak stands are deciduous stands comprised of at least 30% beech and oak.

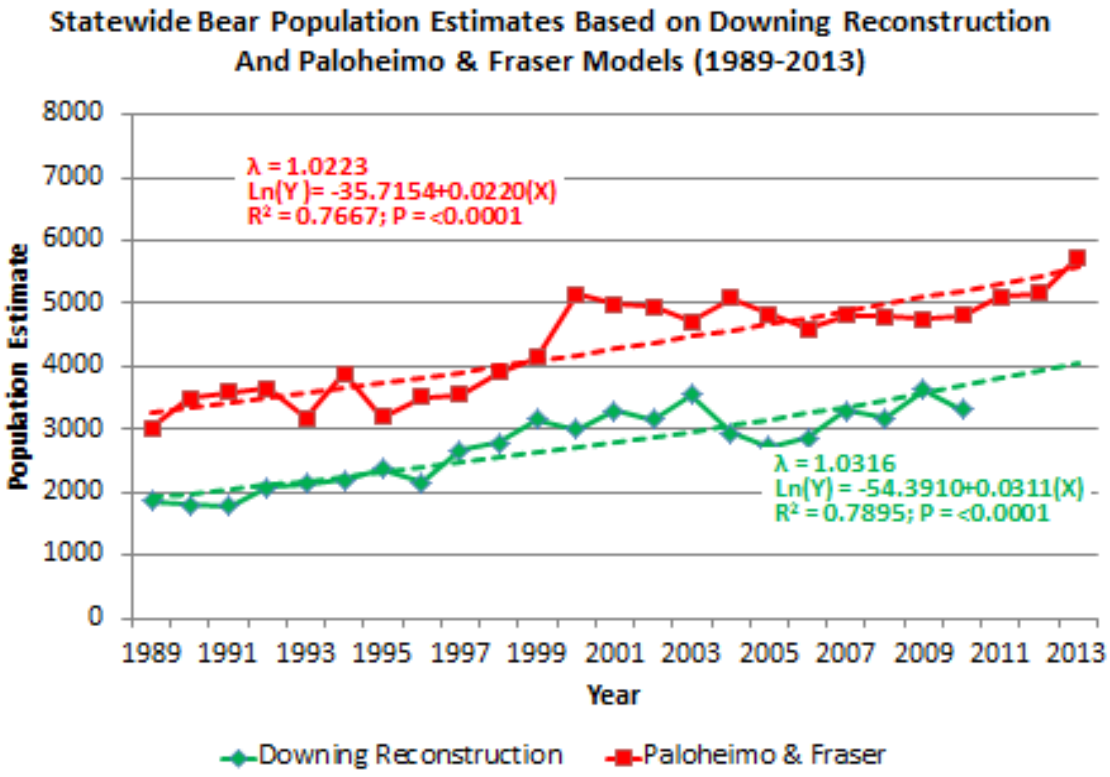

Figure 20. New Hampshire bear population estimates developed using two models, 1989-2013. Both the Downing reconstruction and Paloheimo and Fraser (P&F) models utilize sex-specific age-at-harvest data to estimate population size and change in abundance over time. Downing reconstruction estimates a minimum population size and therefore produces an abundance estimate that is consistently lower than that of the P&F model. During the period 1989-2013, the Downing and P&F models indicated that the bear population was increasing at a rate of 2.2 and 3.2% per year, respectively.

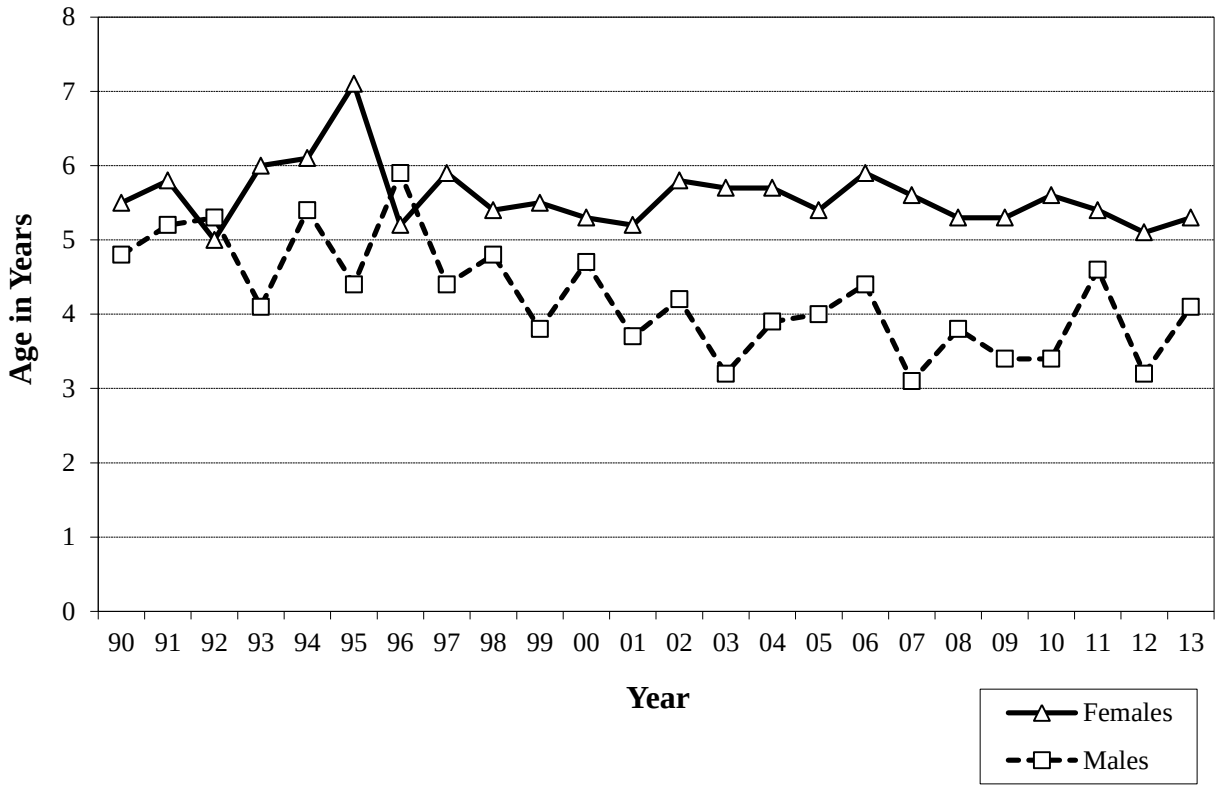

Figure 21. Mean age of harvested female and male black bears in New Hampshire, 1990-2013. Age was determined by tooth section analysis of premolars collected from harvested bears.

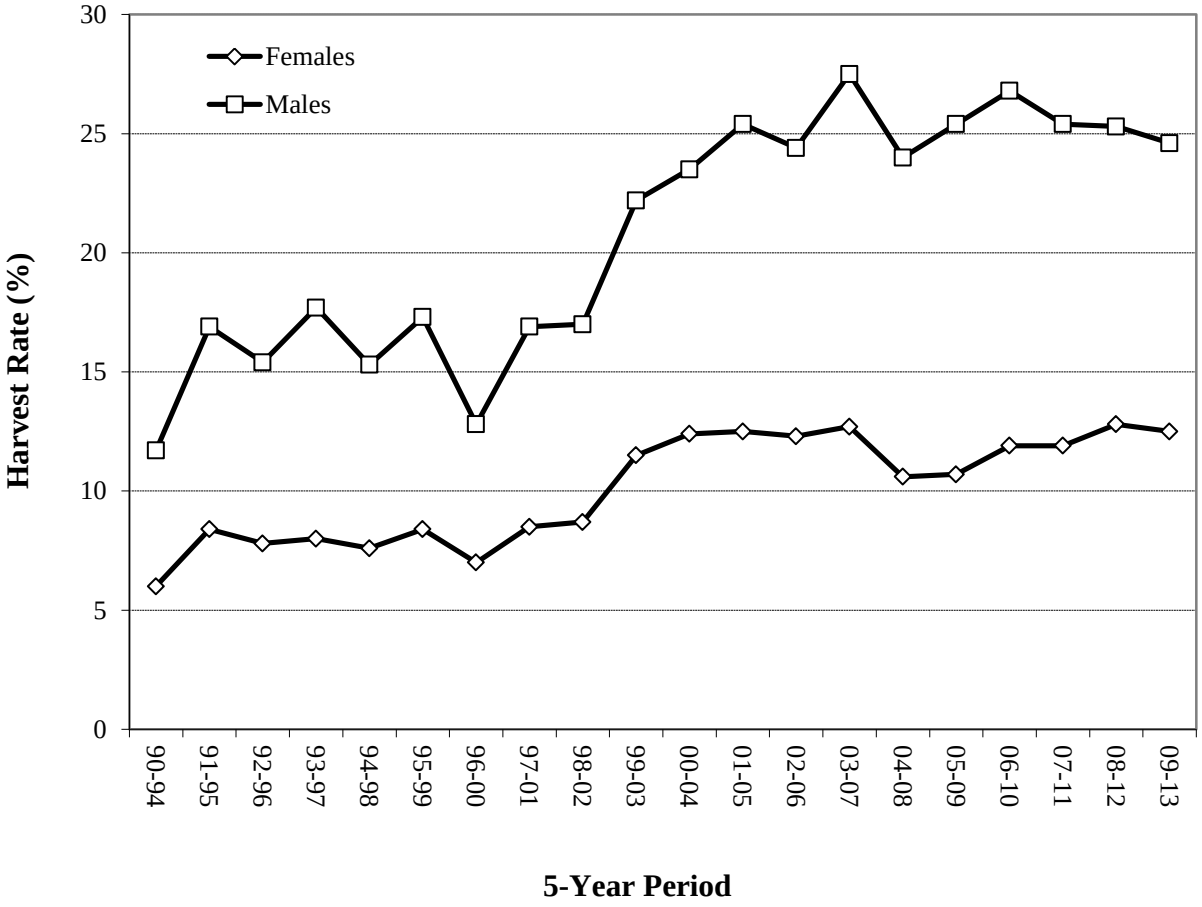

Figure 22. Estimated 5-year running mean harvest rate of female and male black bears in New Hampshire, 1990-2013. Harvest rates were estimated using the differential vulnerability model of Paloheimo and Fraser (1981).

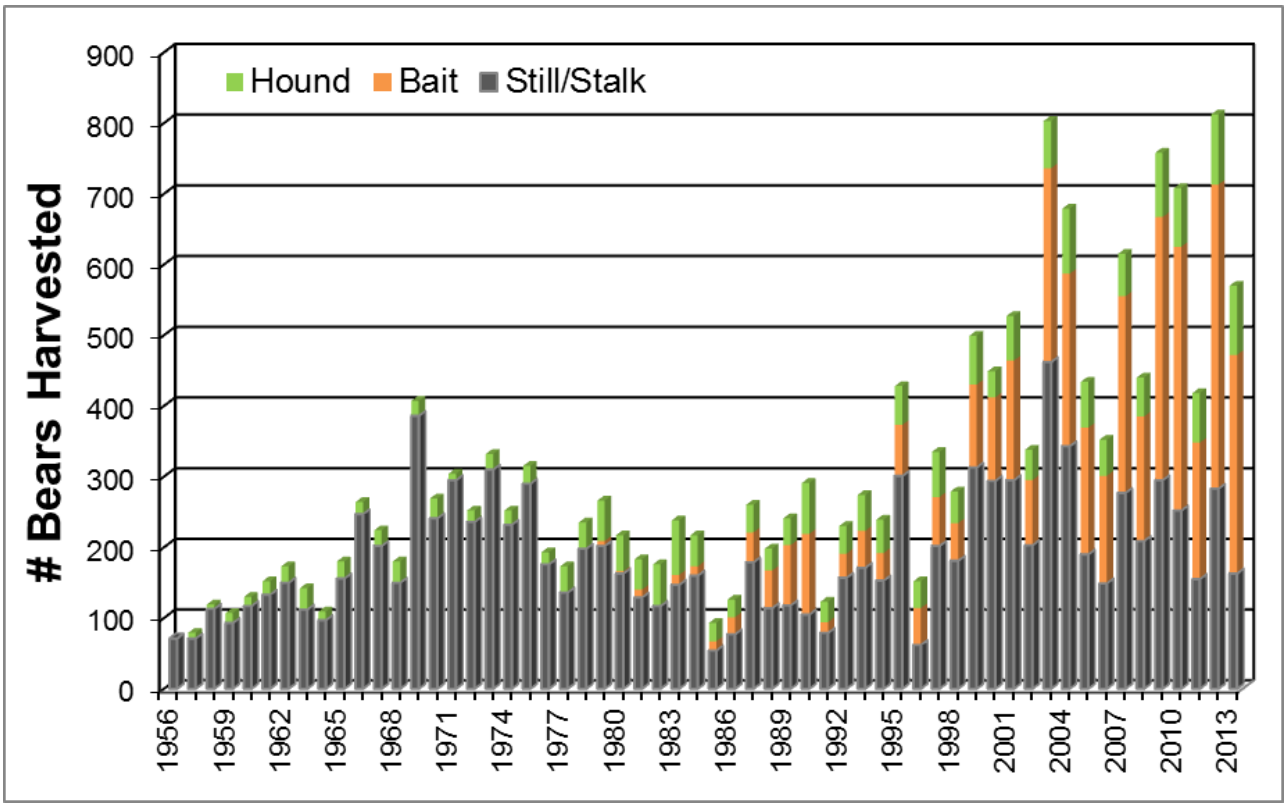

Figure 23. Historical New Hampshire bear harvest by method, 1956-2013. In the early years, most bears were taken via still hunting, and to a lesser extent with pursuit hounds. In more recent times, the majority of the annual harvest is taken with bait, however still and hound hunting continue to account for important components of the harvest. The decline in harvest during the 1980s, as compared to prior years, represents the period of intensified restriction on bear hunting to allow for population growth in range and numbers. The increasing harvest since the 1990s represents a growing bear population, greater hunter interest and participation, and a switch to hunting methods that result in higher success (i.e., baiting). The annual variation in harvest primarily relates to differences in food distribution and abundance and corresponding changes in bear vulnerability.

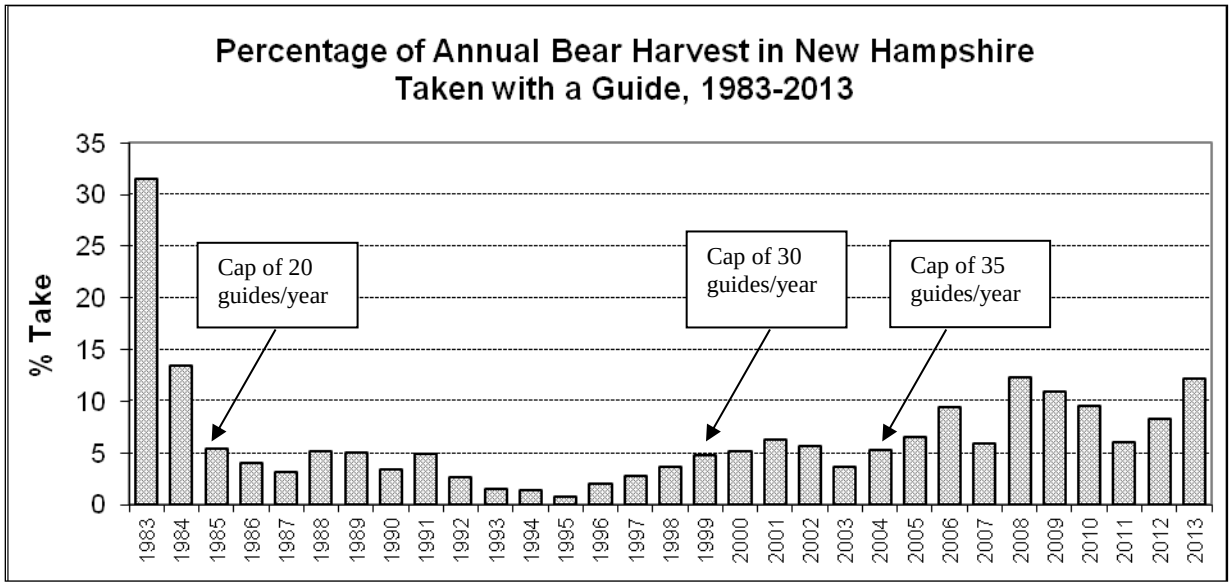

Figure 24. Annual percentage of the bear harvest taken with the use of a registered guide in New Hampshire, 1983-2013. The initial cap on the number of registered guides who could guide for bear was set at 20 per year in 1985. This cap was raised to 30 in 1999 and 35 in 2004. Recently this cap was again raised to 50. These caps were instituted and are being maintained due to concerns over the potential commercialization of bear hunting in New Hampshire.

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Appendix I. Estimates of area (mi^2) considered viable bear habitat as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2001 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	Row Crops	Hay/ Pasture	Orchards	Beech/ Oak	Birch/ Aspen	Hardwoods	White/Red Pine	Spruce/ Fir	Hemlock	Pitch Pine	Mixed Forest	Forested Wetland	Open Wetland (50%)	Cleared
A	0.3	9.8	0.0	37.3	23.1	185.0	6.0	85.4	3.7	0.0	156.6	9.7	5.3	30.0
B	0.8	5.3	0.0	24.4	22.7	115.4	5.6	47.0	2.6	0.0	72.8	4.6	3.1	24.3
C2	0.1	2.1	0.0	16.6	17.7	62.5	6.4	47.1	3.0	0.0	41.6	11.3	3.9	15.7
D1	1.8	8.2	0.0	9.7	24.9	38.3	20.3	20.1	8.2	0.0	35.5	6.3	4.3	29.6
North	**3.0**	**25.4**	**0.0**	**87.9**	**88.4**	**401.2**	**38.3**	**199.6**	**17.5**	**0.0**	**306.5**	**31.9**	**16.7**	**99.6**
C1	0.0	2.0	0.0	19.6	21.3	79.4	2.7	25.0	1.8	0.0	38.0	1.1	1.2	6.4
D2	3.5	24.1	0.0	40.6	76.2	88.7	36.7	28.4	21.1	0.0	89.3	2.9	2.0	25.6
E	0.3	5.2	0.0	84.7	76.2	168.9	12.4	167.5	13.7	0.0	180.9	2.8	1.1	15.9
F	0.3	7.0	0.1	84.0	43.0	99.6	17.7	60.4	19.3	0.0	106.8	0.8	1.1	13.2
White Mtns	**4.1**	**38.2**	**0.1**	**228.9**	**216.6**	**436.6**	**69.4**	**281.3**	**55.9**	**0.0**	**415.0**	**7.5**	**5.4**	**61.2**
G	0.9	27.7	0.1	125.1	15.1	102.2	55.7	59.0	36.3	0.0	151.2	3.4	2.8	22.4
I1	2.9	19.2	0.8	79.7	3.2	23.9	45.7	9.0	22.3	0.0	91.6	1.9	2.8	14.3
J1	0.1	8.2	0.0	75.9	17.8	56.9	64.1	8.0	21.0	5.6	125.9	10.6	4.6	26.3
J2	1.5	35.2	0.7	160.4	2.6	67.7	85.3	8.7	20.7	0.0	270.6	7.4	6.4	47.7
Central	**5.5**	**90.3**	**1.7**	**441.2**	**38.7**	**250.7**	**250.7**	**84.7**	**100.3**	**5.6**	**639.3**	**23.4**	**16.6**	**110.7**
H1	3.2	26.0	0.1	60.6	6.9	43.9	39.9	24.0	25.0	0.0	119.4	0.7	1.0	15.4
I2	0.5	12.6	0.1	78.0	7.4	40.1	31.2	27.3	23.4	0.0	110.9	2.3	2.4	9.2
SW-1	**3.7**	**38.6**	**0.2**	**138.7**	**14.3**	**84.0**	**71.1**	**51.3**	**48.4**	**0.0**	**230.4**	**3.0**	**3.5**	**24.6**
H2	3.5	34.2	0.1	142.7	12.4	49.9	46.7	20.4	52.3	0.0	235.3	4.6	5.3	19.9
K	1.5	33.4	2.6	130.8	5.6	18.8	81.4	12.6	36.7	0.0	202.8	3.6	5.8	26.5
SW-2	**5.0**	**67.6**	**2.7**	**273.5**	**17.9**	**68.7**	**128.0**	**33.0**	**89.0**	**0.0**	**438.2**	**8.2**	**11.2**	**46.4**
L	1.5	20.4	0.5	61.7	0.3	32.7	39.3	2.2	6.3	0.1	172.5	6.4	2.8	44.1
M	0.8	32.5	3.3	70.7	1.9	38.2	54.8	1.5	4.8	0.0	180.0	18.8	4.1	83.5
Southeast	**2.3**	**52.9**	**3.8**	**132.4**	**2.3**	**70.9**	**94.2**	**3.7**	**11.1**	**0.1**	**352.5**	**25.2**	**6.9**	**127.6**
Statewide	**23.5**	**313.1**	**8.5**	**1302.6**	**378.2**	**1312.0**	**651.7**	**653.5**	**322.2**	**5.7**	**2381.7**	**99.3**	**60.2**	**470.1**

Appendix I. Estimates of area (mi^2) not considered viable bear habitat as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2001 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	Developed	Transportation	Alpine	Water	Open Wetland (50%)	Tidal Wetland	Disturbed	Bedrock/ Vegetation	Sand Dunes	Tundra	Habitat Within 300' Buffer of Major Roads
A	1.0	2.2	0.0	16.2	5.8	0.0	0.0	0.0	0.0	0.0	5.8
B	1.2	2.4	0.0	4.8	3.6	0.0	0.1	0.1	0.0	0.0	4.1
C2	1.5	2.9	0.0	15.4	4.3	0.0	0.6	0.1	0.0	0.0	3.9
D1	2.2	6.0	0.0	7.6	4.8	0.0	0.5	0.0	0.0	0.0	11.2
North	5.9	13.5	0.0	44.0	18.6	0.0	1.1	0.2	0.0	0.0	25.0
C1	0.6	1.5	0.0	1.0	1.3	0.0	0.2	0.0	0.0	0.0	2.4
D2	2.3	8.7	1.2	10.3	2.5	0.0	0.4	0.4	0.0	0.1	16.8
E	3.7	6.9	14.8	3.7	1.4	0.0	1.1	1.9	0.0	5.0	14.3
F	2.8	6.6	0.0	5.3	1.3	0.0	0.9	0.6	0.0	0.0	12.2
White Mtns	9.4	23.6	16.1	20.2	6.5	0.0	2.6	2.9	0.0	5.0	45.7
G	7.3	13.6	0.0	24.7	3.6	0.0	0.5	0.4	0.0	0.0	17.8
I1	7.3	13.3	0.0	11.8	3.1	0.0	0.6	0.0	0.0	0.0	13.3
J1	5.1	10.1	0.0	41.0	5.0	0.0	3.2	0.1	0.0	0.0	16.0
J2	11.5	28.5	0.0	124.4	7.5	0.0	4.1	0.0	0.0	0.0	34.8
Central	31.3	65.4	0.0	201.8	19.2	0.0	8.4	0.5	0.0	0.0	81.9
H1	7.4	10.1	0.0	8.7	1.4	0.0	0.3	0.9	0.0	0.0	13.9
I2	3.3	8.9	0.0	19.9	3.0	0.0	0.7	0.0	0.0	0.0	13.9
SW-1	10.7	19.0	0.0	28.6	4.3	0.0	1.0	0.9	0.0	0.0	27.8
H2	10.4	20.8	0.0	24.8	6.2	0.0	0.6	0.4	0.0	0.0	26.3
K	14.2	27.4	0.0	14.9	6.5	0.0	1.8	0.0	0.0	0.0	27.4
SW-2	24.6	48.2	0.0	39.7	12.7	0.0	2.4	0.5	0.0	0.0	53.6
L	20.6	30.1	0.0	31.5	3.5	0.6	6.9	0.0	0.0	0.0	27.9
M	46.2	61.0	0.0	44.8	5.6	7.6	12.8	0.0	0.3	0.0	44.5
Southeast	66.8	91.2	0.0	76.3	9.1	8.2	19.7	0.0	0.3	0.0	72.5
Statewide	148.6	260.9	16.1	410.5	70.3	8.2	35.2	5.0	0.3	5.0	306.5

Appendix I. Estimates of area (mi^2) considered viable bear habitat as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2011 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	Row Crops	Hay/ Pasture	Orchards	Beech/ Oak	Birch/ Aspen	Hardwoods	White/Red Pine	Spruce/ Fir	Hemlock	Pitch Pine	Mixed Forest	Forested Wetland	Open Wetland (50%)	Cleared
A	0.2	7.1	0.0	35.6	21.4	172.6	5.4	75.9	3.2	0.0	147.0	24.0	1.9	60.2
B	0.5	3.8	0.0	21.8	21.6	106.3	4.9	42.5	2.4	0.0	68.7	12.8	0.8	44.1
C2	0.1	0.9	0.0	15.5	16.2	57.4	5.3	37.7	2.7	0.0	38.0	21.3	1.0	34.1
D1	1.6	4.7	0.0	9.3	23.5	36.8	17.4	16.0	7.5	0.0	34.0	20.4	1.3	36.6
North	**2.4**	**16.5**	**0.0**	**82.2**	**82.7**	**373.1**	**33.0**	**172.1**	**15.7**	**0.0**	**287.8**	**78.6**	**5.0**	**175.0**
C1	0.0	0.9	0.0	17.9	19.9	73.7	2.4	23.6	1.6	0.0	36.2	4.0	0.4	17.7
D2	2.3	18.0	0.0	39.4	73.2	87.6	33.4	27.6	20.2	0.0	88.6	10.1	0.8	37.7
E	0.2	3.0	0.0	82.3	74.2	164.3	11.2	165.5	13.3	0.0	178.2	8.8	0.5	25.1
F	0.2	3.9	0.1	82.1	41.5	97.5	16.0	58.9	18.4	0.0	105.2	7.5	0.5	19.9
White Mtns	**2.7**	**25.8**	**0.1**	**221.6**	**208.8**	**423.1**	**63.0**	**275.6**	**53.5**	**0.0**	**408.1**	**30.4**	**2.2**	**100.5**
G	0.5	14.7	0.1	120.7	14.8	102.1	50.1	50.9	34.3	0.0	149.4	24.8	1.1	36.6
I1	0.9	11.8	0.8	75.0	3.1	23.9	39.8	7.1	20.6	0.0	87.5	19.8	1.4	21.8
J1	0.0	3.5	0.0	70.6	16.3	53.8	55.7	6.5	18.7	4.8	116.0	31.4	1.8	45.2
J2	0.5	20.9	0.7	145.5	2.5	64.0	72.7	6.5	18.6	0.0	244.1	48.6	3.3	76.8
Central	**1.9**	**50.9**	**1.6**	**411.8**	**36.6**	**243.8**	**218.2**	**70.9**	**92.2**	**4.8**	**597.0**	**124.7**	**7.6**	**180.3**
H1	1.2	18.2	0.1	58.3	6.9	44.5	36.8	21.6	24.4	0.0	119.4	9.2	1.1	19.7
I2	0.0	7.3	0.1	73.7	7.3	39.8	27.5	23.7	21.9	0.0	105.4	18.7	1.9	18.0
SW-1	**1.2**	**25.5**	**0.2**	**132.0**	**14.1**	**84.3**	**64.3**	**45.3**	**46.3**	**0.0**	**224.9**	**27.9**	**3.0**	**37.7**
H2	1.9	20.3	0.1	136.0	12.1	51.8	41.3	15.5	48.7	0.0	227.1	36.6	3.5	29.2
K	0.1	20.9	2.4	120.1	5.3	21.1	70.4	8.5	33.3	0.0	188.2	39.0	4.4	40.6
SW-2	**2.0**	**41.2**	**2.5**	**256.0**	**17.4**	**72.8**	**111.7**	**24.0**	**82.0**	**0.0**	**415.2**	**75.6**	**8.0**	**69.8**
L	0.4	13.2	0.4	52.5	0.3	28.2	32.4	1.4	5.7	0.1	145.2	39.8	2.4	47.3
M	0.1	17.2	2.6	56.9	1.1	31.5	42.3	0.7	4.0	0.0	135.8	73.7	5.1	65.0
Southeast	**0.6**	**30.4**	**2.9**	**109.4**	**1.5**	**59.6**	**74.7**	**2.2**	**9.7**	**0.1**	**281.0**	**113.5**	**7.6**	**112.3**
Statewide	**10.7**	**190.2**	**7.3**	**1212.9**	**361.1**	**1256.8**	**565.0**	**590.1**	**299.4**	**4.9**	**2214.1**	**450.6**	**33.3**	**675.7**

Appendix I. Estimates of area (acres) not considered viable bear habitat as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2011 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	Developed	Transportation	Alpine	Water	Open Wetland (50%)	Tidal Wetland	Disturbed	Bedrock/ Vegetation	Sand Dunes	Tundra	Habitat Within 300' Buffer of Major Roads
A	3.3	2.2	0.0	16.2	2.1	0.0	2.1	0.0	0.0	0.0	4.3
B	2.7	2.4	0.0	4.8	1.1	0.0	1.8	0.1	0.0	0.0	2.9
C2	3.5	2.8	0.0	15.4	1.1	0.0	1.4	0.1	0.0	0.0	2.8
D1	6.1	6.0	0.0	7.6	1.5	0.0	3.0	0.0	0.0	0.0	7.9
North	**15.6**	**13.5**	**0.0**	**44.0**	**5.9**	**0.0**	**8.4**	**0.2**	**0.0**	**0.0**	**17.9**
C1	1.6	1.5	0.0	1.0	0.5	0.0	1.1	0.0	0.0	0.0	1.8
D2	7.2	8.6	1.2	10.3	1.1	0.0	2.8	0.4	0.0	0.1	13.3
E	9.2	6.9	14.8	3.7	0.6	0.0	3.6	1.9	0.0	4.8	10.9
F	5.7	6.6	0.0	5.3	0.6	0.0	3.0	0.6	0.0	0.0	9.8
White Mtns	**23.6**	**23.6**	**16.1**	**20.2**	**2.7**	**0.0**	**10.5**	**2.9**	**0.0**	**4.9**	**35.8**
G	14.7	13.6	0.0	24.7	1.5	0.0	3.4	0.4	0.0	0.0	14.1
I1	14.3	13.3	0.0	11.7	1.6	0.0	3.4	0.0	0.0	0.0	10.2
J1	9.6	10.1	0.0	41.0	2.0	0.0	6.7	0.1	0.0	0.0	13.3
J2	27.9	28.5	0.0	124.4	3.8	0.0	13.4	0.0	0.0	0.0	26.9
Central	**66.6**	**65.4**	**0.0**	**201.8**	**8.9**	**0.0**	**26.8**	**0.5**	**0.0**	**0.0**	**64.5**
H1	14.1	10.1	0.0	8.7	1.3	0.0	2.1	0.9	0.0	0.0	11.4
I2	6.7	8.9	0.0	19.9	2.2	0.0	1.6	0.0	0.0	0.0	12.3
SW-1	**20.8**	**19.0**	**0.0**	**28.5**	**3.5**	**0.0**	**3.7**	**0.9**	**0.0**	**0.0**	**23.6**
H2	19.9	20.8	0.0	24.8	4.0	0.0	3.4	0.4	0.0	0.0	22.2
K	27.9	27.4	0.0	14.9	4.9	0.0	5.1	0.0	0.0	0.0	22.8
SW-2	**47.8**	**48.2**	**0.0**	**39.7**	**8.9**	**0.0**	**8.5**	**0.5**	**0.0**	**0.0**	**45.1**
L	46.0	30.1	0.0	31.5	2.8	0.5	16.0	0.0	0.0	0.0	17.6
M	119.9	61.0	0.0	44.8	6.0	7.3	20.5	0.0	0.3	0.0	26.5
Southeast	**165.9**	**91.2**	**0.0**	**76.3**	**8.9**	**7.8**	**36.5**	**0.0**	**0.3**	**0.0**	**44.1**
Statewide	**340.2**	**260.9**	**16.1**	**410.5**	**38.8**	**7.8**	**94.4**	**5.0**	**0.3**	**4.9**	**231.1**

Appendix II. Estimates of area (mi^2) as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2001 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	WMU/Region Area	Land Area	Habitat Area	Percent of Land Area Considered Habitat	Habitat Area in Blocks ≥ 2.5 mi^2	Habitat Area in Blocks ≥ 20 mi^2
A	584.6	569.9	552.2	96.9	557.3	547.5
B	346.2	342.2	328.6	96.0	324.4	316.2
C2	257.4	244.5	228.0	93.2	221.1	197.9
D1	241.2	234.4	207.3	88.4	197.4	78.8
North	**1429.4**	**1391.0**	**1316.0**	**94.6**	**1300.2**	**1140.4**
C1	205.7	204.9	198.4	96.8	199.7	196.1
D2	483.9	473.2	439.1	92.8	420.7	317.6
E	782.8	779.9	729.6	93.6	715.5	694.8
F	483.4	479.0	453.2	94.6	438.1	433.3
White Mtns	**1955.8**	**1937.1**	**1820.3**	**94.0**	**1774.0**	**1641.8**
G	672.3	649.9	601.9	92.6	559.9	470.8
I1	368	358.0	317.2	88.6	270	149
J1	507.2	471.8	425.2	90.1	379.7	154.5
J2	929.4	818.8	715.0	87.3	603.6	347.8
Central	**2476.9**	**2298.4**	**2059.3**	**89.6**	**1813.2**	**1122.1**
H1	409.7	401.8	366.2	91.1	339.5	222
I2	395.6	377.7	345.4	91.5	321.9	255.4
SW-1	**805.3**	**779.5**	**711.6**	**91.3**	**661.4**	**477.4**
H2	720	697.3	627.3	90.0	555.1	266.4
K	658.3	637.1	562.0	88.2	451.2	203.7
SW-2	**1378.3**	**1334.4**	**1189.4**	**89.1**	**1006.3**	**470.1**
L	513.9	494.0	390.7	79.1	244.7	59.5
M	722.4	690.2	495.0	71.7	164.9	0
Southeast	**1236.3**	**1184.2**	**885.7**	**74.8**	**409.6**	**59.5**
Statewide	**9282.0**	**8924.6**	**7982.4**	**89.4**	**6964.7**	**4911.3**

Appendix II. Estimates of area (mi^2) as classified by land cover type on a WMU, regional and statewide level in New Hampshire. Estimates were derived using 2011 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	WMU/Region Area	Land Area	Habitat Area	Percent of Land Area Considered Habitat	Habitat Area in Blocks ≥ 2.5 mi^2	Habitat Area in Blocks ≥ 20 mi^2
A	584.6	569.9	554.4	97.3	554.4	544.7
B	346.2	342.2	330.3	96.5	322.7	314.6
C2	257.4	244.5	230.2	94.2	219.8	196.7
D1	241.2	234.4	209.0	89.1	191.7	77.4
North	**1429.4**	**1391.0**	**1323.9**	**95.2**	**1288.6**	**1133.4**
C1	205.7	204.9	198.3	96.8	198.4	194.9
D2	483.9	473.2	438.9	92.7	414.8	316.0
E	782.8	779.9	726.5	93.2	711.9	692.1
F	483.4	479.0	451.9	94.3	436.7	431.9
White Mtns	**1955.8**	**1937.1**	**1815.5**	**93.7**	**1761.8**	**1634.9**
G	672.3	649.9	600.0	92.3	552.9	467.3
I1	368	358.0	313.4	87.5	260.8	146.9
J1	507.2	471.8	424.5	90.0	373.4	153.3
J2	929.4	818.8	704.5	86.0	582.4	322.1
Central	**2476.9**	**2298.4**	**2042.3**	**88.9**	**1769.5**	**1089.6**
H1	409.7	401.8	361.3	89.9	333.2	211.4
I2	395.6	377.7	345.3	91.4	318.8	253.2
SW-1	**805.3**	**779.5**	**706.7**	**90.7**	**652.0**	**464.6**
H2	720	697.3	624.1	89.5	540.6	265.3
K	658.3	637.1	554.2	87.0	427.0	191.8
SW-2	**1378.3**	**1334.4**	**1178.4**	**88.3**	**967.6**	**457.1**
L	513.9	494.0	369.2	74.7	232.5	57.8
M	722.4	690.2	436.1	63.2	135.0	0.0
Southeast	**1236.3**	**1184.2**	**805.3**	**68.0**	**367.5**	**57.8**
Statewide	**9282**	**8924.6**	**7872.0**	**88.2**	**6807.0**	**4837.4**

Appendix II. Change in habitat area (mi^2 and acres) that occurred during the period 2001-2011. Estimates of quantity and change were derived using 2001 and 2011 National Land Cover data consisting of 23 cover types based on classification of Landsat Thematic Mapper imagery.

WMU/ Region	2001 Habitat Area (mi^2)	2011 Habitat Area(mi^2)	Percent Change in Habitat Between Years	Change in Mi^2
A	552.2	554.4	0.4	2.2
B	328.6	330.3	0.5	1.8
C2	228.0	230.2	1.0	2.3
D1	207.3	209.0	0.8	1.7
North	**1316.0**	**1323.9**	**0.6**	**7.9**
C1	198.4	198.3	-0.1	-0.1
D2	439.1	438.9	-0.1	-0.3
E	729.6	726.5	-0.4	-3.1
F	453.2	451.9	-0.3	-1.3
White Mtns	**1820.3**	**1815.5**	**-0.3**	**-4.8**
G	601.9	600.0	-0.3	-2.0
I1	317.2	313.4	-1.2	-3.8
J1	425.2	424.5	-0.2	-0.7
J2	715.0	704.5	-1.5	-10.5
Central	**2059.3**	**2042.3**	**-0.83**	**-17.0**
H1	366.2	361.3	-1.3	-4.8
I2	345.4	345.3	0.0	-0.1
SW-1	**711.6**	**706.7**	**-0.69**	**-4.9**
H2	627.3	624.1	-0.5	-3.2
K	562.0	554.2	-1.4	-7.8
SW-2	**1189.4**	**1178.4**	**-0.93**	**-11.0**
L	390.7	369.2	-5.5	-21.5
M	495.0	436.1	-11.9	-58.9
Southeast	**885.7**	**805.3**	**-9.08**	**-80.4**
Statewide	**7982.4**	**7872.0**	**-1.4**	**-110.3**

Appendix III. Description of 23 National Land Cover types (2001 and 2011) and status of cover types as potential black bear habitat in New Hampshire.

Land Cover Type	Status as Bear Habitat	Description of Cover Type
Developed		
Residential, Commercial, or Industrial	Non-Habitat	Areas built-up by human development.
Transportation and Buffers on Major Roads	Non-Habitat	Roads classified by New Hampshire

		Department of Transportation as Class I-V. Roads classified by USDOT/FHA as arterials and collectors were buffered 300 feet beginning at the edge of pavement.
Active Agricultural Land		
Row Crops	Habitat	Land that is actively farmed.

Hay/Rotation/Permanent Pasture	Habitat	Land that is actively farmed. Commercial and non-commercial fruit orchards.
Fruit Orchards	Habitat	
Forested		Deciduous stands are forested stands comprising < 25% coniferous basal area per acre. Coniferous stands are forested stan

		ds comprising > 65% coniferous basal area per acre.
Beech/ Oak	Habitat	Deciduous stands comprising ≥ 30% beech and oak.
Paper Birch/ Aspen	Habitat	Deciduous stands comprising ≥ 20% paper birch and aspen.
Other Hardwoods	Habitat	Deciduous stands not meeting either

		the beech/oak or paper birch/aspen criteria.
White/ Red Pine	Habitat	Coniferous stands in which white and red pine constitute a majority of the coniferous basal area.
Spruce/ Fir	Habitat	Coniferous stands in which spruce and fir constitute a maj

		ority of the coniferous basal area.
Hemlock	Habitat	Coniferous stands in which hemlock constitutes a majority of the coniferous basal area.
Pitch Pine	Habitat	Coniferous stands in which pitch pine constitutes a majority of the conifero

		us basal area.

Appendix III (cont). Description of 23 National Land Cover types (2001 and 2011) and status of cover types as potential black bear habitat in New Hampshire.

Land Cover Type	**Status as Bear Habitat**	**Description of Cover Type**
Forested (cont)		
Mixed Forest	Habitat	Forested stands comprising >25% and < 65% coniferous basal area per acre.

Alpine	Non-Habitat	Contain stunted vegetation, either hardwood or softwood (usually paper birch or spruce/fir), and occur just below tree line in the White Mountains.
Water		
Open Water	Non-Habitat	Lakes, ponds, some rivers and any other

	open water feature.
Wetlands	Areas dominated by wetland characteristics defined by the U.S. Fish and Wildlife Service National Wetlands Inventory. Wetlands include areas with hydric soils, hydrophytic vegetation

and the hydrologic conditions that result in water at or near the surface for extended periods of the growing season.

Forested Wetlands	Habitat 50% = Habitat 50% = Non-Habitat
Non-forested Wetlands	
Tidal Wetlands	Non-H

	abitat	
Barren Land		
Disturbed	Non-Habitat	Includes gravel pits, quarries or other areas where the earth and vegetation have been altered or exposed.
Bedrock/Vegetated	Non-Habitat	Areas with exposed bedrock or ledge (usually in the mountains) that may have som

		e forms of stunted vegetation growing in cracks or lichens growing on the surface rock.
Sand Dunes	Non-Habitat	Areas along the seacoast that are dominated by sand.
Cleared /Other Open	Habitat	Areas containing clear cut forests, old agricultural field

		s that are reverting to forest, etc.
Tundra	Non-Habitat	Areas dominated by short vegetation that occurs above tree line in the White Mountains.