Brown Bear
(Ursus arctos)

John Schoen and Scott Gende

images by John Schoen

Two hundred years ago, brown (also known as grizzly) bears were abundant and widely distributed across western North America from the Mississippi River to the Pacific and from northern Mexico to the Arctic (Trevino and Jonkel 1986). Following settlement of the west, brown bear populations south of Canada declined significantly and now occupy only a fraction of their original range, where the brown bear has been listed as threatened since 1975 (Servheen 1989, 1990). Today, Alaska remains the last stronghold in North America for this adaptable, large omnivore (Miller and Schoen 1999) (Fig 1). Brown bears are indigenous to Southeastern Alaska (Southeast), and on the northern islands they occur in some of the highest-density populations on earth (Schoen and Beier 1990, Miller et al. 1997).

The brown bear in Southeast is highly valued by big game hunters, bear viewers, and general wildlife enthusiasts. Hiking up a fish stream on the northern islands of Admiralty, Baranof, or Chichagof during late summer reveals a network of deeply rutted bear trails winding through tunnels of devil's club *(Oplopanx horridus)* and currant *(Ribes spp.)* shrubs beneath centuries-old, giant spruce trees where brown bears fish for spawning salmon. These riparian forests play an important role in the productivity and diversity of the Southeast rainforest ecosystem where brown bears, salmon, and large trees have been inextricably linked for millennia.

FIG 1. Brown bears occur throughout much of southern coastal Alaska where they are closely associated with salmon spawning streams. Although brown bears and grizzly bears are the same species, northern and interior populations are commonly called grizzlies while southern coastal populations are referred to as brown bears. Because of the availability of abundant, high-quality food (e.g. salmon), brown bears are generally much larger, occur at high densities, and have smaller home ranges than grizzly bears.

STATUS IN SOUTHEASTERN ALASKA

Distribution

Brown bears are distributed along the Southeast mainland and on the northern islands of the Alexander Archipelago between Icy Strait and Frederick Sound (Klein 1965, MacDonald and Cook 1999) (Fig 2). Admiralty, Baranof, and Chichagof islands—often called the ABC islands (Fig 3)—and many of the smaller adjacent islands are inhabited by brown bears, and people often see bears swimming the smaller (<2 mi [1.6 km]) channels between islands. Even small (<1 mi^2 [3.2 km^2]) islands close to larger islands are visited by bears seeking seasonal berry crops or food in intertidal areas. The brown bear is the only large omnivore on the ABC islands; the wolf (*Canis lupus*) and black bear (*Ursus americanus*) occur primarily on the southern islands south of Frederick Sound and the mainland. In addition, brown bears appear to be regularly dispersed between the mainland coast near

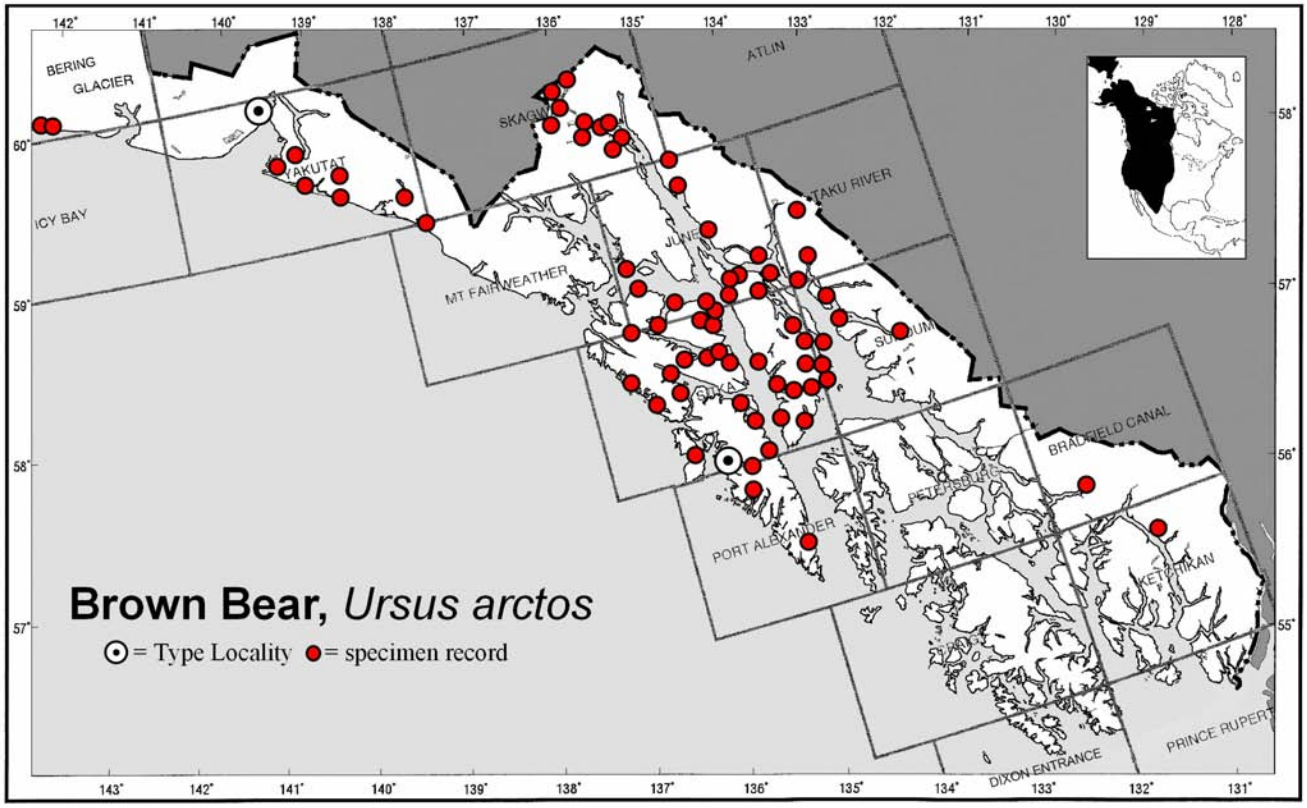


FIG 2.Range map showing the specimen records for brown bears throughout Southeastern Alaska (from MacDonald and Cook in press). Note the distribution is broader than the specimen records indicate.

the Stikine River Delta and the islands of central Southeast, including Wrangell, Mitkof, Etolin, and Deer islands (R. Lowell, Alaska Department of Fish and Game [ADF&G], Petersburg, AK, personal communication 2004). Brown bears are also widely distributed throughout the mainland coast (Fig 4) from the Canadian Border to Yakutat Bay, particularly in the vicinity of the large transboundary river drainages.

Abundance

The highest-density (~1 bear/mi^2 [400/1,000 km^2]) populations of brown bear in Southeast occur on the northern ABC islands (Schoen and Beier 1990, Whitman 2003). Replicated capture-mark-resight (CMR) studies to determine brown bear densities have been conducted on northern Admiralty and northeastern Chichagof islands (Schoen and Beier 1990, Titus and Beier 1993, Miller et al. 1997). Two Admiralty Island CMR density estimates ranged from 1.0 bear/mi^2 to 1.1 bears/mi^2 (400 bears/1,000 km^2 to 440 bears/1,000 km^2), and the Chichagof estimate was 0.8 bears/mi^2 (318/1,000 km^2). These measured brown bear densities are among the highest in the world. Elsewhere in Alaska, brown bear densities (measured by CMR) ranged from 0.03 bears/mi^2 (10/1,000 km^2) in the Alaska Range to 1.5 bears/mi^2 (551/1,000 km^2) in the Katmai region of the Alaska Peninsula (Miller et al. 1997).

Brown bear densities have been measured with standardized techniques in only 2 regions of Southeast. In collaboration with area biologists from the ADF&G, Miller (1993) extrapolated from these estimates to obtain relative brown bear numbers for game management units (GMUs) throughout the state. The Southeast region (GMU 1-5), from the Canadian Border to Yakutat was estimated to have from 5,251 to 6,986 brown bears in 1993 (Miller 1993). In Southeast, the brown bear population along the mainland coast (GMU 1), from the Canadian border to Haines in Upper Lynn Canal, was estimated to be 1,042 bears (ranging from 791 to 1,293). The highest densities were estimated to occur in the upper Lynn Canal and Chilkat River Valley with the lowest density in the vicinity of Glacier Bay. Porter (2003) considered the mainland population to be relatively stable. North of Glacier Bay National Park to Yakutat Bay (GMU 5a) had the highest mainland densities of brown bears, with an estimated population of 522 bears (Miller 1993). Barten (2003) considered the Yakutat population to be relatively stable.

The ADF&G (2000) estimated the brown bear

FIG 3. Pybus Bay on southern Admiralty Island. This watershed has several abundant salmon spawning streams and provides a diversity of high-quality bear habitats, including estuaries, old-growth riparian forests, avalanche slopes, and subalpine meadows. The mix of productive seasonal habitats on the ABC Islands (Admiralty, Baranof, and Chichagof) supports some of the highest density brown bear populations in the world.

FIG 4. Harding River on Bradfield Canal along the southern mainland coast. In general, brown bear populations along the mainland coast occur at lower densities than the ABC islands. However, some major river systems support productive populations of both brown and black bears.

population of GMU 4 (ABC islands) to be approximately 4,200 bears. This estimate was within 100 bears of the estimates by Miller (1993) and Whitman (2003). Whitman (2003) estimated 1,560, 1,550, and 1,045 bears on Admiralty, Chichagof, and Baranof islands, respectively. Both biologists estimated that the highest densities occur on Admiralty Island, Chichagof, and Baranof islands (in descending order).

Taxonomic Considerations

Recent genetic analyses of brown bears from the ABC islands have revealed new and remarkable insights into the biological diversity and geological history of Southeast. By using mitochondrial DNA analysis, Talbot and Shields (1996a, 1996b) determined that the brown bears of the ABC islands represent an ancient and unique lineage that apparently separated from other brown bear populations approximately 550,000 to 700,000 years ago. The data from 3 genes indicate that the mitochondrial DNA of the ABC island brown bears appears to be most closely related to polar bears (Talbot and Shields 1996b), which probably diverged from the same ancient brown bear lineage about 300,000 years ago (Kurten 1968). The antiquity of ABC bears also supports the theory that portions of Alexander Archipelago in Southeast composed a nonglaciated refugium during the Wisconsin glaciation (Heaton et al. 1996, Talbot and Shields 1996b). Klein (1965) earlier postulated that Southeast was completely overridden by ice during the Wisconsin glaciation and that brown bears colonized the islands from the north after the ice receded 10,000 years ago. However, recent remains of brown bears from caves on Prince of Wales Island have been radiocarbon dated from 10,000 to 35,000 years

FIG 5. Brown bears on the ABC Islands are genetically distinct from other Alaska populations and represent a very ancient lineage of brown bears. The Admiralty Island population of brown bear includes a high proportion of very dark bears like this black-colored bear at Pack Creek.

(Heaton et al. 1996). This paleontological and genetic evidence strongly supports the existence of a glacial refugium in Southeast.

In addition, recent nuclear DNA analyses that used microsatellites to study ABC bears indicated that the bears of Baranof and Chichagof represent a genetic population distinct from the population on Admiralty (Paetkau et al. 1998). Although Paetkau et al. (1998) suggested that male dispersal between the islands and mainland may have occurred, the level of genetic isolation and uniqueness of the ABC islands, based on mitochondrial DNA evidence, warrant further examination (S. Talbot, U.S. Geological Survey, Alaska Science Center, Anchorage, AK, personal communication 2004). Clearly, the brown bears of Admiralty, Baranof, Chichagof, and adjacent islands represent an important component of the biodiversity of Southeast and may provide key information about the biogeographic history of this island ecosystem (Fig 5).

Significance to the Region and Tongass National Forest

Because of their large-area requirements and varied habitat use, brown bears represent an important umbrella species for maintaining ecosystem integrity throughout their range in Southeast. The coastal brown bear may also be considered a keystone species because of its role in transferring marine nutrients into the terrestrial environment. And because of its vulnerability to cumulative human activities, the brown bear serves as an indicator of wildland values. These attributes justify identifying brown bear as a focal species for ecosystem management throughout its range in Southeast and the Tongass National Forest.

Brown bears have been a species of high human interest throughout Southeast for centuries. Bears are deeply embedded within the culture of the Tlingit and Haida people of Southeast. In fact, the Tlingit people of Admiralty Island call their island “Kootznoowoo,” which means “fortress of the bear” (Fig 6). Throughout much of the late nineteenth and twentieth centuries, brown bears in Southeast, particularly Admiralty Island bears, attracted big game hunters from all over the world. Today, Southeast brown bears continue to attract big game hunters as well as increasing numbers of wildlife enthusiasts who want to observe bears in their natural habitat.

During the last 100 years, brown bear conservation in Southeast has been highly controversial. Although President Theodore Roosevelt recommended in 1901 that the ABC islands become a bear preserve, many local people in Southeast advocated for the extermination of brown bears because they were dangerous and an obstacle to developing the region’s resources. Following the death of Forest Service employee Jack Thayer from a brown bear attack on Admiralty Island in 1929, The Daily Alaska

FIG 6. Kootznahoo Inlet and the Tlingit village of Angoon on Admiralty Island. The Tlingit people have lived with brown bears in Southeast for centuries and bears play a prominent role in their culture. The Tlingit name for Admiralty Island is "Kootznoowoo" which translated means "fortress of the bear."

Empire wrote (19 Oct 1929): "The brown bears in the First Division ought to be exterminated—and the extermination work ought to begin at once."

In 1930, after visiting Admiralty Island and bear guide Allen Hasselborg, John Holzworth wrote and published The Wild Grizzlies of Alaska. In his book, Holzworth wrote passionately about the brown bear and stated: "I believe he should be appreciated and protected against extermination." This book began a national movement for bear protection in Southeast and particularly on Admiralty Island. The first plan for the management of brown bears on Admiralty Island was prepared by the Alaska Game Commission and National Forest Service in 1932 (Heintzleman and Terhune 1934). For many years afterward, bear conservation was assured. The controversy over brown bear management erupted again when the U.S. Forest Service (USFS) established several 50-year timber contracts in the Tongass in the 1950s and the demand for timber increased. Major logging began on Admiralty Island in the 1960s. After this initial logging another large contract was planned for Admiralty Island and, in reaction, a lawsuit was filed in 1970 and was followed by appeals that stretched over many years. Once again, Admiralty's brown bears were at the center of the controversy. In 1978, President Jimmy Carter declared Admiralty Island a National Monument under the Antiquities Act. In 1980, much of Admiralty Island was designated by Congress, under the Alaska National Interest Lands Conservation Act (ANILCA), as the Kootznoowoo Wilderness.

Bear Hunting

Brown bear hunting remains an important and highly valued recreational activity in Southeast and particularly on the ABC islands. The average annual harvest of brown bears for all of Southeast, including GMUs 1, 4, and 5, is approximately 210 bears (~4% of estimated minimum population), of which about 80% is by nonresidents. Nonresidents are required to engage licensed big game guides to hunt brown bears in Alaska. Average trip-related expenditures for resident and nonresident brown bear hunting in Alaska during 1991 were $1,247 and $10,677, respectively (Miller et al. 1998). The ABC islands (GMU 4) support the highest bear harvest in Southeast and rank the third highest in the state behind Kodiak and the Alaska Peninsula. From 1997 through 2000, the average annual harvest in the ABC islands was 152 (Whitman 2003). Admiralty and Chichagof islands each account for about 40% of the brown bear harvest, and Baranof Island adds another 20%. The mainland coast of Southeast (GMU 1) has an annual harvest of about 28 bears, with about half coming from GMU 1D near Haines (Porter 2003). The Yakutat area (GMU 5) has an annual brown bear harvest of 33 bears (Barten 2003). Throughout much of Southeast, brown bear hunting is by registration permit and hunting is limited to 1 bear per person every 4 regulatory years. For the ABC islands, about 600 permits are issued annually. The overall

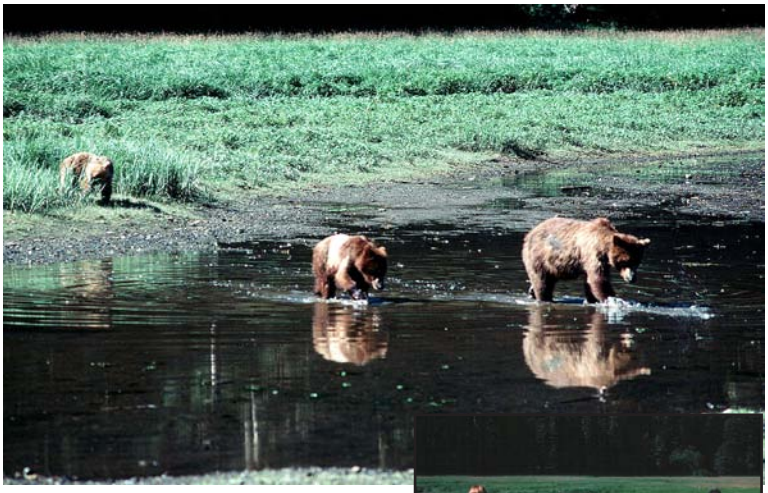


FIG 7. Pack Creek Bear Viewing Area-Stan Price State Game Sanctuary on the east side of Admiralty Island in upper Seymour Canal. Pack Creek is one of the most popular bear viewing sites in Alaska. It is operated cooperatively by the Forest Service and the Alaska Department of Fish and Game. Viewers have the option of watching bears from the spit at the mouth of the creek or hiking a trail upstream to a viewing platform. The 2 watersheds north (Swan Cove) and south (Windfall Harbor) are also included in the area closed to brown bear hunting. Insets include a bear family group in the Pack Creek estuary photographed from the viewing spit and bear viewers on the viewing spit.

management goal is to maintain human-caused mortality of brown bears at sustainable levels at or below 4% of the estimated population level (ADF&G 1998). This goal is being achieved for all areas of Southeast.

Bear Viewing

Interest in brown bear viewing in Southeast has a long history associated with the first hunting closures established on Admiralty Island at Pack Creek and Thayer Mountain in 1934 (Howe 1996). The Pack Creek Bear Viewing Area-Stan Price State Game Sanctuary on Admiralty Island is one of the most popular and well-known areas for brown bear viewing in the state (Fig 7). Public use of this area increased steadily from 668 people in 1988, when a permit system was established, to 1,366 people in 2001 (ADF&G 1998, Whitman 2003). Pack Creek is managed cooperatively by the USFS and ADF&G under a registration permit ($50 permit fee/visitor) with access limited to 24 people per day split equally between the general public and individuals traveling with outfitters and guides (ADF&G 1998). Additional viewing areas in Southeast include the Salt Lake-Mitchell Bay Closed Area on Admiralty Island, Port Althorp Closed Area on northern Chichagof Island, Anan Creek Wildlife Viewing Area on the mainland south of Wrangell, Fish Creek Bear Viewing Area near Hyder, and Chilkoot River State Recreation Site near Haines. The latter 3 sites offer viewing of both black and brown bears. According to Miller et al. (1998), the public interest in viewing concentrations of brown bears exceeded interest in viewing all other wildlife, with the average willingness of Alaska voters to pay $485 for a day trip to see brown bears. For Alaskan voters surveyed by Miller et al. (1998), the highest total benefits from wildlife viewing trips occurred where bears were seen. Clearly, bear viewing is a growing and economically valuable activity throughout Southeast.

Special Management or Conservation Designations

The brown bear is identified as a Management Indicator Species (MIS) under the USFS 1997 Tongass National Forest Land and Resource Management Plan (TLMP) (USFS 1997a). MIS are selected by the USFS for emphasis in planning and

FIG 8. Conceptual sketch of seasonal bear movements in the ABC Islands of Southeast.

Illustration by Richard Carstensen

THE ANNUAL CYCLE OF A SOUTHEAST BROWN BEAR

1. DEN EMERGENCE
From late-March through May most bears emerge form their their high-country dens. Males leave earliest and females with newborn cubs latest.

2. SPRING FORAGING
Bears generally move down from den areas in search of new succulent vegetation including sedges, skunk cabbage, roots, or animal carcasses. South facing avalanche slopes, fens, wet forests, and beaches are commonly used habitats.

3.EARLY SUMMER TRAVELS
From mid-May through mid-July, many bears are actively engaged in breeding and individuals are widely distributed from sea level to alpine ridges. Some bears continue to use tidal sedge flats for grazing while others travel and graze extensively in lush subalpine meadows. Upland forests and avalanche slopes are also used extensively.

4.SALMON SPAWNING
By mid-July, most bears concentrate their activities in riparian forests and tidal estuaries in search of good fishing sites to feast on salmon. Small, shallow streams are the most efficient fishing sites and bears spend much of their time fishing, resting within the cover of riparian forests within 500 ft (152 m) of salmon streams. Dominant bears always get the best fishing sites. Sedges and berries also remain important food items at this time.

5. END OF THE FISH RUNS
As most fish runs wind down by mid-September, many bears begin moving into the upper forest and onto avalanche slopes where they feed on currants and devil's club berries.

6. FALL DENNING
By mid-October, pregnant females begin entering their winter dens. Most dens occur on steep slopes above 1,000 ft (305 m). Dens are often excavated under the root structure of large old-growth trees. In some areas, natural rock caves are also used. Males are the last to enter winter dens.

FIG 9. A brown bear in spring moving down from its high-elevation winter den site on northern Admiralty Island. Males are the first to depart their dens in late March through April. Females with newborn cubs are the last to emerge from dens usually between May and early June.

FIG 10. Coastal sedge meadow on northwestern Baranof Island. Following den emergence in the early spring, many bears move to coastal beaches where they feed on new growth of sedges along the upper tidal zone (note the shorter, light green sedge in the foreground between the taller, blue-green beach rye). Brown bears can often be observed grazing on sedge flats near dusk during May and June in Southeast. Canada geese also feed on sedges sharing this habitat with bears during spring.

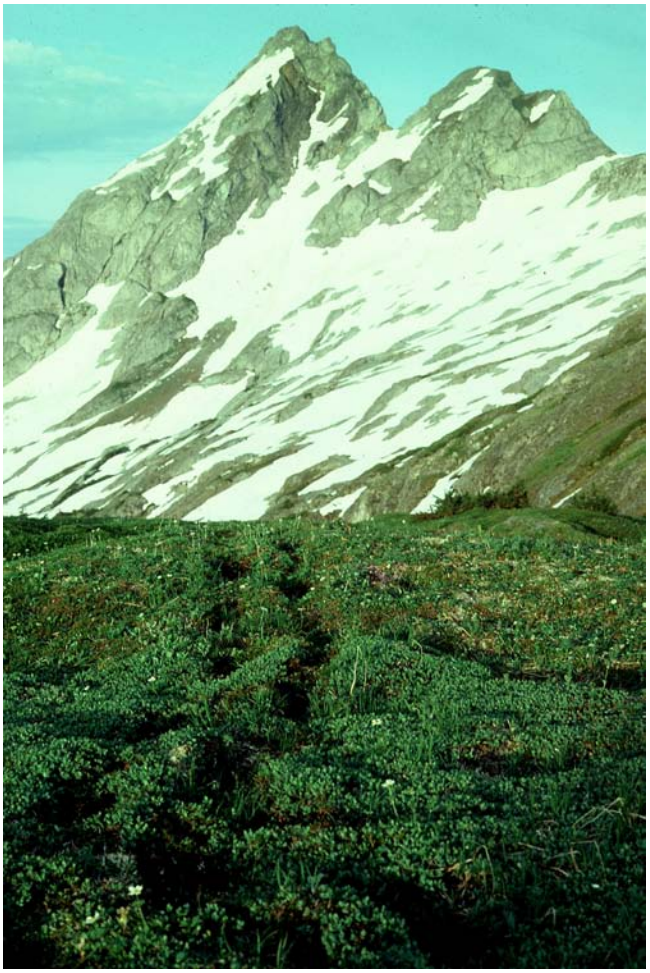
are monitored during forest plan implementation to assess the effects of management activities on their populations and the populations of other species with similar habitat needs that the MIS may represent (USFS 1997a). The brown bear is also 1 of 6 Southeast species identified by the USFS (1997a) as having special management concerns. To many people, both in Alaska and the lower 48 states, Alaska brown bears represent a symbol of wilderness and ecosystem integrity. If forest management activities (such as timber harvest or road construction) reduce the carrying capacity of brown bear habitat in the Tongass Forest, both hunting and viewing opportunities could potentially decrease. In the lower 48, brown bear populations are listed as threatened under the Endangered Species Act and are being recovered at great expense and effort. Alaska has the opportunity and responsibility to avoid the mistakes that led to this situation in the Western United States.

HABITAT RELATIONSHIPS

Brown bears travel extensively and use a variety of habitats throughout their range. The average sizes of annual home ranges for radio-collared bears on Admiralty Island were 39 mi^2 (100 km^2) and 14 mi^2 (37 km^2) for males and females, respectively (Schoen and Beier 1990), and were comparable to home ranges of radio-collared bears on Chichagof Island (Titus et al. 1999). These home range areas are much smaller than those found in interior portions of North America (Schwartz et al. 2003), presumably because coastal resources are more concentrated. Seasonal habitat use often varies widely among individuals of both sexes (Titus et al. 1999). These seasonal habitat preferences are affected by changing food quality and abundance (Fig 8).

Because bears are large bodied, are relatively inefficient at digesting low-quality forage, and remain dormant for approximately half the year, they must concentrate their foraging activity on abundant, high-quality foods. Bears have adapted to periods of food

FIG 11. Heavily used bear trail on an alpine ridge top on Chichagof Island during early summer. Many brown bears make extensive use of subalpine and alpine habitats during this time of the year and deeply rutted bear trails are often observed along alpine ridge tops.



scarcity by seeking secluded refuge in a dormant state in winter dens. Winter denning enables bears to reduce their high metabolic costs of activity and draw upon their accumulated fat reserves until high-quality food again becomes abundant. A den also provides a secure place for a pregnant female to give birth to 1 to 4 tiny cubs usually in January. In Southeast, some bears may only be active for 5 to 8 months of the year. With such a short time to replenish their fat and body reserves, bears must concentrate their food gathering on the most nutritionally productive habitats. Bears are intelligent and long-lived, and learn from their mothers during an extended maternal care period of 2 to 3 years. These attributes and their extraordinary sense of smell make bears highly adaptable for finding and exploiting the most nutritious food resources available throughout their annual home ranges.

Spring: Den Emergence Through Sea-Level Green-up (late March–15 May)

Most brown bears in Southeast emerge from high-elevation dens (mean= 2,100 ft [640 m]) during April and May (Schoen et al. 1987) (Fig 9). Males are the first to depart their winter dens (around mid-April), followed by single females, and lastly females with their newborn cubs (mid-May). Following emergence, many bears begin moving to lower elevations. During spring, brown bears are generally widely scattered from sea level, where they forage on tidal sedge flats, to south-facing avalanche slopes and higher subalpine ridges. The mean elevation of radio-collared brown bears on Admiralty and Chichagof islands during spring was above 1,000 ft (305 m) (Schoen and Beier 1990). Upland old-growth forests and avalanche slopes were the habitats most extensively used by radio-collared brown bears on Admiralty and Chichagof islands during spring (Schoen and Beier 1990, Titus and Beier 1994). In both studies, female brown bears were more widely distributed than males, perhaps to avoid dangerous interactions and risks of infanticide, as suggested by Wieglus and Bunnel (1995). During spring, brown bear diets on Admiralty Island are composed largely of sedges (*Carex spp.*), other green vegetation, and roots (McCarthy 1989) (Fig 10). Skunk cabbage roots (*Lysichiton americanum*) and horsetail (*Equisetum*

FIG 12. During late summer, most bears on Admiralty and Chichagof islands spend more than half their time feeding and resting in old-growth riparian forests. This riparian forest on Admiralty Island was used extensively by bears fishing for salmon and feeding on berries. Riparian forests provide important bear habitat during late summer and fall and these sites are often characterized by an extensive network of bear trails and mark trees.

FIG 13. Pacific salmon are a critical food resource for Alaska's coastal brown bear populations. All 5 species are used wherever they are accessible to bears. Clear, shallow streams increase fishing success for bears over deep, fast flowing, glacial streams. Individual bears display many different fishing techniques. Bears are highly selective of fresh salmon and specific fish parts such as eggs and brains which have the highest nutritional value.

spp.) are particularly important spring forage plants. The primary animal components of the spring diet of Admiralty Island bears are deer (*Odocoileus hemionus*), voles (*Microtus spp.*), and herring (*Clupea pallasii*) roe (McCarthy 1989).

Early Summer: Green-up to Beginning of Salmon Runs (16 May–15 July)

By mid-May, most bears have emerged from their winter dens. Early summer is the peak of the breeding season in Southeast, and courting pairs are often observed in coastal sedge meadows and on upper subalpine and alpine ridges. During early summer, bears are widely distributed and habitat use varies greatly. By mid-June, many radio-collared bears on Admiralty and Chichagof islands were observed at higher elevations where they foraged on the new growth of succulent plants in alpine and subalpine meadows and avalanche slopes (Schoen and Beier 1990, Titus et al. 1999) (Fig 11). Old-growth forest habitat is used substantially by bears throughout this season both for feeding and travel between coastal and alpine habitats. During early summer, brown bear diets on Admiralty Island are dominated by sedges, other green vegetation, and roots (McCarthy 1989).

Late Summer: Primary Salmon Spawning (16 July–15 September)

By mid-July, most brown bears in Southeast have moved to low-elevation coastal salmon streams (Schoen and Beier 1990, Titus and Beier 1999). During this period, riparian old-growth forest represented from 40–55% of the habitat use of radio-collared bears on Admiralty and Chichagof islands, and 66% of all Admiralty Island bear locations

FIG 14. Spawning chum salmon. Chum and pink salmon are widely distributed throughout streams in southeast and are used extensively by brown bears. Silver salmon are also widely distributed. Red salmon have a much more limited distribution and often spawn in association with lakes. King salmon are the least common species in Southeast occurring primarily in big mainland river systems. The timing of the spawning run and occurrence of species varies by stream and bears visit specific streams when fish are spawning. Bears are generally more successful fishing in smaller streams where fishing is easier than larger, deeper streams.

FIG 15. A pair of sibling brown bears in a riparian forest along the Kadashan River on Chichagof Island. Protection of the region's salmon runs and riparian forest habitat adjacent to salmon streams is fundamental to the conservation of brown bears in Southeast.

occurred within a 525-ft (160-m) band on either side of salmon streams (Schoen and Beier 1990) (Fig 12). Likewise, during August on Chichagof Island, 60% of radio-collared bear locations were within a 3,200-ft (1,000-m) buffer around fish streams and 36% were within a 500-ft (153-m) buffer (Titus and Beier 1999).

During late summer and early fall, salmon make up a major portion of the brown bear diet, although sedges, skunk cabbage, and the berries of devil's club and blueberry (*Vaccinium spp.*) are also used (McCarthy 1989). Salmon, skunk cabbage, and devil's club are all found in abundance in low-elevation riparian sites in Southeast; blueberry shrubs are more scattered throughout the forest; and coastal sedges occur most abundantly in association with tidal wetlands. During late summer, brown bears are more concentrated than at any other time of the year and their activities are most focused on fishing for spawning salmon along low-elevation fish streams (Fig 13).

During late summer and early fall, bears consume large quantities of fish to rebuild their body condition and lay on essential fat reserves required to successfully reproduce and survive another 4 to 7 months in winter dens. Brown bears can increase their body mass over the summer and fall by as much as 50% when salmon are abundant (Hilderbrand et al. 1999a). On the Kenai Peninsula of Alaska, Hilderbrand et al. (1999a) estimated that individual female brown bears consumed 23.8 lb/day (10.8 kg/day) and 2,207 lb/season (1,003 kg/season) of salmon during the summer and fall.

Not only do bears utilize habitats throughout the summer that maximize their energy intake, but they also behave in a manner that maximizes energy intake while feeding on salmon (Fig 14). These feats are accomplished by two foraging tactics. First, when streams are shallow and salmon abundant, bears will selectively capture spawning salmon that are highest in energy content (Gende et al. 2004a). Salmon do not feed after they enter the freshwater systems, using stores of protein and fat to fuel metabolic and spawning activities. Therefore, the stores of fat and protein found in salmon decrease almost linearly with the number of days that the fish are in the streams (Gende et al. 2004b). Gende et al. (2004b) demonstrated that salmon will lose almost 90% of their stores of fat and nearly 50% of their stores of protein during just 10 days from the time fish enter the streams until they die naturally (senescent death).

FIG 16. Devil's club berries grow abundantly in riparian forests and avalanche slopes and are used extensively by bears during late summer and fall.

Concurrent with this decrease in energy are increases in scars and skin fungus and a concomitant loss of skin pigmentation. Bears can visually differentiate between salmon that have been in the stream for some time (lower energy) and salmon that have just entered the stream (higher energy). In addition, female salmon allocate much of their fat reserves to producing energy-rich eggs. The eggs of a fully mature (ripe) female salmon constitute nearly 20% of her body mass, but because the eggs are very high in fat density, the eggs constitute nearly 50% of the total fat found in female salmon. Consequently, a bear that captures a female salmon that has already spawned her eggs receives a meal that is far less nutritious than if it captured a female salmon that has yet to spawn.

By utilizing daily surveys of fish killed in streams and directly observing bears from tree stands, Gende et al. (2004a, 2004b) and Gende and Quinn (2004) found that bears preferentially kill male and female salmon that have just entered the stream, thereby maximizing their energy intake while fishing for salmon. Not only were bears observed preferentially attacking salmon that had just entered the stream, but they were also observed capturing and releasing "older" fish—those that had been in the stream for some time and had less energy. Bears were also observed frequently carrying captured fish to the stream bank and sniffing the anal area or stepping on the fish to see if eggs were extruded. Fish that were not ripe were almost always abandoned, and the bears returned to the stream to capture other fish.

The other way that bears maximize energy intake is by preferentially consuming the body parts of salmon that are highest in energy density (Gende et al. 2001). Some body parts of salmon, particularly the eggs, skin, and brain, have much higher energy density than other parts (such as the muscle, gills, and fins). In an analysis of more than 20,000 salmon carcasses across many streams, Gende et al. (2001) found that bears preferentially consumed these high-energy body parts when salmon abundance was high. The findings demonstrate that brown bears preferentially kill high-energy salmon and partially consume the highest-energy body parts, thereby maximizing energy intake while feeding on salmon.

The additive costs of hibernation, gestation, and lactation put great energetic demands on female bears in general (Watts and Jonkel 1988, Farley and Robbins 1995), and reproductive success is strongly correlated to fall body weight in black, polar, and brown bears (Rogers 1976, Schwartz and Franzmann 1991, Atkinson and Ramsay 1995, Hilderbrand et al. 1999b). The availability of spawning salmon as a food resource in late summer and fall positively affects body size, reproductive success, and population density of brown bears and represents a major influence on bear habitat quality (Hilderbrand et al. 1999b). The Alaska population densities of coastal brown bears, where salmon are abundant, are significantly higher (up to 80 times) than those

FIG 17. A female brown bear and 2 yearling cubs in a subalpine meadow on northern Admiralty Island. Subalpine meadows provide important foraging habitats for bears in early summer and a small number of female bears on Admiralty Island do not use fish streams but continue to use interior habitats, including subalpine and avalanche slopes, throughout the summer.

of interior bears without salmon (Miller et al. 1997). Riparian forest habitat in association with productive salmon spawning streams is considered seasonally critical habitat and a key component for ensuring productive brown bear populations in Southeast (Schoen and Beier 1990, Titus and Beier 1999, Titus et al. 1999) (Fig 15).

During late summer and fall, bears also forage extensively on berries, including devil's club, blueberry, currant, salmonberry (*Rubus spectabilis*), and twisted stalk (*Streptopus spp.*) (McCarthy 1989, Willson and Gende in press) (Fig 16). Willson and Gende (in press) describe brown bears as important agents of seed dispersal.

Although salmon streams provide highly valuable feeding habitat in Southeast, not all brown bears use salmon streams. On Admiralty Island, some females (14% of radio-collared bears) and their offspring remained in interior areas of the island at higher elevations (Schoen et al. 1986) (Fig 17). This subpopulation of "interior" bears did not utilize salmon (Hilderbrand et al. 1996, Ben-David et al. 2004). Female brown bears that remained at higher elevations foraged on sedges, grasses, and other green vegetation, and also consumed deer and voles (McCarthy 1989). On Admiralty and Chichagof islands, the distribution of radio-collared females with cubs of the year was farther from salmon streams during the spawning season than for males or females without young (Ben-David et al. 2004). Females that avoided salmon streams also weighed less than females that had access to salmon (Ben-David et al. 2004). Presumably, the reproductive potential of female bears that avoid feeding on salmon is lower than those using salmon (Bunnell and Tait 1981; Hilderbrand et al. 1999a, 1999b). However, data from this study (Ben-David et al. 2004) were insufficient to measure a difference. It is likely that a degree of avoidance of salmon streams by females with young cubs is a tradeoff between reducing risks of cub mortality in high bear densities around fish streams and acquiring higher-quality food (Weilgus and Bunnell 1995, 2000; Ben-David et al. 2004).

Similarly, Gende and Quinn (2004) found that feeding and intake of brown bears on northeast Chichagof Island were strongly related to social dominance. Larger, more-dominant bears visited the stream more often, spent longer time on the stream foraging, and had higher daily energy intake than did subordinate bears. Subordinate bears avoided the larger dominant bears and hastily captured or scavenged fish. Therefore, intake rates at salmon streams may be regulated, in part, by density-dependent processes (Gende and Quinn 2004).

Fall: Decline in Fish Runs to Denning (16 September–mid December)

By mid-September, many salmon runs are in decline, herbaceous vegetation has gone to seed, and peak berry production at sea level is over. Most brown bears begin to move away from coastal salmon

FIG 18. Avalanche slopes (shown here on northern Admiralty Island) are used extensively by brown bears during spring, early summer, and fall. Bears often use south facing avalanche slope in early spring for feeding on roots and the new growth of succulent vegetation when snow begins to melt.

FIG 19. When salmon runs decline in the fall, many bears move up to avalanche slope to forage on currants and devil's club berries.

streams during September and head toward higher elevations. Upland old growth and avalanche slopes were the habitat types most used by radio-collared brown bears during fall on Admiralty and Chichagof islands (Schoen and Beier 1990, Titus et al. 1999). During this time, it is important for bears to pack on the fat in preparation for their long winter dormancy. Some bears, particularly males, may continue to fish for salmon into November on streams with late runs. However, most bears move into higher elevation avalanche slopes where they forage on berries, particularly devil's club and stink currants (McCarthy 1989) (Fig 18, 19). Other plants used include skunk cabbage, sedges, red elderberry *(Sambucus racemosa),* and roots of beach lovage *(Ligusticum scoticum).*

By early October, the first winter snowfall usually occurs in the high country and herbaceous forage is no longer available after the first frosts. Winter denning begins in October and November. The mean date of den entry for radio-collared bears on Admiralty and Chichagof islands from 1981–1986 was 30 October (Schoen et al. 1987). Pregnant females are the first to enter winter dens; females with older cubs and single females den later; and males are the last to seek out winter den sites. By mid-November, about 80% of males and 95% of female brown bears have entered dens and begun their winter dormancy. On Admiralty and Chichagof islands, brown bears prefer den sites on moderate to steep slopes above 985 ft (300 m) (Schoen et al. 1987). Upland old-growth-forest habitat at higher elevations is most commonly used by brown bears, although alpine and subalpine slopes are also used substantially for denning. Dens on Admiralty and Chichagof islands most commonly occurred in natural rock cavities or were excavated under the root structure of old-growth trees or into earthen slopes (Schoen et al. 1987) (Fig 20, 21). On Admiralty and Chichagof islands, radio-collared male brown bear spent an average of 165 days in winter dens, compared with 211 days for females with newborn cubs (Schoen et al. 1987).

Habitat Capability Model

To evaluate brown bear habitat values within watersheds and compare watershed values within biogeographic provinces for this assessment, a brown bear habitat capability model (Schoen et al. 1994) was used as revised by an interagency team of biologists. This model was also used in the 1997 Tongass Land Management Plan. Habitat values were rated, using habitat-preference data from Schoen and Beier (1990), on the basis of their value to bears during late summer. During this time, bears are most concentrated. They are feeding on salmon to build up fat reserves for denning and are vulnerable to

FIG 20. A recently used brown bear den under an old-growth Sitka spruce tree near the upper tree line on northern Admiralty Island. Many bears excavate dens under the root structure of large old-growth trees.

FIG 21. A natural cave den on a steep alpine slope on northern Admiralty Island. Natural rock caves are commonly used den sites for bears on Admiralty. Some of these dens have likely been used by bears for centuries although bears seldom use the same den twice.

human activities in the low-elevation coastal riparian zones. In particular, the late summer season, when most bears concentrate to feed on spawning salmon, is considered critical for brown bears in Southeast.

The model was designed to evaluate habitat capability on a landscape scale based on habitat characteristics and proximity to human activity. Habitat types specified in the model include riparian forest, beach-fringe forest, upland forest, clearcut or second-growth, subalpine forest, avalanche slopes, alpine tundra, and estuary. Riparian forests were identified with a landscape-based model and further subdivided by presence or absence of anadromous fish. Additional model details (including habitat coefficients) and results are presented in Chapter 2. Brown bear habitat values of watersheds are ranked within each biogeographic province and presented in a watershed matrix for Southeast (Appendix B).

FOREST ECOLOGY AND MANAGEMENT

Ecosystem Consequences of Bear-Salmon Relationships

Brown bears have the ability to capture many spawning salmon, as indicated by predation rates at many streams in Southeast and Southwest Alaska (Quinn et al. 2003). As mentioned earlier, bears often carry the captured salmon to the riparian forest where they are only partially consumed. This sequence, capture-carry-partial consumption, represents an important process for the riparian ecosystem in Southeast because it makes a tremendous amount of salmon-derived nutrients and energy available to riparian biota (Gende et al. 2002). For example, salmon, which are rich in nutrients and energy, can represent an import food source for scavengers that feed on carcasses abandoned by bears in the riparian area. Insects, birds, mammals, and many other species use these carcasses (Cederholm et al. 2000, Gende et al. 2002, Schindler et al. 2003). The nutrients from carcasses and bear scat also leach into the forest soil and are taken up by riparian plants, including trees (Ben-David et al. 1998, Hilderbrand et al. 1999c). Growth rates of plant have also been correlated with the amounts of salmon-derived nitrogen available to them, particularly in areas where bears typically carry the fish to be consumed (Helfield and Naiman 2001, but see Kirchhoff 2003). The ecological importance of bear-salmon relationships to forest ecosystems is just beginning to be understood. Clearly, the inter-relationships among salmon, bears, large-tree forests, and other myriad organisms are complex and critically important to the integrity of these productive and increasingly rare ecosystems (Fig 22).

FIG 22. Salmon stream, estuary, and riparian forest at the Kadashan River on southeast Chichagof Island. This combination of habitat types and abundant spawning runs of pink, chum, and silver salmon provide an optimal habitat mosaic for brown bears. The Kadashan Watershed ranks as one of the highest brown bear watersheds on Chichagof Island.

Forest Composition and Ownership

Temperate coniferous rainforest covers more than 11 million acres (4.5 million ha) or about half of the land area of Southeast (Hutchison and LaBau 1975, Harris and Farr 1979). The majority of the forested land in Southeast occurs in the Tongass National Forest, which makes up 80% of the Southeast land base (USFS 2003). About two-thirds of the Tongass Forest is forested, although productive old growth encompasses only 5 million acres (2 million ha), or about 30% of the land area of the Tongass (USFS 2003). The USFS (2003) defines productive old growth as "…forest capable of producing at least 20 cubic ft of wood fiber per acre per year." The majority of productive old growth on state and private lands has already been harvested during the last 40 years (USFS 2003).

Old-growth forests are diverse and highly variable in structure. Productive old growth (one-third of the Tongass) is where all commercial logging occurs. And productive old growth below 800 ft (244 m) covers only 18% of the Tongass (USFS 2003). In the most productive stands of old growth, individual trees may be 4–8 ft (1.5–2.5 m) in diameter and more than 200 ft (60 m) in height. These large-tree stands are rare in Southeast, representing only 3% of the Tongass land base (USFS 2003). Stands of riparian spruce forests (Fig 23), largely confined to valley bottom flood plains, sometimes include exceptionally large spruce trees more than 9 ft (2.7 m) in diameter and are very rare, representing less than 1% of the Tongass land base (USFS 2003). For more details about the ecological structure and composition of old growth, see Chapter 5.

Timber Harvest

Clearcutting is the dominant timber harvest method in Southeast (USFS 1997a). Forest succession in Southeast following clearcutting has been described by Harris (1974), Harris and Farr (1974, 1979), Wallmo and Schoen (1980), and Alaback (1982). In general, after logging, herbs, ferns, and shrubs grow abundantly for several years and peak at about 15 to 20 years. At about 20 to 30 years, young conifers begin to overtop shrubs and dominate the second-growth stand. After 35 years, conifers completely dominate second growth, the forest floor is continually shaded, and forbs, shrubs, and lichens largely disappear from second-growth

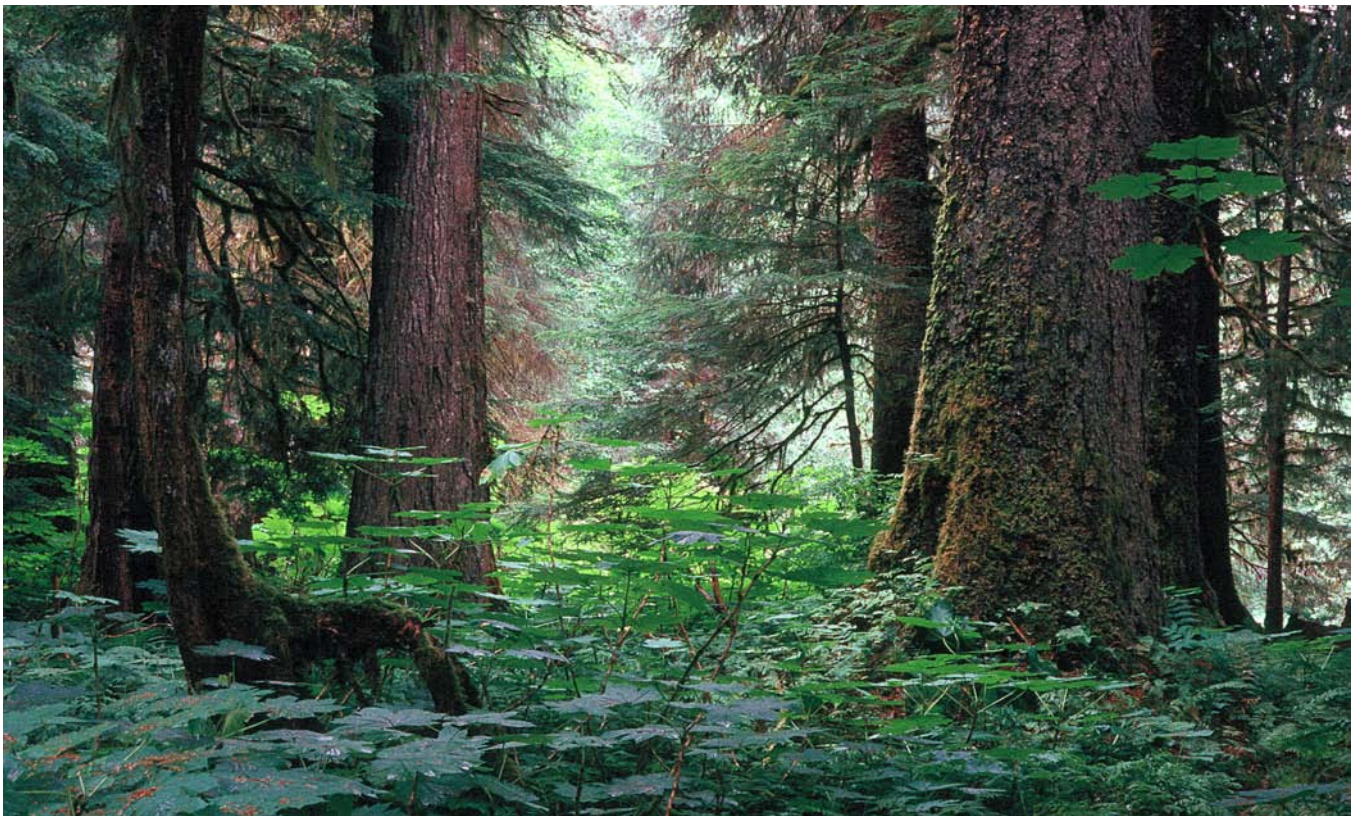


FIG 23. Old-growth riparian forests like this one along the Kadashan River on southeast Chichagof Island provide valuable summer brown bear habitat but are relatively rare throughout Southeast. Some individual spruce trees in these highly productive riparian stands measure from 4 ft to 9 ft (1.5-2.7 m) in diameter. Large-tree, riparian old-growth stands represent less than 1% of the land base of the Tongass National Forest.

stands. The absence of vascular plants under second growth generally persists for more than a century following canopy closure (30–130 yr). Consequently, clearcutting old growth and managing second growth on 100- to 120-year rotations significantly reduces foraging habitat for most wildlife species for 70–80% of the timber rotation (Harris 1974, Wallmo and Schoen 1980, Alaback 1982).

Although riparian large-tree old growth represents a small proportion of the land area in Southeast, these stands have been disproportionately harvested throughout the region (USFS 2003). For example, on southeast Chichagof Island, 21,564 acres (8,727 ha) of old growth have been harvested, representing a decline in old growth of 14% (Shephard et al. 1999). This harvest resulted in a 44% decline in riparian spruce (which represented only 8% of the area) and 250 mi (400 km) of logging roads in valley bottoms.

IMPLICATIONS FOR CONSERVATION

Although brown bears are very adaptable and once ranged widely across the northern hemisphere, they possess many biological characteristics that increase their vulnerability to human interactions and forest management (Schoen 1990). For example, bear traits of high ability to learn, omnivorous diet, and opportunistic behavior have allowed them to exploit a variety of food resources over a wide range of habitats. Because bears have relatively inefficient digestive systems for processing low-quality forage (Bunnell and Hamilton 1983) and are active for only a portion of the year, they must exploit the most valuable feeding areas. This feeding requirement often brings them into contact with humans who are using the same productive lands (such as coastal areas, valley bottoms, and fish streams).

Brown bears are large, occasionally dangerous animals capable of inflicting serious injury or death to humans. This potential danger has shaped human attitudes toward bears and resulted in significant and often unjustified killing of bears by humans. Because brown bears have low reproductive rates (Bunnell and Tait 1981), their populations are particularly vulnerable to increased mortality. Adding still more risk, population declines of brown bears are often difficult to detect in a manner sufficiently timely to take corrective action (Schwartz et al. 2003). Fundamental factors influencing brown bear populations include

FIG 24. Recent clearcuts (brown cuts < 2 yrs, light green cuts < 10 yrs) and a road dominate this valley bottom on southeastern Chichagof Island near Kook Lake. Brown bears tend to avoid young clearcuts. Riparian areas with little or no forest buffers along salmon streams receive less bear use than streams with large forested buffers.

FIG 25. A 60 year-old second-growth forest provides little value as foraging habitat for wildlife, including brown bears. Following timber harvest, it generally takes several centuries for a clearcut to again attain the full ecological characteristics of old growth.

habitat quality, human density, and human behavior and tolerance toward bears (Mattson et al. 1996, McLellan 1998, Apps et al. 2004).

Forest management influences habitat quality for bears and can also increase road development (Schoen 1991). Although old-growth forest habitat is used extensively by brown bears in Southeast, clearcuts were little used by radio-collared bears on Chichagof Island (Schoen et al. 1994, Titus and Beier 1994) (Fig 24). Riparian areas that have been clearcut with little or no buffer along salmon spawning streams receive limited use by brown bears (Schoen et al. 1994, Titus and Beier 1999). And the dense second-growth forests that succeed clearcuts offer poor foraging habitat for bears and other herbivores (Fig 25). Therefore, the conversion of old growth to younger forests will reduce habitat value for brown bears in Southeast and potentially decrease the ecological services (such as transfer of marine nutrients to riparian forests and seed dispersal) that bears provide.

Roads generally result in harmful impacts to large carnivores (Noss et al. 1996, Trombulak and Frissell 1999). The construction of roads into roadless brown bear habitat has been demonstrated by many investigators to have significant adverse impacts on bear populations by increasing human access, which results in displacement of bears or the direct mortality of bears through legal hunting, defense of life or property (DLP) kills, illegal killing, and road kills (McLellan and Shackleton 1989, McLellan 1990, Mattson 1990, Schoen et. al. 1994, Mace et al. 1996, Apps et al. 2004). In Yellowstone Park, brown bears avoided areas within 1,640 ft (500 m) of roads (Mattson et al. 1987). Kasworm and Manley (1990) documented an 80% decline in brown bear habitat use within 0.6 mi (1 km) of roads open to motorized vehicles in Montana. Titus and Beier (1991) demonstrated the strong relationship of road construction to increased bear mortality on northeastern Chichagof Island (Fig 26, 27). Suring and Del Frate (2002) demonstrated

FIG 26. Recent timber harvest and logging roads in the lower Game Creek Watershed on northeast Chichagof Island. The extensive road system in this valley significantly increased human access to interior regions of this valley that, prior to logging, provided a refuge for bears.

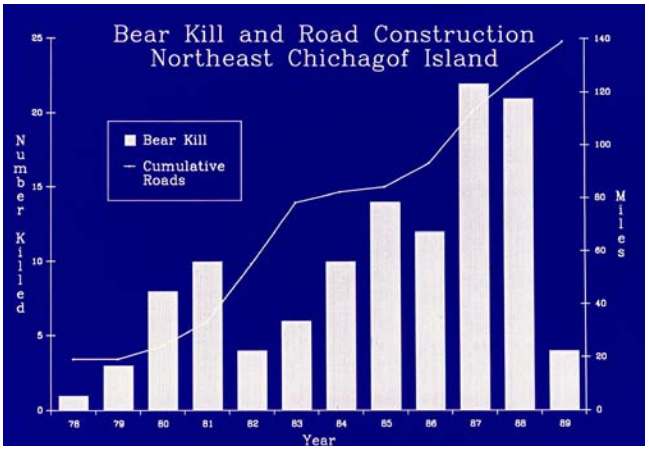


FIG 27. Brown bear kill and road construction on northeast Chichagof Island (from Titus and Beier 1991). Brown bear mortality is strongly correlated with increasing miles of roads. An emergency closure of the hunting season in 1989 reduced the total kill that year. Prior to the significant road network on northwest Chichagof, most of the hunting pressure on brown bears was closer to the coast where access was primarily by boat. Although hunting season restrictions can reduce the number of bears killed, road access also increases the likelihood of bears killed illegally and in defense of life or property.

an increasing probability of brown bears killed in DLP with increasing road density on the Kenai Peninsula. And female brown bears avoided areas on the Kenai Peninsula that were road accessible (Suring et al. in review).

In Southeast, brown bears are most concentrated during late summer (mid-July through mid-September) in riparian forest habitat associated with anadromous spawning streams. Maintaining this important riparian habitat and abundant salmon runs is considered essential for maintaining productive brown bear populations in Southeast (Schoen et al. 1994, Titus and Beier 1999). The maintenance of riparian buffers along anadromous salmon streams is also vitally important for sustaining productive salmon runs (USFS 1995). Although riparian forests make up only a small portion of the land base of Southeast, they have been disproportionately logged (Shephard et al. 1999, USFS 2003).

In 1996 and 1997, the USFS convened a brown bear risk-assessment panel to assess the likelihood that the alternatives in the revision to the TLMP would result in habitat sufficient to support viable and well-distributed brown bear populations across their historical range in the Tongass National Forest. One major finding of the panel was that an undisturbed buffer (no harvest, no roads) along salmon-bearing streams where bears concentrate and feed helps to maintain brown bear habitat. The panel recommended a 500-ft (153-m) buffer along each side of anadromous salmon streams (Swanston et al. 1996). However, the final record of decision for the TLMP (USFS 1997b) established a narrower riparian buffer and left the burden of proof on biologists about whether to apply the broader brown bear buffer "…where based upon the evaluation, additional protective measures are needed…" Titus and Beier (1999) determined that the larger brown bear buffer included 13% more relocations of radio-collared bears than the smaller riparian standard and guidelines buffer. They agreed with the brown bear risk-assessment panel that the larger buffer should be applied across all salmon-spawning streams used by brown bears, rather than in a discretionary manner.

The panel also unanimously agreed that the likelihood of maintaining viable and well-distributed

FIG 28. High-value brown bear habitat in the Admiralty Cove Watershed on northern Admiralty Island. Here, habitat values within the entire watershed, as well as adjacent watersheds, have been permanently protected in the Admiralty Island National Monument and Kootznoowoo Wilderness. Conservation and habitat management for large, wide-ranging animals like brown bears are more appropriately accomplished at the landscape scale—entire watersheds or multiple watersheds—than the scale of individual habitat patches within a watershed.

populations of brown bears declined with increasing acres of forest harvested. The risk assessment panel also identified increasing miles of roads as a negative impact to the conservation of bear populations. More roads equated to increased mortality and gaps in the distribution of bear populations. The panel stressed the importance of maintaining roadless reserves distributed throughout the range of brown bears. In addition, the fish and riparian risk-assessment panel, also convened as part of the process to revise the TLMP, identified roads as a high risk factor for anadromous fish.

The bear panel said that the "first priority" of the USFS should be "to retain currently unroaded watersheds in a roadless condition." The panel also stated: "[W]ithout effective access management, increased roading in brown bear habitat would most likely result in increased brown bear mortality due to legal hunting, illegal killing, and defense of life and property." Further, "[d]epending on the extent of additional roading, these actions could increase the number, size or duration of temporary gaps, and in some cases (e.g., portions of the mainland), cause permanent gaps in distribution of the brown bear population." Based on this conservation assessment, Southeast provinces with the greatest impacts on brown bear habitat were East Chichagof and East Baranof which have lost 34% and 30% of their original habitat value, respectively (refer to chapter 2).

Conservation of brown bears in Southeast depends on maintenance and conservation of key habitats, including important food resources, and management of mortality rates within sustainable levels. Maintaining the productivity of Pacific salmon stocks throughout Southeast is an essential component of conserving brown bear populations. To ensure that brown bear populations are well represented throughout their natural range in Southeast and available for human use and enjoyment, watersheds with a variety of high-value habitat should be identified and protected at the watershed scale within each biogeographic province that supports brown bear populations (Fig 28). Brown bear and the Pacific salmon may serve as important umbrella species for maintaining ecosystem integrity within Southeast and the Tongass National Forest (Fig 29).

FIG 29. With foresight and vision, land and wildlife managers throughout Southeast and the Tongass National Forest have a unique opportunity to safeguard the integrity of Alaska's temperate rainforest ecosystem and conserve productive populations of brown bears, Pacific salmon, and riparian large-tree forests in perpetuity.

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