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# OLD-GROWTH & SECOND-GROWTH FOREST

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## PRODUCTIVE OLD GROWTH

According to the 2008 Tongass Land Management Plan, productive old-growth (POG) forest is defined as old-growth forest lands capable of producing at least 20 cubic ft/ac (1.4 cubic m/ha) of wood fiber per year, or having greater than 8,000 board ft/ac (47 cubic m/ha) (USFS Tongass National Forest 2008c), with some stands having as much as 200,000 board ft/ac (1166 cubic m/ha).

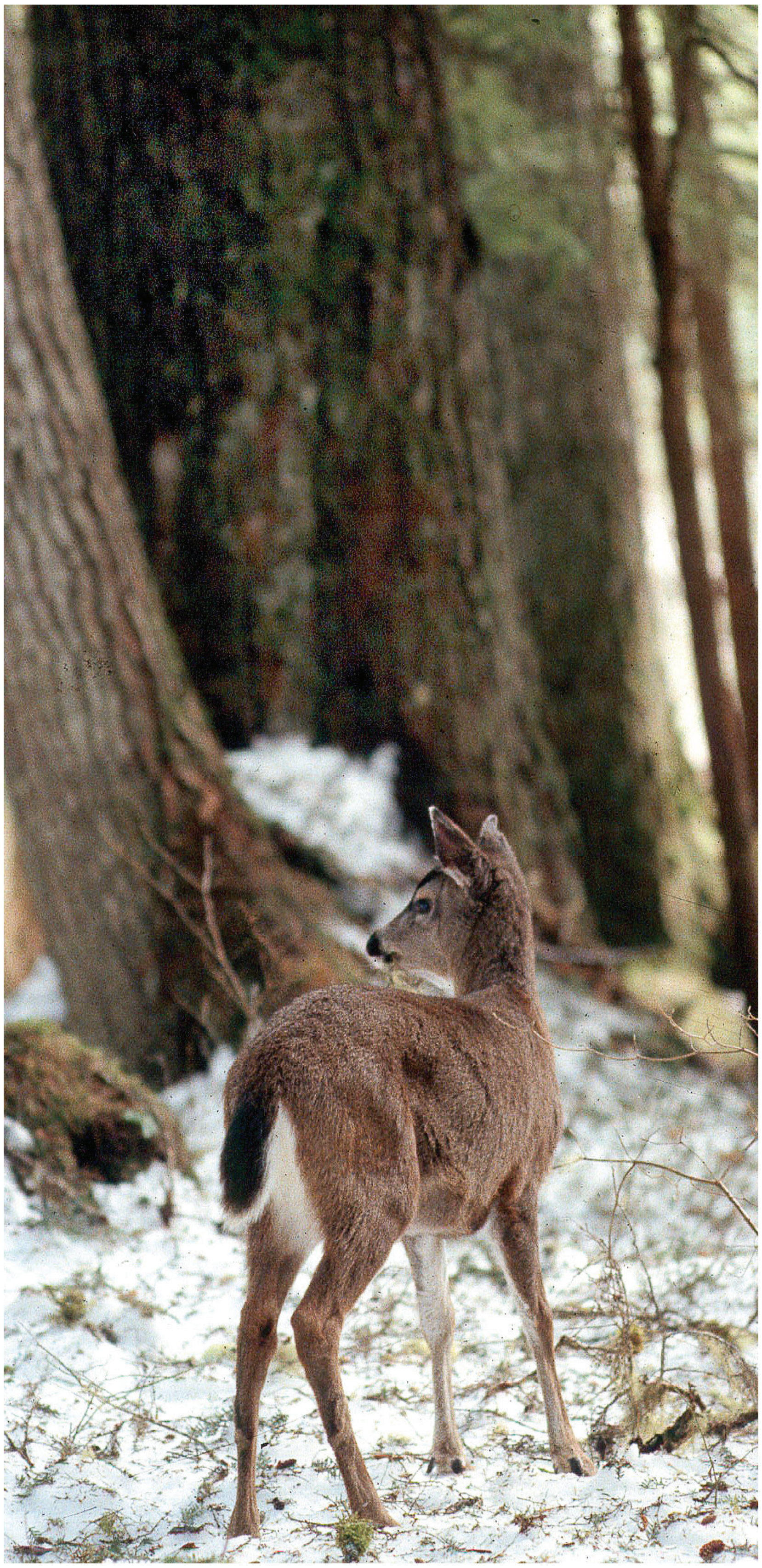
This is a good technical definition, but what is lacking is a sense of the size of the trees in these forest stands, their natural history, and their importance to the ecology of Southeast Alaska. Productive old-growth forest may contain trees that exceed 1,000 years of age; dominant trees typically exceed 300 years of age. The largest trees may reach heights of 130–175 ft (40–50 m) with diameters ranging from 5–11 ft (1.5–3.4 m). Tree species found in these stands typically include western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), and sometimes red or yellow cedar (*Thuja plicata* and *Cupressus nootkatensis*, respectively). Western hemlock tends to dominate in the oldest stands, as it is the more shade-tolerant species.

One key characteristic of old-growth stands is that they include trees of multiple ("uneven") ages and sizes, from seedlings and saplings to pole-sized trees (30–80 years) to trees many centuries old. This forest structure is the cumulative result of many single tree or small tree-group mortality events caused by disease or wind opening gaps in the canopy and creating the space for a rich understory of herbs, ferns, and shrubs, as well as the next generation of trees vying for dominance. Even without the creation of a new forest gap, the multi-aged canopy typical of an old-growth forest lets in adequate sunlight, supporting an understory of blueberries and huckleberries of the genus *Vaccinium*, along with rusty menziesia (*Menziesia ferruginea*), salmonberry (*Rubus spectabilis*), devil's club (*Oplopanax horridum*), and red elderberry (*Sambucus racemosa*).

Productive old-growth forest can include a range of forest types and size classes. Differences in soil drainage result in widely divergent forest structure and stand dynamics. For example, forests growing at lower elevations on well-drained alluvial and floodplain soils are relatively rare, yet are very diverse and productive. Likewise, forests at low elevations on karst formations also produce stands of very large trees. Karst formations in limestone and marble bedrock allow water to drain and trees to grow very large by preventing water-logged soils that can reduce growth rates. Upland forests tend to be dominated by stands of western hemlock and mixed western hemlock-Sitka spruce. Conversely, old-growth forest can be made up of small trees that grow on poorly-drained wet (hydric) soils for centuries without ever reaching a size class that would merit the label productive old growth.

This variation in productive old-growth forests has been described by Caouette and DeGayner (2005), who devised a system to categorize POG stands based on tree size, stand density, and geomorphic stratification grouped into floodplain and upland types as well as forests associated with karst landscapes. Productive old-growth stands were categorized based on a measure of quadratic mean diameter into "large-tree" (>21 in [53 cm]), "medium-tree" (17–21 in [43–53 cm]), and "small-tree" (<17 in [43 cm]).

Productive old-growth forest currently comprises 27% of the land cover in Southeast Alaska, with 3% in large-tree, 20% in medium-tree, and 4% in small-tree size classes. Large-tree old-growth forests are very important habitat for fish and wildlife populations. For example, during periods of deep snow, Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) move into large-tree stands (Schoen and Kirchhoff 1990) where the massive canopy structure intercepts and holds large amounts of snow, providing for winter foraging opportunities below the canopy (Kirchhoff and Schoen 1987). Trees that grow along streams, particularly larger trees, provide an important source of long-lasting woody debris that provides stream structure and enhances habitat for salmon (Murphy and Koski 1989). Productive old growth provides dens for black bears (*Ursus americanus*) and wolves (*Canis lupus*), and nesting trees for Northern Goshawks (*Accipiter gentilis*) (Erickson et al. 1982, Iverson et al. 1996, Person and Russell 2009), as well as habitat for countless other species.



*John Schoen*

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

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## SECOND GROWTH

The temperate rainforests of Southeast Alaska are in the perhumid (continuously wet) rainforest zone with high annual precipitation distributed throughout the year. Disturbance events impacting large swathes of forest, such as wildland fires, are not common in Southeast. In this zone, wind is the dominant natural disturbance regime while fire is comparatively rare (Alaback et al. 2013). Wind disturbance events tend to occur most frequently on higher elevation south-facing slopes (Doerr et al. 2005), affecting small patches (2–3 ac [.8–1.2 ha]) at a time (Alaback et al. 2013). Thus the kind of large-scale impacts created by industrial logging are in stark contrast to natural windthrow events (Brady and Hanley 1984) and represent a precarious experiment in ecosystem ecology with unknown long-term impacts.

It is estimated that 12% of all productive old-growth forest in Southeast Alaska has been harvested (>800,000 ac [>323,749 ha]). Areas that were harvested after 1986 consisted of approximately 29% large-tree, 65% medium-tree, and 6% small-tree productive old-growth forest types. These figures are likely lower than what was the historic harvest rate (pre-1986) for the large-tree forest type, because regulations in the 1979 Tongass Land Management Plan and 1990 Tongass Timber Reform Act placed new restrictions on logging in the most productive floodplain forests. Accounting for data deficiencies, the Audubon-TNC Conservation Assessment estimated that roughly 50% of the original large-tree old-growth forests have been logged.

Importantly, this logging was not evenly distributed across Southeast, with rates as high as 32% of all POG and 40% of all large-tree POG being harvested on North Prince of Wales Island. Nearly all of the previously harvested areas shown on the accompanying map were once productive old-growth forests. In total, large trees in Southeast Alaska have been the target of industrial logging operations for 60 years. During this time large trees were logged disproportionately, known as "highgrading" (Albert and Schoen 2013). To that end, extremely large trees, those 3 ft (1 m) or more in diameter, have been almost completely removed from the landscape. Remnant patches of productive large-tree old growth are very important for maintaining wildlife populations and biodiversity (Houde et al. 2007) within the matrix of logged lands.

The highgrading within the Prince of Wales Island Complex has resulted in a dramatic shift in forest structure from historic old-growth conditions (see Figure 3c in Albert and Schoen 2013). North Prince of Wales Island was logged at a rate 2.7 times higher than the forest-wide average, and 1.6 times higher than the next most intensively logged province (Dall Island Complex). In total, 120,000 ha (296,000 ac) have been logged in this single province, which is 38% of what has been logged forest-wide. At the landscape scale, 31% of contiguous high-volume forest in Southeast Alaska historically occurred on Northern Prince of Wales Island, and these forests were reduced by 94% between 1954 and 2004 (191,596 ac [77,536 ha] down to 11,864 ac [4,801 ha]) (Albert and Schoen 2013).

Second-growth stands are ecologically much different from old-growth stands. Unlike uneven-age, multi-story old growth generated through small patch disturbances, clearcut logging removes many tens of hectares (hundreds of acres) of contiguous timber at one time. Following clearcutting in Southeast, a forest's succession follows in multiple stages (Harris 1974, Harris and Farr 1974b, Harris and Farr 1979, Wallmo and Schoen 1980, Alaback 1982). Initially young seedlings and saplings generate an abundance of new forage (i.e. herbs, ferns, and shrubs) for some species, including deer, during snow-free months. Conifer seedlings grow abundantly and peak at approximately 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, stands move into the "stem-exclusion" phase where pole-sized trees grow so tightly packed that light does not reach the forest floor. In this stage, conifers completely dominate second growth, the forest floor is continually shaded, and the understory (including forbs, shrubs, and lichens) largely disappears from the even-aged, second-growth stand.

This results in an excess of lands being converted from high forage to essentially no forage. Therefore, an excess of logging causes an ecological "debt" that eventually must be accounted for. This stage typically lasts >100 years (Wallmo and Schoen 1980, Dellasala et al. 1996), while climax uneven-aged old-growth characteristics can take several centuries to redevelop (Alaback 1982, DellaSala 2011).

## CONSERVATION ISSUES

The Tongass National Forest has identified a suite of Management Indicator Species that are monitored in order to assess the effects of management activities on their populations and on the populations of other species that share similar habitat requirements (USFS Tongass National Forest 2008c). Some of the species identified in the 2008 Tongass Land Management plan as Management Indicator Species that depend upon productive old-growth forest include: Sitka black-tailed deer, American marten (*Martes americana*), coho salmon (*Oncorhynchus kisutch*), and pink salmon (*Oncorhynchus gorbuscha*). Other species of interest identified by the US Forest Service that need productive old-growth forest habitat include the northern flying squirrel (*Glaucomys sabrinus*), marbled murrelet (*Brachyramphus marmoratus*), and Queen Charlotte Goshawk (*Accipiter gentilis laingi*) (USFS Tongass National Forest 2008a). The relationship between productive old-growth forest and these species is described below:

- The herbaceous understory, along with the ability of the canopy to intercept heavy winter snows, makes productive old-growth forests particularly good deer habitat during hard winters (Kirchhoff and Schoen 1987, Schoen and Kirchhoff 1990). Hard winters with lasting deep snow are an important stochastic influence on the Sitka black-tailed deer, reducing total population size (Olson 1979); thus the amount of productive old-growth forest that remains plays an important role in the abundance of this species.
- The American marten (*Martes americana*) is a small- to medium-sized carnivore of the weasel family whose fate is bound with that of productive old-growth forest. Studies have shown the marten's strong preference for large-tree old-growth and unfragmented forests (Flynn et al. 2004).
- Productive old-growth forest plays a large role in the maintenance of healthy salmon populations, and the nutrients that salmon provide in turn create a healthy and productive ecosystem. When bears and other animals carry salmon away from streams, the carcasses serve as fertlizer for the near-stream vegetation and trees (Gende et al. 2002).
- Research has shown that over 20% of the foliar nitrogen of trees and shrubs growing near streams is derived from spawning salmon (Helfield and Naiman 2001). Coho and pink salmon are two of the widely distributed salmon species in Southeast Alaska. Maintaining productive old-growth forests and forested buffers along salmon streams is vitally important to these species for several reasons.
- Without buffers, sedimentation caused by logging can cover the clean gravel needed for spawning (Scrivener and Brownlee 1989). The lack of forested stream buffers can also contribute to high levels of pre-spawning mortality in small drainages at low elevations due to higher stream temperatures and resulting low oxygen levels (Murphy 1985, Halupka et al. 2000). The mature trees that surround salmon streams also often either fall or drop branches, creating large woody debris in the stream. This creates pools that help salmon (especially coho salmon) to remain in the stream despite high water levels in the fall and to overwinter successfully (Tschaplinski and Hartman 1983, Heifetz et al. 1986, Murphy et al. 1986).
- The northern flying squirrel has been shown to be closely associated with old-growth forest (Carey 1995). Gliding, not flying, in Tongass forests, this species plays an important ecological role by feeding on the fruiting bodies of mycorrhizal fungi and dispersing the spores throughout the forest (Maser and Maser 1988). These fungi form a beneficial symbiotic relationship with the roots of many woody plants, including conifer trees. The mycorrhizal fungi are able to enhance nutrient acquisition for the trees, while extracting some sugars from the roots.

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- The Marbled Murrelet nests in the abundant moss present on the large branches of mature trees. The best habitat for the Marbled Murrelet is considered to be large contiguous blocks of high volume, low elevation old-growth forest (USFS Tongass National Forest 2008a).
- The Queen Charlotte Goshawk, a subspecies of the Northern Goshawk, is listed as a sensitive species and is known to select nesting sites in mature, high volume stands of western hemlock. Individual nest trees typically average 27 in (68.7 cm) diameter at breast height (Flatten et al. 2001).

According to Albert and Schoen (2013), results of a review of habitat thresholds literature (to inform forest planning in coastal British Columbia) indicated that maintaining loss of habitat below 40% of historical abundance poses a low risk to most species, whereas declines above that level result in less confidence that risks of extirpation will remain low (Price et al. 2009). On the basis of this criterion, rare forest types that have been reduced by >40% of historical abundance such as landscape-scale blocks of high-volume old growth, and particularly those on Prince of Wales Island, may warrant special consideration (Cook et al. 2006).

The loss of old-growth forest to industrial-scale clearcut logging has been central to petitions to list the Queen Charlotte Goshawk, Prince of Wales flying squirrel (*Glaucomys sabrinus griseifrons*), and Alexander Archipelago wolf (*Canis lupus ligoni*) under the US Endangered Species Act.

## MAPPING METHODS

### Productive Old Growth

The productive old-growth data layer was created by Albert and Schoen for the Audubon-TNC Conservation Assessment. Methods are as follows. The Tongass Forest timber inventory provided the foundation for mapping of vegetation, and was augmented with timber inventory data from Haines State Forest and with classified Landsat Multi-spectral Scanner (MSS) imagery from the Interim Landcover Mapping Program of the US Geological Survey. This imagery, in combination with 1997 US Forest Service (USFS) aerial photography, allowed development of a reasonably current database of forest condition on USFS, state, and private lands across Southeast. Although land cover categories were limited by the resolution of information from management agencies, it was mostly possible to maintain consistency among general types throughout the region. To represent the diversity of ecological values associated with forest ecosystems, a general classification developed by Caouette and DeGayner (2005) was used based on tree size and stand density and a geomorphic stratification grouped into flood plain and upland types as well as forests associated with karst landscapes. Stands of productive old growth were categorized based on a measure of quadratic mean diameter into "large-tree" (>21 in [53 cm]) , "medium-tree" (17–21 in [43–53 cm]), and "small-tree" stands (<17 in [43 cm]) using the USFS database on existing vegetation, historical information on forest structure contained in the 1986 Timtype (Timber Type) database, and data on hydric (wet) soils contained in the National Wetlands Inventory. Forest condition on private lands was estimated by using Landsat ETM (1999–2000) and USFS orthophotographs (1996). For lands within the Tongass National Forest, floodplain forests were identified based on the Tongass National Forest soils database. For lands outside the Tongass, a multivariate modeling approach was used.

Using the total acreage of habitat, Audubon and TNC ranked watersheds in Southeast Alaska, stratified by biogeographic province (Albert and Schoen 2007). Watersheds were ranked for riparian and upland forest habitat separately. The top (#1 ranked) riparian and/or upland forest watersheds in each province are shown on the map.

### Second Growth

The second-growth dataset that is included here brings together multiple data sources to create a seamless data layer for all of Southeast Alaska. The 2013 Land Cover dataset produced by the Tongass National Forest was used to identify young-growth areas on Tongass National Forest (both natural and resulting from harvest activity). The Forest Type dataset produced by Albert and Schoen 2007 Conservation Assessment and Resource Synthesis for Southeast Alaska was used to locate post-harvest second-growth areas on non-Tongass National Forest lands (Albert and Schoen 2006, USFS Tongass National Forest Timber Management Staff 2013b). Additionally, locations on non-Tongass National Forest Lands where post-harvest young growth identified in the 2013 Size Density layer agreed with the 2013 Activity Polygon from Tongass National Forest (showing timber harvest or other management) were classified as second growth. This captured recent logging activity that has taken place since 2007 as well as historical harvests not detected via the remote-sensing approach used for development of the Forest Types dataset (USFS Tongass National Forest Timber Management Staff 2013a). Finally, the 2016 USFS Harvest Activity nationwide layer was used to add in harvested stands not portrayed by the other layers.

### Landscape-scale Forest Change

The inset maps represent the 1954 and 2004 forest conditions, showing change in the amount of historic landscape-scale forest in $m^3/km^2$. Albert and Schoen developed this metric using a moving-window analysis of volume with a 0.6 mi (0.9 km) radius, in order to integrate "information on forest structure and the degree to which productive old growth-forests are contiguous across the landscape" (Albert and Schoen 2013).

## MAP DATA SOURCES

- Landscape-scale Forest Change: Albert and Schoen (2013)
- Productive Old-growth Forest: Albert and Schoen (2007b)
- Second-growth Forest: Audubon Alaska (2014), based on: Albert and Schoen (2007b), USFS Tongass National Forest Timber Management Staff (2013a), USFS Tongass National Forest Timber Management Staff (2013b); US Forest Service (2016).

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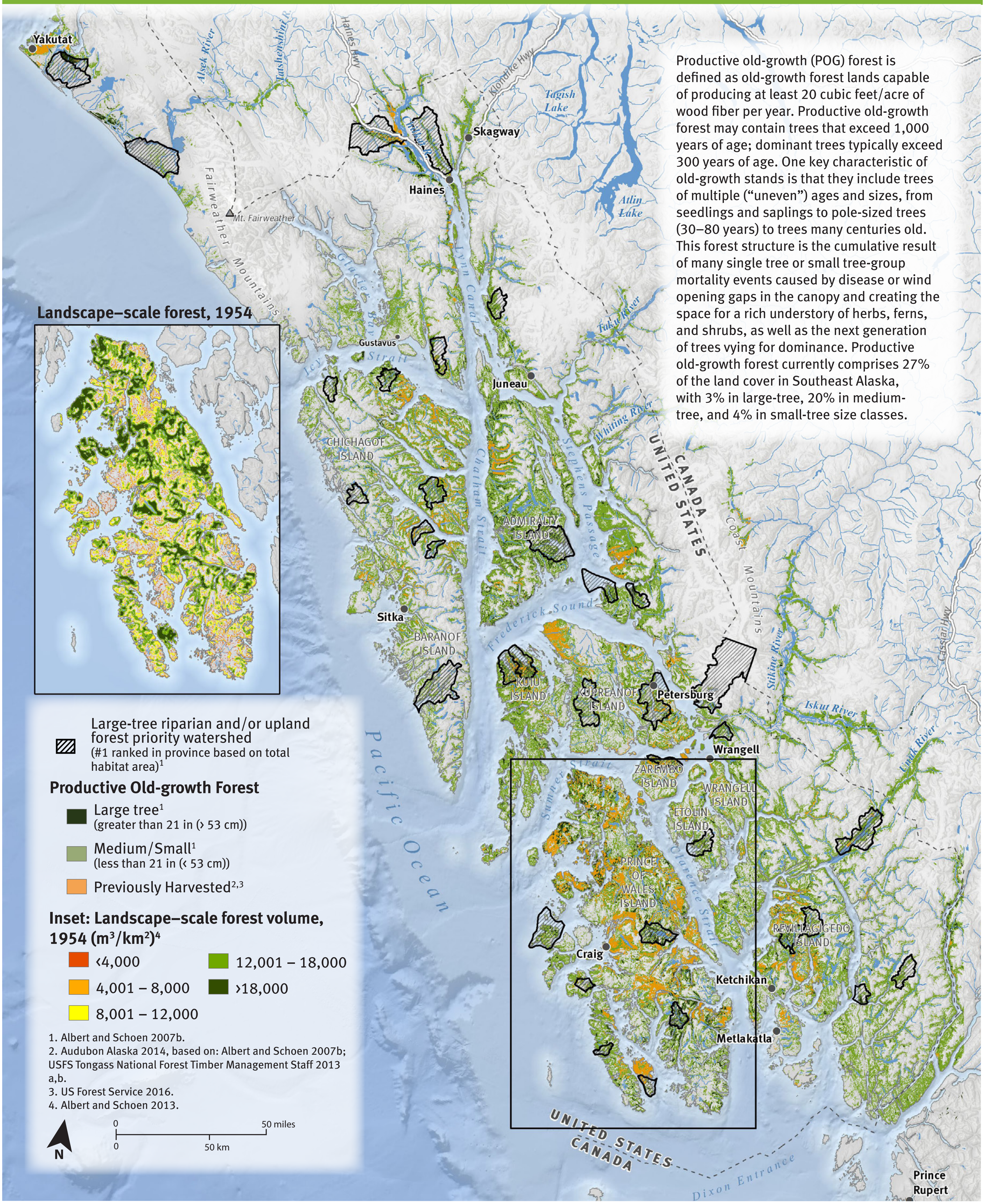
**Above:** Old-growth forest is characterized by large snags, trees of diverse size and age, multiple canopy layers with frequent gaps, and luxuriant understory of forbs, shrubs, and hemlock saplings. Old growth has high habitat value for many species of fish and wildlife. **Below:** A post-logging forest stand, approximately 60 years old. The stand is even-aged, has a closed canopy with little understory, and habitat value for most wildlife is low.

Audubon ALASKA

The Nature Conservancy

# Productive Old-growth Forest

Productive old-growth (POG) forest is defined as old-growth forest lands capable of producing at least 20 cubic feet/acre of wood fiber per year. Productive old-growth forest may contain trees that exceed 1,000 years of age; dominant trees typically exceed 300 years of age. One key characteristic of old-growth stands is that they include trees of multiple ("uneven") ages and sizes, from seedlings and saplings to pole-sized trees (30–80 years) to trees many centuries old. This forest structure is the cumulative result of many single tree or small tree-group mortality events caused by disease or wind opening gaps in the canopy and creating the space for a rich understory of herbs, ferns, and shrubs, as well as the next generation of trees vying for dominance. Productive old-growth forest currently comprises 27% of the land cover in Southeast Alaska, with 3% in large-tree, 20% in medium-tree, and 4% in small-tree size classes.



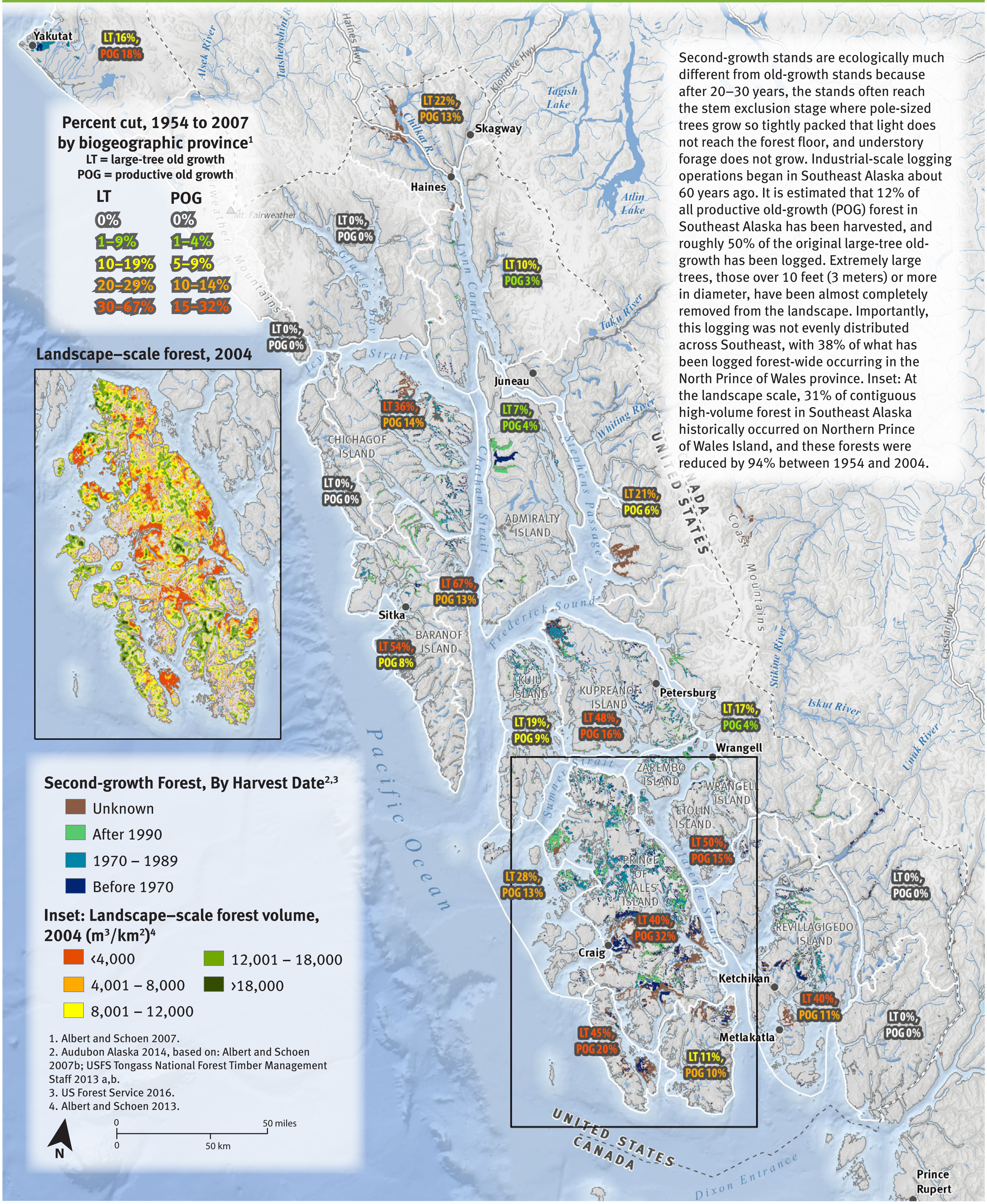

*Map 3.6: Productive Old-growth Forest*

# Second-growth Forest

Audubon ALASKA

The Nature Conservancy

Second-growth stands are ecologically much different from old-growth stands because after 20–30 years, the stands often reach the stem exclusion stage where pole-sized trees grow so tightly packed that light does not reach the forest floor, and understory forage does not grow. Industrial-scale logging operations began in Southeast Alaska about 60 years ago. It is estimated that 12% of all productive old-growth (POG) forest in Southeast Alaska has been harvested, and roughly 50% of the original large-tree old-growth has been logged. Extremely large trees, those over 10 feet (3 meters) or more in diameter, have been almost completely removed from the landscape. Importantly, this logging was not evenly distributed across Southeast, with 38% of what has been logged forest-wide occurring in the North Prince of Wales province. Inset: At the landscape scale, 31% of contiguous high-volume forest in Southeast Alaska historically occurred on Northern Prince of Wales Island, and these forests were reduced by 94% between 1954 and 2004.




*Map 3.7: Second-growth Forest*