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NORTHERN FLYING SQUIRREL

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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).

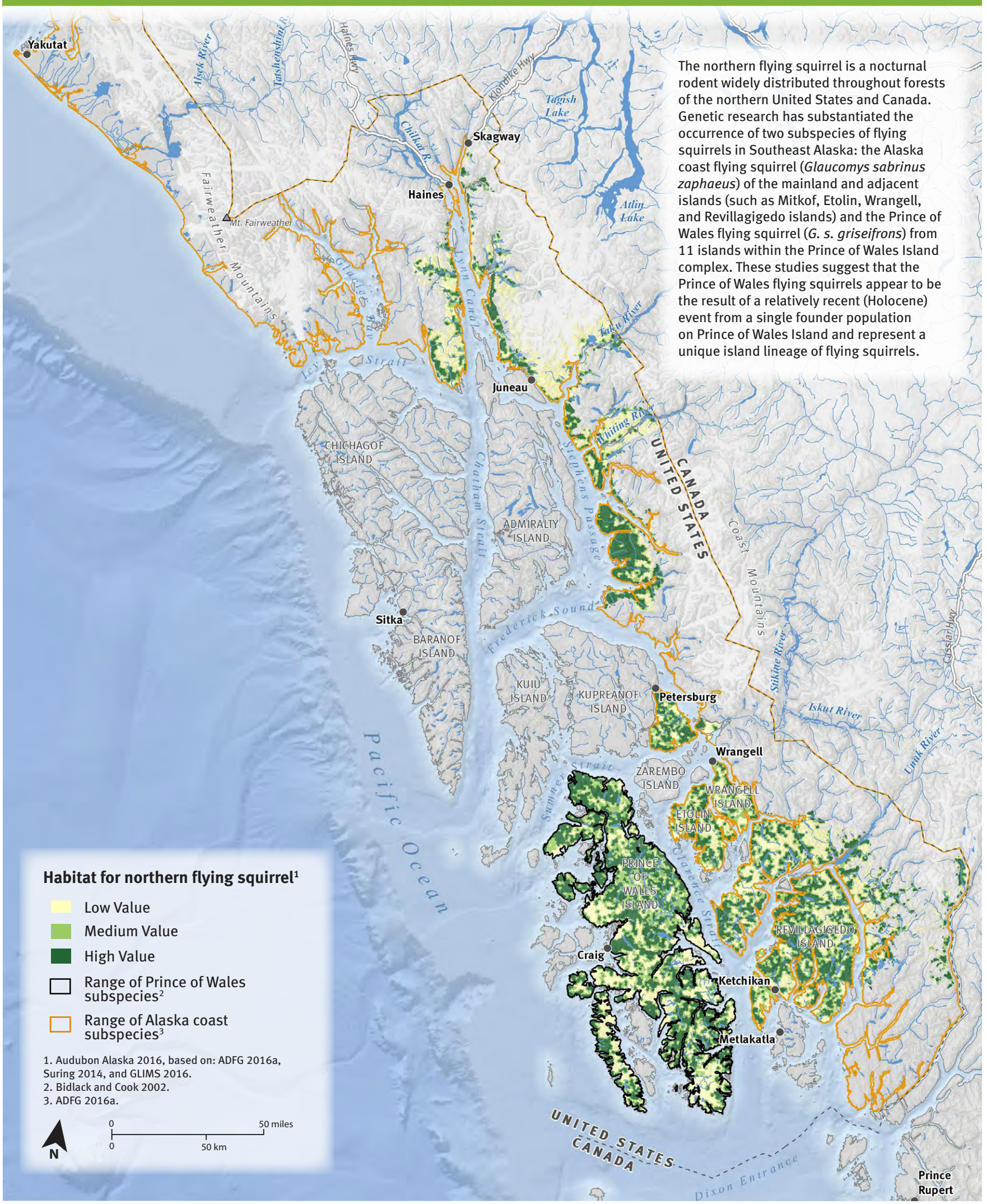
MAP DATA SOURCES

- 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.



Habitat for northern flying squirrel[1]

- Low Value
- Medium Value
- High Value
- Range of Prince of Wales subspecies[2]
- Range of Alaska coast subspecies[3]

1. Audubon Alaska 2016, based on: ADFG 2016a, Suring 2014, and GLIMS 2016.
2. Bidlack and Cook 2002.
3. ADFG 2016a.

N

0 50 miles
0 50 km

Map 6.2: Northern Flying Squirrel