Black Bear Ecology and the Use of Prescribed Fire to Enhance Bear Habitat

Keith M. Weaver[1]

Abstract

The black bear (*Ursus americanus*) is a species of interest for wildlife and forest managers, landowners, hunters, and the public. Because of their overall adaptability to changing habitat conditions, wide-ranging nature, and omnivorous habits, black bears are readily accommodated in a forest management program. A well-managed forest that provides adequate opportunities for movements, foraging, denning, and cover has better potential to satisfy the needs of bears than an unmanaged forest. Food supplies should be abundant, stable, and diverse. Habitats that harbor natural dens should be conserved, known den sites should be protected, and creation of potential den habitat and den sites should be considered in forest habitat treatments. In addition, natural escape cover should be maintained, and opportunities should be undertaken to create or enhance cover for bedding, escape, and dispersal. Although bear habitat management has traditionally been associated with timber management, the use of prescribed fire holds promise as an effective tool for enhancement of black bear habitat in the central hardwood landscape. In this paper, various aspects of black bear habitat ecology are reviewed, and the use of prescribed fire alone or in conjunction with other silvicultural techniques to maintain, enhance, and restore habitat conditions for black bears is explored. Evaluation of prescribed fire behavior and activity, habitat responses to fire under various conditions, and associated implications for bears could be useful in developing "best fire management practices" in bear habitat. Prescribed fire should be used in an adaptive management approach. This entails not only the application of fire, but also the diligent monitoring of habitat and wildlife responses, and fine-tuning future actions. Topics of investigation concerning bears and fire are listed. Public education programs conveying the ecological effects and benefits of prescribed fire for habitat, wildlife, and humans, and the development of public/private partnerships for habitat management are recommended.

Background

The black bear is a species of management interest in most areas of its range. Humans hold widely divergent viewpoints regarding bears. Black bears are characterized as big game animals, links to cultural heritage, food sources, dangerous animals, tourist attractions, photographic subjects, spiritual beings, indicators of healthy ecosystems, symbols of wilderness, pawns for environmental activism, agricultural pests, and as a threat to resource extraction and economic development programs. Because of the importance of bears in the lives of many humans, and the need to satisfy legislative, regulatory, or other obligations to properly manage wildlife and their habitats, wildlife and land managers seek to enact management practices beneficial to bears and humans. Responsible bear management includes the recognition that carrying capacity has biological and socioeconomic aspects. Both must be considered for their relevance to providing adequate resources for bears, reducing human/bear conflicts, and fostering public acceptance of bears. Bear damage complaints in agriculture and garbage usually increase when shortages of natural foods occur, which provides additional justification for establishing and maintaining suitable forest conditions for bears. This is particularly necessary in fragmented habitat where bears are surrounded by more agriculture and development than forest. Bear habitat management should focus on providing suitable habitat and habitat linkages, abundant natural food supplies, denning sites, escape cover, and human access management. The purpose of this paper is to highlight some aspects of black bear habitat ecology and to explore the use of prescribed fire to enhance bear habitat in the central hardwood landscape. The concept of prescribed fire as used in this paper is the application of human ignited and controlled fire to a site, according to approved techniques, within specified limits of the physical conditions of air, soil, and vegetation, in order to effect a desired change in site conditions, for the purpose of achieving previously defined goals and objectives.

Habitat

Black bears are adaptable, opportunistic, and highly mobile animals. Bears can move great distances in response to changing weather, food supplies, habitat conditions, disturbance, and internal population pressures. Movements and home range size vary greatly depending on age, sex, reproductive status, population density, and habitat quality. Males typically range farther than females. Sizes of bear home ranges in the Cherokee National Forest in east Tennessee, as determined through analysis of radiotelemetry data, varied from 20 to 192 square kilometers for males and 4 to 23 square kilometers for females (Villarubia 1982, Garris 1983, Clevenger 1986). Such mobility simplifies habitat management for bears in some respects, because management actions can be directed beyond the microsite to the forest or landscape scale. Conservation or creation of habitat linkages between disjunct tracts of forest can help provide corridors for bear movements in search of food, dens, and mates; juvenile dispersal; and also facilitate bear population expansion.

Although black bears are creatures of the forest, they do not require wilderness or old growth habitats. However, both of these habitat characteristics can be useful components of the overall bear landscape. Black bears can survive and coexist with human inhabitation nearby if the bears are afforded a forest that satisfies their life requisites. The use of

[1]Refuge Manager, U.S. Fish and Wildlife Service, Nulhegan Basin Division, Silvio O. Conte NFWR, P.O. Box 427, Island Pond, VT 05846.

prescribed fire can aid in establishment of desired regeneration. It also can be used for site preparation in reforestation programs that will expand forested habitat and provide an additional buffer from human encroachment into bear habitat. The greater the quantity, but perhaps more important, the quality of bear habitat, the less chance for conflicts between humans and bears.

The key to improving the quality of bear habitat is to provide habitat diversity. Within the forest, a mosaic of habitats or habitat conditions (e.g., species composition, age class, structure, successional stage, openings, understory) holds the best potential for the satisfaction of bear life requirements. The value of managing a mixed pine-oak-hickory component within the central hardwood landscape should not be overlooked for its benefit for bears. A diverse forest may be better adapted to withstand the ravages of disease, insect invasions, or catastrophic events. Therefore, a properly managed forest likely will provide better bear habitat potential than an unmanaged forest. Indeed, the outcome of modeling timber harvest effects on black bear population dynamics in the southern Appalachian Mountains indicated that forests with carefully designed timber management regimes would yield greater food abundance and stability than unmanaged forests (Brody and Stone 1987). It is important to recognize that a decision not to perform habitat manipulation has its own consequences that also must be evaluated for their impact on bears.

The credibility and compatibility of forest management in providing for bear habitat needs was demonstrated by the U.S. Fish and Wildlife Service through promulgation of a special rule in the Threatened listing for the Louisiana black bear (*U. a. luteolus*), which states, in part, that the provisions of the Federal listing "... shall not prohibit effects incidental to normal forest management activities within the historic range of the Louisiana black bear except for activities causing damage to or loss of den trees, den tree sites or candidate trees" (Federal Register 7 January 1992, 57(4) sub-sect. 17.40, i(2), pp. 594-595). Normal forest management activities were defined in the rule as "... activities that support a sustained yield of timber products and wildlife habitats, thereby maintaining forestland conditions in occupied habitat." Although the range of the Louisiana bear is distant from the central hardwood landscape, the premise is identical; responsible forest management is good bear habitat management.

Traditionally, forest management for black bears has been a function of timber management. Treatments such as clearcut, patch clearcut, shelterwood and irregular shelterwood, and thinning are useful methods for creating, improving, and maintaining desirable bear habitat. However, the ability to manage forests with conventional silvicultural techniques has been hindered because of increasing public resentment to timber harvest, increased environmental regulation, and decreasing budgets. Therefore, the use of prescribed fire may provide a complementary habitat management technique for bears. Prescribed fire also may be a useful tool to enhance bear habitat in areas where timber harvest is impractical or prohibited. Ideally, the integration of prescribed fire with other silvicultural treatments affords the greatest potential for maintenance and establishment of suitable bear habitat conditions. A comprehensive prescribed fire program also should include hazard fuel reduction burns that serve to reduce the occurrence or severity of wildfires that could destroy bear habitat and negate beneficial habitat management programs.

The practice of managing forests, landscapes, or wildlife populations implies making choices that entail potential risks and benefits, and advantages and disadvantages for target and nontarget sites, species, and humans. Therefore, it is imperative that clear management goals and objectives are defined and approved, appropriate methods employed, outcomes evaluated for success or failure, and modifications for future achievement enacted. Prescribed fire use must not be relegated to the "meet the target" syndrome. Additionally, a forest management program should not be expected to provide for every wildlife or human use, on every acre, in every management compartment, or in every decade. Some sites are better suited to a certain management purpose than others, and there are practical limitations to the degree of manipulation that can be achieved or the extent of attention that can be devoted on a site during any given period. Tradeoffs will occur and management choices must be made that will accommodate the greatest suite of needs and interests within applicable laws, policy, funding, technology, and practicality. These choices should be based on the best available technical information; however, when developing new practices, guiding methodologies are often limited, and sometimes the intuition and experience of managers must be relied on to determine the prudent course of action.

Foods

Nutrition is the foundation for the survival and welfare of individual bears and the dynamics of bear populations (e.g., Rogers 1976, 1987, 1993). Therefore, it is critical that forest management practices for black bears ensure a variety of stable and abundant food supplies throughout the year. This can be accomplished by providing habitat diversity; a mosaic of habitat types, stand ages, and conditions; high yields of soft and hard mast; herbaceous foods; and decomposing wood that harbors insect and other invertebrate life. Forested habitat, forest openings, edge habitats, riparian borders, and crop fields within and adjacent to forested habitat provide feeding opportunities for bears. Black bears are excellent tree climbers and are able to forage in all vertical strata of the forest; therefore, the impacts of habitat management actions on food production in the overstory, midstory, and understory should be considered. Black bears are wide-ranging, omnivorous, and opportunistic in their feeding habits. Thus they are able to capitalize on a wide range of conditions in their search for food. Food "preferences" (Bacon and Burghardt 1983) are difficult to determine, but bear foraging behavior and food consumption are influenced by: season, food abundance and accessibility, proximity of other foraging bears, bear densities, human activity in bear habitat, physiological condition (e.g., pre and post denning), and reproductive status.

Hard Mast

The use of the term hard mast in this paper refers collectively to the fruit of oaks (*Quercus* spp.), beechnuts (*Fagus grandifolia*), and hickories and pecans (*Carya* spp.). In the fall and early winter prior to denning, bears in the eastern deciduous forest feed heavily on hard mast, particularly acorns. They largely depend on these foods to build sufficient fat reserves to survive the period of winter dormancy (Beeman and Pelton 1980, Eagle and Pelton 1983, Clark and others 1987, Rogers and Allen 1987). Bears forage for hard mast in tree crowns prior to nut drop, and on the ground post-drop. The abundance and availability of hard mast affect black bears at the individual and population levels. The availability of hard mast, particularly where there are few other foods, has been documented to affect population growth (mortality, natality, interbirth interval), bear numbers, fall feeding movements, and denning chronology (Pelton 1985, 1989; McLaughlin and others 1994; McLaughlin 1998; Schooley and others 1994). Such effects of hard mast on black bear survival and population dynamics in the Southern Appalachians have been modeled (Brody and Stone 1987, McLean and Pelton 1994).

Hard mast production should be an important consideration in bear habitat management in the central hardwood landscape. Where feasible, hard mast producing species, particularly oaks, should be encouraged as a major bear forest habitat component in silvicultural and prescribed fire treatments. Long timber rotations (75 to 100 years) will favor hard mast production, and are compatible with peak acorn yield potential (Pelton 1985, Hillman and Yow 1986, Brody and Stone 1987). Treatments should be directed toward maintaining diversity of hard mast species, high mast yields, and perpetuating desired species in future stands. A notable problem in upland hardwood management has been the difficulty in regenerating oak stands on high quality sites following harvest. Thus, many oak-dominated stands have been converted to stands of less desirable species in terms of hard mast such as yellow poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) (O'Hara 1986, Kays and others 1988). If this conversion occurs on a wide scale it could adversely affect bear populations. However, upland oaks exhibit morhpological and physiological characters that suggest greater fire adaptation than some of their competing species including: thick bark, vigorous sprouting ability, deep roots, rot resistance following scarring, xeromorphic leaves, and greater hardiness to drought and nutrient-poor sites (Abrams 1992). Historically, oak domination on central hardwood sites has been in response to a fire regime (Abrams 1992). Advance regeneration in the understory is a prerequisite for reestablishment of an oak-dominated stand subsequent to harvest. Van Lear and Waldrop (1989) suggested that repeated understory burns in summer and winter during an extended period (e.g., 5 to 20 years) prior to harvest could be successful in establishing adequate oak advance regeneration. Recently, compelling evidence has been presented that the proper timing, intensity, and periodicity of prescribed fire applied 3 to 5 years following shelterwood cutting in stands with advance oak regeneration will favor oak reproduction and establishment on productive upland sites. The concept, development, and applications of this technique as well as instructions for its implementation are presented by Brose and Van Lear (1998, 1999) and Brose and others (1999a,b). The benefits and drawbacks of prescribed burning in oak-dominated shelterwood stands in different seasons also are discussed by Brose and Van Lear (1998, 1999). The effects of prescribed burning on hard mast production were discussed by Harlow and Van Lear (1989). They commented that hot surface fires in the fall could readily consume acorns in the duff layer, but that low intensity surface fires could serve to expose recently fallen acorns without substantial loss of mast crops. Consumption of heavy leaf litter by fire could aid in the successful location and caching of acorns by blue jays (*Cyanocitta cristata*) and squirrels (*Sciurus* spp.), which could promote oak regeneration (Galford and others 1988). They also indicated winter burning might reduce acorn predation by weevils, thus increasing their availability for wildlife.

Squawroot (*Conopholis americana*), a saprophyte associated with oaks, is an important component of spring diets of bears following den emergence. Squawroot provides nutrition for bears at a period when soft mast production is not yet available. The perpetuation of an oak component in the forest would hopefully enable continued availability of squawroot. The ecology of oaks, squawroot, and fire warrants investigation.

Soft mast

Although hard mast crops are important for black bears, they only are seasonally present, and abundant yields are sporadic. Therefore, other foods also must be available throughout the year. In addition, during hard mast failures, alternate food sources are of great importance. Soft mast produced by woody and herbaceous species is a vital food source that also should be managed as a viable component of bear habitat. Use of the term soft mast in this paper refers to fruits with fleshy exteriors such as berries, drupes, and pomes (Harlow and Van Lear 1989). In the central hardwood landscape, bears consume the fruits of a wide variety of plants such as: blackberries (*Rubus* spp.), blueberries (*Vaccinium* spp.), huckleberries (*Gaylussacia* spp.), serviceberry (*Amelanchier* spp.), pokeberry (*Phytolacca americana*), elderberry (*Sambucus canadensis*), devil's walking stick (*Aralia spinosa*), flowering dogwood (*Cornus florida*), paw-paw (*Asimina triloba*), sassafras (*Sassafras albidum*), *Ilex* spp., hawthorn (*Crataegus* spp.), black cherry (*Prunus serotina*), black gum (*Nyssa sylvatica*), and persimmon (*Diospyros virginiana*). Growth of most of these plants are stimulated by increased light penetration to the forest floor from canopy openings that result from timber harvest, construction of wildlife openings, creation of interior forest trails, and wind or ice damage. Silvicultural and prescribed fire treatments that promote establishment, diversification, proliferation, and perpetuation of soft mast as a forest component in conjunction with hard mast are highly encouraged. Soft mast production peaked 3 to 5 years after clearcuts, shelterwood cuts, and group selection treatments in mixed pine-hardwood stands in the Oauchita Mountains of

Arkansas and Oklahoma (Perry and others 1988). However, it was noted that without additional treatment, such as burning or thinning, soft mast production was expected to decline significantly as canopies in the harvested areas closed. Fruit producing vines such as grape (*Vitis* spp.) and greenbrier (*Smilax* spp.) are also readily eaten by bears; their growth should be encouraged. Heavy canopies of vines (e.g., grape slicks) generally are not compatible with oak regeneration, but if these growths are managed for fruit production (versus mainly vegetative growth), they add a valuable component of diversity for bear foods, and can be important to bears during shortages of hard mast.

The effects of prescribed fire on soft mast production in hardwood stands has received little attention in the literature. A literature review of the effects of prescribed fire on soft mast production in various pine forest types in the Southeast was presented by Harlow and Van Lear (1989). Many soft mast producing species considered in this paper decreased fruit production in the year following burning; however, fruiting in flowering dogwood was increased in the next year after burning. Studies reviewed indicated that fruiting increased 2 to 5 years following burning in species that occur in the central hardwoods such as blueberries and huckleberries, blackberries, persimmon, chokeberry (*Sorbus arbutifolius*), muscadine grape (*V. rotundifolia*), *Viburnum* spp., yaupon (*I. vomitoria*) and plum (*Prunus umbellata*). Harlow and Van Lear (1989) suggested staggered burning cycles of 3 to 5 years. Juxtaposition of burned and unburned areas to promote stable and abundant soft mast crops also has been recommended (Landers 1987, Harlow and Van Lear 1989). Burning rotations of 3 to 10 years were recommended for soft mast production for bears in pine-hardwood stands in coastal North Carolina (Hamilton 1981) and pine dominated habitat in the panhandle of Florida by (Stratman 1998).

Herbaceous Foods

Bears forage in the forest understory, forest openings, and edge habitats for herbaceous plants. The succulent sprouts of various plants stimulated by prescribed fire can provide feeding opportunities in the understory. Pack and others (1988) documented a 31 percent increase in herbaceous forbs, grasses, and sedges following late winter-early spring burns in oak-hickory stands in West Virginia that had previously been thinned. Treatments involving thinning alone or thinning following burning did not produce similar results. To prevent risk of fire injury to the residual stand, they recommended burning only after logging slash had decomposed to the point where it would not constitute a major fuel component. Masters and others (1993), studying timber harvest and fire effects in pine-oak-hickory stands in the Ouachita Mountains of Oklahoma, reported that fire could reduce accumulations of litter and standing dead herbaceous vegetation that impeded new herbaceous growth. The combination of timber harvest and burning increased light penetration to the forest floor, resulted in increased soil temperatures and nitrogen availability, which, in turn, stimulated earlier and greater herbaceous growth and production.

Establishment of a system of widely dispersed forest openings, perhaps <1 ha in size, maintained in various age and species compositions, would provide additional diversification of bear foraging opportunities. Abandoned log loading sites and old fields can be converted to wildlife openings and managed to produce herbaceous vegetation. Old trails or roads not used for transportation routes within the forest can be converted and maintained as linear wildlife openings (Hillman and Yow 1986). Openings could even be created in marginal forest stands using a hot fire that would kill woody vegetation. Annual burning likely will be necessary to stimulate high seed production and maintain herbaceous conditions. Disking or mowing on a 1 to 3 year rotation can be used to maintain openings in early successional stages. However, prescribed fire could provide an alternate method for rejuvenation of herbaceous growth and to setback woody succession. Use of prescribed fire can eliminate the need of accessing remote openings with machinery, and reduce costs of maintaining and operating tractors and implements. Openings can be enhanced with periodic sowing of food plants such as clovers (*Trifolium* spp.), wheat, rye, chufa (*Cyperus esculentus*), brown-top millet (*Panicum ramosum*), or bahia grass (*Paspalum notatum*). Prescribed fire can aid site preparation for initial or subsequent seedings. Edge plants such as blackberries, pokeweed, elderberry, and devil's walking stick that proliferate in and around forest openings further increase habitat diversity and feeding opportunities. These openings also provide habitat for a host of other wildlife species. Prescribed fire management is also indicated for vegetation management in rights-of-way, and for the perpetuation and management of grassy balds in the Southern Appalachians. Resultant vegetation and soft mast within and along the edges of these treatment areas serve to increase bear feeding opportunities.

Invertebrates

Invertebrates such as beetles, ants, termites, and their eggs and larva are protein-rich foods for bears. Such food items often are found inside or underneath decaying trees and logs. Decayed logs that are rolled over or torn apart in search of insects are a common sight in most areas of bear activity. These logs typically are remnants of logging slash or fallen dead trees. Black bears consume insects during most of their non-denning period. Bears also feed on wild honey bees and their honey that are found in standing hollow dead trees, and in cavities in living trees. Retention of standing and fallen snags, and logging slash is encouraged to provide invertebrate food sources. When planning a prescribed fire program with bear habitat enhancement in mind (versus strictly hazard fuel reduction, for example), such food shelters for bears should be favored. Some areas typically targeted for slash reduction burns should be left unburned, or at a minimum, some slash should be protected from fire near the forest edge. Slash left solely for bear foraging opportunities should not be piled. When using prescribed fire in the understory, some fallen logs and standing snags should be protected from fire when and where feasible.

Denning Sites

In the central hardwood landscape, bears may occupy a variety of winter den types including elevated tree cavities, cavities in the base of a hollow tree or under boulders; excavated cavities, hollow logs, brushpiles, or ground nests. Typical bear den trees are: living (although dead trees also are used), large (dbh >90 cm), and old (>150 years). Entrances to elevated cavities may range from 5 to 30 meters above ground. Entrances to den cavities are either through a broken top or a side hole caused by a limb break. Cavities in the base of hollow trees are often initially caused by bark injury (including fire injury) that allowed entry of fungi or other agents that eventually resulted in cavity creation. Potential den tree species in the central hardwoods would include: northern red oak (*Q. Rubra*), chestnut oak (*Q. Prinus*), white oak (*Q. Alba*), yellow poplar, red maple, yellow birch (*B. alleghaniensis*), white pine (*Pinus strobus*), and eastern hemlock (*Tsuga canadensis*). Excavations usually occur on side hills under a blowdown, root cavity, hollow tree base, log, or stump. Brushpile dens typically are found in logging slash or sites of extensive wind throw. Ground nests are usually located in dense thickets of woody vegetation such as rhododendron (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), or in regenerating clearcuts.

Recommendations for timber management for black bears in the southern Appalachian Mountains suggest that potential den trees should be reserved from logging, and that a minimum of 5 to10 percent of the forest be maintained in age classes of 250 years or older to ensure adequate supplies of den trees (Pelton 1985, Hillman and Yow 1986). Retention of individual large trees that contain elevated cavities, and large trees with heart rot or wind, lightning, or fire injuries that could develop cavities for dens, is also encouraged during harvest operations. Preferably, such trees should be left in small reserve clumps to help prevent wind throw, particularly in clearcuts or shelterwood cuts. Ideally, pre-burn scouting should be performed to identify potential bear den trees, and these should be protected from fire by clearing woody debris and other fuels from around the base (particularly in the case of standing dead snags). Similarly, downed hollow logs large enough to accommodate a denning bear (approximately 50 cm in diameter) should be protected from fire consumption. When silvicultural treatments are to be followed by prescribed burns, the logging operators should be instructed to clear tops and other slash away from reserved trees to protect them from flareup during the burn.

Ground denning (excavations, brushpiles, ground nests) opportunities are increased following most silvicultural treatments. Practical methods to provide ground denning sites include promoting thick regeneration and scattered piling of felled tops to create potential brushpile den sites. Like old growth habitat, early successional habitat also should be managed as a viable bear habitat component. In forests where few opportunities exist for tree denning (either due to age class structure, tree species composition, or past management practices), regeneration resulting from timber harvest could be crucial habitat for denning bears. Under such circumstances, a forest managed with consideration for tree and ground denning sites for bears will provide more varied denning potential than an unmanaged forest. However, such logic notwithstanding, the conservation of dense rhododendron and laurel thickets, which is contrary to promoting timber regeneration, also will provide ground denning habitat for bears. An integrated approach of providing early successional habitat (regeneration) and maintaining dense shrub thickets would diversify and expand availability of ground denning habitat.

Although no studies in the central hardwood region have dealt with the issue of prescribed fires and denning bears, a study in coastal North Carolina (Lombardo 1993) and two studies in Florida (Land 1994, Stratman 1998) documented abandonment of ground nests by bears, including a female with cubs, during prescribed burns. The bears in the Lombardo study subsequently redenned; such information was not reported in the Florida studies. Conversely, on the Appalachicola National Forest in Florida, denning bears were not disturbed from ground nests during prescribed burn operations (Seibert 1993). These reports serve to remind the manager that prescribed burns must be undertaken with a clear recognition and understanding of the potential risks and benefits to the targeted habitat or wildlife component, both on the site-specific versus forest scale, and on the individual animal versus population scale. Burn units must be properly laid out and of manageable size to allow for responsible protection of special resources and to minimize potential adverse effects to the physical environment, habitat, wildlife, or humans.

Escape Cover

Large expanses of contiguous forest or mountainous, inaccessible forested terrain serve to insulate bears from human disturbance. However, as forests become smaller and more fragmented, and as human encroachment and disturbance in bear habitat increases, escape cover will become even more vital to insulate bears from human activities. Escape cover is recognized as an important component of bear habitat (Pelton 1985, Rogers and Allen 1987, McLaughlin and others 1988). Black bears can thrive in close proximity to humans if afforded areas of retreat that ensure little chance of close contact or visual encounters with humans (Pelton 1982). Areas of dense or impenetrable vegetation that limits visibility and hinders travel by human and dogs, such as rhododendron thickets and regeneration following clearcuts and shelterwood cuts, can provide high quality shelter for daybeds and escape cover for bears. Because dense stands of rhododendron and mountain laurel are not conducive to oak regeneration, this is another situation of tradeoffs, one that pits the need for regeneration versus escape cover.

The utility of large trees as bear escape cover should not be overlooked. Black bears evolved behaviorally and morphologically as tree climbers, and are well-adapted for arboreal escape (Herrero 1972). The largest tree in the area is often chosen as a resting or bedding spot by females with cubs. The female can tree the cubs when danger is perceived, and may accompany them up the tree, protect the base of the tree, or flee the area to distract intruders. Bears also will use large trees for resting. Pockets of old growth forest can ensure the availability of large trees for escape and resting, but ideally, scattered large trees should be available throughout the forest to provide the greatest opportunity for tree escapes. Just as den trees and candidate den trees can be reserved from timber harvest and protected from damage during prescribed burns, so can escape trees. Such trees actually may serve multiple purposes as denning, escape, and resting sites.

Roads

Considerable attention has been given to the potential effects of roads on bears in the Southern Appalachians (Carr and Pelton 1984, Hillman and Yow 1986, Brody and Pelton 1989, Beringer and others 1990). The impacts of roads on bears are determined primarily by road structure, location, traffic characteristics, and timing of road use. Roads no longer in service and without management purpose should be closed and reforested, or seeded to serve as linear wildlife openings (Hillman and Yow 1986, Reed and others 1996). However, existing roads can have a useful function in a comprehensive fire management program. Forest roads can serve as firebreaks, primary ignition lines, and escape routes during prescribed burn operations; avenues into treated habitat for monitoring and research of the effects of prescribed fire programs on habitat and wildlife; and as access for wildfire suppression operations for the protection of bear habitat. Roads can be gated to reduce vehicular access into bear habitat, maintained as linear wildlife openings, and prescribed burned to encourage bear food plants within and adjacent to the roadbed, and still allow access for management or emergency purposes.

Summary

Black bears are not obligatory inhabitants of old growth forest or wilderness areas. Forests managed according to the basic concepts discussed in this paper have the potential for providing black bear habitat that is superior to unmanaged forests. Forest and wildlife managers should not be restricted in the methods and tools available to accomplish bear habitat management. Rarely is there only one “right” way to achieve a desired future forest condition. Management actions must be driven by overall goals and objectives. Prescriptive criteria should be formulated to effect burn conditions that will achieve management objectives for the burn unit, and such criteria must be strictly adhered to in “go-no go” decision making. Firing techniques must be appropriately selected and applied to meet burn objectives. Burns must be adequately monitored from ignition to completion to record fire behavior and intensity, and to ensure prescriptive criteria are being satisfied. Burn units must be of manageable size to minimize chance of fire escape, and to have reasonable opportunity to suppress the fire should prescriptive limits be exceeded, or if adverse conditions or circumstances are encountered. Burn plans must define methods to measure whether burns achieved specified burn objectives or not and why. Fire management plans must include provisions for monitoring of both first order fire effects and longer term impacts on habitat and associated wildlife responses. Results of fire management actions must be evaluated to ensure goals and objectives indeed are being accomplished, and future actions modified as necessary in an adaptive management fashion. Through such efforts, “best fire management practices” can be developed that will guide future management actions.

Black bear habitat and landscape management in the central hardwoods, including the use of prescribed fire and wildfire suppression, should be directed toward: (1) forest conservation; (2) creating and maintaining habitat diversity; (3) providing stable, diverse, and widely available food supplies throughout the year; (4) maintaining and increasing suitable denning sites and habitat; (5) providing escape cover; (6) conservation, enhancement, and establishment of habitat linkages; (7) reforestation programs; and (8) human access management. Responsible forest management can accommodate the needs of consumers, recreationists, residents, visitors, and bears. Bears and humans can coexist if habitat is available that satisfies the life requirements of bears, and if bears do not unduly interfere with human objectives for use of the same landscape.

As with any wildlife population, the objectives and attitudes of land owners, land managers, resource users, legislators, and the general public will determine if bears are considered a positive or negative benefit, and ultimately, if bears can survive. Expanding public awareness about the ecology and management of bears, and the utility and benefits of prescribed fire and other silvicultural techniques should encourage acceptance of agency and private programs designed to conserve, manage, and restore bear populations. Public education should include the concept of maintaining functional ecosystems, watersheds, and landscapes as the basis for conserving a unique wildlife heritage. A considerable amount of the wildlife habitat in the eastern United States is in private ownership. Therefore, it is crucial that private landowners also develop a vested interest in black bear conservation and management to ensure long-term welfare of the species. Technical advice and assistance with prescribed fire management of wildlife habitat should be provided to private landowners by federal and state agencies. Effective partnerships among agencies, universities, non-governmental organizations, private enterprise, and the public will aid in information transfer, cooperative programs, and increased funding, with the end result being increased fire management success for the benefit of bears, other wildlife, and humans in the central hardwood landscape.

Future topics for study concerning the relationship of bears, fire, and people in the central hardwood landscape include: (1) determining the most effective integration of prescribed fire and other silvicultural techniques to produce a productive and diverse forest; (2) effects of prescribed fire on hard mast, soft mast, squawroot, and herbaceous food production; (3) utility of prescribed fire in perpetuating a hard mast species component in the forest; (4) creation or perpetuation of escape cover through the use of prescribed fire; (5) use of burned areas by bears; (6) behavior of bears during prescribed burns; and (7) effective public education programs to convey the benefits of prescribed fire for wildlife habitat enhancement, forest resource production, hazard fuel reduction, and public use.

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