MAMMALS

Southeast Alaska's naturally fragmented landscape, created by its steep mountains, island archipelago, and glacial history, have greatly influenced the distribution and speciation of mammals. At multiple times in recent history, from the lengthy Pleistocene Ice Age (1.6 million to 12,000 years ago) to the very recent Little Ice Age (500 to 150 years ago), glacial ice sheets have advanced and retreated, at times covering virtually all of what is Southeast Alaska today. The physical geography and geologic history explain much of today's heterogeneous species patterns. During the most recent glacial maximum (71,000 to 12,000 years ago), sea level was lower due to much of the world's freshwater being captured in continental ice sheets. Some pockets of land that were free of both ice and seawater became strongholds for wildlife during that time. As the ice receded, these "refugia" were centers from which species dispersed and recolonized newly open areas. Some species moved east from coastal refugia while others moved west into Southeast Alaska from interior areas that are part of British Columbia. Along the way, animals encountered natural barriers such as difficult topography and wide ocean passages, which shaped dispersal patterns and affected the ability to colonize new lands. Today, brown bears live on the northern islands of Admiralty, Baranof, and Chichagof (ABC) while black bears and wolves live on the southern islands. All three species inhabit the mainland. Deer occur in higher density on the islands, and in lower density on the mainland, but have yet to colonize Glacier Bay despite the presence of suitable habitat.

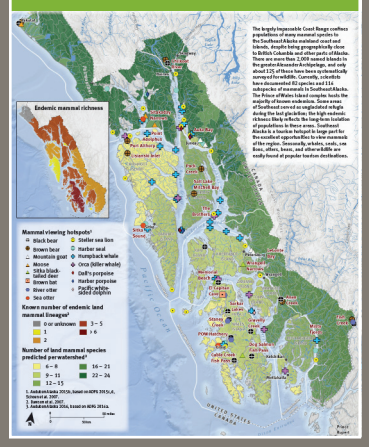
Importantly, the Alexander Archipelago is a center of endemism. The greatest number of known endemic mammal species live on Prince of Wales (POW) Island: species such as the POW flying squirrel, coastal marten, and Alexander Archipelago wolf. So far, scientists have documented 82 species and 116 subspecies of mammals, of which 24 occur only in Southeast Alaska. These mammals represent 63 genera, 28 families, and 8 orders; about 20% of the known mammal taxa are endemic (MacDonald and Cook 2007). We are likely only starting to uncover the genetic diversity that has evolved in the Alexander Archipelago. Remarkably, recent genetic studies revealed that the ABC island brown bears are descendants of polar bears that were stranded in the area during a major glacial period (550,000 to 700,000 years ago) and later hybridized with brown bears migrating from the mainland. This population represents an important component of the biodiversity of Southeast. Studies like this one continue to provide key information about the biogeographic history of this island ecosystem. Southeast Alaska, especially Glacier Bay, is a natural laboratory for studying the succession and dispersal of life following glacial retreat as plants, fish, birds, and mammals colonize new areas. Although less obvious on the human time scale, Southeast Alaska is a young landscape still breaking free from its recent glaciation. Species patterns are not yet settled and continue to evolve today.

~ Melanie Smith

David Shaw

MAMMALS MAPS INDEX

Mammal Species Richness



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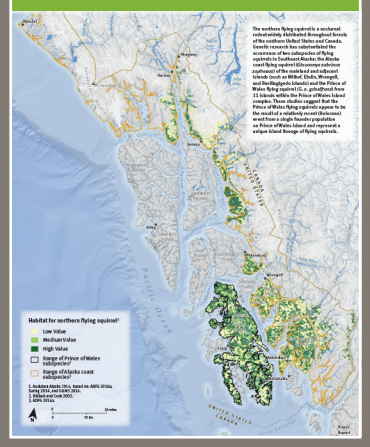
Northern Flying Squirrel



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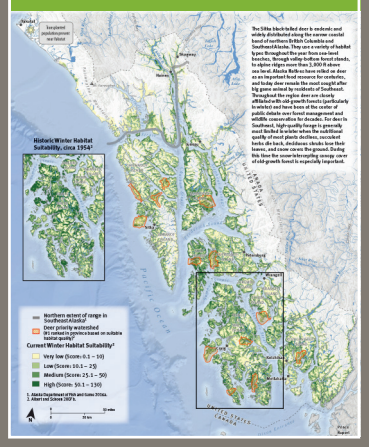
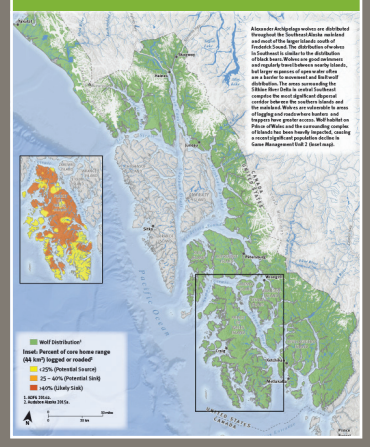
Sitka Black-tailed Deer



MAP 6.3 / PAGE 154

Alexander Archipelago Wolf



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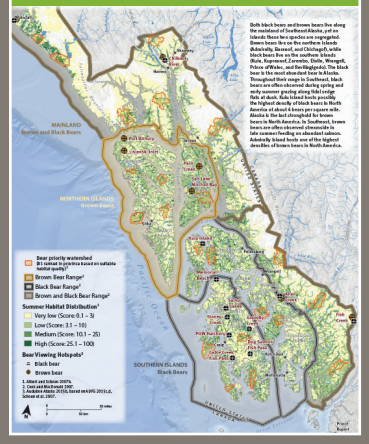
Brown Bear and Black Bear



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MAMMAL SPECIES RICHNESS

Benjamin Sullender

The coastal temperate rainforests of Southeast Alaska harbor a wide variety of flora and fauna. The region's variable connectivity, both historic and current, has created striking patterns of species distribution across the landscape. Distribution patterns here are characterized in terms of richness (the number of species present in a given area) and endemism (the number of endemic species, or organisms indigeneous to a particular geographic location and occurring nowhere else).

Historically, parts of the Alexander Archipelago likely served as glacial refugia during the Wisconsin glaciation, about 20,000 years ago (Carrara et al. 2007). Sea levels were much lower at that time due to much of the world's fresh water being tied up in expansive ice caps, thus exposing parts of the continental shelf (refer to Figure 6-1). The southern tip of Baranof Island and the western sections of the Prince of Wales (POW) Island complex remained ice free and served as terrestrial habitat for continental species displaced by the expanding ice sheets (Carrara et al. 2007, Pauli et al. 2015). Long-standing populations in these refugia, coupled with sporadic re-colonization events and dispersal barriers such as steep topography, strong currents, and expanses of open water, have resulted in regionally high levels of endemism (Cook et al. 2006) and highly varied species richness (MacDonald and Cook 1996) across the archipelago. Within Southeast Alaska as a whole, the largely impassable Coast Range confines populations of many species to the mainland coast and isolated islands, despite being geographically close to British Columbia and other parts of Alaska.

Wildlife respond to the region's underlying geologic and geographic structure in patterns that emerge among biogeographic provinces. POW and the complex of surrounding island (POW Complex) hosts the majority of known endemism in the region. Because some areas of the complex likely served as a glacial refuge during the last glaciation (Carrara et al. 2007, Pauli et al. 2015), the very high endemic richness likely reflects the long-term isolation of these populations (Kondzela et al. 1994, Dickerman and Gustafson 1996).

There are more than 2,000 named islands in the greater Alexander Archipelago, and only about 125 of these have been systematically surveyed for wildlife (Dawson et al. 2007). Currently, scientists have documented 82 species and 116 subspecies of mammals in Southeast Alaska. These mammals represent 63 genera, 28 families, and 8 orders (MacDonald and Cook 2007). Of the described taxa, 24 occur only in Southeast Alaska, meaning that about 20% of the known mammal taxa (including species and subspecies) are endemic.

Old-growth forest provides important habitat for some of these endemic mammals. For example, black and brown bears (*Ursus americanus* and *U. arctos*, respectively) are associated with old-growth, particularly riparian forests with salmon (*Oncorhynchus spp.*) spawning streams (Titus and Beier 1999). Bat species (*e.g. Myotis spp.*) rely on old-growth for adequate roosting (Parker et al. 1996). Northern flying squirrels (*Glaucomys sabrinus*) display a key role in temperate old-growth rainforest ecosystems even though some research resists classification as a bona fide management indicator species for old-growth forest. (Smith et al. 2005). In addition to serving as a food source for old-growth-associated predators such as martens and owls, flying squirrels serve as a dispersal vector for mycorrhizal fungi. These fungi have a symbiotic relationship with dominant conifers, and are essential for forest development (Flaherty et al. 2010). The American marten relies on old-growth forests to find large stumps and tree hollows suitable for denning (Buskirk and Ruggiero 1994), and the endemic coastal marten in Southeast Alaska could display a similar preference. However, more research is needed to determine whether patterns for American martens are consistent with the endemic coastal marten (Dawson et al. 2007).

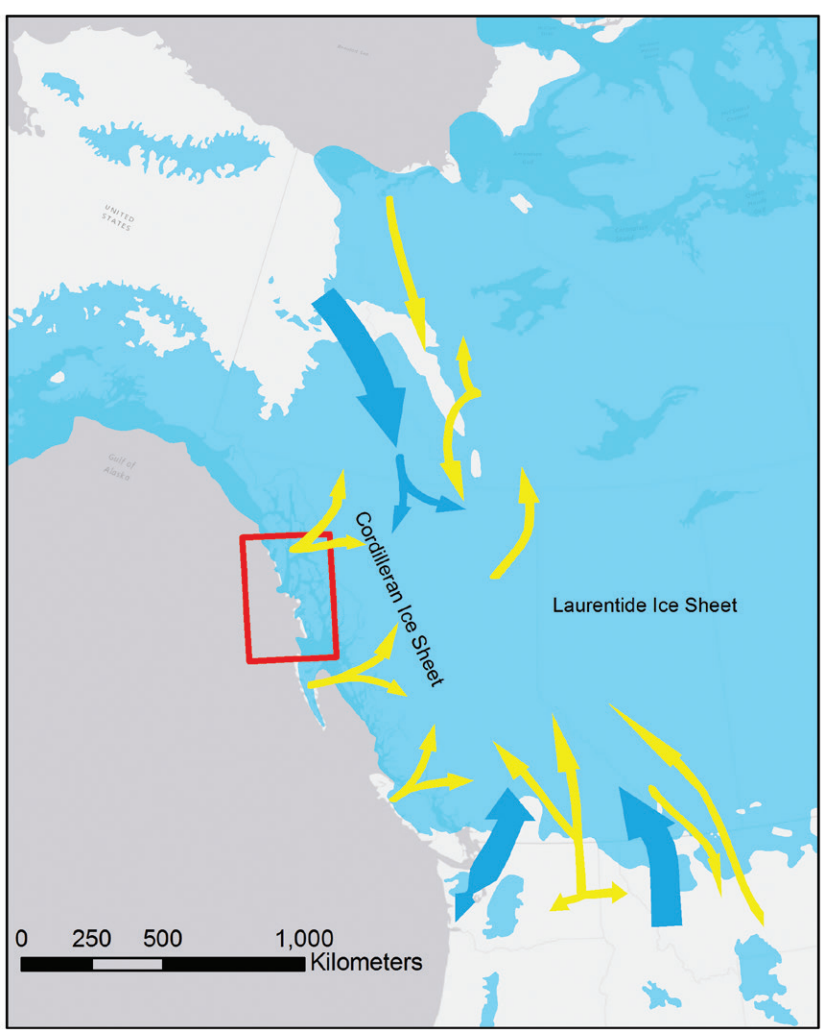
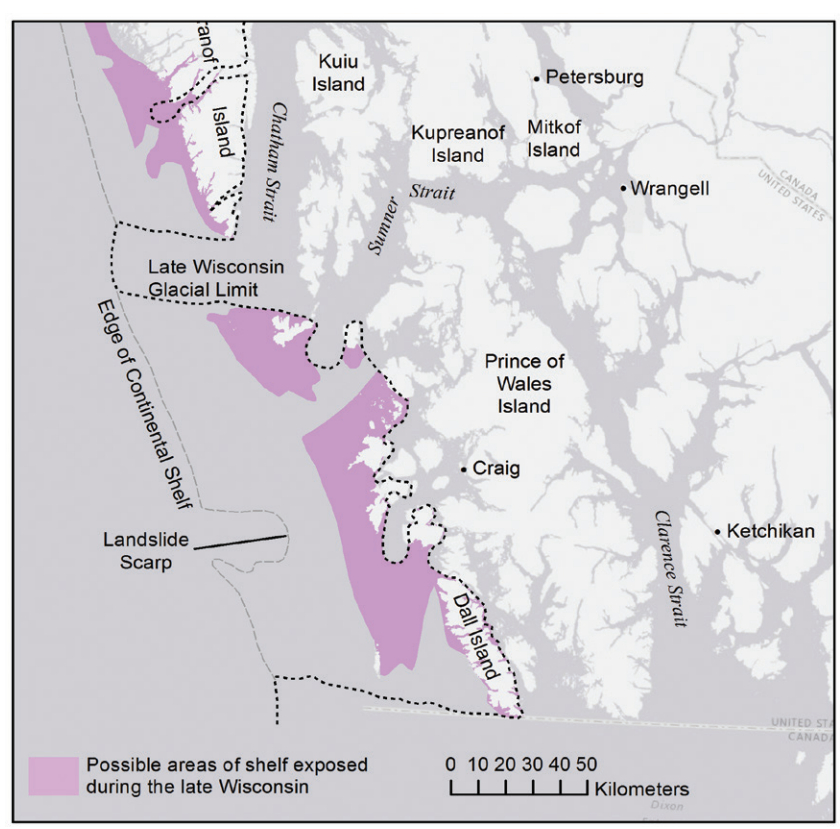


FIGURE 6-1. Extent of glacial coverage during last glacial maximum (light blue), and major (dark blue) and minor (yellow) post-glacial colonization routes (top; adapted from Shafer et al. 2010). Red box indicates approximate bounds of the bottom map, which illustrates refugia using glacial extents (dotted lines) and unglaciated abovewater areas (purple polygons; adapted from Carrara et al. 2007).



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CONSERVATION ISSUES

Despite rapidly accumulating evidence of Southeast Alaska's biological significance, scientific understanding of the region's terrestrial mammals has developed in a piecemeal fashion. Effective management plans for the region's mammal species will require a comprehensive research effort to fill in existing gaps (Smith 2005). The region is characterized by a dynamic geological history and a complex landscape of connected habitat and dispersal barriers. Such factors pose significant challenges to species management. In order to overcome these obstacles, researchers should gather genetic and species distribution data with a representative coverage from across the region's geography. Two main research needs exist: clarify the region's taxonomy; and improve the delineation of species and endemic distribution.

New and advanced phylogenetic techniques, used for measuring taxonomic distinctiveness, offer an opportunity to reassess historic morphological descriptions of new species and subspecies. However, researchers have yet to apply these methods to much of Southeast Alaska. This paucity of data has led to the widespread and erroneous perception that there are few endemic taxa at risk of extirpation (Cook and MacDonald 2001).

Genetic information must be considered alongside an island-specific understanding of species ranges, habitat associations, and demography. Although the distribution models used here are a useful first step, the input survey data is patchy and may overlook important areas simply due to a restricted sampling extent. Additional observation data will improve quantification of population structure and functional connectivity for species across land usage types, a key component of assessing population viability in this fragmented landscape (Smith and Person 2007).

For example, phylogenetic evidence suggests that the POW flying squirrel (*Glaucomys sabrinus griseifrons*) is genetically distinct from other flying squirrel populations (Bidlack and Cook 2002). But poor information about population size and habitat associations led the US Fish and Wildlife Service (USFWS) recently to reject a petition to consider this squirrel as endangered or threatened (US Fish and Wildlife Service 2012). Similar uncertainty may threaten the endemic bat subspecies *Myotis lucifugus alascensis*. Cutting-edge analyses have revealed genetic distinctiveness (Carstens and Dewey 2010, Vonhof et al. 2015), but little information is known regarding population status.

For the Alexander Archipelago wolf (*Canis lupus ligoni*), the uncertainty rests not so much with the population size, but rather in the interpretation of genetic information. The scientific community accepts estimated population trends, but a conclusive decision on genetic distinctiveness has proven fractious (Weckworth et al. 2005, Weckworth et al. 2010, Cronin et al. 2014;2015, Weckworth et al. 2015). The 2016 USFWS Endangered Species Act status review recognized the Alexander Archipelago wolf of Southeast Alaska and coastal British Columbia as a subspecies of gray wolf, and recognized the discrete population of wolves in the POW Complex. However, the Service decided that listing of the Alexander Archipelago wolf was not warranted at this time (US Fish and Wildlife Service 2016).

In two decades of management plans, the US Forest Service (USFS) has referred to the importance of managing for endemics, but has failed to operationalize these concerns. The 1997 Tongass Land Management Plan (TLMP) mentioned endemic mammals as a priority, but the agency never developed a specific research and monitoring agenda (US Forest Service 1997b). Similarly, the 2008 TLMP listed endemic terrestrial mammals as a separate standard and guideline for management, with the mandate to assess impacts "relative to the distinctiveness of the taxa, population status, degree of isolation, island size, and habitat associations" (US Forest Service 2008a). Unfortunately, achieving the mandate will prove difficult, because all of these metrics suffer from the data gaps mentioned above.

It is of paramount importance to thoroughly investigate the genetic distinctiveness and geographic associations of wildlife, particularly terrestrial mammals, within Southeast Alaska. Without investing in an understanding of Southeast Alaska's ecological baseline, managers will remain largely unaware of potential species extirpations, the erosion of endemic hotspots such as the POW Complex, and the overall ecological significance of this region.

MAPPING METHODS

The Alaska Department of Fish and Game (ADFG) developed species profiles for 201 animals that occur in Alaska (Alaska Department of Fish and Game 2016a). For each species, a description and range map was generated based on expert knowledge and modeling efforts varying by species. This map summarizes the results of these range maps to show the number of mammal species predicted to occur in each subwatershed in Southeast Alaska (HUC 12, or sixth level watershed). Overall, these models predict the presence of 30 mammal species in Southeast Alaska out of a total of 40 mapped across the state by ADFG.

Note that the number of mammal species included in this analysis (30) is much smaller than the total number that have been physically documented to occur in Southeast Alaska (82), which is, in turn, almost certainly an underestimation of actual species richness (Dawson et al. 2007). Even models of known species have insufficient data or produce non-viable results due to inaccuracy or uncertainty. Due to limitations both inherent in the observation data and stemming from the modeling process, readers should interpret the results summarized on this map as an approximate representation of the relative level of species richness among the biogeographic provinces, rather than exact species numbers. Given these constraints, the information is most useful when used as a way to interpret broad ecological patterns and relationships.

Endemic mammal species richness is illustrated in the inset map. As with the species richness data, counts of endemic species are approximate and are best interpreted as a relative index of endemism among subregions of the Alexander Archipelago.

Mammal viewing hotspots were digitized by Audubon Alaska based on the ADFG Southeast Alaska wildlife viewing guides (Alaska Department of Fish and Game and US Forest Service 2006, Alaska Department of Fish and Game 2015c;d).

TABLE 6-1 Mammal species included in species richness map (based on ADFG 2015 distribution data).

American Marten	Keen's Myotis	Northern Redbacked Vole
American Mink	Little Brown Bat	Gray Wolf
Arctic Ground Squirrel	Meadow Vole	Pacific Marten
Black Bear	Moose	Red Fox
Brown Bear	Mountain Goat	Red Squirrel
Collared Pika	Muskrat	Roosevelt Elk
Coyote	North American Beaver	Silver-haired Bat
Dall Sheep	North American Porcupine	Sitka Black-Tailed Deer
Ermine	North American River Otter	Snowshoe hare
Hoary Marmot	Northern Flying Squirrel	Wolverine

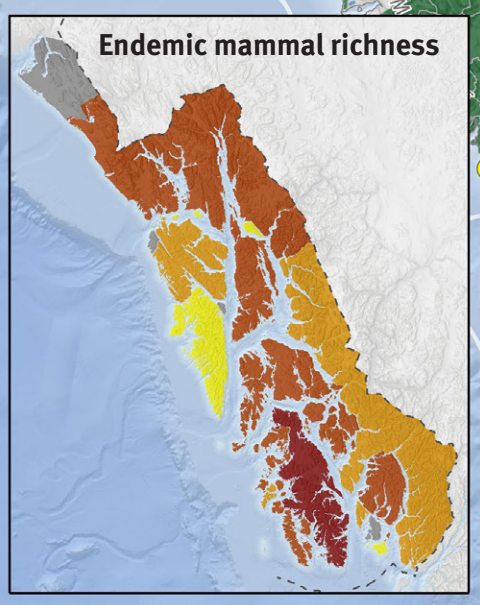
MAP DATA SOURCES

- Mammal species richness: Alaska Department of Fish and Game (2016a)
- Endemic species richness: Dawson et al. (2007)
- Mammal viewing hotspots: Audubon Alaska (2015b), based on Alaska Department of Fish and Game (2015c) and Alaska Department of Fish and Game (2015d).

Mammal Species Richness

Audubon ALASKA

The largely impassable Coast Range confines populations of many mammal species to the Southeast Alaska mainland coast and islands, despite being geographically close to British Columbia and other parts of Alaska. There are more than 2,000 named islands in the greater Alexander Archipelago, and only about 125 of these have been systematically surveyed for wildlife. Currently, scientists have documented 82 species and 116 subspecies of mammals in Southeast Alaska. The Prince of Wales Island complex hosts the majority of known endemism. Some areas of Southeast served as unglaciated refugia during the last glaciation; the high endemic richness likely reflects the long-term isolation of populations in these areas. Southeast Alaska is a tourism hotspot in large part for the excellent opportunities to view mammals of the region. Seasonally, whales, seals, sea lions, otters, bears, and other wildlife are easily found at popular tourism destinations.



Mammal viewing hotspots[1]

- Black bear
- Brown bear
- Mountain goat
- Moose
- Sitka black-tailed deer
- Brown bat
- River otter
- Sea otter
- Steller sea lion
- Harbor seal
- Humpback whale
- Orca (killer whale)
- Dall's porpoise
- Harbor porpoise
- Pacific white-sided dolphin

Known number of endemic land mammal lineages[2]

- 0 or unknown
- 1
- 2
- 3 – 5
- › 6

Number of land mammal species predicted per watershed[3]

- 6 – 8
- 9 – 11
- 12 – 15
- 16 – 21
- 22 – 24

1. Audubon Alaska 2015b, based on Alaska Department of Fish and Game 2015c,d; Schoen et al. 2007.
2. Dawson et al. 2007.

N

0 50 miles

0 50 km

Yakutat
Skagway
Chilkoot River
Haines
Sitakaday Narrows
Point Adolphus
Port Althorp
Lisianski Inlet
Auke Bay
Juneau
Pack Creek
Salt Lake - Mitchell Bay
The Brothers
Sitka
Sitka Sound
Petersburg
LeConte Bay
Wrangell Narrows
Wrangell
Memorial Beach
El Capitan Cave
Anan Creek
Sarkar Lakes
Staney Creek
Gravelly Creek
Fish Creek
Misty Fjords
POW Hatchery
Craig
Dog Salmon Fish Pass
Cable Creek Fish Pass
Ketchikan
Metlakatla
Prince Rupert
Pacific Ocean
UNITED STATES
CANADA
Dixon Entrance

Map 6.1: Mammal Species Richness

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NORTHERN FLYING SQUIRREL

John Schoen, Winston Smith, and Brian Clark
Revised by Nils Warnock

The northern flying squirrel (*Glaucomys sabrinus*) is an arboreal rodent widely distributed throughout forests of the northern United States and Canada from the eastern seaboard to the Pacific coast and from California to Alaska. Because of its largely nocturnal behavior, the flying squirrel—although common in many forests—remains a mystery to most people. The flying squirrel has enormous eyes and thick, soft fur, brown on top and light underneath. Smaller than the red squirrel (*Tamiasciurus hudsonicus*), the flying squirrel does not actually fly but glides through the forest canopy by stretching out the lateral skin (patagia) between its front and back legs.

The northern flying squirrel apparently expanded into Southeast from a single refugium or isolated population (the southern continental refugium) from the east (Cook et al. 2006, Cook and MacDonald 2013). Genetic research has substantiated the occurrence of two subspecies of flying squirrels from Southeast: the Alaska Coast flying squirrel (*G. s. zaphaeus*) of the mainland and adjacent islands (such as Mitkof, Etolin, Wrangell, and Revillagigedo islands) and the POW flying squirrel (*G. s. griseifrons*) from 11 islands within the POW Complex (Demboski et al. 1998, Bidlack and Cook 2001). These studies suggest that the POW flying squirrels appear to be the result of a relatively recent (Holocene) event from a single founder population on POW Island and represent a unique island lineage of flying squirrels.

Northern flying squirrels inhabit forests along the mainland coast of Southeast Alaska east of Glacier Bay and south to the Canadian border (MacDonald and Cook 1996, MacDonald and Cook 1999). Flying squirrels also occur on at least 15 islands within the southern Alexander Archipelago south of Sumner Strait, including Mitkof, Wrangell, Etolin, POW, Kosciusko, Heceta, Suemez, Tuxekan, Dall, Revillagigedo, and the Outside islands (MacDonald and Cook 1999, Bidlack and Cook 2001).

Throughout the Pacific Northwest, the northern flying squirrel is closely associated with old-growth forests (Witt 1992, Carey 1995, Carey et al. 1999, Smith 2012). In Oregon and Washington, northern flying squirrel abundance was positively correlated with a >80 year old forest landscape; relative abundances of flying squirrels were significantly lower post-cut when more than 60% of green trees were harvested (Holloway et al. 2012).

The density of flying squirrels in the Alexander Archipelago is among the highest documented in North America. Smith and Nichols (2003) reported mean densities of 7.9 and 4.2 squirrels per ac (3.2 and 1.7 squirrels per ha) on POW Island in old-growth western hemlock-Sitka spruce (*Tsuga heterophlla-Picea sitchensis*) forest and muskeg-bog scrub forest, respectively. On POW, flying squirrel densities were higher in old-growth hemlock-spruce forests than in scrub forests in spring and autumn, but particularly in autumn when mean densities were 56% higher in old growth hemlock-spruce (Smith and Nichols 2003, Smith et al. 2004). Flying squirrel densities increased with density of large trees and snags. Other habitat variables that appear important to flying squirrels include cover of ericaceous shrubs (such as *Vaccinium spp.*) and coarse woody debris (Smith et al. 2004).

Cavities in trees and snags are used by flying squirrels in Southeast for denning habitat (Bakker and Hastings 2002). On POW, of 118 flying squirrel dens surveyed, 51% were in snags, 42% in trees with no visible drays (nests), 2% in trees with visible drays, 3% on the ground and 3% in unknown habitat. Western hemlock and western red cedar (*Thuja plicata*) were the most commonly used live trees for dens (Pyare et al. 2010). Squirrels may move their dens up to 20 times a year among many different den trees within a 20-ac (8-ha) area and can travel as much as 1.2 mi (1.9 km) in a single night (Mowrey 1994).

Bob Armstrong

Snags and old-growth trees provide important habitat for northern flying squirrels.

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Northern flying squirrels are omnivores, but they play a key ecological role in forest regeneration in the Pacific Northwest because they forage on the fruiting bodies of underground fungi and disseminate fungal spores throughout the forest (Maser et al. 1985, Maser and Maser 1988, Carey et al. 1999). These colonies of mycorrhizal fungi form a symbiotic relationship with the roots of many woody plants, including conifer trees. The mycorrhizal fungi expand the root function of conifers, enhancing nutrient acquisition for trees while extracting sugars from the trees.

In Southeast, flying squirrels also consume truffles, although to a lesser degree than in southern forests (Flaherty et al. 2010). The primary summer and autumn diet of flying squirrels in old-growth forests from the POW Complex was vegetation, truffles, mushrooms, lichens, and insects (Pyare et al. 2002, Flaherty et al. 2010). In terms of relative abundance, at least on POW, 76–90% (autumn, spring) of the squirrel's diet consisted of conifer seeds and lichen, while the rest consisted of epigeous fungi, truffles, and invertebrates (Flaherty et al. 2010). Flying squirrels are also important prey for hawks, owls, and small carnivores (Smith et al. 2005, Mowrey 2008).

There do not appear to be population size or trend data for either subspecies of flying squirrel inhabiting the Tongass. Both the northern flying squirrel and its subspecies, *G. s. griseifrons*, were listed as Species of Greatest Conservation Need in the State of Alaska Wildlife Action Plan (Alaska Department of Fish and Game 2015a).

The subspecies *G. s. griseifrons*, endemic to the POW Complex, was proposed for federal listing as an endangered or threatened species in October 2011, but this petition was found by the USFWS to be unwarranted (US Fish and Wildlife Service 2012). *G. s. griseifrons* was listed as a subspecies of ecological concern in the Tongass National Forest (West 1993) and as potentially endangered in the Status Survey and Conservation Action Plan for North American Rodents prepared by the International Union for the Conservation of Nature (Hafner et al. 1998). NatureServe (2014) ranks the POW flying squirrel as G5T2 (species as a whole is not threatened, but subspecies is imperiled).

Flying squirrels were a "design" species for small size old-growth reserves (10,000 ac [<4,050 ha]) in the 1997 Tongass National Forest Land and Resource Management Plan (TLMP) (US Forest Service 1997a) because of their assumed "dependency on the forested habitats" (Suring et al. 1993). The 2008 TLMP plan amendment (US Forest Service 2008a) evaluated 14 populations of Southeast Alaska endemics and found that under all alternatives evaluated, the POW flying squirrel had the greatest viability concern over time (US Forest Service 2008a).

Multiple studies have established that large trees and snags are ecologically significant correlates of flying squirrel density and habitat use (Smith et al. 2004, Smith et al. 2005, Pyare et al. 2010). The presence of large trees and snags provides nesting cavities for flying squirrels (Bakker and Hastings 2002) and may provide food sources that are more abundant in habitats with larger trees (Smith and Nichols 2003, Smith et al. 2005).

Travel corridors are especially important to flying squirrels because of their method of gliding locomotion (volplaning) (Flaherty et al. 2008). A study of flying squirrel old-growth relationships in interior upland forests by Mowrey and Zasada (1982) found that uninterrupted forest corridors were important for maintaining flying squirrel populations. The distance between the launching and landing trees is important for flying squirrels to move through their home range. Volplaning enabled the flying squirrels to reach distances of between 33–164 ft (10–50 m) in interior Alaska (Mowrey and Zasada 1982). Wider gaps in forest cover were found to increase the risk of predation, especially those gaps wider than 98 ft (30 m) that lack tall trees scattered throughout forest openings.

CONSERVATION ISSUES

As an island endemic, the POW flying squirrel is particularly vulnerable to risk of extinction because of restricted range, small population size, minimal genetic variation, and susceptibility to random events (Soule 1984, Reichel et al. 1992, Frankham 1998). They are also susceptible to fragmentation and loss of habitat, over-harvesting, and introduction of exotic invasive species (Cook et al. 2006). Although the 1997 TLMP (US Forest Service 1997a) included standards and guidelines for reducing extinction risks to island endemics, the guidelines only applied to islands where there was evidence of endemic species (Smith 2005). Unfortunately, the distribution of small mammals on many islands remains unknown (MacDonald and Cook 1996, MacDonald and Cook 1999).

Population persistence of northern flying squirrels requires a surprisingly large intact habitat area. On POW, Shanley et al. (2013) found that habitat patches occupied by radiomarked flying squirrels had ≥ 73% old-growth forest cover or a minimum total area of 180 ac (73 ha) of old-growth forest. Modeling flying squirrel persistence in Old Growth Reserves on POW Island, Smith and Person (2007) concluded that for flying squirrels to persist with 95% certainty for 50–100 years with no immigration to a patch, Old Growth Reserves would have to have an upland old growth component of 12,355–195,213 ac (5,000–79,000 ha), respectively.

Converting structurally diverse old-growth forests with large trees and snags to clearcuts and young second-growth stands with smaller trees and snags, less large woody debris, and fewer shrubs will likely reduce carrying capacity for flying squirrels in Southeast. This forest transformation is particularly a concern on the POW Complex, where substantial timber harvest has occurred and future harvests are planned both on national forest and private lands. Although scrub forests (which are unlikely to be logged) have been demonstrated to support reasonable densities of flying squirrels and may provide a buffer against extensive logging of productive old growth (Smith and Nichols 2003, Smith 2005, Smith and Person 2007), additional fragmentation of productive old-growth stands may increase risks of maintaining viable, well-distributed populations of the endemic POW flying squirrel in the long term.

Maintaining adequate old-growth reserves across the POW Complex as well as promoting second-growth restoration (for example, including snags, large woody debris, legacy trees, and thinning) will likely be important for conserving this island endemic. Although Smith et al. (2005) indicated that flying squirrels were not an ideal management indicator species of old-growth forest structure, Smith's (2012) evaluation of northern flying squirrels as sentinels of forest ecosystem processes and condition concluded that the persistence of the northern flying squirrel affirmed the existence of essential ecological components and processes typical of healthy montane or boreal coniferous forest ecosystems.

Clearly, a comprehensive conservation strategy for populations of this important endemic arboreal rodent is needed for Southeast Alaska.

MAPPING METHODS

Habitat quality as shown was digitized from a spatial analysis of habitat relationships by Suring (2014). Suring's analysis used a Bayesian network composed of site, stand, and broad-scale indices to create an overall quality metric. High quality habitat was associated primarily with increased downed wood, and other important factors include high densities of living and dead trees, moderate canopy closure, and low fragmentation (Suring 2014). Audubon Alaska edited this layer by clipping the digitized version of Suring's results to the Alaska Department of Fish and Game (2016a) range extent of the northern flying squirrel, and removing areas covered by glaciers from GLIMS (2016). Confirmed extent of the POW subspecies was selected from the Alaska Department of Fish and Game (2016a) range extent layer, based on Figure 1 in the publication by Bidlack and Cook (2002).

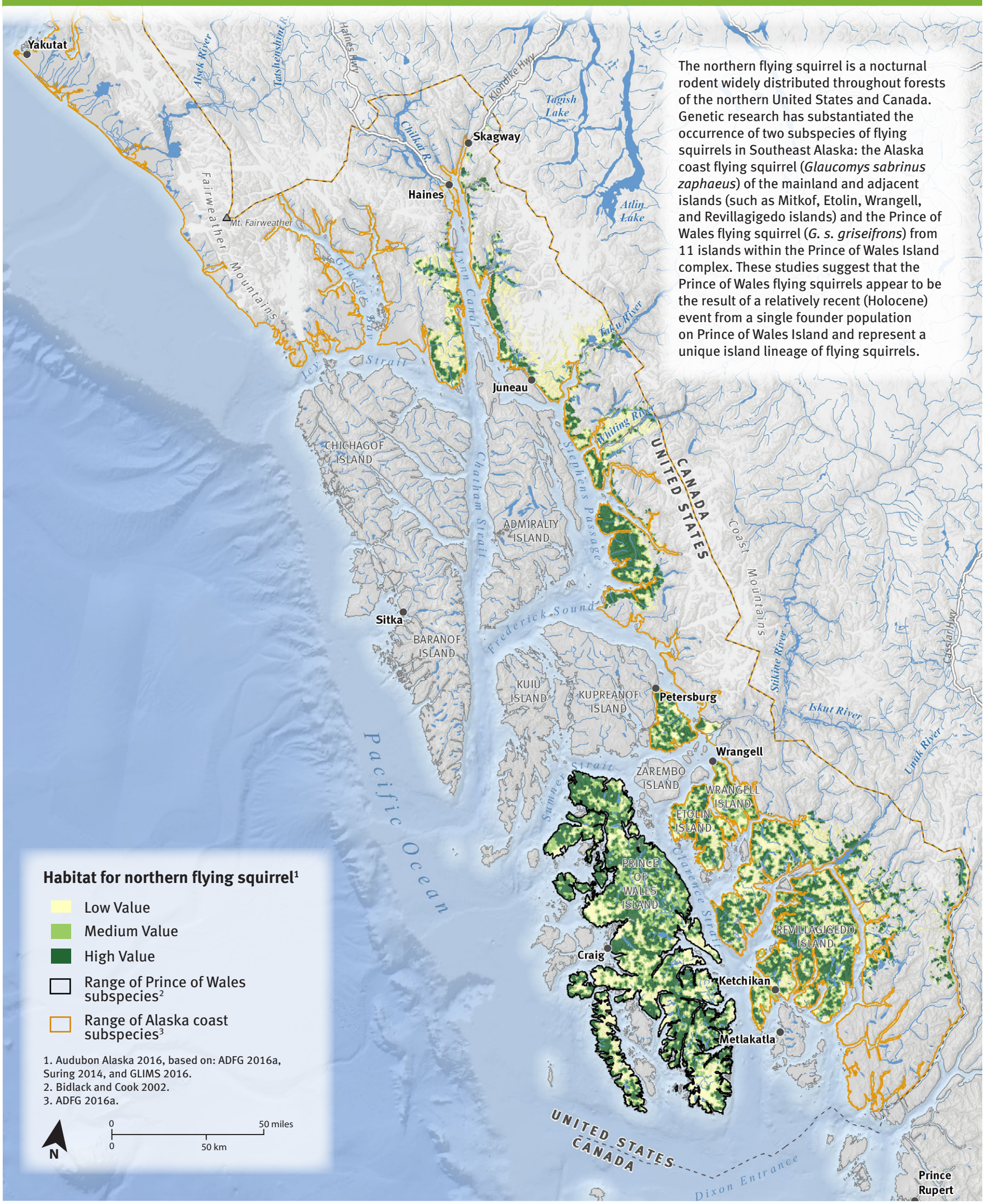
MAP DATA SOURCES

- Alaska coast subspecies range: Alaska Department of Fish and Game 2016a
- Confirmed POW subspecies range: Bidlack and Cook (2002)
- Habitat quality: Audubon Alaska (2016), based on Alaska Department of Fish and Game (2016a), Suring (2014), and GLIMS (2016).

Audubon ALASKA

Northern Flying Squirrel

The northern flying squirrel is a nocturnal rodent widely distributed throughout forests of the northern United States and Canada. Genetic research has substantiated the occurrence of two subspecies of flying squirrels in Southeast Alaska: the Alaska coast flying squirrel (*Glaucomys sabrinus zaphaeus*) of the mainland and adjacent islands (such as Mitkof, Etolin, Wrangell, and Revillagigedo islands) and the Prince of Wales flying squirrel (*G. s. griseifrons*) from 11 islands within the Prince of Wales Island complex. These studies suggest that the Prince of Wales flying squirrels appear to be the result of a relatively recent (Holocene) event from a single founder population on Prince of Wales Island and represent a unique island lineage of flying squirrels.



Map 6.2: Northern Flying Squirrel

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SITKA BLACK-TAILED DEER

John Schoen and Matthew Kirchhoff
Revised by Nils Warnock

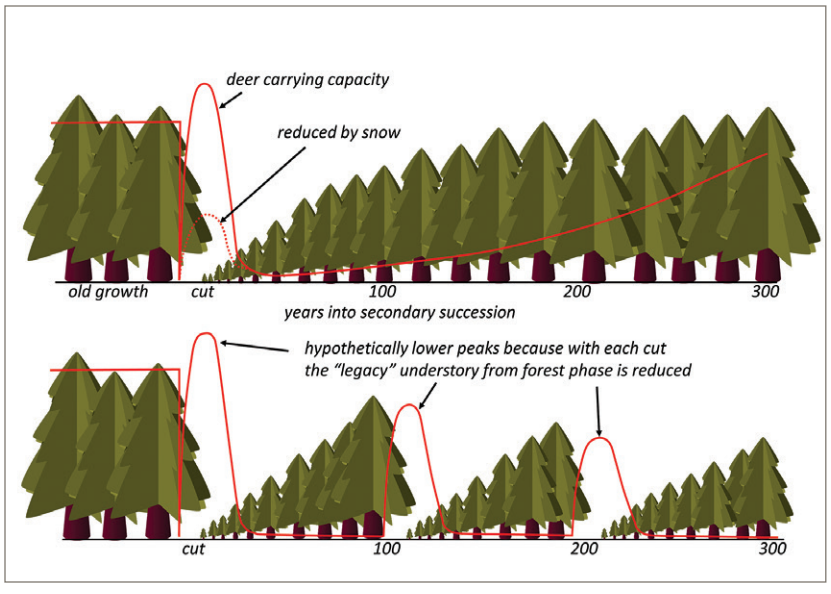
The Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) is endemic and widely distributed along a narrow coastal band of northern British Columbia and Southeast Alaska (Wallmo 1981). Genetic data suggest that this subspecies of mule deer recolonized Southeast around 10,000–15,000 years ago from coastal Washington and Oregon following the retreat of glaciers (Latch et al. 2009). They are the most common and widespread large mammal of the Alexander Archipelago.

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). 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. Alaska Natives have relied on deer as an important food resource for centuries (Crone and Mehrkens 2013), and today deer remain the most sought after big game animal throughout much of coastal Southeast (Person and Brinkman 2013).

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 1993). See Figure 6-2 for an illustration of carrying capacity related to forest succession after clearcut logging.

Sitka black-tailed deer are naturally distributed throughout most of Southeast, south of Berner's Bay and Cape Spencer (MacDonald and Cook 1996, 1999). They occur on most islands of the Alexander Archipelago, except offshore islands like Forrester, Hazy, and St. Lazaria, and most islands within Glacier Bay (Klein 1965a). Even many small (200 ac [80 ha]) islands adjacent to larger islands often have transient deer populations. 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 2003b, Barten 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 McKnight 1973).



Erika Knight

FIGURE 6-2 Deer Carrying Capacity (adapted from Wallmo and Schoen 1980). Hypothesized changes in deer carrying capacity during successional development of hemlock-spruce forests in Southeast 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.

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, Meriam 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 1965a, 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 1965a, Schoen and Kirchhoff 1990, Parker et al. 1999, Person and Brinkman 2013).

Figure 6-3 and the following sections briefly summarize seasonal habitats and forages used by deer throughout their annual cycle in Southeast.

SPRING SEASONAL HABITAT USE

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). Most spring deer use on Admiralty Island generally occurred below 1000 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). A study in an extensively logged area of northern POW Island (Yeo and Peek 1992) revealed deer using clearcuts in spring, with a recorded 65% of radio-collared deer use occurring in clearcuts (1–30 yr after logging). 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*); fiddlehead ferns; new leaves of devil's club (*Oplopanax horridum*) and blueberry plants (*Vaccinium spp.*); alder catkins and buds (*Alnus rubra*); and many newly emerging forbs (Hanley and McKendrick 1985, Parker et al. 1999).

SUMMER SEASONAL HABITAT USE

Summer is an important time for deer to continue 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 1965a, Schoen and Kirchhoff 1985, Schoen and Kirchhoff 1990, Yeo and Peek 1992, Farmer 2002).

During summer, subalpine habitats are generally very productive, providing an abundance of high-quality forage (Klein 1965a, Hanley and McKendrick 1983, 1985). In portions of Southeast, where deer have access to subalpine habitats, many deer migrate seasonally to these higher-elevation sites. On POW 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 Peek 1992, Farmer 2002).

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FIGURE 6-3 The 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 onto upper forest slopes. Resident deer generally remain at lower elevations but use more forest openings for feeding.

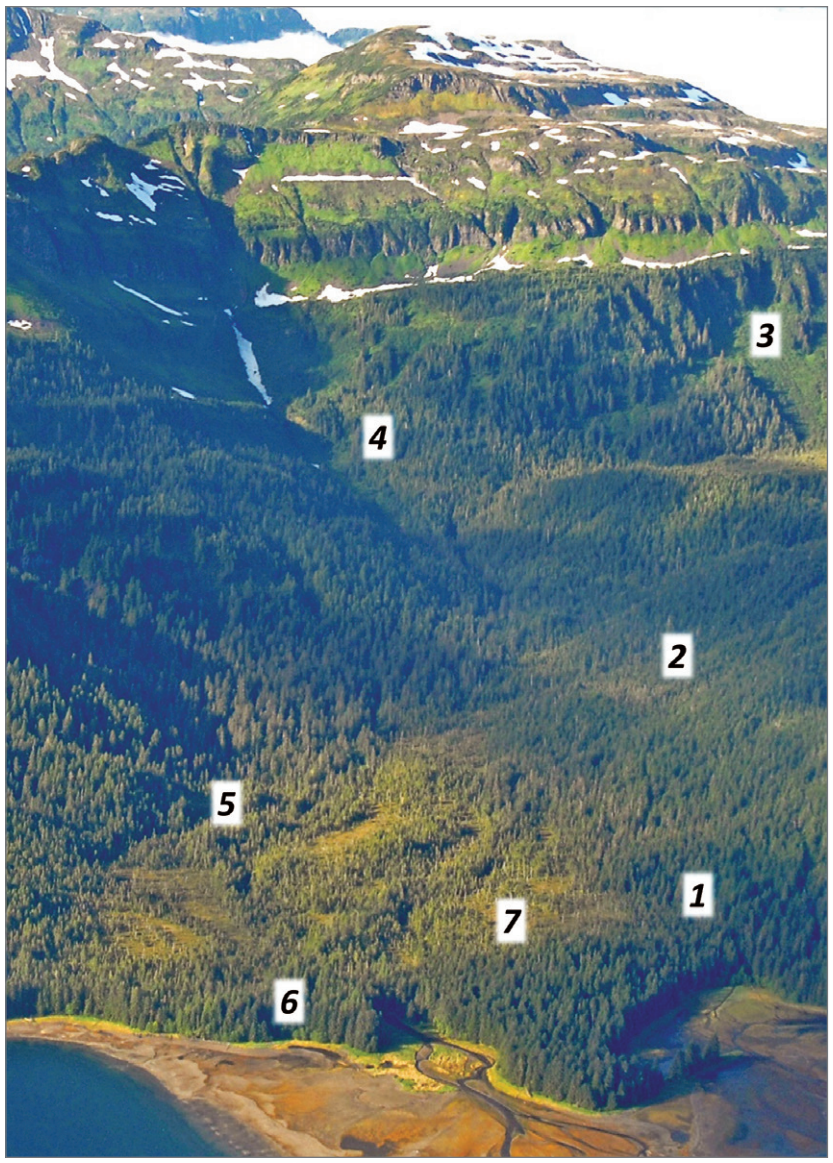
3. **Subalpine Summer Ranges:** Migratory deer generally reach their ranges by the end of June or early July. On subalpine meadows between 1,800 and 3,000 ft (549–915 m), deer find abundant and nutritious herbaceous forage interspersed among stunted stands of Sitka spruce and mountain hemlock (*Tsuga 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 forest 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 be seen foraging along upper beaches and young clearcuts during spring at this time.



John Schoen

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.

John Schoen

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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 (*Vaccinium spp.*), leaves of other shrubs, bunchberry (*Cornus canadensis*), trailing raspberry (*Rubus pedatus*), and several fern species (Hanley and McKendrick 1985, Parker et al. 1999).

FALL SEASONAL HABITAT USE

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. 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 type, 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 SEASONAL HABITAT USE

Deer distribution is most limited during winter. On unlogged lands in northern Admiralty Island in northern Southeast, virtually all winter deer use was within old-growth forest habitat below 1000 ft (300 m)(Schoen and Kirchhoff 1990). 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).

Deer selection for old-growth stands of large trees is a response to the ability of bigger trees to intercept snow, reducing snow depths on the ground (Hanley and Rose 1987, Kirchhoff and Schoen 1987). Deer used old growth more during years of heavier snow, and used young 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.

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. 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). During winter, deer substantially increase their use of shrub stems, conifers, and arboreal lichens, particularly when snow accumulation covers other more nutritious forage (Hanley and McKendrick 1985, Parker et al. 1999). 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, windthrow-generated stands of hemlock-spruce may also provide good winter deer-habitat. Some of these windthrow-generated stands, although technically not old growth, also provide adequate snow interception and abundant forage production, particularly on south-facing slopes.

POPULATION INFORMATION

Quantitative estimates of the Southeast Alaska Sitka black-tailed deer population are lacking (US Forest Service 2012). 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, Brinkman et al. 2011).

Although winter snowpack varies significantly across Southeast, there is a clear trend toward deeper, more prolonged snow in northern and eastern Southeast. 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, including the southern Cleveland Peninsula north of Ketchikan, Thomas Bay near Petersburg, Cape Fanshaw, and Juneau.

John Schoen

Recent clearcuts produce an abundance of deer forage including forbs, ferns, and shrubs. The availability of this forage to deer 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. Then, these second-growth 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 again.

The major predators of deer in Southeast are wolves (*Canis lupus*), black bears (*Ursus americanus*), and brown bears (*Ursus arctos*). Deer are the major prey species for island populations of wolves in Southeast (Smith et al. 1987, Kohira 1995, Person 2001).

Deer populations in Southeast are currently highest on the northern islands north of Frederick Sound, intermediate on the central and southern islands, and lowest on the mainland coast (Kirchhoff 2003b, Lowell 2004, Mooney 2004, Porter 2004). Some islands of Game Management Unit (GMU) 3 (in central Southeast) have still not rebounded from three severe winters in the late 1960s and early 1970s (Olson 1979, Kirchhoff 2003b). 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 2003b) and high black bear numbers (Peacock 2004).

Deer hunting is an important and highly valued recreational and food-gathering activity throughout most of Southeast where deer are abundant (Person and Brinkman 2013). 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 2004). Of 20 subsistence communities in Southeast, an average of 90% of households harvested subsistence resources, and deer made up an average of 23.6% of subsistence food in those households (Kruse and Frazier 1988, US Forest Service 1997a).

CONSERVATION ISSUES

The Sitka black-tailed deer in Southeast is a Management Indicator Species under the USFS 1997 Tongass National Forest Land and Resource Management Plan (TLMP) (US Forest Service 1997b;2012). The deer is one of six species identified by the USFS (2012) as having special management concerns. Low-elevation old-growth forests have been documented as important winter habitat. This is particularly the case for large-tree old growth during deep winter snows.

Converting productive old-growth forest habitat—with abundant, high-quality food—to less-productive, even-age second growth will reduce habitat values and the productivity and resilience of deer populations throughout their range in Southeast. 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, even the temporary availability of forage in clearcuts is greatly diminished. Furthermore, Farmer et al. (2006) found that deer using clearcuts and second-growth habitats have a higher mortality risk compared to those in old-growth habitats.

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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 is already happening on POW Island (Person 2013).

Clearcutting is the dominant timber harvest method in Southeast (US Forest Service 1997a) and has a much different effect on forest structure than the natural disturbance regime caused primarily by wind (Alaback 1982, Brady and Hanley 1984). Forest succession in Southeast following clearcutting has been described by Harris (1974), Harris and Farr (1974), Harris and Farr (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. 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.

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 and Schoen 1980, Alaback 1982, Person and Brinkman 2013). 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 Tappeiner 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 spacing to prolong understory productivity, however, reduces gross timber volume and wood quality (DeMars 2000). On POW Island, deer densities on managed land logged >30 years ago supported significantly fewer deer compared to both managed land logged <30 years ago and unmanaged land (Brinkman et al. 2011).

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, Duncan 1999, Deal 2001).

Studies comparing winter deer use of old growth to clearcuts and second growth found significantly lower use (by seven times) 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).

Regardless of season or snow conditions, 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, Brinkman et al. 2011, Person and Brinkman 2013). Under deep-snow conditions, 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 a timber rotation of fewer than 200 years, long-term habitat values are reduced because of limited forage resources within the closed-canopy, even-aged second growth. This permanent cycle of diminishing forage has been described as "succession debt" (Person 2001, Person and Brinkman 2013).

Not just the quantity of forage is important to deer but also the quality of forage. 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, Van Horne et al. 1988, Hanley et al. 1989). Thus 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).

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).

Optimal habitat conditions in Southeast Alaska must encompass diverse habitats that provide deer with a variety of options to satisfy changing seasonal needs and variable weather conditions. Large- and medium-tree stands of hemlock-spruce, particularly at low elevations, have high habitat value for deer in deep-snow winters. 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 (Albert and Schoen 2013). The disproportionate loss of this scarce but important habitat will disproportionately affect deer during severe winters (Schoen and Kirchhoff 1990, Person and Brinkman 2013).

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 (Albert and Schoen 2007b).

MAPPING METHODS

The winter habitat capability model for deer (Albert and Schoen 2007b), adapted from a model described in Suring et al. (1992), provides a relative index of winter habitat, based on the following inputs: snow accumulation, elevation, aspect, and land cover. Each of these was divided into categories, then attributed in a matrix of relative habitat capability values:

- Elevation: < 800 ft, 800–1,500 ft, >1,500 ft (< 244 m, 244–457 m, >457 m)
- Aspect: South, West, East, North
- Snow: Low, Intermediate, High
- Land Cover: High Volume, Medium Volume, and Low Volume Productive Old Growth; Non-Productive Old Growth; Young Growth, 0–25 years old; Young Growth, 2–200 years old; Other.

See Albert and Schoen (2007b) for more details and the complete capability value matrix.

This model was evaluated in March 2005 by an interagency expert review panel, including ADFG, Audubon Alaska, The Nature Conservancy, USFS, and USFWS, and as a result of this workshop, the relative snowfall model was updated using the PRISM climatic model. This model uses point data from weather stations from 1961–1990, combined with a digital elevation model, to generate gridded estimates of monthly and annual temperature, better accounting for the effects of terrain and mountains.

MAP DATA SOURCES

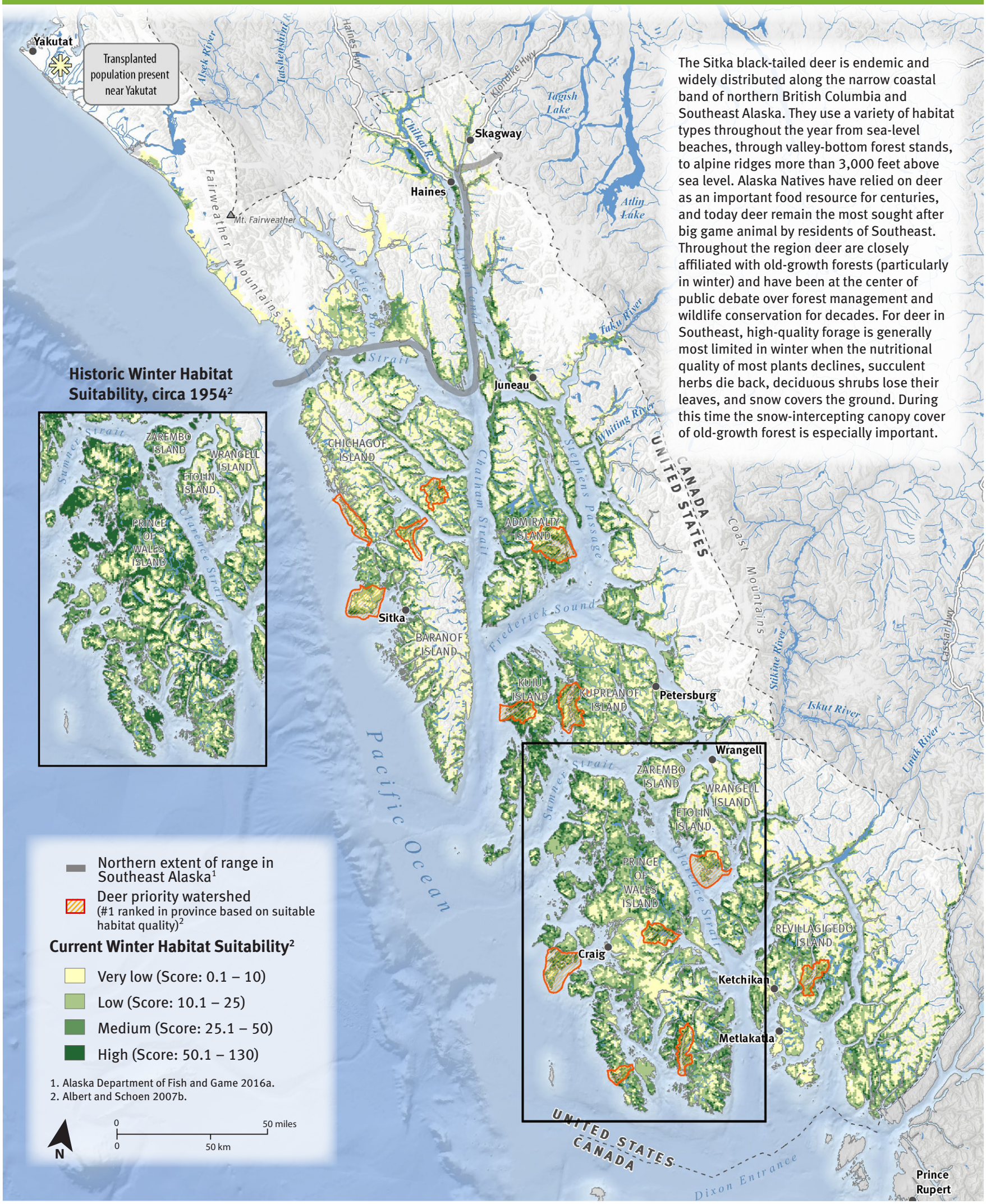
- Habitat suitability index model: Albert and Schoen (2007b).
- Northern range extent: Alaska Department of Fish and Game (2016a).

Sitka Black-tailed Deer

Audubon ALASKA

The Nature Conservancy

The Sitka black-tailed deer is endemic and widely distributed along the narrow coastal band of northern British Columbia and Southeast Alaska. They 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 feet above sea level. Alaska Natives have relied on deer as an important food resource for centuries, and today deer remain the most sought after big game animal by residents of Southeast. Throughout the region 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. 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, deciduous shrubs lose their leaves, and snow covers the ground. During this time the snow-intercepting canopy cover of old-growth forest is especially important.



Map 6.3: Sitka Black-tailed Deer

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ALEXANDER ARCHIPELAGO WOLF

Melanie Smith, John Schoen, David Person, and Benjamin Sullender

Although the gray wolf (*Canis lupus*) was once widely distributed and occupied a variety of habitats throughout the northern hemisphere, its current range has been substantially reduced (Nowak 1979, Mech 1995). In recent years, the wolf has recolonized portions of its historic range and today there are more than 5,500 wolves in the contiguous US (US Fish and Wildlife Service 2015). In North America, most people associate wolves with the northern wilderness areas of Canada, Alaska, and Minnesota. Unlike most of the Lower 48 states where wolf populations have been extirpated or significantly reduced in numbers and range, the wildlands of Alaska generally maintain secure and productive wolf populations.

Wolves are highly social canids that generally organize into packs. Packs utilize a specific home territory for hunting and breeding, and defend their territory from other wolf packs. In most parts of Alaska, wolf packs depend on large ungulate populations—primarily moose (*Alces alces*) and caribou (*Rangifer tarrandus*)—as their major food resource. Wolves in Southeast Alaska are largely co-located with their primary prey, the Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), which populate the islands and southern mainland. Southeast Alaskan wolves also prey upon moose and mountain goats (*Oreamnos americanus*) along much of the mainland coast. Deer are an especially important food source during winter months, comprising up to 90% of their diet (Person et al. 1996). Other important food items consumed by wolves include beaver (*Castor canadensis*) and spawning salmon (*Oncorhynchus spp.*) (Wood 1990, Kohira 1995).

Within Southeast Alaska, the Alexander Archipelago wolf (*C. l. ligoni*) is smaller and has darker fur than other Alaskan wolf populations (Goldman 1944, Wood 1990). As a result of the isolated and naturally fragmented geography of Southeast, the Alexander Archipelago wolf is more restricted in distribution and potentially more sensitive to human activity and habitat disturbance than elsewhere in the state. This greater sensitivity is especially concerning in the southern archipelago where deer populations are strongly impacted by the loss and fragmentation of old-growth forest habitat.

Bob Armstrong

A black wolf near Juneau. Southeast wolves are generally smaller and darker than interior Alaska wolves.

DISTRIBUTION

Wolves are distributed throughout the Southeast Alaska mainland and most of the larger islands south of Frederick Sound (Klein 1965b, MacDonald and Cook 1999). It is likely that only the largest islands (including POW, Kuiu, Kupreanof, Mitkof, Etolin, Revillagigedo, Kosciusko, Zarembo, and Dall islands) maintain persistent wolf populations (Person et al. 1996). Wolf packs may occur on smaller islands and overlap several islands at a time, but usually do not persist there permanently (Klein 1965b, Person et al. 1996). The distribution of wolves in Southeast is similar to the distribution of black bears (*Ursus americanus*). Neither wolves nor black bears occur on the northern islands of Admiralty, Baranof, or Chichagof (ABC Islands), where brown bears (*U. Arctos*) are abundant.

Wolves are good swimmers and regularly travel between nearby islands. Although wolves can swim up to 2.5 mi (4 km) (Person et al. 1996), larger expanses of open water appear to act as a barrier to movement and likely limit wolf distribution throughout Southeast (Person et al. 1996). The areas surrounding the Sitkine River Delta in central Southeast comprise the most significant dispersal corridor between the southern islands and the mainland.

TAXONOMY

Because fossil evidence of wolves is lacking in Southeast, it appears that wolves have occurred in the region only during the last 10,000 years and the species likely colonized the area from glacial refugia to the south (Klein 1965b, Weckworth et al. 2005). Weckworth et al. (2005) have described two distinct genetic clusters of wolves within Southeast: the isolated POW Complex, and the rest of Southeast. This relationship parallels the high level of endemism (i.e., taxonomic group restricted to a particular region) found in that area for other species (MacDonald and Cook 1996, Bidlack and Cook 2002, Fleming and Cook 2002, Lucid and Cook 2004).

Recently, due in part to the USFWS status review process, debate about Alexander Archipelago wolf taxonomy intensified. Most recently, Cronin et al. (2014) sampled wolves across North America to identify geographic genetic differentiation, concluding that there is "considerable differentiation...between wolves in Southeast Alaska and wolves in other areas." They also concluded that the immense variability within the Southeast Alaska population precludes designation of Southeast Alaska wolves as a unique subspecies of gray wolf.

Following that, Weckworth et al. (2015) and Fredrickson et al. (2015) challenged Cronin et al.'s logical framework, making a compelling case for the existence of the Alexander Archipelago wolf subspecies as well as the POW population segment. Most recently, in early 2016, the USFWS published its status review, and found the Alexander Archipelago wolf of Southeast Alaska and coastal British Columbia to

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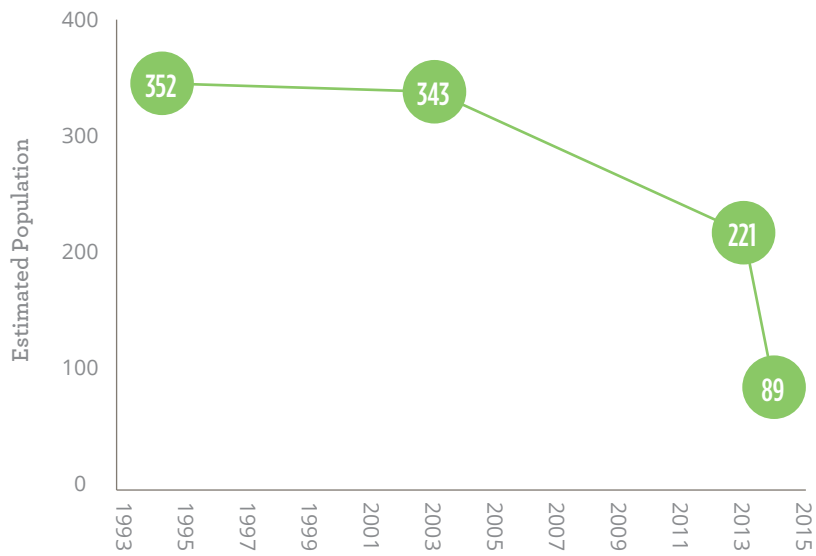
TABLE 6-2. Estimated abundance of wolves in Game Management Unit 2 (Prince of Wales Complex).

Source	Estimate[1]	Year	GMU2 Total
Person et al. (1996)	39 wolves per 1000 km²	Fall 1994	352
ADFG (2009)	38 wolves per 1000 km²	Fall 2003	343
ADFG (2015b)	24.5 wolves per 1000 km²	Fall 2013	221
ADFG (2009)	9.9 wolves per 1000 km²	Fall 2014	89

[1]Wolf density estimates were applied across the Game Management Unit 2 (GMU2) extrapolation area (9025 km²). Note that the 2003 ADFG estimate was expressed as 326 wolves on POW and surrounding islands (~8615 km²) rather than as a density, then converted to cover the same area.



be a valid subspecies of gray wolf and described the POW Complex as a discrete population. However, they also found that listing was not warranted at this time.

ABUNDANCE

Person et al. (1996) estimated the Southeast Alaska wolf population as between 700 and 1,000 individuals during the fall of 1995; island populations generally occur at higher densities than mainland populations. In 1995, an estimated 352 wolves populated POW and the complex of adjacent islands including Kosciusko, Dall, and Outside islands (i.e. the POW Complex); these wolves likely represented a third of the total Southeast Alaska wolf population and thus the highest-density wolf population in the state (Person et al. 1996, Person 2001). However, the abundance of wolves in the POW Complex has significantly decreased in the last two decades.

In 2013, Person and Brinkman developed a predator-prey model for POW and Kosciusko islands that represented past and future conditions. The researchers conducted a thought experiment as though the wolf had been listed as threatened under the Endangered Species Act (ESA), and used their model to simulate the likely outcome. The model included hypothetical data of a wolf harvest curtailment in 1996. Even with this hypothetical listing included in the model, the researchers found that "wolf and deer populations will decline substantially by 2045" (Person and Brinkman 2013).

ADFG estimated 221 wolves resided in the POW Complex in 2013, which represented a 37% decline during the 18 years since the 1995 estimate of 352. This decline caused great concern among experts, reflecting what they called the unraveling of a healthy ecosystem and previously functioning predator-prey relationship on POW Island (Person 2013, Person and Brinkman 2013).

One year later, in 2014, a follow-up population estimate by ADFG indicated a more dramatic decline: an estimate that only 89 wolves remained. This number reflected a 60% loss from the previous year and a total 75% loss over the 1994 to 2014 time period. Additionaly, the 2014 estimate was calculated prior to the documented legal harvest of 29 wolves in 2015.

In 2016, the USFWS concluded a status review for the Alexander Archipelago wolf subspecies in consideration of these changes in population abundance and habitat impacts. USFWS found the GMU2 population to be discrete under its distinct population segment policy, but did not find the population to be significant, citing that it constituted only 6% of the rangewide population on only 9% of the suitable range (US Fish and Wildlife Service 2016). Using the current depressed population numbers to make this finding appears to be circular reasoning. Although the current population may make up only 6% of the estimated total individuals, the historic GMU 2 population (circa 1995) constituted approximately 20% of Alexander Archipelago wolves. According to Table 6-1, POW wolves historically occurred in densities four times greater than today, likely among the highest density occurrence across their range.

WOLF HUNTING AND TRAPPING

Alaska classifies wolves as both furbearers and big-game species and allows harvest by both trapping and hunting. From 2001 to 2010, the average annual wolf harvest for Southeast (GMUs 1–5) was 152 animals (Alaska Department of Fish and Game 2012). During this time, the average annual harvests were 61 wolves for the mainland (GMUs 1 and 5) and 91 wolves for the islands (GMUs 2–3).

The trapping season for wolves in Southeast generally runs from late fall to late spring. The hunting season generally runs from early fall to late spring. Dates vary to some extent across units, and are currently significantly shortened in GMU2 (POW and adjacent islands). On the southern islands (GMUs 2 and 3), hunting and trapping mortality of wolves was significantly higher in areas with the highest road densities (Person et al. 1996, Person and Russell 2008).

Research shows that the legal harvest number significantly underestimates the total take of wolves in the POW area. Illegal take of wolves on the Forest is common and "may at times equal the legal harvest" (Person and Brinkman 2013). Person and Russell (2008) reported in their study of radio-collared wolves on POW Island that 47% of the total wolf take was from unreported illegal harvest.

HABITAT RELATIONSHIPS

The wolf is identified as a Management Indicator Species under the 2008 TLMP. The USFS selects Management Indicator Species for emphasis in planning, and monitors the species during forest plan implementation to assess the effects of management activities on their populations and the populations of other species whose habitat needs are similar (US Forest Service 2008b).

Throughout much of Southeast, particularly on the southern islands and portions of the mainland, wolves primarily prey upon deer, which represent the largest component (up to 77%) of their diet (Smith et al. 1987, Kohira 1995, Person et al. 1996). Person et al. (1996) estimated that the annual predation rate was approximately 26 deer per wolf. Pack size on the southern islands ranged from 2–16 wolves per pack, and home range size was correlated with pack size, which is in turn related to the area of winter deer habitat (Person 2001).

Critical winter deer habitat is a good indicator of habitat quality for wolves in southern Southeast (Person 2001). On northern POW Island (which has been extensively logged during the last 60 years), clearcuts within 30 years of logging and old-growth hemlock forests received the highest proportion of winter use by radio-collared deer (Yeo and Peek 1992). During winters with increasing snow depths, deer used old growth more than clearcuts. Optimal habitat conditions for deer in Southeast must encompass a diversity of habitats that provide deer with a variety of options to satisfy changing seasonal needs and variable weather conditions. Large- and medium-tree old growth (particularly at low elevations and on southerly exposures) has high habitat value for deer, particularly when deep snow accumulations occur (Hanley and Rose 1987, Kirchhoff and Schoen 1987, Schoen and Kirchhoff 1990).

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Melanie Smith

High road density is linked to increased wolf mortality rates in Southeast Alaska.

The absence of deer forage in second growth generally continues for more than a century following canopy closure (30–130 years). Therefore, 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 and Schoen 1980, Alaback 1982). Experts describe this situation as "succession debt" (Person 2001, Person and Brinkman 2013) because the full impacts on wildlife, particularly deer, may not immediately be expressed, but will continue for many decades after timber harvesting.

This succession debt is most prounounced on the POW Complex, and has implications for the island's wolves. Over the next twenty years, an estimated 360,000 ac (146,000 ha) of clearcut land in GMU2 will be in the stem exclusion phase, equal to about 35% of the total historic productive old growth. Similarly, approximately 40% of the high-quality deer habitat in the POW Complex has been clearcut in the last 60 years. This reduction in deer habitat will likely translate to a significant population decline in deer, which will in turn precipitate a consequent decline in the number of wolves in the region.

In addition to potentially reducing the density of the wolf's primary prey, forest management also has a direct effect on wolf mortality. As deer populations decline, people in local communities may turn to predator control to limit competition for their deer hunting, which can result in illegal poaching and increased political pressure to raise the legal harvest (Person and Brinkman 2013). The current high rate of illegal wolf take in the POW Complex (Person and Russell 2008) suggests that some members of the community may already be practicing unauthorized "wolf control" to enhance deer populations.

The roads constructed for old-growth logging facilitate legal hunting and trapping as well as illegal poaching. Not surprisingly, hunting and trapping generally take place near roads and beaches because access is easier. Brinkman et al. (2009) found that deer hunters on POW Island generally do not travel more than 6 mi (10 km) from a road in pursuit of large game, with a median distance of 2 mi (3.2 km). The further away a game animal stays from a beach or road, the more likely it is to survive. The POW Complex has about 4,200 mi (6,760 km) of roads. With such an extensive network of existing roads, the average distance to any road within GMU2 is 2.1 mi (3.4 km), and only 1.7 mi (2.7 km) on POW Island itself, leaving little secure habitat for wolves or deer.

Wolf research in the lake states has identified a strong negative correlation between road density and wolf abundance, with wolves being extirpated in areas where road densities exceeded 0.9 mi/mi^2 (0.6 km/km^2) (Jensen et al. 1986, Mech et al. 1988, Fuller 1989). Similarly, in Alaska, Person and Russell (2008) found that mortality rates increase up to a road density of 1.4 mi/mi^2 (0.9 km/km^2), after which population instability ensues.

Road density in the region is high. Density averages 0.8 mi/mi^2 (0.5 km/km^2) across GMU2 and 1.1 mi/mi^2 (0.7 km/km^2) for the North POW Province (based on a 6-mi [10-km] search radius, approximately equal to the average size of the analysis units used in the Person and Russell study). Because those values are averages, many areas have density values well over 1.4 mi/mi^2 (0.9 km/km^2). These broad landscape patterns corroborate habitat modeling, expert opinion, and recent population estimates that illustrate heavy regional habitat impacts.

According to Person (2013), logging has a direct and quantitative impact on the health of wolf populations, especially on isolated POW Island:

"When about 40% of a [wolf] pack's total home range is logged and roaded, there is a very high risk that mortality (mostly from hunting and trapping) will exceed reproduction and the pack area becomes a population sink. Indeed, even when as little as 25% of a pack's home range is logged, the ratio of reproduction to mortality is very close to one. Sinks are only maintained by immigration of wolves from other areas, which...is not likely to happen on Prince of Wales Island given the population's isolation and small numbers."

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Audubon Alaska conducted a spatial analysis using the 25% and 40% thresholds identified by Person (2013) to identify wolf population sinks in GMU2. The analysis included all previously logged areas and all existing roads, buffered to 0.6 mi (1 km; the distance considered readily accessible to hunters and trappers, per Brinkman et al. (2009)). The analysis also used a search area equivalent to an average wolf core home range of 17 mi^2 (44 km^2) (D. Person, personal communication, March 2014). The data combination created a continuous surface that estimated the total logged and roaded area within a wolf home range. Based on the above road density thresholds, most of GMU2 is a population sink for wolves, with 69% classified as likely sink habitat (>40% logged and roaded), 9% more as potential sink habitat (>25% logged and roaded), and 22% as potential source habitat (<25% logged and roaded).

The southern portion of POW Island is less densely roaded, but still may not provide much refuge for wolf populations. This part of the island has lower habitat productivity and smaller deer populations (Woodford 2014), indicating poor habitat quality for wolves (Person 2001). The scarcity of prey likely prevents wolves in southern areas from achieving sufficient density to recolonize the heavily roaded northern areas. With increasing road-induced mortality in the north and insufficient habitat in the south, the POW wolves face an uncertain future.

CONSERVATION ISSUES

To many people, Alaskan wolves represent a symbol of wilderness and ecosystem integrity. For many years, the wolf population in the Lower 48 states was listed as endangered or threatened under the Endangered Species Act. Some portions of the population have now been recovered at great expense and effort, while others remain listed. Alaska has the opportunity and responsibility to avoid the mistakes that led to such situations. The wolf's large area requirements and ecological position as a top-level carnivore make it an important umbrella species for maintaining ecosystem integrity throughout its range in Southeast. And because of its vulnerability to cumulative human activities, the wolf also serves as an indicator of wildland values. These attributes justify identification of the wolf as a focal species for ecosystem management throughout its range in Southeast and the Tongass National Forest.

Currently, there are significant concerns about the Alexander Archipelago wolf in southern Southeast Alaska. This concern arises from a number of mutually reinforcing factors:

- Genetic evidence for designation as a subspecies (Alexander Archipelago population) and distinct population segment (POW Complex sub-population)
- Very small population estimate
- Steeply declining population trend
- Low female:male ratio resulting in impaired ability to recover population
- Cumulative broad-scale habitat fragmentation and degredataion which depress deer populations and thereby food abundance for wolves
- Persistent anthropogenic threats, including clearcut logging, road construction and rehabilitation, and poaching
- High levels of illegal take.

These myriad factors and the associated uncertainty around the future of the POW Complex discrete population of Alexander Archipelago wolves in particular call for prudent and conservative population management and habitat conservation. Hunting and trapping must take place at a sustainable level for the POW Complex wolf population to survive. The American Society of Mammologists (2015) estimates that 200 wolves are a minimum population needed in the POW Complex before further hunting and trapping should be considered. For now, ADFG, the Alaska Board of Game, and the Federal Subsistence Board should halt all hunting and trapping of wolves in the region, and conduct scientific research to identify a population goal and sustainabale population level. Once a population goal is identified and achieved, a conservative management regime should recognize the high rate of illegal take of wolves and the potential challenges the region's wolf population will face as deer populations on POW decline as a result of succession debt.

Along with these measures by the State, the Forest Service can take immediate and important steps to protect POW Complex wolves. The USFWS (2016) found timber to be the primary stressor on wolf and deer habitat in Southeast Alaska, and report expected further decline in the POW wolf and deer populations. To address this, the USFS should end large-scale old-growth clearcut logging and road-building. Second, the USFS should close unneccessary logging roads in the POW Complex to create large areas of habitat that are more difficult for legal and illegal hunters to access.

MAPPING METHODS

ADFG developed the wolf range layer based on expert input and known habitat associations (Alaska Department of Fish and Game 2016b).

The inset map shows areas predicted as potential sources, potential sinks, or likely sinks. Audubon mapped these patterns based on research by David Person, as described earlier in this account, published in Audubon's Prince of Wales Wolves report (2015a).

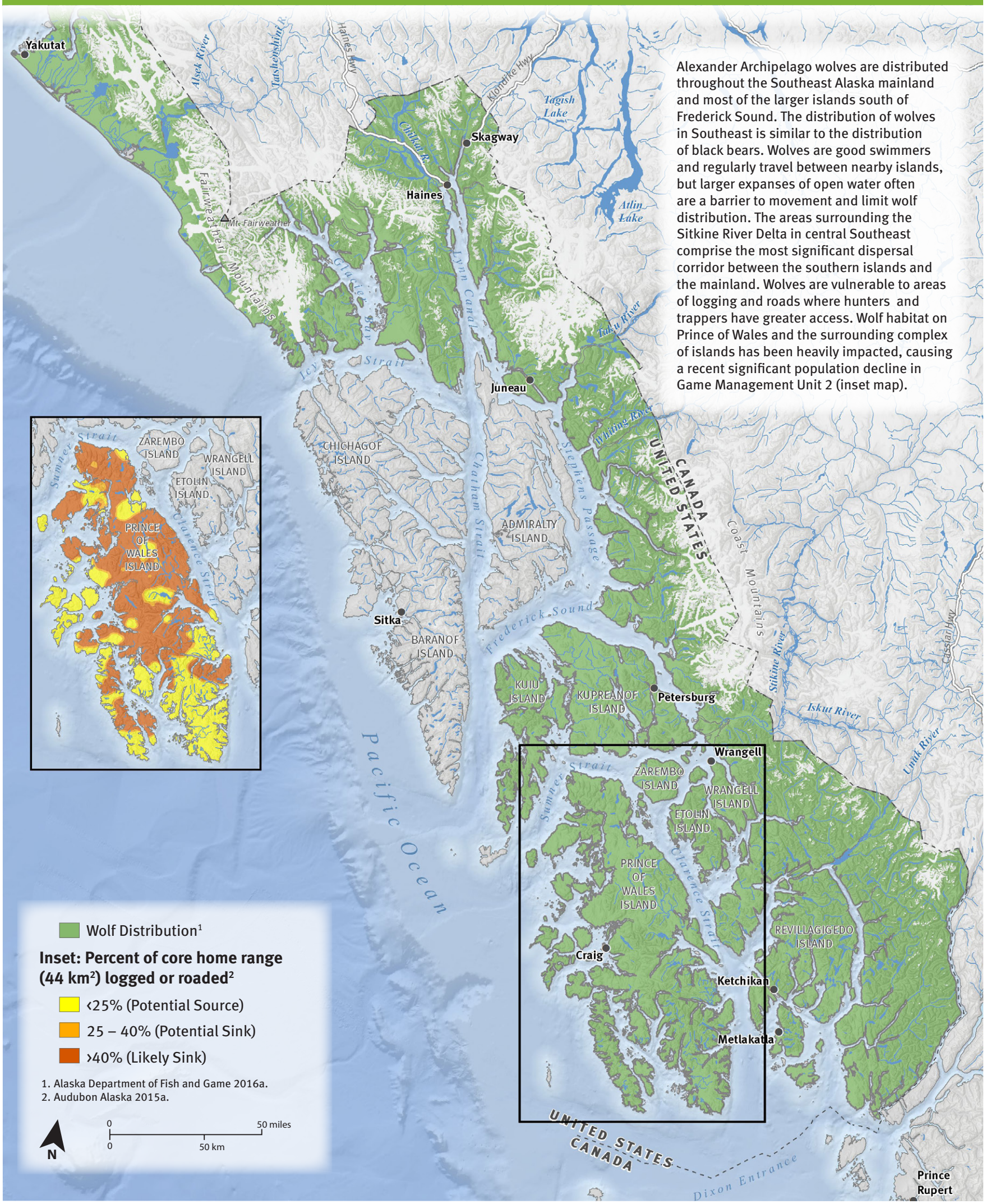
MAP DATA SOURCES

- Range: Alaska Department of Fish and Game (2016a)
- Wolf source-sink analysis: Audubon Alaska (2015a).

John Hyde

Audubon ALASKA

Alexander Archipelago Wolf



Alexander Archipelago wolves are distributed throughout the Southeast Alaska mainland and most of the larger islands south of Frederick Sound. The distribution of wolves in Southeast is similar to the distribution of black bears. Wolves are good swimmers and regularly travel between nearby islands, but larger expanses of open water often are a barrier to movement and limit wolf distribution. The areas surrounding the Sitkine River Delta in central Southeast comprise the most significant dispersal corridor between the southern islands and the mainland. Wolves are vulnerable to areas of logging and roads where hunters and trappers have greater access. Wolf habitat on Prince of Wales and the surrounding complex of islands has been heavily impacted, causing a recent significant population decline in Game Management Unit 2 (inset map).

Map 6.4: Alexander Archipelago Wolf

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BROWN BEAR

John Schoen and Scott Gende
Revised by Nils Warnock

Alaska remains the last stronghold in North America for the brown bear (*Ursus arctos*), supporting roughly 95% of the US population and 55% of the North American population (Miller et al. 1997, Miller and Schoen 1999, McLellan et al. 2008). Brown bears are indigenous to Southeast Alaska, and on the northern islands they occur in some of the highest-density populations on earth (Schoen and Beier 1990, Miller et al. 1997).

Hiking up a fish stream on the ABC Islands during late summer reveals a network of deeply rutted bear trails winding through tunnels of devil's club (*Oplopanax horridum*) and currant shrubs (*Ribes spp.*) beneath centuries-old, giant spruce (*Picea sitchensis*) trees where brown bears fish for spawning salmon (*Oncorhynchus spp.*). 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.

Studies of brown bears in Southeast highlight the fact that there are at least two clades of bears to consider: the brown bears of the Southeast mainland and the brown bears of the ABC islands. Genetic analyses have revealed new and remarkable insights into the biological diversity and geological history of Southeast bears. Mitochondrial DNA results (Talbot and Shields 1996b, Talbot and Shields 1996a) initially suggested that the brown bears of the ABC islands represented an ancient and unique lineage that separated from other brown bear populations approximately 550,000 to 700,000 years ago. Evidence indicated that the DNA of ABC island brown bears was most closely related to polar bears (*Ursus maritimus*) (Talbot and Shields 1996b, Talbot and Shields 1996a). Further microsatellite studies of ABC bears concluded that the bears of Baranof and Chichagof represented a genetic population distinct from the Admiralty population (Paetkau et al. 1998).

However, in a recent paradigm-changing paper presenting results of genome-wide sequence work on ABC bears, it was concluded that the ABC brown bears actually derive from a population of polar bears stranded in the area by the receding ice at the end of the last glacial period (Cahill et al. 2013). As this polar bear population hybridized with migrating brown bears from the mainland, an admixed population formed, with brown bear phenotypes and, to a certain degree, genotypes (Cahill et al. 2013). Clearly, the brown bears of ABC and adjacent islands represent an important component of the biodiversity of Southeast and continue to provide key information about the biogeographic history of this island ecosystem.

Brown bears are found in highest densities on the ABC islands where it is the only large omnivore; the wolf (*Canis lupus*) and black bear (*Ursus americanus*) occur primarily on the southern islands south of Frederick Sound and the mainland. Brown bears are generally absent on the larger islands to the south of the ABC islands. Notable is the lack of brown bears on POW Island, although fossil records indicate that brown bears historically occurred there as recently as about 7,000 years ago (Heaton et al. 1996). Brown bears appear to be regularly dispersed between the mainland coast near the Stikine River Delta and the islands of central Southeast, including Wrangell, Mitkof, Etolin, and Deer (Lowell 2004). People often see bears swimming the smaller (<1 mi [1.6 km]) channels between islands. In addition, brown bears, (albeit at significantly lower densities) are widely distributed on the Southeast mainland from the southern border with Canada to Yakutat Bay, particularly in the vicinity of the large transboundary river drainages (e.g. Flynn et al. 2010, Crupi et al. 2014).

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). 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 important 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. 1999a). Growth rates of plants 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, and see Kirchhoff 2003a). The ecological importance of bear-salmon relationships to the forest ecosystem is complex and not completely understood; but clearly, the interrelationships among salmon, bears, large-tree forests, and other myriad organisms are critically important to the integrity of these productive and increasingly rare ecosystems.

A female brown bear walks the beach near Pack Creek on Admiralty Island.

David Shaw

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FIGURE 6-4 The Annual Cycle of a Southeast Brown Bear

1. **Den Emergence:** From late March through May most bears emerge from 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 forest 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.

John Schoen

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 and Beier 1999, Flynn et al. 2007). These home range areas are much smaller than those found along the mainland coast like the Malaspina Forelands near Yakutat (Crupi et al. 2014), to the southeast of Wrangell (Flynn et al. 2010), and in interior portions of North America (Schwartz et al. 2003), presumably because salmon and other food resources are more concentrated on the ABC islands (see graph by Crupi et al. 2014). Seasonal habitat use often varies widely among individuals of both sexes (Titus and Beier 1999, Flynn et al. 2007). These seasonal habitat preferences are affected by changing food quality and abundance.

Because bears are large bodied, are relatively inefficient at digesting low-quality forage, and may only be active for five to eight months of the year, they must concentrate their foraging activity on abundant, high-quality foods. Bears have adapted to periods of food 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 one to four tiny cubs, usually in January.

Figure 6-4 and the following sections briefly summarize the annual cycle of a brown bear.

Spring: Den Emergence through Sea-Level Green-up (late March to mid-May)

Most brown bears in Southeast emerge from high-elevation dens (mean of 2,100 ft [640 m]) during April and May (Schoen et al. 1987). 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). During spring, brown bear diets on Admiralty Island are composed largely of sedges (*Carex spp.*), other green vegetation, and roots (McCarthy 1989). Skunk cabbage roots (*Lysichton americanum*) and horsetail (*Equisetum spp.*) are particularly important spring forage plants. The primary animal components of the spring diet of Admiralty Island bears are deer (*Odocoileus hemionus sitkensis*), voles (*Microtus spp.*), and herring (*Clupea pallasii*) roe (McCarthy 1989).

Early Summer: Green-up to Beginning of Salmon Runs (mid-May to mid-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). 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 (mid-July to mid–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, Flynn et al. 2007, Flynn et al. 2010, Crupi et al. 2014). 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 four to seven 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

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(Hilderbrand et al. 1999b). Salmon make up a major portion of the brown bear diet, although sedges, skunk cabbage, and the berries of devil's club, blueberries (*Vaccinium spp.*), currant, salmonberry (*Rubus spectabilis*), strawberries (*Frageria spp.*)and twisted stalk (*Streptopus spp.*) are also used (McCarthy 1989, Willson and Gende 2004, Crupi et al. 2014).

In this period, 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. During this period, riparian old-growth forest represented about half of the habitat use of radio-collared bears on Admiralty and Chichagof islands. Two-thirds of all Admiralty Island bear locations occurred within a 525-ft (160-m) band on either side of salmon streams (Schoen and Beier 1990).

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. 1999c). 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 element of bear habitat quality (Hilderbrand et al. 1999c, Crupi et al. 2014).

Although salmon streams provide highly valuable feeding habitat in Southeast, not all brown bears use salmon streams. In late summer on northeast Chichagof Island, selection probabilities for habitats used by male bears were highest in estuaries and closed forest, while for females it was estuaries followed by avalanche slopes (Flynn et al. 2007). 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). This subpopulation of "interior" bears did not use 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). 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 (Wielgus and Bunnell 1995, Ben-David et al. 2004).

Fall: Decline in Fish Runs to Denning (mid-September to 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 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 and Beier 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 (*Ribes bracteosum*) (McCarthy 1989). 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. Pregnant females are the first to enter winter dens; females with older cubs and single females den later; 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. Dens occur on moderate to steep slopes, ranging from about 350 to 4,300 ft (107 to 1311 m), but usually between about 500 to 2,000 ft (152 to 610 m) elevation (Schoen et al. 1987, Flynn et al. 2010, Crupi et al. 2014). 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). On Admiralty and Chichagof islands, radio-collared male brown bears spent an average of 165 days in winter dens, compared with 211 days for females with newborn cubs (Schoen et al. 1987). Flynn et al. (2010) noted that at least four of their marked bears left their original den sites for extended periods of time during the winter.

Brown bear densities on the ABC islands are estimated between 823 and 1700 bears/1000 mi^2 (318 to 656 bears/1,000 km^2), which are among the highest in the world. Elsewhere in Alaska, brown bear densities ranged from 26 bears/1000 mi^2 (10 bears/1,000 km^2) in the Alaska Range to 1427 bears/1000 mi^2 (551 bears/1,000 km^2) in the Katmai region of the Alaska Peninsula (Miller et al. 1997).

Human Management

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. The Tlingit people of Admiralty Island call their island "Kootznoowoo," which means "fortress of the bear." 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.

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. Controversy over brown bear management erupted when the 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. 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.

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 is approximately 210 bears (~4% of estimated minimum population), of which about 80% is by nonresidents. 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. While harvest of bears within the GMUs (where data are collected) generally falls within guidelines (Alaska Dept of Fish and Game 2011), the annual human-caused mortality of brown bears in GMU4 in recent years is of management concern (US Forest Service 2012).

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. Public use of this area increased steadily from 668 people in 1988, when a permit system was established, to 1,585 people in 2014 (Alaska Dept of Fish and Game 1998; personal communication, Kevin Hood, USFS, Dec 2015). Additional viewing areas in Southeast

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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 three sites offer viewing of both black and brown bears. Clearly, bear viewing is a growing and economically valuable activity throughout Southeast.

CONSERVATION ISSUES

Because of their large habitat 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 the brown bear as a focal species for ecosystem management throughout its range in Southeast and the Tongass National Forest. To ensure that brown bear populations are well represented throughout their natural range in Southeast and available for human use and enjoyment, areas 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.

The Alaska population densities of coastal brown bears, where salmon are abundant, are significantly higher (up to 80 times) than those 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 et al. 1999).

The brown bear is identified as a Management Indicator Species under the 1997 TLMP. Management Indicator Species 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 (US Forest Service 1997b). The brown bear is also one of six Southeast species identified by the USFS (US Forest Service 1997b) as having special management concerns.

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. However, 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). Along the southern mainland coast of the Southeast, bears are highly vulnerable to spring and fall hunting because of their propensity to move to estuarine and beach fringe habitats (Flynn et al. 2010).

While old-growth forest habitat is used extensively by brown bears in Southeast, clearcuts were sparingly used by radio-collared bears on Chichagof Island (Schoen et al. 1994, Titus and Beier 1994). 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); further, the dense second-growth forests that succeed clearcuts offer poor foraging habitat for bears and other herbivores. 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 2000, Person and Brinkman 2013). 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 kills, illegal killing, and road kills (McLellan and Shackleton 1989, Mattson 1990, McLellan 1990, Schoen et al. 1994, Mace et al. 1996, Apps et al. 2004).

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 (US Forest Service 1995). Although riparian forests make up only a small portion of the land base of Southeast, they have been heavily and disproportionately logged (Shephard et al. 1999, Albert and Schoen 2013).

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. The panel recommended a 500-ft (153-m) buffer along each side of anadromous salmon streams (Swanston et al. 1996). More recently, based on studies of collared brown bears on Northeast Chichagof Island, either complete watershed protection or no-cut buffers of 1000 ft (305 m) were recommended for maintaining abundant, healthy brown bear populations (Flynn et al. 2007). The panel also unanimously agreed that the likelihood of maintaining viable and well-distributed populations of brown bears declined with increasing acres of forest harvested. For reasons discussed above, the panel stressed the importance of maintaining roadless reserves distributed throughout the range of brown bears.

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.

MAPPING METHODS

To evaluate areas as habitat for brown bear, the habitat capability model developed by Schoen et al. (1994) and applied in the TLMP (US Forest Service 1997b), was used (Albert and Schoen 2007b). This model was designed to evaluate habitat capability on a landscape scale based on (1) habitat characteristics and (2) proximity to human activity. Application of this model provided an index of relative habitat values at a landscape scale, and not prediction of density or population size. Availability of salmon is one primary characteristic of high-quality habitat for brown bears in late summer. Vegetation types specified in the model include floodplain forest, beach-fringe forest, upland forest, clearcut or second-growth, subalpine forest, avalanche slopes, alpine tundra, estuary, and other.

In addition to the habitat distribution, this map also shows the top watershed in each biogeographic province, as well as information on how the brown and black bears are distributed throughout the region, based on Cook and MacDonald (2007).

MAP DATA SOURCES

- Habitat suitability index model: Albert and Schoen (2007b)
- Bear regions: Cook and MacDonald (2007)
- Mammal viewing hotspots: Audubon Alaska (2015b), based on Alaska Department of Fish and Game (2015c) and Alaska Department of Fish and Game (2015d).

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BLACK BEAR

John Schoen and Lily Peacock
Revised by Nils Warnock

The black bear (*Ursus americanus*) is the most abundant bear in Alaska. It is indigenous to Southeast Alaska where the species is common along the mainland coast and southern islands. Throughout their range in Southeast, black bears are often observed during spring and early summer grazing along tidal sedge flats at dusk.

Most Southeast black bears have the characteristic coloration of a black coat and brown muzzle. Some brown-colored "cinnamon bears" occur on the mainland, and a white to blue color-phase "glacier bear," although rare, occurs most commonly on the northern mainland between Juneau and Yakutat. The subspecies *U.a. pugnax* is recognized as occurring throughout most of Southeast (MacDonald and Cook 1999). The subspecies *U. a. emmonsii* also is recognized near Yakutat Bay and includes the glacier bear color-phase (MacDonald and Cook 1999).

Adult male black bears in Alaska weigh from 200 to more than 400 lb (91–182 kg), with adult females weighing about half that amount. Southeast bears are the largest black bears in Alaska, and some big males may weigh more than 500 lb (227 kg).

Black bears are distributed along the entire Southeast mainland and on most of the southern islands of the Alexander Archipelago from the Canadian border to Frederick Sound (except Warren, Coronation, and Forrester islands) (Klein 1965b, Manville and Young 1965, MacDonald and Cook 1999). Black bears do not occur on the islands north of Frederick Sound, including the ABC Islands, which are inhabited by brown bears. Black bears occur on Douglas Island near Juneau and Sullivan Island in Lynn Canal. Throughout the islands, the black color-phase is predominant.

In comparison to brown bears, black bears are generally more secretive, more tolerant of human activity, less aggressive and threatening to humans, and have higher reproductive rates than brown bears. Therefore, the vulnerability of black bears to resource development and increasing human interactions is likely lower than for brown bears.

Habitat loss and fragmentation of forestland, however, has isolated some peripheral populations, increasing conservation concerns throughout the southern range of the black bear in North America (Servheen 1990). And because of its vulnerability to cumulative human activities, the black bear may serve as an indicator of wildland values. 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 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 on their accumulated fat reserves until high-quality food again becomes abundant. Dens also provide a secure place for pregnant females to give birth to one to four tiny cubs, usually in January. In two studies on the mainland near Juneau, home ranges were 4–5 mi^2 (10–13 km^2) (Barten 2002).

Most black bears in Southeast probably emerge from winter dens during April and May. Presumably like brown bears, males leave their winter dens before females, particularly females with spring cubs. Following den emergence, many black bears are observed foraging on tidal sedge flats and south-facing avalanche slopes for newly emergent sedges and other vegetation (Erickson et al. 1982). In late May and early June, Sitka black-tailed deer fawns (*Odocoileus hemionus sitkensis*) are an important food item.

Bob Armstrong

A black bear female and two cubs walking a salmon stream in the fall searching for fish.

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By mid-summer, many black bears in Southeast seek out anadromous fish streams where they fish for spawning salmon (*Oncorhynchus spp.*). On the mainland, where black bears overlap with brown bears (*Ursus arctos*), black bears may use salmon streams less frequently to avoid conflict with dominant brown bears. The availability of spawning salmon as a food resource in summer and fall positively affects body size in bears, and reproductive success is strongly correlated to fall body weight in black and brown bears (Rogers 1976, Schwartz and Franzmann 1991, Hilderbrand et al. 1999c).

During summer and fall, black bears also consume abundant berries when available, including salmonberries, blueberries, currants, and devil's club berries (*Vaccimium spp.*). Habitats with abundant berry crops include riparian forest (salmonberry, currants, devil's club), avalanche slopes (salmonberry, currants, devil's club), young clearcuts (salmonberries, blueberries), and alpine-subalpine ridges (blueberries).

By early October, the first winter snowfall generally occurs in the high country and most herbaceous forage is unavailable after the first frosts. Winter denning begins in October and November. Bears require large-diameter trees and snags for denning. Because large trees and snags occur only in old-growth forests (Kramer et al. 2001), old growth represents important winter denning habitat.

POPULATION INFORMATION

Peacock (2004) reported one of the highest-density populations of black bears in North America on northern Kuiu Island. The northern Kuiu density estimate was 3.9 bears/mi^2 (1.5/km^2). In contrast, measured black bear densities on the Kenai Peninsula and in the Susitna basin of Southcentral Alaska were 0.7 and 0.4 bear mi^2 (0.27 and 0.17 bear/km^2), respectively (Schwartz and Franzmann 1991, Miller et al. 1997).

Few other population studies or density estimates have been conducted on black bears in Southeast. However, in 2002 the ADFG (Alaska Dept of Fish and Game 2002) estimated black bear numbers, assuming a density of 1.5 bears/mi^2 (0.58 bear/km^2) throughout forested habitat, in each GMU throughout Southeast.

The ADFG estimates for black bear numbers throughout forested habitat were 7,666 bears for the Southeast mainland from the Canadian Border to Yakutat and 8,740 bears for the southern island population. The total population estimate of more than 16,000 black bears for Southeast may be conservative based on Peacock's research. Although these estimates should be considered very general, the southern island populations likely occur at higher densities than the mainland populations.

No population trend data appear to exist for black bear populations in Southeast Alaska. The black bear is one of the most popular species of big game in Southeast and is hunted by resident and nonresident sport hunters and local subsistence hunters. The 1991–2000 10-year reported annual kill (including sport hunting, defense of life or property, and other) of black bears on the Southeast mainland from the Canadian Border to Yakutat (including Revillagigedo and adjacent islands near Ketchikan) was 224 bears (Alaska Dept of Fish and Game 2002).

Forest management influences habitat quality for bears and also expands road infrastructure, which increases human access (Schoen 1991). In nearly all areas of Southeast, the reported annual kill of black bears has increased significantly (e.g. Pinjuv 2013). This area has been receiving substantial hunting pressure because it is widely recognized for producing trophy black bears. Kuiu Island accounts for the bulk of the harvest (Lowell 2002). The expanding harvest of black bears is compounded by the increasing density of roads that are being constructed concurrently with logging in the southern islands.

Although old-growth forest habitats are often used by black bears in Southeast, young clearcuts are also used extensively by black bears for foraging habitat (Erickson et al. 1982, Lindzey 1986). However, more than 25 years after logging, clearcuts become stem-exclusion forest. Over time, the conversion of old-growth forest to a mix of clearcuts and second growth can be expected to reduce both foraging and denning habitat for black bears (Lindzey 1986).

National Park Service

Glacier bear color-phase of black bear.

CONSERVATION ISSUES

Because of large habitat area requirements and varied habitat use, bears are an umbrella species for maintaining ecosystem integrity throughout their range. The black bear is identified as a Management Indicator Species under the TLMP of 1997 and the Amendment of 2008 (US Forest Service 1997b;2008a). Management Indicator Species 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 (US Forest Service 1997b). It is reasonable to assume that black bears (like brown bears) might play a role in transferring marine nutrients into the terrestrial environment and, therefore, could be considered a keystone species.

To ensure that black bear populations are well represented throughout their natural range in Southeast, areas with a variety of high-value habitat should be identified and protected at the watershed scale within each biogeographic province that supports productive bear populations. The associated map highlights the top-ranked watershed for black and brown bear summer foraging habitat for each biogeographic province.

Roads generally result in harmful impacts to large carnivores (Noss et al. 1996, Trombulak and Frissell 2000), including black bears (Edwards et al. 2013). The construction of roads into roadless black bear habitat will increase human access, which will likely increase the direct mortality of bears through legal hunting, kills in defense of life or property, illegal killing, and road kills.

Little habitat research has been conducted on black bears in Southeast, and this lack of information must be corrected. Conservation of black bears in Southeast will require a comprehensive assessment of bear habitat relationships and a better understanding of the effects of forestry and roads on bear populations.

Maintaining 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) and is likely also important for black bears. The maintenance of riparian buffers along anadromous salmon streams is also vitally important for sustaining productive salmon runs (US Forest Service 1995). Although

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riparian forests make up only a small portion of the land base of Southeast, they have been heavily and disproportionately logged (Shephard et al. 1999, Albert and Schoen 2013).

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 historic 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 (Swanston et al. 1996). The final TLMP record of decision (US Forest Service 1997b) established riparian buffers for brown bears. There are no requirements in the TLMP for black bear riparian buffers. The brown bear risk-assessment panel stressed the importance of maintaining roadless reserves distributed throughout the range of brown bears. In addition, the TLMP fish and riparian risk-assessment panel identified roads as a high risk factor for anadromous fish. It is reasonable to assume that maintaining a network of roadless reserves also would be a sound investment for black bear conservation throughout their range in Southeast. Based on the Audubon-TNC conservation assessment, Southeast provinces with the greatest impacts on black bear habitat were North POW, Etolin / Zarembo, Kupreanof / Mitkof, and Kuiu which have lost 52%, 35%, 33%, and 30% of their original habitat value, respectively (Albert and Schoen 2007a).

Black bear conservation will be enhanced by the protection of key habitats, including important feeding and denning habitats, and management of mortality rates within sustainable levels. Maintaining the productivity of Pacific salmon stocks throughout Southeast is an essential component for conserving productive bear populations.

MAPPING METHODS

To evaluate areas as habitat for black bears, the brown bear habitat capability model was applied (Albert and Schoen 2007b). An interagency group of experts (representing ADFG, USFS, USFWS, Audubon, and TNC) concluded that, in the absence of empirical data on black bear habitat relationships, the brown bear model provided a reasonable representation of summer habitat capability for the black bear throughout its range in Southeast (Albert and Schoen 2007b). This model was designed to evaluate habitat capability on a landscape scale based on (1) habitat characteristics and (2) proximity to human activity. Application of this model provided an index of relative habitat values at a landscape scale, and not prediction of density or population size. Availability of salmon is one primary characteristic of high-quality habitat for bears in late summer.

In addition to habitat distribution, this map also shows the top bear watershed in each biogeographic province (Albert and Schoen 2007b), as well as information on how black and brown bears are distributed throughout Southeast Alaska, based on Cook and MacDonald (2007).

MAP DATA SOURCES

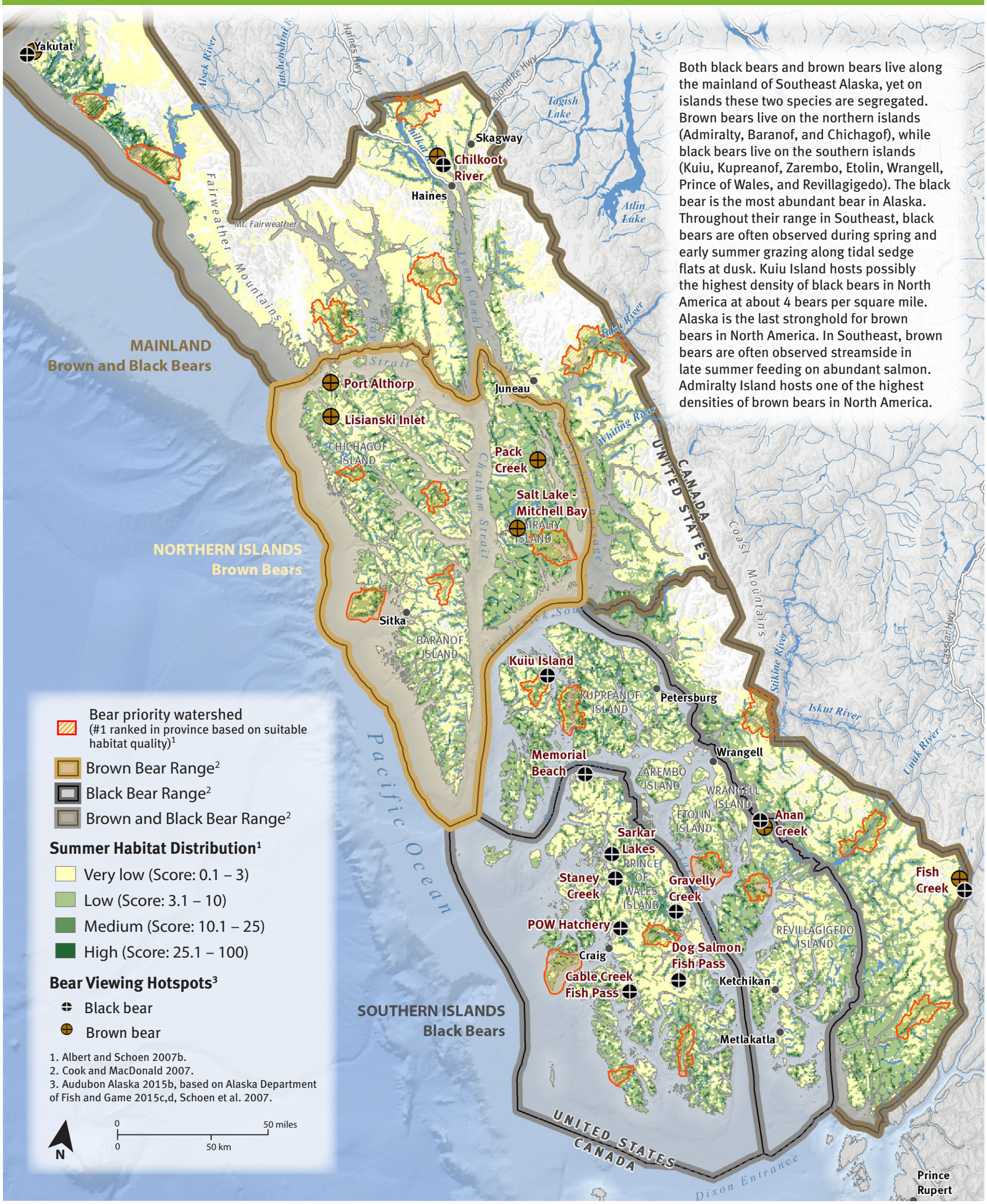
- Habitat suitability index model: Albert and Schoen (2007b)
- Bear regions: Cook and MacDonald (2007)
- Mammal viewing hotspots: Audubon Alaska (2015b), based on Alaska Department of Fish and Game (2015c) and Alaska Department of Fish and Game (2015d).

Bob Armstrong

Audubon ALASKA

The Nature Conservancy

Brown Bear and Black Bear



Both black bears and brown bears live along the mainland of Southeast Alaska, yet on islands these two species are segregated. Brown bears live on the northern islands (Admiralty, Baranof, and Chichagof), while black bears live on the southern islands (Kuiu, Kupreanof, Zarembo, Etolin, Wrangell, Prince of Wales, and Revillagigedo). The black bear is the most abundant bear in Alaska. Throughout their range in Southeast, black bears are often observed during spring and early summer grazing along tidal sedge flats at dusk. Kuiu Island hosts possibly the highest density of black bears in North America at about 4 bears per square mile. Alaska is the last stronghold for brown bears in North America. In Southeast, brown bears are often observed streamside in late summer feeding on abundant salmon. Admiralty Island hosts one of the highest densities of brown bears in North America.

Map 6.5: Brown Bear and Black Bear

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