Sitka black-tailed deer
(Odocoileus hemionus sitkensis)

John Schoen and Matt Kirchhoff

images by John Schoen

The Sitka black-tailed deer—a subspecies of the mule deer—is endemic to and widely distributed along the narrow coastal band of northern British Columbia and Southeastern Alaska (Southeast) (Wallmo 1981). This subspecies occupies the northwestern-most extent of the natural range of mule and black-tailed deer and overlaps the occurrence of the temperate rainforest (Wallmo 1981). Alaska Natives have relied on deer as an important food resource for centuries, and today deer remain the most sought after big game animal throughout much of coastal Southeast. For most Southeast Alaskans, deer are highly valued whether for food or aesthetic enjoyment.

The Sitka black-tailed deer is the most common and widespread large mammal of the Alexander Archipelago in Southeast (Fig 1). These small, sturdy deer average about 120 lb (54 kg) for bucks and 80 lb (36 kg) for does. During summer, deer are widely scattered and commonly observed from sea level to lush subalpine meadows above tree line. As winter snow accumulates in the high country, deer move into the lower-elevation rainforest where they find shelter and food under the forest canopy. Throughout most of Southeast, deer are closely affiliated with old-growth forests (particularly in winter) and have been at the center of public debate over forest management and wildlife conservation for decades (Wallmo and Schoen 1980, Schoen et al. 1988, Hanley 1993a).

FIG 1. Black-tailed buck in velvet. Sitka black-tailed deer are the most abundant and widespread big-game species in southeastern Alaska

STATUS IN SOUTHEASTERN ALASKA

Distribution

Sitka black-tailed deer are naturally distributed throughout most of Southeast south of Berner's Bay and Cape Spencer (MacDonald and Cook 1996, 1999) (Fig 2). Deer were transplanted to islands within Yakutat Bay in 1934, Sullivan Island in Lynn Canal in 1951–54, and near Skagway in 1951–56 (Burris and McKnight 1973). The Skagway transplant failed (MacDonald and Cook 1999), but deer still remain on Sullivan Island and in the Yakutat area (Kirchhoff 2003; N. Barton, Alaska Department of Fish and Game [ADF&G], Juneau, AK, personal communication 2004). Deer from Southeast were also successfully transplanted to the large islands of Prince William Sound in 1916 and the Kodiak Archipelago in 1924–34 (Burris and McNight 1973). In Southeast, deer occur on most islands of the Alexander Archipelago, except offshore islands like Forrester, Hazy, and St. Lazaria, and most islands within Glacier Bay (Klein 1965). Even many small (<200 acres [80 ha]) islands adjacent to larger islands often have transient deer populations.

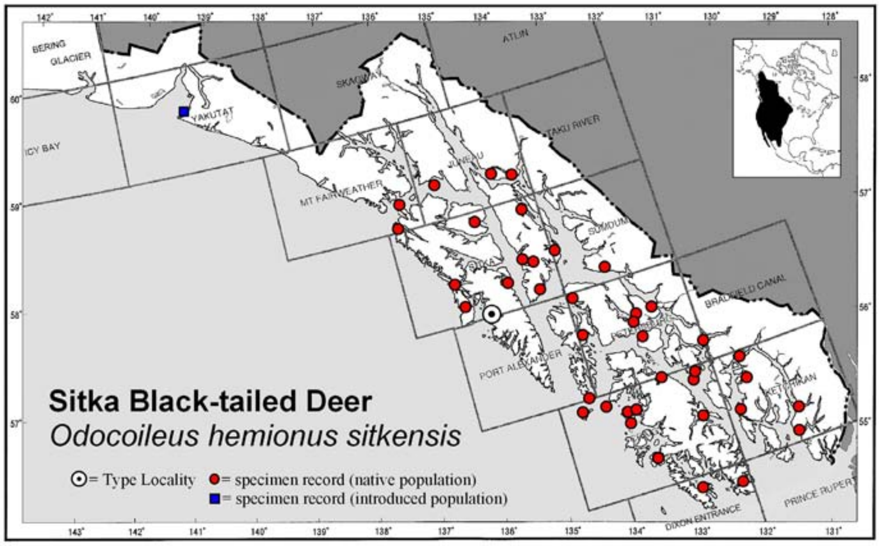

FIG 2. Range map showing the specimen records for Sitka black-tailed deer throughout Southeastern Alaska (from MacDonald and Cook in press). Note the distribution is broader than the specimen records indicate.

Abundance

Deer populations fluctuate dramatically throughout Southeast, largely in response to the severity of winter weather, particularly the depth and duration of winter snow accumulation (Klein and Olson 1960, Olson 1979). Although winter snowpack varies significantly across Southeast, there is a clear trend toward deeper, more prolonged snow in northern and eastern Southeast (Fig 3). The lower elevations along the outer coast, especially in the southern archipelago, are frequently snow free because of the strong influence of warmer maritime weather (Klein 1979). As a result of the more severe winter snow conditions and less productive forest habitat, mainland populations of deer are generally lower than island populations. Deer consistently occur around several mainland areas, however, including the southern Cleveland Peninsula north of Ketchikan, Thomas Bay near Petersburg, Cape Fanshaw, and Juneau.

The major predators of deer in Southeast are wolves (*Canis lupus*), black bears (*Ursus americanus*), and brown bears (*Ursus arctos*), all of which occur throughout the Southeast mainland. Brown bears are also distributed throughout the northern islands of Southeast, including Admiralty, Baranof, Chichagof, and adjacent islands. Brown bears also have recently become established on Kupreanof Island. Although neither wolves nor black bears occur on the northern islands, both species occur on the larger islands south of Frederick Sound (Klein 1965). Deer are the major prey species for island populations of wolves in Southeast (Smith et al. 1987, Kohira 1995, Person 2001). In the southern islands of the archipelago, wolf and black bear predation may delay recovery of deer populations following heavy winter mortality caused by deep snow accumulation (Klein 1979; Olson 1979). On Prince of Wales Island, deer populations generally rebounded following the severe winters of 1969 and 1971. Complex circumstances, including habitat relationships, likely are involved in population suppression by predators (D. Person, wildlife biologist, ADF&G, Ketchikan, AK, personal communication 2005).

Deer populations in Southeast are currently highest in the northern islands north of Frederick Sound, intermediate on the central and southern islands, and lowest on the mainland coast (Kirchhoff 2003; R. Lowell, ADF&G, Petersburg, AK, personal communication 2004; P. Mooney, ADF&G, Sitka, AK, personal communication 2004; B. Porter, ADF&G, Ketchikan, AK, personal communication 2004) (Fig 4, 5). Some islands of Game Management Unit 3 (in central Southeast) have still not rebounded from 3 severe winters in the late 1960s and early 1970s (Olson 1979; Kirchhoff 2003). This slow rebound may be the result of a combination of factors, including several severe winters, low-quality winter deer habitat in some locales (such as Kupreanof Island), and the persistence of relatively high numbers of wolves and black bears. Kuiu Island, in particular, currently has very low deer numbers (Kirchhoff 2003) and high black bear numbers (Peacock 2004).

Significance to the Region and Tongass National Forest

The Sitka black-tailed deer is the most-pursued species of big game in Southeast. During the 20 years from 1983 to 2003, an average annual harvest of 12,361 deer was taken by an average of 7,994 hunters (Straugh et. al. 2004). Deer hunting is an

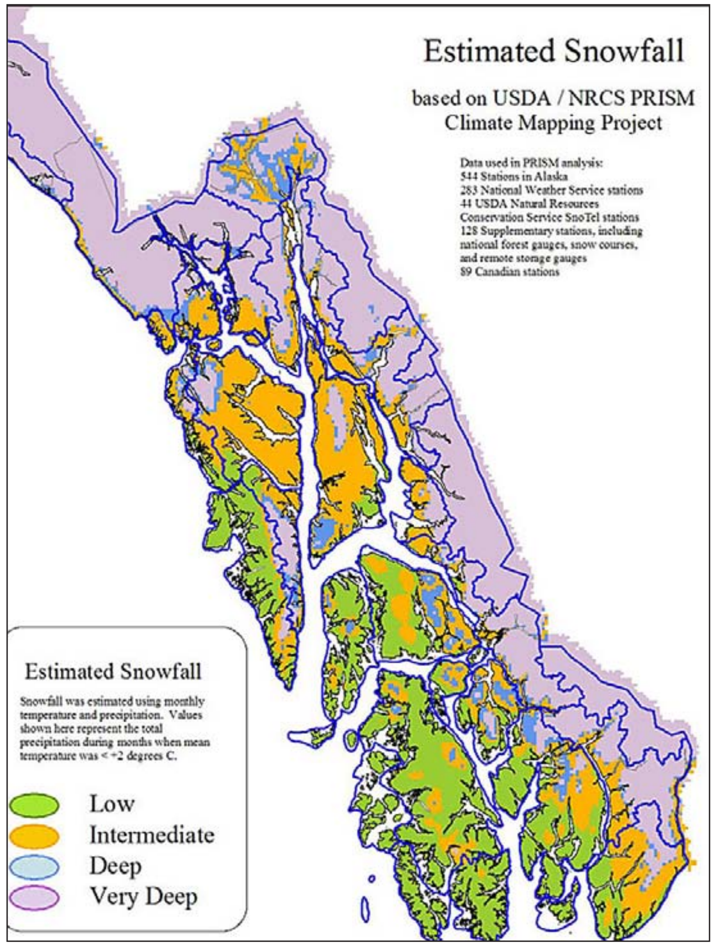

FIG 3. Map of estimated snowfall across southeastern Alaska showing regions of predicted low, intermediate, deep, and very deep snowfall based on monthly temperature and precipitation data. Winter snowfall and accumulation on the ground is a key variable for predicting high-quality winter deer habitat. In general, northern Southeast and the mainland receive higher snowfall and consequently have lower deer carrying capacity.

important and highly valued recreational and food-gathering activity throughout most of Southeast where deer are abundant (Fig 6). Deer are also an important resource for subsistence hunting (U.S. Forest Service [USFS] 1997). Of 20 subsistence communities in Southeast, 90% of households, on average, harvested subsistence resources, and deer made up, on average, 23.6% of subsistence food in those households (USFS 1997; Kruse and Frazier 1988).

The Alaska National Interest Lands Conservation Act (ANILCA) defines subsistence as "the customary and traditional uses by rural Alaska residents of wild renewable resources for direct, personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade." ANILCA provides for "the continuation of the opportunity for subsistence uses by rural residents of Alaska, including both Natives and non-Natives, on the public lands." By federal law, subsistence use "shall be the priority consumptive uses of all such resources on the public lands of Alaska." If deer populations decline, residents of rural communities are given priority use over urban residents (e.g, Juneau and Ketchikan).

Special Management or Conservation Designations

The black-tailed deer in Southeast is also a Management Indicator Species (MIS) under the USFS 1997 Tongass National Forest Land and Resource Management Plan (TLMP) (USFS 1997). MISs are selected by the USFS for emphasis in planning and 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 1997). The deer is also 1 of 6 species identified by the USFS as having special management concerns. If forest management activities (such as timber harvest) reduce the carrying capacity of important deer range in the Tongass National Forest, both sport hunting and subsistence hunting opportunities will likely be restricted. This situation already is happening on Prince of Wales Island (D. Person, personal communication 2005).

HABITAT RELATIONSHIPS

The natural range of Sitka black-tailed deer in both British Columbia and Southeast closely overlaps the distribution of the coastal temperate rainforest. Deer use a variety of habitat types throughout the year from sea-level beaches, through valley-bottom forest stands, to alpine ridges more than 3,000 ft (915 m) above sea level (Fig 7).

Much emphasis has been placed on the importance of winter habitat and the effects of deep, prolonged snow accumulations on deer populations in Southeast (Klein and Olson 1960, Merriam 1971, Barrett 1979, Klein 1979, Olson 1979). Spring, summer, and fall range conditions are also important for maintaining the nutritional plane of deer on an annual basis and ensuring healthy, productive populations (Klein

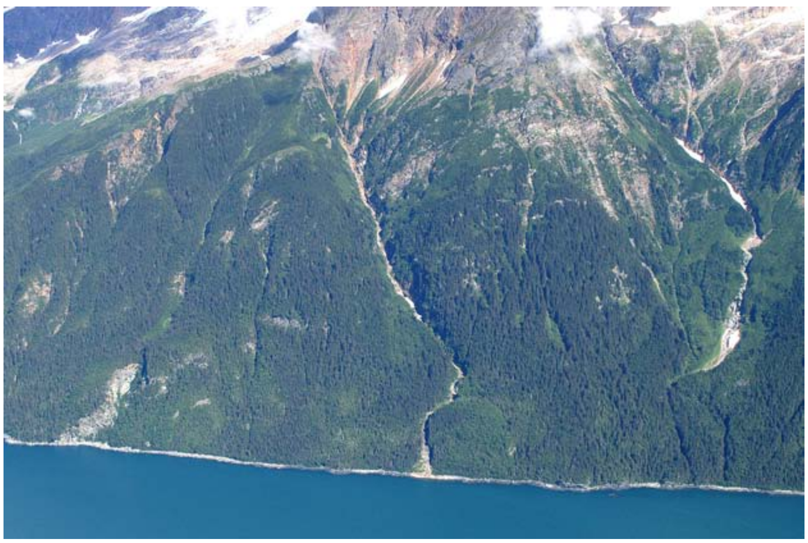

FIG 4. Southwestern Admiralty Island—Chaik Bay Watershed—provides an optimal mix of seasonal deer habitats. During winter deer use low-elevation old-growth forest while in summer they move up to subalpine meadows above tree line.

FIG 5. Much of the mainland coast—like this area of eastern Lynn Canal north of Juneau—provides lower-quality deer habitat because of its steep topography and relatively sparse forest cover. Deer abundance on the mainland coast of Southeast is generally lower than the islands due to the combination of deeper snow accumulation and lower-quality winter deer habitat.

FIG 6. Many Southeast residents hunt deer throughout the archipelago for up to 5 months of the year and deer meat is a staple food for many households.

1965, Hanley and McKendrick 1985, Hanley et al. 1989, Parker et. al. 1999). Furthermore, it is important to have a variety of habitats (including a diversity of mature and old-growth forest stands) and topographic conditions so that deer can select the most appropriate foraging habitats as seasons and environmental conditions change (Klein 1965, Schoen and Kirchhoff 1990, Parker et al. 1999).

Habitat selection by animals can influence reproduction, recruitment, and survivorship. Farmer (2002) evaluated deer habitat selection and its relationship to survivorship of radio-collared deer on Heceta Island in southern Southeast. His research demonstrated that mortality risks for female deer increased as the proportion of older clearcuts (30–39 yr) and second-growth forest (>40 yr) increased within their annual home ranges. Mortality risks from wolf predation also increased with increasing proportions of muskeg within home ranges.

Deer are most widely dispersed and use the greatest variety of habitats during summer when unrestricted by snow. In contrast, winter snow accumulation often confines deer to lower elevations and limits their habitat options, although the effects of snow accumulation vary annually and geographically. The following sections briefly summarize seasonal habitats and forages used by deer throughout their annual cycle in Southeast.

Spring

With the advent of spring, the winter snow cover begins to recede from low to higher elevation and deer begin dispersing from winter ranges to forage on newly emerging plant growth (Schoen and Kirchhoff 1985).

FIG 7. A year in the life of a Southeast deer: following the food in a typical island watershed.

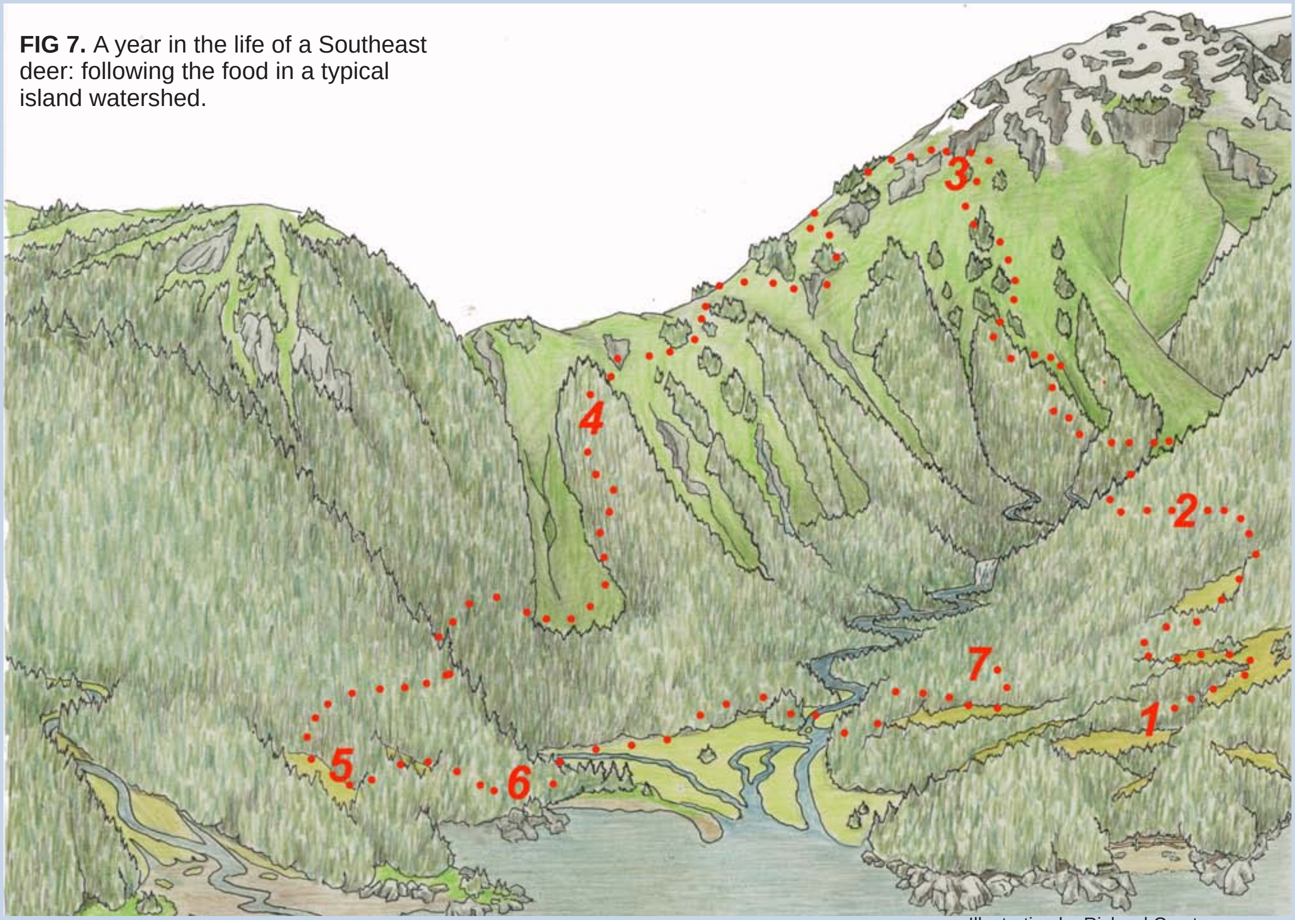

Illustration by Richard Carstensen

Annual cycle of a Southeast deer

1. FAWNING
In late May and early June, black-tailed does drop their fawns. During late spring, deer are scattered from sea level to 1,500 ft (457 m) in search of new plant growth. Deer use old-growth forests and increase their use of open-canopy stands, fens, tidal meadows, and young clearcuts at this time.

2. UPWARD MIGRATION
Throughout June, migratory deer continue to disperse off their winter ranges following the receding snow line on to upper forest slopes. Resident deer generally remain at lower elevations but use more forest openings for feeding.

3. SUBALPINE SUMMER RANGES
Migratory deer generally reach their ranges by the end of June or early July. On subalpine meadows between 1,800 and 3,000 ft (549-915 m), deer find abundant and nutritious herbaceous forage interspersed among stunted, stands of Sitka spruce and mountain hemlock (*Tsuga mertensiana*).

4. FALL MIGRATION
Following the first high-country frosts in mid to late September, forage plants die and migratory deer move into the upper forests. Throughout the next month, many deer move down to lower elevations as snow accumulates in the high country.

5. THE RUT
The breeding season, or rut, begins in late October and continues through November. Deer are widely dispersed from sea level to 1,500 ft (457 m). Old-growth forests are important foraging habitats but deer also make use of forest openings and muskeg fringes during the rut.

6. WINTER RANGE
From December through March, deer in Southeast are generally confined to old-growth forest winter ranges below 1,000 ft (305 m). Southern exposures generally accumulate less snow and provide greater access to evergreen forbs like bunchberry dogwood and trailing raspberry. Deer move up and down forested slopes following changes in the snow pack throughout the winter. During deep snows, medium- and large-tree old-growth hemlock spruce forests provide the best winter habitat.

7. SPRING SNOW MELT
Spring is a transition period as deer begin to expand their movements beyond the confines of their winter range in search of new plant growth. Wet, open-canopy forests with newly emergent skunk cabbage shoots are important foraging sites for deer in spring. Deer can also been seen foraging along upper beaches and young clearcuts during spring. at this time.

FIG 8. Skunk cabbage is usually the first plant to become available to deer in the early spring. Skunk cabbage has the highest protein content of any plant in the forest at this critical time in the deer's annual cycle, and often most plants in low elevation forest patches, like those shown here, will be nipped by deer in late March or early April.

FIG 9. Black-tail deer foraging in a subalpine forest opening at 2,000 ft (610 m) on Admiralty Island. Subalpine meadows are used by migratory deer and provide an abundant source of nutritious forage plants. High-elevation subalpine and alpine ridges may also offer deer more security from wolf and bear predation because of lower predator densities.

Most spring deer use on Admiralty Island generally occurred below 1,000 ft (305 m), and southerly exposures were selected by deer over northerly exposures because they are the first to become snow free and expose new plant growth (Schoen and Kirchhoff 1990). Old-growth forest was the habitat type most selected (93% use) by radio-collared deer on an unlogged study site on Admiralty Island (Schoen and Kirchhoff 1990). During spring on Admiralty, deer used a variety of stand types within the old growth, ranging from scrub stands to large-tree hemlock-spruce stands. In a study in an extensively logged area of northern Prince of Wales Island, Yeo and Peek (1992) observed deer using clearcuts in spring and recorded 65% of radio-collared deer use occurring in clearcuts (1–30 yr after logging) from April through 15 October. Similar patterns of use were observed for radio-collared deer on Heceta Island (Farmer 2002).

Spring is a time when animals must begin replenishing their muscle and fat reserves that have been depleted during winter. Deer especially seek out the new shoots of skunk cabbage (*Lysichton americanum*) (Fig 8), fiddlehead ferns , new leaves of devil's club (*Oplopanax horridum*) and blueberry plants (*Vaccinium spp*.), alder (*Alnus rubra*) catkins and buds, and many newly emerging forbs (Hanley and McKendrick 1985, Parker et. al. 1999).

Summer

Summer is an important time for deer to replenish their fat reserves and for female deer to meet the added nutritional costs of lactation (Parker et al. 1999). During summer, deer are widely dispersed from sea level to high alpine ridges, and they forage in a variety of habitats (Klein 1965, Schoen and Kirchhoff 1985, 1990, Yeo and Peak 1992, Farmer 2002).

On Admiralty Island in northern Southeast, subalpine habitats were selected by radio-collared deer and represented a third of their habitat use (Schoen and Kirchhoff 1990) (Fig 9). Old-growth forest accounted for more than half of the habitat use by deer, although it was used less than its availability within the study area. Within old growth, most of the use was in open scrub stands. Many of these open-canopy stands were at higher elevations and had productive forb and shrub communities providing nutritious summer forage. On Prince of Wales and Heceta islands in southern Southeast, old growth and clearcuts (1–30 yr after logging) with abundant forb and shrub communities were used extensively by deer, and second-growth forests (40–60 yr after logging) received little use (Yeo and Peak 1992, Farmer 2002).

During summer, subalpine habitats are generally very productive, providing an abundance of high-quality forage (Klein 1965; Hanley and McKendrick 1983, 1985). In portions of Southeast, where deer have access to subalpine habitats, many deer migrate seasonally to these higher-elevation (>2,000 ft [610 m]) sites. Schoen and Kirchhoff (1985) found that 75% of radio-collared deer on Admiralty Island migrated to higher-elevation summer range. Migratory deer

FIG 10. Old-growth forests are considered critical winter deer habitat in Southeast because they provide deer with the combination of abundant forage and shelter from deep snow.

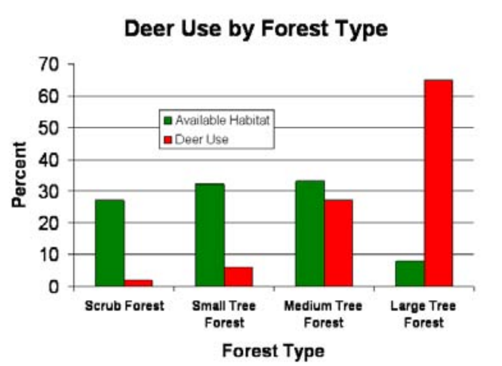

FIG 11. Winter deer use of old-growth forest types compared to availability within the home range of radio-collared deer on Admiralty Island during the deep snow winter of 1982. The green bars show the availability of forest types while the red bars show the habitat use by radio-collared deer. During deep snow conditions, deer use was concentrated in large-tree old growth because it had the lowest snow depths and most available food compared to forests with smaller trees. (From Schoen and Kirchhoff 1990)

appeared to take advantage of topographic variation and altitudinal progression of plant growth in seeking out the highest-quality forage (Klein 1965, 1979; Schoen and Kirchhoff 1990). On smaller islands and in watersheds without productive subalpine habitats (such as portions of Prince of Wales Island), deer used lower-elevation forested habitat year-round. Although low-elevation habitat can be productive, year-round use by abundant deer can lead to overbrowsing, which increases nutritional stress (Klein 1965).

Deer in summer have been observed feeding on more than 70 plant species, especially forbs (Parker et. al. 1999). Important deer forage species in summer (both in terms of deer use and nutritional quality) include skunk cabbage, devil's club leaves, blueberry leaves, leaves of other shrubs, bunchberry (*Cornus Canadensis*), trailing raspberry (*Rubus pedatus*), and several fern species (Hanley and McKendrick 1985, Parker et al. 1999). In a study of tame deer on Channel Island near Wrangell, herb-layer forbs, ferns, and skunk cabbage made up nearly 75% of the deer's diet under snow-free conditions (Parker et al. 1999).

Fall

Migratory deer begin moving off the high-elevation subalpine meadows following the first killing frosts of autumn as quality and availability of herbaceous forbs declines. On Admiralty Island, radio-collared deer were widely distributed below 2,000 ft (610 m) during fall (Schoen and Kirchhoff 1990). As snow accumulates in the high-elevation, open habitats, these areas are avoided by deer, as are northern exposures. Old-growth forests were overwhelmingly selected by deer on Admiralty Island in fall. Within the old-growth forest, deer selected hemlock-spruce stands with large trees (Schoen and Kirchhoff 1990). Forbs, skunk cabbage, shrub leaves, and fern rhizomes are important components of the fall diet of Southeast deer (Hanley and McKendrick 1985, Parker et al. 1999).

Winter

Deer distribution is most limited during winter. On unlogged, northern Admiralty Island in northern Southeast, virtually all winter deer use was within old-growth forest habitat below the 1,000-ft (300-m) elevation (Schoen and Kirchhoff 1990) (Fig 10). Southern exposures were also selected by Admiralty deer. Within the old-growth forest, radio-collared deer selected large-tree hemlock-spruce stands and avoided scrub forest and small-tree stands, especially in high snow years (Schoen and Kirchhoff 1990) (Fig 11).

FIG 12. A Sitka Black-tailed doe standing in a snow-free area under the canopy of a large old-growth tree. The broken, multi-layered canopy of old growth allows sunlight to reach the forest floor enabling abundant growth of understory plants like bunchberry dogwood and trailing raspberry. The big limb structure of old trees also intercepts substantial snowfall enabling deer to forage in snow-free or low-snow patches under the canopy.

Deer selection for old-growth stands of large trees is a response to the ability of larger trees to intercept snow, reducing snow depths on the ground (Hanley and Rose 1987, Kirchhoff and Schoen 1987). Although large-tree hemlock-spruce stands are important for deer in winter, valley bottom stands of large trees dominated by spruce and devil's club are less important. These floodplain spruce stands generally accumulate more snow and have lower abundance of herb-layer evergreen forbs and blueberry shrubs.

On northern Prince of Wales Island in southern Southeast (which was extensively logged during the last 40 years), clearcuts (<30 years after logging) and old-growth hemlock forests received the highest proportion of winter deer use (Yeo and Peek 1992). Deer used old-growth more during years of heavier snow, and used clearcuts more during years of light snow (Yeo and Peek 1992). Deer can use forest openings and young clearcuts to a greater extent in southern than northern Southeast because less snow accumulates in the south.

On Mitkof Island in central Southeast (also extensively logged during the last 40 years), deer used a mix of clearcuts (<40 years after logging) and old-growth hemlock-spruce-cedar forest during winter (Doerr et al. 2005). Deer habitat use on Mitkof varied between low-snow and deep-snow conditions. During the deep-snow winter, deer selected south slopes, elevations under 502 ft (153 m), areas within 1,000 ft (305 m) of saltwater, and old-growth stands of medium to large trees (measured as high-volume strata in the TLMP timber inventory) (Doerr et al. 2005). Deer avoided north, east, and west slopes; elevations above 800 ft (244 m); scrub forests; small-tree old growth; and clearcuts (<40 yr). Doerr et al. indicated that deer avoided "gap-phase" old growth in their Mitkof study area. This finding may be an artifact of the removal of much of the "gap-phase" old growth from lower elevations by extensive logging. What remained of these gap-phase old-growth forests

FIG 13. Black-tailed deer foraging on arboreal lichens, probably *Alectoria* or *Usnea* species. During deep snow periods, when most other food is buried, arboreal lichens are blown down from the tops of old-growth trees and are used extensively by deer as a main source of energy.

occurred largely on north-facing slopes at higher elevations that accumulated substantial snow.

In areas subject to persistent winter snow, the most valuable winter deer habitat provides abundant winter forage and a well-developed forest canopy that intercepts snow (Fig 12). These conditions are generally found in low-elevation, old-growth forest (Bloom 1978, Barrett 1979, Wallmo and Schoen 1980, Rose 1984, Hanley et al. 1989, Schoen and Kirchhoff 1990). Although the quality of winter habitat provided by old growth is higher than that of second-growth forests, some mature (>150 yr), but even-aged, wind-generated stands of hemlock-spruce may also provide good winter deer habitat. Some of these wind-generated stands, although technically not old growth, also provide adequate snow interception and abundant forage production, particularly on south-facing slopes (see Chapter 5).

For deer in Southeast, high-quality forage is generally most limited in winter when the nutritional quality of most plants declines, succulent herbs die back, and deciduous shrubs lose their leaves. Herb-layer plants (including evergreen forbs such as bunchberry and trailing raspberry) are highly nutritious and sought after by deer when available, but their use declines in winter months if buried under snow (Hanley and McKendrick 1985, Parker et al. 1999). One benefit of the herbaceous layer in old-growth forest in winter is the high protein content that may minimize the need for deer to draw down their body protein reserves (K. Parker, University of Northern British Columbia, personal communication 2005). During winter, deer substantially increase their use of shrub stems and conifers (42–65% of the winter diet on Channel Island) and arboreal lichens, particularly when snow accumulation covers other more nutritious forage (Hanley and McKendrick 1985, Parker et al. 1999). Arboreal lichens, which fall from the forest canopy during winter storms, are particularly high in digestible energy and highly sought after by deer during heavy snow conditions (Fig 13). On Wrangell Island, lichens represented 34% of the midwinter diet of deer (Parker et al. 1999). Parker et al. (1999) also observed significant deer use (up to 30% of the diet in December) of the underground rhizomes of shield fern *(Dryopteris dilatata)* when the ground was unfrozen and snow free.

Habitat Capability Model

To evaluate deer habitat values within watersheds and compare watershed values within biogeographic provinces for this assessment, the deer habitat capability model (Suring et al. 1992) was used as revised in 2005 by an interagency team of biologists. Habitat values were rated, using habitat preference data from Schoen and Kirchhoff (1990), on the basis of their value to deer during the winter season. The model estimates relative values of habitats for deer in winter based on elevation, aspect, slope, stand age and stand size. Additional model details (including habitat coefficients) are presented in Chapter 2. The winter habitat values of watersheds to deer are ranked within each biogeographic province and presented in a watershed matrix for Southeast (Appendix B).

FOREST ECOLOGY AND MANAGEMENT

Forest Composition and Ownership

Temperate rainforests occur in coastal maritime climates with a minimum of 80 in. (200 cm) of annual rainfall well distributed over the year (Alaback 1990). Temperate coniferous rain forests cover more than 11 million acres (4.5 million ha) or about 46% 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). In Glacier Bay National Park and Preserve,

FIG 14. A large-tree stand of old growth hemlock-spruce in the Kadashan watershed on Chichagof Island. This upland old-growth stand measured more than 50,000 board ft per acre and several of the individual spruce in this stand were 4-5 ft (1.2-1.5 m) in diameter. Large-tree stands like this are quite rare in Southeast but provide important habitat for many wildlife species including deer.

FIG 15. A small-tree stand of old growth hemlock and yellow cedar on southern Baranof Island. This upland old-growth stand measured less than 10,000 board ft per acre with the larger trees measuring 1-2 ft (0.3-.6 m) in diameter. Small-tree stands like this are very abundant in Southeast. Stands like these tend to accumulate much more snow than large-tree stands.

FIG 16. A 5-yr old clearcut on southeast Chichagof Island. Clearcuts at this age produce an abundance of deer forage including forbs, ferns, and shrubs. The availability to deer of this forage declines rapidly, however, when snow accumulations exceed 12 in (30 cm). The habitat value of clearcuts to deer also begins to decline when the conifer canopy shades out most forbs and shrubs 20 to 30 years after clearcutting.

FIG 17. A 60-yr old second-growth stand near Juneau. Beginning 25-35 years after clearcutting, the shaded floor of even-aged second growth produces little deer forage. These stands provide very poor deer habitat regardless of the season. Once cut, it can take several centuries to develop the full ecological characteristics of old growth.

which encompasses about 15% of Southeast, forested land is sparse. State and Native corporation lands encompass about 5% of Southeast, and corporation lands are generally well-forested. About two-thirds of the Tongass is forested, although productive old growth encompasses only 5 million acres (2 million ha) (~30%) of the land area (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 been harvested during the last 40 years (USFS 2003).

Old Growth

Because the forests of Southeast Alaska are perpetually wet, wildfire is not a factor in forest development in the region. Most natural disturbance is caused by frequent winds that blow down single trees or small patches of trees scattered throughout the forest (Harris and Farr 1974, Ruth and Harris 1979, Alaback 1982). Old growth in Southeast is characterized by an uneven-aged, multilayered overstory; old (>250 yr) dominant trees; and abundant understory plants (Harris and Farr 1979, Alaback 1982, Brady and Hanley 1984, Schoen et al. 1988). These forests include seedlings, saplings, and trees from 300 to 900 years old. The

FIG 18. The upper photo is the floor of a second-growth forest devoid of green plants. The lower photo is the floor of an old-growth forest with abundant plant growth, including bunchberry, trailing raspberry, and ferns. Once old growth is clearcut and placed under short timber rotations of 90-120 years (the time it will be cut again), its value as deer habitat will be substantially and permanently reduced.

FIG 19. Large-tree old growth is rare in Southeast but provides important winter deer habitat, particularly during winters of heavy snowfall where deer find lower snow depths and more available forage than forests with smaller trees.

variety of tree ages and sizes provides openings in the upper forest canopy through which sunlight reaches the forest floor, resulting in an abundance of understory plants composed of mosses, ferns, forbs, and shrubs.

Old-growth forests are diverse and highly variable in structure, often on less than an acre (<0.4 ha) scale. Productive old-growth forest (where all commercial logging occurs) represents about one-third of the land base of the Tongass. Productive old growth below 800 ft (244 m) represents only 18% of the Tongass (USFS 2003). In the most productive stands of hemlock-spruce 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 (Fig 14). These large-tree stands are rare in Southeast, representing only 3% of the Tongass land base (USFS 2003). At the other end of the forest spectrum are scrub stands with short, small trees 0.5–1.5 ft (0.150-.46 m) in diameter and less than 40 ft (12 m) tall (Fig 15). These old-growth stands grow on poorly-drained soils and around muskeg bogs and are much more common in Southeast, representing more than 26% of the Tongass land base (USFS 2003). For more description of the ecological structure and composition of old growth, see Chapter 5.

Second Growth

Clearcutting is the dominant timber harvest method in Southeast (USFS 1997) and has a much different effect on forest structure than the natural disturbance regime caused primarily by wind (Alaback 1982, Brady and Hanley 1984, Hanley et al. 1997). 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, deer forage (herbs, ferns, and shrubs) and conifer seedlings grow abundantly several years after logging and peak at about 15 to 20 years (Fig 16). 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 deer forage (including forbs, shrubs, and lichens) largely disappears from the even-aged, second-growth stand (Fig 17). The absence of deer forage in second growth generally continues 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 deer for 70–80% of the timber rotation (Harris 1974, Wallmo

FIG 20. Snow accumulations are much deeper in scrub forest and small-tree old growth than in large-tree old growth because the open canopy and small limb structure fails to intercept and hold significant snow loads. The availability of forage in such stands is greatly reduced and the energetic cost of movement is significantly increased.

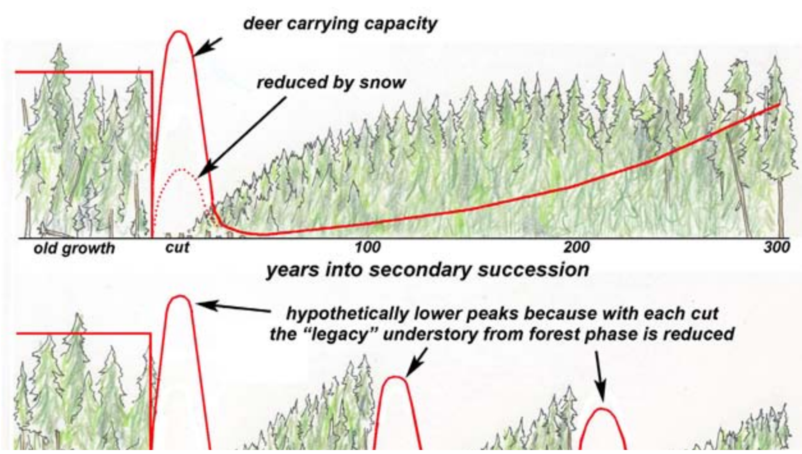

FIG 21. Hypothesized changes in deer carrying capacity during successional development of hemlock-spruce forests in southeastern Alaska. Upper: forest succession from clearcutting to old growth; lower: clearcutting on 100 year rotations. In early clearcut stages (dotted line), winter carrying capacity may be reduced by snow accumulation (adapted from Wallmo and Schoen 1980).

and Schoen 1980, Alaback 1982). For more detailed information on forest succession see Chapter 5.

Forage production for deer can be prolonged in young second growth by a series of precommercial thinnings (Kessler 1984, Doerr and Sandburg 1986, DellaSala et al. 1994, Doerr et al. 2005). However, the benefits of these techniques appear to be relatively short-lived (15–25 yr) (Alaback and Tapeiner 1984, Alaback and Herman 1988). Doerr et al. (2005) suggested that, through thinning treatments, the forage productivity of clearcuts could be extended up to about 40 years. Use of very wide tree spacings to prolong understory productivity, however, reduces gross timber volume and wood quality (Demars 2000). Thinning treatments are also costly, and the benefits of increased forage may not be available if deep-snow accumulations penetrate the open canopies of young, thinned stands. Compared to clearcutting, removal of individual trees through partial harvest or selection logging offers good potential for maintaining understory abundance and deer habitat values (Harris and Farr 1979, Kirchhoff and Thomson 1998, USFS 1999, Deal 2001). Hanley (2005) also suggested additional research is needed to evaluate second growth red alder stands and commercial thinning of older stands.

IMPLICATIONS FOR CONSERVATION

Studies comparing winter deer use of old growth to clearcuts and second growth found significantly lower use of logged sites in both the northern and southern archipelago (Wallmo and Schoen 1980, Rose 1984). The same studies revealed increased use of clearcuts during spring and summer in the absence of snow. In fact, more deer use of clearcuts than old growth occurred in the southern study area during spring (Rose 1984). During 2 winters on Prince of Wales Island with limited snow below 492 ft (150 m), radio-collared deer selected clearcuts (Yeo and Peek 1992). However, deer use of clearcuts declined significantly beyond 164 ft (50 m) from the forest edge (Mankowski and Peek 1989). On Mitkof Island, deer used clearcuts (<40 yr) during nonwinter seasons and low-snow winters but avoided clearcuts during a deep-snow winter (Doerr et al. 2005).

Regardless of season or snow conditions, however, second-growth forests (30–40 yr after logging) provide poor foraging habitat for deer (Harris and Farr 1979, Wallmo and Schoen 1980, Alaback 1982, Farmer et al. 2006). Under deep-snow conditions,

FIG 22. Tyee Watershed on southern Admiralty Island provides a mix of different habitat types that can be used by deer during different seasons and snow conditions. Open, small-tree old growth provides valuable foraging habitat during spring, summer and fall snow-free periods while large-tree old growth provides important winter habitat during deep snow conditions. The higher elevation subalpine habitats provide abundant, high-quality summer range.

arboreal lichens—blown from the forest canopy—provide an important food resource for deer (Parker et al 1999). Lichens are abundant in old-growth forests but are largely absent from clearcuts and second growth. Once an old-growth forest is placed under timber rotations of less than 200 years, long-term habitat values are reduced because of limited forage resources in the closed-canopy, even-aged second growth (Fig 18). This permanent cycle of diminishing forage has been described as "succession debt" by Person et al. (2001).

Not just the quantity of forage but also the quality of forage is important to deer. Plants grown in open clearcuts generally have higher tannins (compounds that lower digestibility and increase toxicity) and lower digestible protein than plants grown under the shaded forest canopy (Hanley et. al. 1987, 1989; Van Horne et. al. 1988). Although the plant biomass in clearcuts (5–20 yr after logging) is generally abundant during snow-free periods, the quality of forage may not meet the protein requirements of lactating does, and when given a choice, deer appear to prefer forest-grown plants to clearcut-grown plants (Hanley et. al. 1987). Foraging efficiency of Sitka black-tailed deer and their functional response to forage biomass, quality, and distribution has been described by Spalinger et al. (1988). The foraging efficiency of individual deer is not highly related to the density or biomass available in a habitat, but is more importantly related to plant size and quality. Therefore, the high biomass that may be available in young clearcut stands does not increase foraging efficiency of deer relative to stands of lower food density, such as old growth.

During winter, the most nutritious deer forage (such as herb-layer evergreen forbs) generally becomes unavailable when snow depths exceed 4 in. (10 cm) (Parker et al. 1999). At depths greater than 12 in. (30 cm), not only is food buried, but the energetic costs of moving through snow also increase significantly (Parker et al. 1984). During heavy snow conditions, old growth with large trees (which intercept snow and reduce accumulation on the ground) provides much of the winter habitat selected by deer (Bloom 1978, Barrett 1979, Hanley and Rose 1987, Kirchhoff and

Schoen 1987, Schoen and Kirchhoff 1990) (Fig 19, 20).

Hanley and Rogers (1989) provided a technique for estimating deer carrying capacity based on the quantity of available forage that achieves specific nutritional requirements under various environmental conditions. During summer, young (5 yr) clearcuts provided the highest carrying capacity to meet basic maintenance levels of an adult doe. However, old growth provided higher carrying capacity to meet the nutritional requirements for lactating does with twins. According to this model, the carrying capacity of second growth for lactating does was many times lower than that of old growth. Nonproductive (i.e., small-tree) old growth had higher carrying capacity than productive (i.e., medium- and large-tree-) old growth during summer. During winter with no snow, the carrying capacity of old growth was estimated to be slightly higher than clearcuts and substantially higher than second growth (Hanley and Rogers 1989). In winters with 5 in. (12 cm) of snow accumulation on the ground, Hanley and Rogers (1989) estimated the carrying capacity of productive old growth to be much higher than that of nonproductive old growth, second growth, or clearcuts.

Converting productive old-growth forest habitat—with abundant, high-quality food—to less-productive, even-age second growth will reduce long-term carrying capacity for deer in Southeast (Fig 21). Although young clearcuts provide abundant forage for deer during snow-free periods, the nutritional quality of this forage is lower than that of forage in old growth, and forage is only abundant for approximately 25% of the timber rotation period. In winters with deep-snow accumulation, the abundance of forage in clearcuts is unavailable to deer. Furthermore, Farmer et al. (2006) studies revealed that deer using clearcuts and second-growth habitats have a higher mortality risk compared to those in old-growth habitats. Based on this conservation assessment, North Prince of Wales (which originally had the highest amount of derr habitat) has lost an estimated 38% of its original habitat value (refer to chapter 2). Other provinces where winter deer habitat has declined substantially include East Chichagof, Etolin/Zarembo, and Kupreano/Mitkof.

More than just the amount of old growth that is converted to clearcuts and second growth must be considered. The quality and location of the old-growth stands influence habitat values and ultimately local deer populations. Productive hillside stands of old-growth hemlock-spruce with large trees provide optimal foraging conditions during winters with deep snow because such stands provide the greatest availability of high-quality forage. During low snow conditions, scrub forests and small-tree forests also provide abundant, high-quality forage.

Optimal habitat conditions in Southeast must encompass diverse habitats that provide deer with a variety of options to satisfy changing seasonal needs and variable weather conditions (Fig 22). Large- and medium-tree stands of hemlock-spruce, particularly at low elevations, have high habitat value for deer in deep snow winters. Young clearcuts and small-tree old-growth stands have value in areas with low snow conditions. In Southeast, large-tree old growth represents a small (<4%) proportion of the land area, but these stands have been disproportionately harvested throughout the region (USFS 2003). The disproportionate loss of this scarce, but important, habitat will disproportionately affect deer during severe winters (Schoen and Kirchhoff 1990).

To maintain productive deer populations at the watershed scale will require retaining a mosaic of representative habitats that are well distributed across the area and available to deer throughout their annual cycle. Seasonal habitat values vary geographically throughout Southeast in response to local environmental factors, including weather and predation. To ensure that deer populations are well represented throughout their natural range in Southeast and available for human use and enjoyment, watersheds with a variety of high-value deer habitat should be identified and protected at the watershed scale (Schoen et al. 1984) within each biogeographic province of Southeast.

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