United States Department of Agriculture

Forest Service

Pacific Northwest Region

Finney Adaptive Management Area Plan

Mt. Baker-Snoqualmie National Forest

April 2011

Summary

This plan identifies two primary learning themes that will be pursued in the Finney Adaptive Management Area (AMA). One theme involves upland treatments to restore some characteristics of old-growth forest stands in younger stands. In western hemlock plant associations, results would determine in the North Cascades respond to forest management similar to other ecological regions. Similar upland treatments in Pacific silver fir plant associations will be extremely valuable because very little research has been conducted in these forest types. The second theme would evaluate the impacts of management of forests in Riparian Reserves on biological diversity, productivity, temperature, vegetation, and aquatic habitat features. At this time, none of the learning themes would require changing standards and guidelines established by the Northwest Forest Plan.

The plan also includes smaller-scale studies of local importance that are on-going or may occur in the future. These studies also provide learning opportunities that may help inform future management of forests in the North Cascades.

The Finney Adaptive Management Area plan is not a decision document. The environmental effects of implementing parts or all of the plan will be evaluated in the future when the locations of treatment areas is identified. Successful implementation of the plan will require the development and maintenance of partnerships with research institutions, Indian Tribes, non-governmental organizations, and the timber industry.

Area Assessment

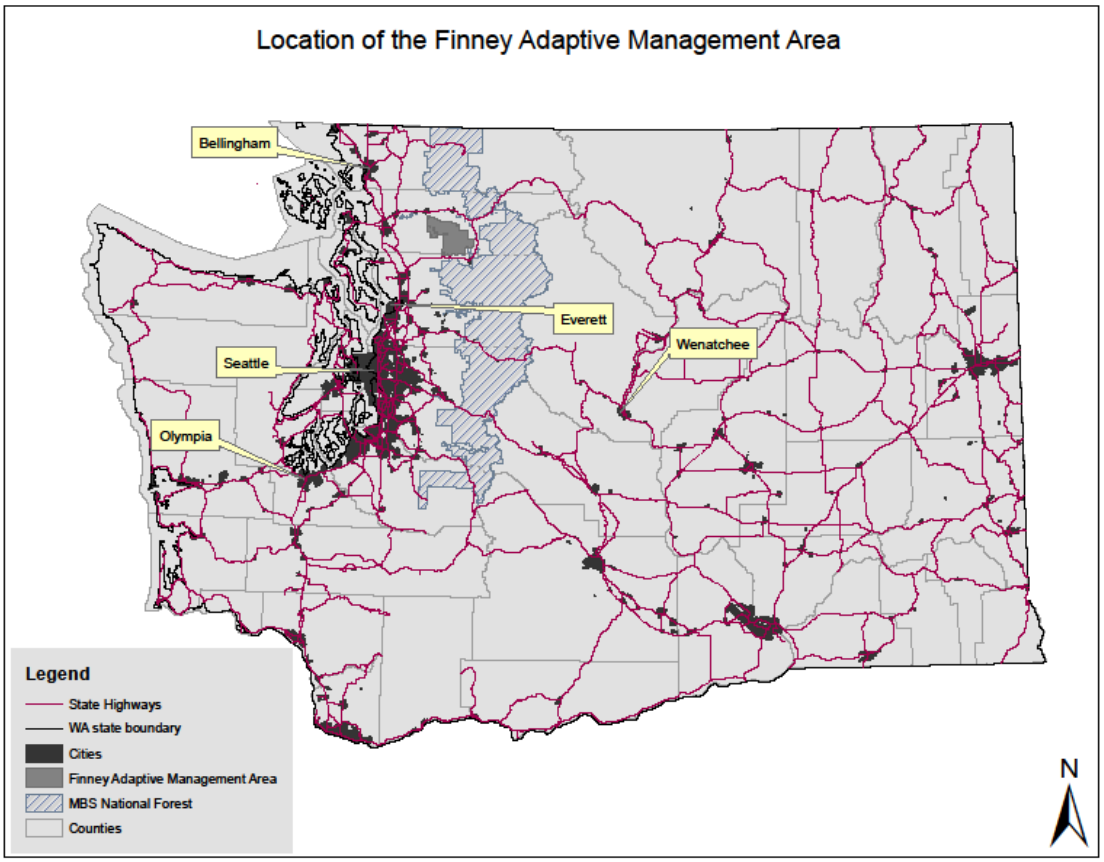
Introduction

The Northwest Forest Plan established ten Adaptive Management Areas (AMA) in California, Oregon, and Washington states to encourage the development and testing of technical and social approaches to achieving the desired ecological, economic, and other social objectives in National Forests. Each AMA is required to have a plan to guide activities within the AMA.

Although discussions regarding the development of a plan for the Finney AMA began in 1994, the completion of a plan for the Forest's other AMA, Snoqualmie Pass, was determined to be more urgent. There was a pending large-scale land exchange with Plum Creek Timber Company and Master Plan development for The Summit at Snoqualmie ski area that required completion of the Snoqualmie Pass AMA plan. This AMA plan was completed in the mid 1990s.

Development of the Finney AMA plan resumed in 1997 prompted, in part, by interest expressed by the Provincial Advisory Committee (PAC). A field visit to the AMA with the PAC occurred that summer. In 1998 Regional Forest Service funding for AMAs ceased (Stankey and Clark 2006) resulting in slower progress in developing a plan for the AMA. In 1999 and 2000, discussions on completing the AMA plan continued including meetings and another field visit with the PAC.

Figure 1. Location of the Finney Adaptive Management Area in Washington State.



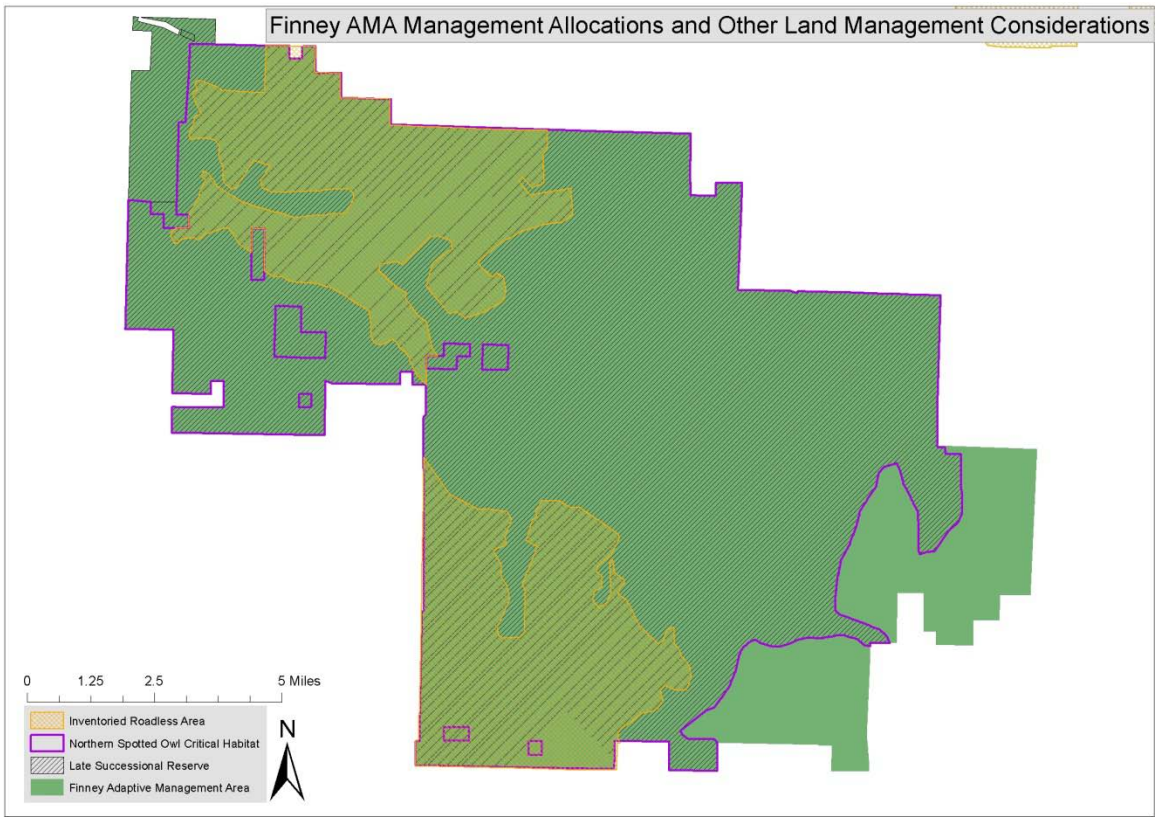
In 2002, the first draft Finney AMA plan was completed. Review of this draft at the Regional level in 2003 indicated multiple areas of concern and a lack of support for the approach taken. Despite this set back, public interest in developing a viable plan for the Finney AMA continued.

This plan was developed to identify priority learning themes for the Finney AMA and the strategies to fund the research activities that are designed to inform forest management in the local geographic area.

Geographic Setting

The 98,400 acre Finney Adaptive Management Area is located in the north-central part of the Western Washington Cascades Province (Figure 1). This parcel of National Forest System land is separated from the rest of the Mt. Baker-Snoqualmie National Forest by one to twelve miles of river valleys on State and private lands (Figure 3). Elevation in the AMA ranges from 400' to just over 5,100'. Primary land uses in these areas are agriculture and forest management. The communities of Arlington, Oso, Darrington, Rockport, Concrete, Hamilton, Lyman, Sedro-Woolley, Burlington, Mount Vernon, and Stanwood lie within a ½ hour drive of the area and surround the AMA.

Figure 2. Location of Late-Successional Reserve, Inventoried Roadless Areas and Critical Habitat for Northern Spotted Owl in the Finney Adaptive Management Area.



Approximately 85,677 acres, or 87%, of the AMA is designated Late Successional Reserve (LSR). Most of this LSR is designated as a Managed Owl Conservation Area (MOCA) in the Recovery Plan for the Northern Spotted Owl (Figure 2). The MOCA is intended to provide for up

to 19 spotted owl pairs (USFWS 2008). Because the Finney AMA is relatively close to saltwater, it may also be important to the recovery of another threatened bird species, the marbled murrelet.

There are two RARE II (Roadless Area Review and Evaluation) Inventoried Roadless Area parcels totaling about 27,837 acres located within the AMA that are also Late Successional Reserve. Within the non-LSR portion of the AMA, the 1990 Land and Resource Management Plan for the Mount Baker-Snoqualmie National Forest allocates approximately 956 acres to deer winter range and two parcels of land totaling approximately 231 acres as “mature and old growth wildlife habitat”. The remainder of this portion of the AMA was allocated to Timber Management Emphasis.

Biophysical Environment

Aquatic System

The Finney AMA straddles two important fish rearing river basins: the Stillaguamish and the Skagit Rivers. The northern one-half of the AMA drains into the Skagit Wild and Scenic River system. The fisheries of the Skagit and the Stillaguamish Rivers attract the fishing public and one of the largest concentrations of wintering bald eagles in the lower 48 United States.

Fisheries

The streams draining the Finney AMA flow into the Skagit, Sauk or Stillaguamish Rivers. These rivers support all five species of Pacific salmon, cutthroat trout, bull trout, steelhead, and several species of non-game fish. Nearly all of these species have special status for a higher level of concern. The Finney AMA includes portions of the Deer Creek, a stream made famous by the author Zane Grey in “Tales of Fresh Water Fishing” from the early 20th century, and this part of the Mt. Baker-Snoqualmie National Forest continues to be of general interest to the public because of its long history as an area where salmon and trout were plentiful.

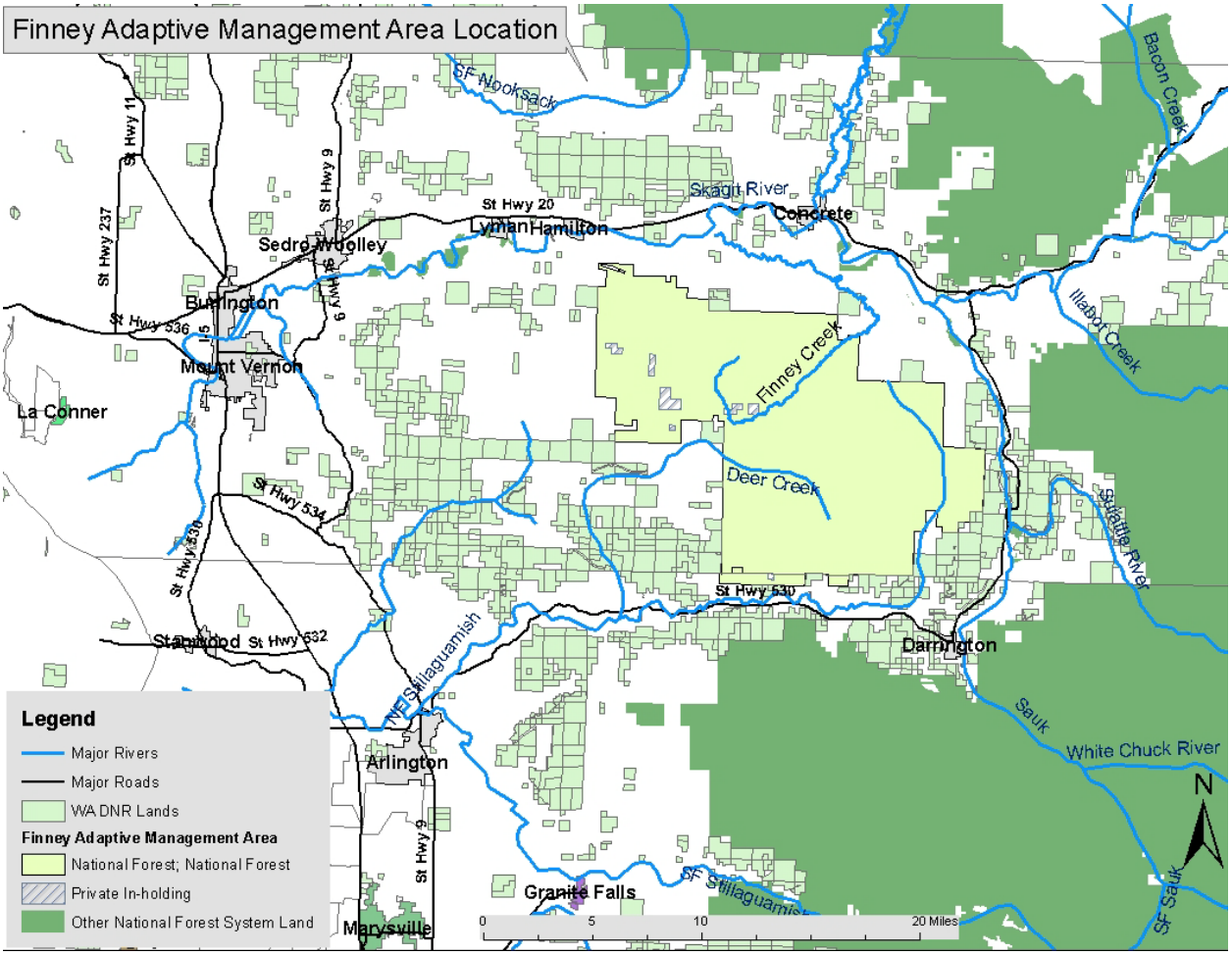
Fish habitat conditions were significantly degraded as a result of timber harvests and road construction in the 1970’s. In 1983 a severe storm produced 37 major landslides in the Finney and Deer Cr. watersheds, including the massive DeForest Creek landslide that impacted many miles of important steelhead spawning and rearing habitat in Deer Creek (USDA 1999). Fish populations in the rivers surrounding the AMA remain depressed from historic levels. Species most directly affected by degraded conditions within the AMA are: bull trout, steelhead, coho salmon, coastal cutthroat trout, and rainbow trout. Following extensive aquatic restoration and road work over the last 20 years, streams conditions have improved somewhat, but conditions are still considerably degraded. Degraded fish habitat conditions include reduced pool frequency, reduced pool depth, increased width/depth ratios, increased sedimentation, increased stream temperatures, and reduced large wood frequency; nearly every measure of fish habitat conditions has been impacted.

Water Quality

Deer Creek and the North Fork Stillaguamish River watersheds have in the past been included on the Washington State Department of Ecology's Section 303(d) list as water quality impaired. The

303(d) list from 2008 shows Deer Creek, Little Deer Creek, and the North Fork Stillaguamish River as having segments rated as Category 2 or 4a. Category 2 streams do not have data sufficient for a listing, but may continue to have concerns with water quality, and Category 4a is listed as water impaired by a pollutant, but a TMDL (Total Maximum Daily Load) addressing the impairment has been developed and approved. (http://www.ecy.wa.gov/programs/wq/303d/index.html)

Figure 3. Location of the Finney Adaptive Management Area.



Watershed and Channel Processes

The three major drainages in the AMA, Finney, Deer, and North Fork Stillaguamish, are impaired with respect to peak flow hydrology and higher than natural sediment supply. Increases in coarse sediment supply tend to fill pools and aggrade channels, resulting in reduced habitat complexity, reduced rearing capacity for some salmonids, reduced survival of incubating eggs, and changed benthic invertebrate production and communities. Impaired sediment supply and peak flow hydrology can limit egg to fry survival for chinook populations downstream of the AMA. This is likely the case for other salmonid species.

Landslides are the primary reason for the unnaturally high sediment supply in Finney Creek and some other watersheds in the North Cascades. Landslides usually occur during rain-on-snow storms. The frequency and magnitude of sediment delivery due to landslides are increased due to the concentration of water from road surfaces and the interception of subsurface flows by road cuts that funnel water into drainage channels resulting in higher flows in creeks. Timber harvest also contributes to landslides during rain-on-snow storms by changing the distribution of snow accumulation and increasing melt rates of snow.

General Channel Conditions

Lower Finney Creek (below the falls that is an anadromous fish barrier downstream of federal land): Accelerated sedimentation, an unconfined valley bottom, and the removal of large wood from the riparian area, have resulted in a wide, shallow channel with little complexity or structure. The extreme aggradation of the channel has caused increased meandering of the stream that has undercut the toe slopes and added to an already elevated sediment supply.

A review of aerial photos shows that the lower reach is responding to excessive sediment loading by widening. Between 1974 and 1991, the channel width in the lower reach increased by 77%, with 19 of 22 transects being wider in 1991. Channel widening results in decreased pool depth and frequency, reduced stream shading, and fewer side channels that serve as refugia for aquatic organisms during floods. Tributary pool area loss, channel widening in the main stem, and summer temperatures exceeding 65 degrees F (18 degrees C), have created habitat conditions that are below their potential for all species.Upper Finney Creek (within the AMA): The singular most impacting mechanism in the upper basin is from shallow landslides becoming debris torrents/dam breaks. These failures deposit sediment, temporarily blocking portions of upper Finney Creek. These blockages lend themselves to dam break floods that deliver stored sediment to the lower Finney Creek basin.

Deer Creek: Rapid incision of Deer Creek stream channels into glacial fills of the valley floors and in tributary valleys created terraces with steep inner gorge faces that are prone to small, deep-seated slumps and shallow-rapid landslides. Deer Creek and its tributaries have undergone dramatic channel changes since logging began in the 1940s, although harvest does not appear to have increased peak flows. Numerous small, incised channels appear to have scoured in response to road runoff and the removal of structure (wood) in steep channels in glacial sediments. Sediment from landslides and bank erosion triggered by logging and roads in Little Deer Creek and upper Deer Creek has traveled to Deer Creek and is associated with channel widening.

North Fork Stillaguamish River: Similar channel conditions and processes occur in this watershed as in the Finney watershed. A large number of higher gradient stream channels (particularly within the Upper North Fork) have been scoured as a result of debris torrents. Sediment waves have filled and widened reaches of the main stem river over the years, most notably down river from the AMA between Rollins Creek and Boulder River.

Terrestrial System

Vegetation

The landscape of the Finney AMA represents an environment that is colder and wetter than virtually all forest lands in the contiguous USA. Forests developed under conditions where fire was a rare occurrence. When fire occurred, it usually happened only around the warmer or drier edges or many hundreds of years ago. The Finney AMA is atypical of the remainder of the Northwest Forest Plan area due to very infrequent fire and high precipitation. This results in stands reaching ages much older than in NWFP areas further south.

In the Finney AMA the Pacific Silver Fir Zone occupies about 60% of the area. The Mountain Hemlock Zone is 24 % and Western Hemlock Zone is 16% of the area. Even now, with 40% of the forested area harvested since WWII, about 50% of the current forests are over 500 years old. Prior to statehood about 90% of the forests were older than 400 years. Most of the rest of northwestern Washington forests were about 55-65% old-growth through most of the last millennium.

Stand conditions prior to statehood were probably unusual for this area over the last 1000 years. In the late 14th century, for example, much of the area was in young-growth forest. The temporal variation in forest age class representation is due to the pattern of wildfires that have returned at intervals of 100 to over 1000 years. The frequency of wildfires varies as a result of changes in climate.

Within the Finney AMA, there has been approximately 32,468 acres of forest management recorded by the Forest Service. Most of these areas were regenerated using clear cut harvest methods. Summarized by forest zone, these activities equal 6,067 acres (39 percent) of the area in the western hemlock zone, 21,838 acres (37 percent) of the area in the Pacific silver fir zone, and 4,537 acres (14 percent) of the area in the mountain hemlock zone. The current status of forest conditions by zone is presented in Table 1.

Pacific Silver Fir Zone forests (PSFZ) do not usually include the large sized trees or the high biomass of forests at lower elevations or in areas with less precipitation. They often have fewer Douglas-fir or western redcedar than lower elevation forests. They usually are dominated by a mix of western hemlock and Pacific silver fir, which are the early seral as well as the climax tree species. Silver fir trees do not grow as big or as tall as Douglas-fir or western hemlock, so definitions that include large size as a major criterion can misrepresent the nature of old-growth Pacific silver fir forests.

Succession in the Western Hemlock Zone (WHZ) is different from the PSFZ in many ways. It is warmer there and drier. There is less snow, even in very snowy winters, and summers can be drier, especially in drought years. Early seral stages can have distinctly different tree components than later stages, although in wetter areas early and later seral tree species compositions are often more similar. Red alder can occupy early stages of succession under the right conditions, and can dominate the ecosystem for up to 100 years. Douglas-fir is the most common early seral tree species. It can persist for 1000 years or more, occurring as a few scattered, large individuals in very old stands. This pattern of succession has been described many times and is relatively more predictable than the relatively unknown PSFZ succession pattern.

Table 1. Forest Stand Conditions (acres) in the Finney Adaptive Management Area.

Seral Stage	Western Hemlock Zone	Pacific Silver Fir Zone	Mountain Hemlock Zone	Total
Early	1,780	18,926	4,696	25,402
Mid	6,282	5,790	50	12,122
Mature	2,986	2,306	28	5,320
Old Growth	4,532	29,641	16,560	50,733
Total	15,580	56,663	21,334	93,577

In the more productive, lower elevation WHZ forests, forest stands progress rapidly through succession, moving from pioneer stage to an early seral stage to a mid seral stage in 20-30 years, and from an early seral to a late seral stage in 200 years. In the silver fir and mountain hemlock forests of the higher elevations, this development takes 20-80 years for the pioneer to mid, and over 200 years for the mid to late.

Little is known about the successional development in areas as wet as the Finney AMA, particularly in the Pacific Silver Fir and Mountain Hemlock Zones (MHZ). Much of what is known about the major types of vegetation in the Finney is known from the Silver Fir Spacing Trial (Curtis 2008) or from the existing set of permanent Ecology Program benchmark/monitoring plots. Succession in the Mountain Hemlock Zone is poorly studied and poorly known, especially in this wet and maritime environment.

Mesic to moist silver fir plant associations occupy most of the AMA. An analysis of data from ecology plots in Plant Association Group (PAG) 2207 (Silver Fir - wet *Vaccinium alaskense*), the most common PAG in the AMA, were conducted to contribute to the development of adaptive management learning themes. The analysis used data from stands aged from 20 – 800 years old. These stands initiated and developed during many different climate conditions. Local EcoPlots have shown greatly increased tree growth in recent decades.

Total tree volume is less in PSFZ than in the Western Hemlock Zone. This is partially due to the absence of Douglas-fir in the Pacific Silver fir forest zone. Stand development for the first 200 years in the PSFZ includes a rapid increase in tree volume and basal area (BA). After 200 years there is a slight increasing trend in volume and BA up to 800 years.

Plot data indicate that the stem exclusion phase in the 2207 PAG occurs when stands are about 100 through 300 years of age. After that, openings are likely more common. Mean Annual Increment peaks about year 100, which is younger than in WH PAGs. Quadratic Mean Diameter (QMD) peaks at 18” Diameter at Breast Height (DBH) in about year 200 and then declines to about 14” in older stands. The QMD peak in silver fir is lower than the 30” DBH peak in WH PAGs.

Snags 5” DBH and greater increase in silver fir stands up to year 100, decrease to year 200, and then increase again up as stands age to 800 years. At ages when snag density is high, they contribute up to 19% of the total standing tree biomass in the stand. The analysis also determined that Silver fir advanced regeneration at ages of up to 60 years will respond to increased sunlight with good growth when overstory trees die or are removed.

Climate

Lowlands receive average annual precipitation of 70-90". The upper elevations receive an estimated 100 to 150", much of that as snow in winter. Snow accumulations usually reach 6-15 feet at higher elevations by the end of March. In the transitory snow zone (1,500-3,500 feet), rain-on-snow events can occur from late October through January, resulting in concentrated, rapid snowmelt. These events are characterized by accumulations of wet loosely packed snow subject to warm, windy rainstorms that result in heavy runoff over a short period. Rain-on-snow events often trigger snow avalanches and debris torrents and slides. Most peak flows occur during these late fall/early winter months, and sometimes result in severe flooding. The largest flood on record occurred in November 1990 during a rain-on-snow event.

Vegetation in the AMA has been variable since the last glacial maximum with plant distribution and the vegetation zone patterns responding to changes in climate. During the Medieval Optimum, (about 900 to 1300 AD) the climate was believed to be warmer and drier than today, and the western hemlock zone covered more of the watershed and at higher elevations. The Pacific silver fir zone occurred over less area and the mountain hemlock zone probably covered a smaller area than today. At this time, the upper elevation range of Douglas-fir was 500 to 1,000 feet higher and the lower elevation range of silver fir was about 1,000 feet higher than it is now. During the last 600 years, Douglas-fir distribution contracted and the silver fir zone expanded downward as the climate became wetter.

Future temperatures in northwest Washington are predicted to be warmer than in the last 150 years. Average temperatures are expected to be 3-5 degrees (Fahrenheit) higher by 2050 and 5-8 degrees warmer by 2100. The greatest difference is predicted to be during the summer months.

There is no certainty on the annual change in precipitation, but most simulations suggest a slight increase. The timing that precipitation occurs strongly suggests that there will be increased precipitation in the fall and winter and less precipitation during the summer months.

If summer precipitation decreases substantially to the extent that soil moisture becomes limited, growth in the western hemlock and pacific sliver fir forest zones would decrease. However, if precipitation declines during summer are less dramatic, tree growth is expected to increase in these forests. In the mountain hemlock forest zone, tree growth is expected to increase due to the warmer spring temperatures, longer growing season, and shorter duration snow packs.

The expected changes in temperature and precipitation could accelerate the pace that of late-successional and old growth forest conditions develop. They may also alter the success of individual tree species establishment and survival. Due to the relatively high precipitation expected, it is unlikely that insect and disease mortality will change appreciably from existing levels.

Regional Forester's Sensitive, Rare, and Uncommon Plants

There are six known Sensitive, rare and uncommon plants in the Finney AMA (Table 2). These include one lichen, three fungi, and two vascular plants.

Table 2. Relative rarity of the Sensitive, rare and uncommon plant species occurring at sites in the Finney AMA compared to the number of sites on the Mount Baker-Snoqualmie National Forest (MBSNF) and Mount Baker (MBRD) and Darrington Ranger Districts (DRD).

	Number of known sites in the AMA	Number of known sites on the MBSNF	Number of known sites on MBRD and DRD
Hypogymnia duplicata	15	125	83
Spathularia flavida	1	1	1
Helvella elastica	1	2	1
Collybia bakerensis	1	14	13
Carex magellanica subsp. irrigua	1	1	1
Galium kamtschaticum	1	86	50

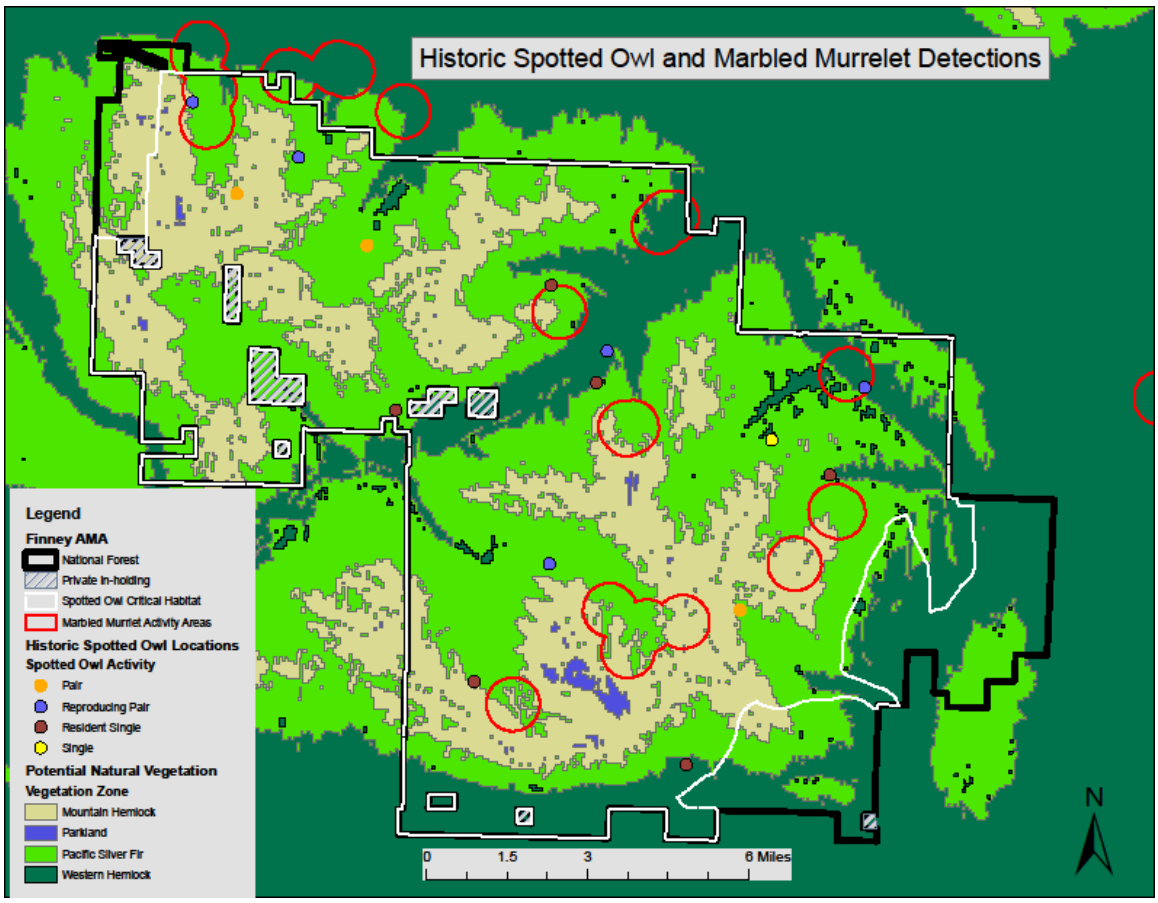
Wildlife

Two wildlife species of special interest in the Finney AMA are the federally listed marbled murrelet and northern spotted owl. The nesting habitat of both of these species is closely associated with structural characteristics found in old growth forests. The recovery efforts for these two species include maintaining existing habitat across the landscape and the restoration of late-successional forest components.

The Recovery Plan for Northern Spotted Owl is being litigated and critical habitat may change in the near future. The following discussion defines the current situation, which may be different at the time of implementing components of this plan. The Finney AMA contains critical habitat for the recovery of the spotted owl in a Managed Owl Conservation Area (MOCA) 2 that is largely congruent with the LSR portion of the AMA (Figure 2). MOCA 2s are designed to support up to 19 pairs of northern spotted owls. Although the Recovery Plan indicates that all of this MOCA is habitat-capable (USFWS 2008, page 85), it also indicates that spotted owl habitat is limited to

forested areas below the transition to subalpine forest, which is the mountain hemlock forest zone. Since 24% of the AMA is within the mountain hemlock forest zone, habitat-capable areas in the MOCA likely approximate 75% of its area. The Finney AMA is within the Western Washington Cascades province where the Recovery Plan target is 70 percent of the habitat-capable acres comprising suitable habitat. Currently suitable habitat comprises no more than 55% of the suitable habitat within the AMA. With approximately 29% of the habitat capable acres in the early seral stage of forest succession, achieving this recovery goal will require at least 100 years of forest growth.

Figure 4. Historic locations of northern spotted owls and marbled murrelet activity areas in the vegetation zones of the Finney Adaptive Management Area.



The LSR portion of the AMA is also critical habitat for the marbled murrelet. Because the AMA is within 20 to 40 miles of saltwater it may be more important to the species' recovery than habitats that are more distant from foraging and wintering habitat.

No surveys for spotted owl or marbled murrelets have been conducted in the AMA since the early 1990s. Recent detections of murrelet nest sites on cliffs and high elevation ground sites in British Columbia and Olympic National Park have broadened the range of potential nesting habitat. On the MBS, murrelet surveys have resulted in detections of murrelet activity associated with nesting primarily within the western hemlock zone and silver-fir zone, within 40 to 45 miles of salt water,

however two sites with marbled murrelet nesting behavior are in the mountain hemlock forest zone in the AMA (Figure 4).

The AMA is not suitable habitat for the resident endangered gray wolf due to insufficient prey densities. The AMA is within the North Cascades Grizzly Bear Recovery Area; however, there are no records of confirmed presence of the federally threatened grizzly bear in the AMA. On the U.S. side of the recovery area, the population has either gone extinct since the last confirmed sighting in 1997, or will likely become extinct in the absence of a translocation program.

Regional Forester's sensitive wildlife species identified as documented or suspected on the MBS include bald eagle, peregrine falcon, common loon, harlequin duck, Van Dyke's salamander, Larch Mountain salamander, Townsend's big-eared bat, wolverine, Johnson's hairstreak butterfly, four slugs, and one snail. Of these species, harlequin duck and bald eagle are known to occur, and Townsend's big-eared bat and Johnson's hairstreak butterfly likely occur in the AMA. Potentially suitable habitat is lacking for all others.

Social Environment

Land Ownership

Within the AMA lie scattered parcels owned by Longview Fiber and Christian Futures, Inc. These parcel total approximately two square miles.

For approximately 2 miles along its southern border, the AMA abuts many small privately owned land parcels. The AMA is almost entirely surrounded by large blocks of land owned by timber companies and State forest lands managed by the Washington State Department of Natural Resources (DNR). Longview Fiber Company border the AMA along almost all of its western edge. Sierra Pacific lands abut the AMA largely along its northeastern and eastern edges. DNR-managed lands commonly border the AMA from its southwestern corner to its southeastern edge (Figure 2). Grandy Lake Forest parcels occur sporadically along the edge of the AMA. Most of these lands are managed by clear cut harvesting with rotation ages of 30 to 60 years depending on site productivity (Mason 2007).

The DNR currently manages approximately 50,000 acres of lands surrounding the AMA according to its Habitat Conservation Plan (HCP) that will be in effect for the next 60 years. The HCP identified 50,000 acres of land surrounding the AMA to provide nesting, roosting, or foraging (NRF) spotted owl habitat and an additional 20,000 acres to facilitate spotted owl dispersal between the AMA and other federal lands. Because northern spotted owl home ranges are very large, it is difficult for DNR to provide for the entire suite of habitat needs for this species. Their role is more to support the contribution of federal lands to the species recovery. The DNR is interested in learning how to better develop spotted owl habitat on the 88% of its NRF lands that are not currently identified as spotted owl nest patch cores.

Local Communities

Indian Tribes have used the Finney AMA for centuries. Tribes continue to use the area for treaty-protected activities such as hunting, gathering, and cultural activities. Restoring the salmonid fisheries is of high importance to Indian Tribes both for commercial sales and for ceremonial harvest.

Residents of the communities in and around the Finney AMA have a variety of lifestyles and interests. Communities away from I-5 tend to be more rural with their history steeped in mining and logging. There has been substantial natural resources utilization, with much of the timber resources locally milled, or transported within the Puget Sound region for manufacturing and use in value-added products. Mining originally drew settlers to the Stillaguamish and Upper Sauk River basins.

The population growth in Skagit County between the 2000 census and 2009 was nearly 15 percent, to 118,900 (Washington State Office of Financial Management, http://www.ofm.wa.gov/pop/april1/default.asp), and the projected population by the year 2030 is to 178,000 (Washington State Office of Financial Management[1]). However most of the growth has been and is expected to be in the western part of the county. Ethnicity in Skagit County in 2000 was 86% white, 11% Hispanic, 1.9.% American Indian, 1.7% Asian/ Pacific Islander and less than 1% black.

The population growth in Snohomish County between the 2000 census and 2009 was nearly 16 percent, to 704,300 (Washington State Office of Financial Management[2]), and the projected population by the year 2030 is 950,000 (Washington State Office of Financial Management, http://www.ofm.wa.gov/pop/gma/projections07.asp). Like Skagit County most of the growth has been and is expected to be in the western part of the county along the I-5 corridor. Ethnicity in in 2008 was 88% white, 5.9% Hispanic, 1.5.% American Indian, 8.1% Asian/ Pacific Islander and 2.3% black (http://www.snohd.org/Shd_HS/Reports/HPAPublication_2010.pdf).

Economy

Historically, Skagit County's major economic activities were primarily natural resource oriented, based on agriculture, forestry, and commercial fisheries. The late1970s and 1980s brought economic hardship to the County because of the downturn in the wood products industry as well as in food processing.

Eastern Skagit County, upriver from and including Sedro-Woolley, and eastern Snohmish County were hit as hard as any area in Western Washington by the economic downturn in the timber industry that began in the late 1980s. The communities with high employment in the timber industry within the Finney AMA's area of influence include Sedro-Woolley, Lyman, Hamilton, Concrete, Rockport, Marblemount, and Darrington. Several of these communities have received assistance through the Northwest Economic Adjustment Initiative. Assistance has ranged from the completion of community action plans to the design of water/waste-water systems.

By the early 1990s, Skagit County became one of the nine most impacted "distressed timber counties" in Washington State. Between 1989 and 1994 total timber harvest (private and public) decreased 30 to 60% in Skagit and Snohomish Counties (Raettig and Christiensen 1999). Employment in the forest products industry declined by more than 25% in Skagit County and 10 to 15% in Snohomish County. Because the economies of both counties were diversified, total county employment in this sector of the economy was less than 5% (Raettig and Christiensen 1999). However, timber production has historically been important to less economically diversified communities distal to I-5.

Darrington is a small rural community, which has been impacted by the changes in the timber industry during the past two decades. It was heavily dependent on the timber industry with

approximately 45% of employment in the forestry and forest manufacturing sector. Summit Timber (now Hampton Lumber) was the main employer with about 370 employees during their peak operations. The sawmill and cogeneration plant currently employs 100 – 125 people, but creates additional employment through contracting work for logging and other forest management activities. Although some of this reduction in jobs is due to improved technology, the decreased timber supply from National Forest System lands was also a factor. In order to maintain the current level of log processing, Hampton Lumber obtains about 15% of its logs from Canada and eastern Washington. Increased fuel costs may limit the mills ability to obtain logs from these sources.

Since the 1980s many smaller sawmills and other wood processing facilities in rural areas have closed. These mills have been replaced by new, modern computerized mills that are strategically located closer to major transportation routes. This has resulted in a shift of manufacturing jobs from the eastern communities to the larger cities in the western parts of the counties.

Reduced timber related employment, increased recreation and tourism activity, urban development, and population growth have changed the character and places of employment. Currently residents of the communities in and around the Finney AMA have a variety of lifestyles and interests. Communities away from I-5 tend to be more rural. The collection of special forest products, such as boughs is a small industry. Employment in forestry jobs has dwindled and there is a trend toward employment offered in the larger communities situated closer to the interstate system. Many residents commute 50-80 miles to work, or are telecommuting. Tourism is still a minor part of the economy.

Adaptive Management Learning Themes

Desired Condition of the AMA

The Finney AMA was established as part of a network of ten adaptive management areas in the Northwest Forest Plan which amended Forest Plans within the region. These AMAs were designated to encourage the development and testing of technical and social approaches to achieve desired ecological, economic and other social objectives. Each AMA had an emphasis area for testing scientific and technical innovation and experimentation.

The emphasis of the Finney AMA is to restore late-successional forest and riparian habitat components (USDA, USDI 1994, Page D-13). Most of the AMA is Late-successional Reserve that has a desired condition of 80% or more late-successional forest (USDA 2001). Because this portion of the AMA is also critical habitat for the northern spotted owl and marbled murrelet, there is a desire to have stands with high crown closure by the time they reach mature and old-growth seral stages. While stands are in the early and mid-seral stages, the desired condition is to maintain tree stocking levels sufficient to allow the development into late successional forest while providing horizontal and vertical heterogeneity (diversity) in forest structure. This diversity in forest structure will provide a wider range of habitat conditions for many species associated with late-successional forests. There is also a desire to provide some economic benefits to communities whose economies are strongly timber dependent.

In the short-term, increased diversity in forest structure in early and mid-seral stands will provide a wider range of habitat conditions for many species associated with late-successional forests. This is expected to result in greater species richness for plant and animal species, as well as higher abundance of those species associated with less dense forest conditions. In the long-term, the AMA will provide increased nesting habitat for northern spotted owls and marbled murrelets. Whether these conditions translate into higher populations may be dependent on other factors such as competition with barred owls and the availability of prey species for marbled murrelets in Puget Sound.

Desired conditions for the riparian/aquatic system include reducing stream temperatures in Deer Creek and decreasing the intensity of peak flows and sediment delivery in all three watersheds. Over the next 50 years these improvements in hydrology and the development of mature riparian forest vegetation are expected to increase pool frequency and depth, decrease stream width/depth ratios, decreased stream temperatures, and increase large wood frequency. These factors should contribute to recovery of viable populations of bull trout, salmon, and steelhead.

There is a desire for the AMA to contribute some social and economic benefits to the surrounding communities through vegetation manipulations designed to achieve habitat management goals of the AMA. Indian Tribes desire knowledge on the ability to increase the availability of treaty-protected resources. It is also expected that there will be coordination of adaptive learning with adjacent landowners, especially the DNR.

Learning Themes

Six potential learning themes were initially developed by an interdisciplinary team of MBS employees as having the greatest potential value in realizing the AMAs goals. To incorporate other social, economic, and political knowledge, these themes and background information were

distributed to approximately 75 people from universities and other research institutions, the timber industry, environmental groups, local Indian Tribes, local citizens, and state and federal organizations. In addition to receiving the information, these individuals and the general public were also invited to participate at an April 23, 2008 meeting. This meeting was organized by Paul Kriegel of Goodyear Nelson, Will Hamilton of American Forest Resources Council, Jen Watkins of Conservation Northwest, and Kevin Geraghty of North Cascades Conservation Council (NCCC).

More than 40 invitees attended the meeting to hear presentations by Shirley Lorentz (MBS silviculturist), Gary Ketcheson (MBS hydrologist), Peter McBride (Washington State Department of Natural Resources), Kevin Geraghty (NCCC), Jonathan Guzzo (Washington Trails Association), Derek Churchill (Conservation Northwest), Mark Baugh (Hampton Affiliates), and Curt Veldhuisen (Skagit River System Cooperate representing the Swinomish and Sauk-Suiattle Indian Tribes). The meeting concluded with small groups discussing and recommending learning themes for the AMA (Appendix A).

A second public meeting was held on August 2, 2008 to discuss possible vegetation manipulations in potential candidate stands in the AMA. This meeting was lightly attended. Following this meeting, the MBS interdisciplinary team considered all the available information and decided that AMA objectives would best be met by pursuing the learning themes described below. Additional learning themes that include on-going studies and research ideas that have yet to be fully developed are listed at the end of this section of the plan.

Restoration of Late-Successional Forest

A strategy to restore some components of late-successional forests during the development of younger stands has been proposed (Franklin 2009, Johnson and Franklin 2009, Tappeiner 2009). In brief, this strategy involves using variable density thinning (including areas of no thin and small regeneration patches that mimic natural disturbances) to increase horizontal and structural diversity within relatively homogeneous young plantations. These treatments are expected to increase biological diversity of plants and animals. Franklin (2009) cautions that there are strong regional differences in the response of western hemlock to site conditions. These regional differences should be expected to result in differing stand responses. Because implementing this strategy is new, it is not known if the late-successional characteristics created will persist until the forest becomes late-successional or if additional treatments would be needed to retain them (Franklin 2009).

Several large-scale experiments are being conducted within the NWFP area (Poage and Anderson 2007) that contribute to learning from the implementation of this restoration strategy. However, none of these experiments are in the North Cascades Ecoregion. Because of the differences in plant communities, fire frequency, temperature, and precipitation, between the Finney AMA and where these experiments are being conducted, the results may not be applicable to the Finney, or elsewhere in the North Cascades Ecoregion. Furthermore, there is little research anywhere that has been conducted, or is on-going, in PSFZ forests that comprise 60% of the Finney AMA.

Adaptive learning from experimentation would accomplish two goals. First to determine if vegetation treatments designed to develop some late-successional forest characteristics in 40 to 80 year-old stands in the WHZ in the North Cascades Ecoregion produce different results than in

other ecoregions. The second goal is to develop guidelines for restoring some late-successional forest characteristics in 40 to 80 year-old stands in the PSFZ.

Adaptive learning will also enable the effects of climate change on forest productivity to be measured. This will allow for evaluation of current assumptions on desired tree stocking levels.

Restoration of Riparian Habitat Conditions

Watershed restoration on National Forest System land began following the 1983 storm which saw 37 major landslide failures in Finney/Deer Watersheds. Since that time, development and utilization of variety of drainage structures such as the vented concrete ford or "Texas Crossing" have been utilized as well as conventional drainage improvement and fill stabilization have been the focus of restoration strategies. On Forest Service System land 25.7 miles of system road have been treated since 1986 (15.7 miles decommissioned and 10 miles upgraded).

Watershed restoration through treating roads in the Finney Creek Watershed and Deer Creek Watershed are nearly complete. The North Fork Stillaguamish road deficiency treatments are about 30% complete. Restoration on private and State lands started with closing roads in the mid 1990's and continues under Washington State Timber, Fish and Wildlife Rules.

Watershed restoration within the AMA has also included the placement of large wood structures on NFS lands in Deer Creek, and on and off NFS lands in Finney Creek. Wood structures were designed to narrow stream channels. Monitoring to date has not conclusively determined that the structures have been effective in reducing stream temperatures, but data from 2008 and 2009 may indicate a trend of decreasing temperatures resulting from wood structures.

In most national forests within the Northwest Forest Plan area, riparian zones are bounded by the default buffers of the Aquatic Conservation Strategy (http://www.reo.gov/library/reports/RODjan01.pdf). The primary intent of these default riparian buffers was primarily to protect riparian vegetation from harm during forest management activities and less to accelerate the recovery of riparian communities and stream channels from previous damage. As envisioned by the authors of the Aquatic Conservation Strategy (Sedell et al. 1994), Adaptive Management Areas were meant to provide managers with an opportunity to experiment with a variety of management techniques in order to achieve natural resource goals more quickly than simply allowing an area to recover passively.

Riparian forests mediate a variety of ecosystem processes that contribute both to the maintenance of productive aquatic habitat and to other ecological “goods and services” that are valued by society, such as protecting biodiversity and buffering the effects of storm flows. Current implementation procedures to achieve the objectives for aquatic and riparian conservation in the Finney AMA tend to focus on temperature, large wood and sediment. While these are key indicators of habitat for salmonids, maintaining ecologically functional riparian zones is necessary for a fuller complement of ecological “goods and services”.

Managing for Resilient Riparian Conditions Based on Natural Disturbance Regimes

Managing for resilience in an environment where salmon and trout may be at risk will require decisions about habitat that are by necessity relatively short-term and geographically focused. Management plans for the Finney AMA will continue to identify restoration and protection

actions at site-specific scales that are consistent with landscape-based strategies. Local spatial and short-term temporal scales are small relative to the distribution and persistence of Pacific salmon as a whole, but they are very important for developing management strategies that promote the local population resilience. In addition to temporal trends and cycles, much recent work has emphasized the importance of acute disturbances resulting from events such as wildfire (Rieman and Clayton 1997; Dunham et al. 2007), volcanism (Bisson et al. 2005), and earthquakes (Hastings 2005).

In recent years there have been an increased number of studies involving fish and fish habitat centered on the watershed (Benda et al. 1998) and landscape (Reeves et al. 1995) scales. This has required that aquatic ecosystems be considered in the context of time scales of decades to centuries. Time has not previously been a major consideration when considering the behavior of aquatic ecosystems. A consequence of this oversight is that aquatic ecosystems have been assumed to be relatively stable through time, and have been thought to recover relatively quickly if disturbed by natural events. Terrestrial ecosystems, in contrast, have been understood to vary dynamically over long time periods, and forested landscapes have been characterized as a series of patches of different forest ages that gradually change over time.

The relatively static view of aquatic and riparian ecosystems currently reflected in fixed habitat standards in many environmental regulations is beginning to change, in part as a result of having to take a longer term perspective. There is an emerging view that streams and associated riparian areas undergo successional changes similar to upland forests, and that they can experience a wide range of conditions like the terrestrial ecosystems in which they are embedded.

Resilience of Pacific salmon is influenced by watershed processes that supply structural components of the aquatic environment such as coarse sediment and large wood, as well as those that support the transfer of energy and nutrients through aquatic food webs. These processes are linked to riparian forests, and forests in upland portions of the watershed that may erode and contribute large trees and coarse sediment to streams. Considerable regulatory attention has been given to riparian forest protection, largely to preserve trees for stream shading, streambank stabilization, and as future sources of large wood for fish habitat (Bisson et al. 2006). Contemporary forest practices typically restrict harvest in riparian zones, but often overlook the importance of wood recruitment from uplands. In some locations, wood recruited to channels from landslides can constitute a significant portion of the wood load in the stream network (May and Gresswell 2003) and redistribution of hillslope-derived wood through fluvial transport is an important process in habitat formation downstream (Benda et al. 2003).

Resilience of Pacific salmon is also tied to recovery of aquatic and riparian food webs (Bisson and Bilby 1998; Naiman et al. 2002). For example, some projects have attempted to improve freshwater productivity by placing salmon carcasses in streams to restore an important annual source of marine-derived nutrients where salmon runs are depleted (Stockner 2003; Wilzbach et al. 2005). Managing tree species composition in riparian zones can also influence aquatic food webs. For example, conifers in riparian zones may be important contributors of large wood for habitat, but smaller deciduous species such as nitrogen-fixing alders can deliver more energy and nutrients to streams (Karlsson et al. 2005).

Salmon and trout require many different habitats in freshwaters (Groot and Margolis 1991), including those used for egg incubation, juvenile rearing, and migration of adults. Neighborhood effects may also be important; for example, use of a specific location may be related more to use

of nearby habitats than to characteristics of the habitat itself (Isaak et al. 2007; Mull and Wilzbach 2007). In a general sense, habitat diversity appears to be essential for supporting salmonids, but understanding more specifically how watershed processes influence population resilience and expression of life histories remains an important information need.

The conceptual basis for aquatic and riparian management is shifting from an equilibrium perspective to one that recognizes dynamic, non-equilibrium conditions and natural variability (Naiman et al. 1992; Wellington et al. 2005). A dynamic view of aquatic ecosystems requires an increased appreciation of infrequent but large events such as physical disturbances (e.g., wind storms, fires, and floods) that create and maintain habitats. This perspective recognizes disturbance and successional processes that do not occur in an orderly or predictable manner (Pahl-Wostl 1995). Within an area affected by a disturbance, several transitional states may be expressed over time such that the timing or duration of any particular state may be difficult to predict (Wondzell et al. 2007). Succession from one state to another can occur slowly in response to geomorphic adjustments (i.e., elevation change by an earthquake) or more rapidly in response to large, infrequent events such as floods, widespread timber harvest, and landslides. The signature and legacy of these events can influence local conditions for long time periods (Foster et al. 2003). Stream conditions can thus be viewed as transitory, reflecting local spatial controls, past natural disturbance, and land-use impacts.

Management of the freshwater habitat of Pacific salmon is shifting toward a focus on natural processes and variability rather than attempting to maintain or engineer a desired set of conditions through time (Lugo et al. 1999; Dale et al. 2000). When applied to the management of aquatic ecosystems, the concept of resilience requires us to abandon the idea that any water body not conforming to an idealized notion of optimum habitat needs to be fixed or restored. From this new perspective, resource managers must examine variability in current aquatic conditions and establish the large-scale spatial and temporal context of a watershed (4th-order and larger streams over many decades), historical changes in the system, and potential threats and expectations. The fundamental idea is to characterize variation in natural processes within stream networks and ask where we are, where we want to go, and how we get there, in the context of restoring a natural range of habitat conditions.

Historically, in the long intervals between wildfires, riparian forests in the Finney area were likely dominated by late-seral conifers; however, it is likely that there were localized patches of younger trees and recently-disturbed ground caused by flooding, windthrow, and landslides. These patches of localized disturbance, often found at tributary junctions, can serve as nodes of habitat complexity and biodiversity (Benda et al. 2004), even though they may depart from an idealized notion of how streams in old-growth forested watersheds should appear (Reeves and Bisson 2009). Large, stand replacing fires occurred in the area in 1301, 1508, 1701. The extent to which these fires altered riparian stands has not been fully characterized and they may have been followed by episodes of high landslide frequency; changes in shading and sediment input may have been affected by fire or mass erosion individually, or both. Additionally, some stands have experienced tree mortality from root disease (*Armillaria*), which may have produced gaps that facilitated the establishment of western redcedar and red alder at sites where they would normally be excluded by Douglas-fir and western hemlock. The overall conclusion is that the natural condition of riparian forests in the Finney AMA was likely late-seral forests, with relatively small patches of recently-disturbed plant associations or young mixed hardwood-conifer stands.

Recent natural disturbances to the stream channels have included landslides, windthrow, flooding, and timber harvest. These disturbances have created relatively small patches of varying riparian stand age and stream habitat conditions. Fish habitat concerns most commonly associated with these disturbances have included increased water temperature, elevated fine sediment levels with more frequent bedload movement during storms, and the long-term depletion of large wood from the channels. However, not all of the changes have necessarily had negative consequences for native fishes. Localized forest disturbances help create nodes of habitat complexity that differ from the surrounding landscape, and patchy openings in the riparian canopy can allow more light to reach stream channels, stimulating primary production (Naiman et al. 2000). It is neither desirable nor in the interests of restoring aquatic productivity to maintain a completely disturbance-free riparian zone dominated by old forest (Reeves and Bisson 2009). Therefore, while restoration of late-seral riparian stands is warranted in watersheds where large trees and densely-shaded riparian canopies have been extensively removed by natural or anthropogenic processes, provisions for allowing natural disturbances to occur (or designing forest treatments that emulate changes produced by natural disturbances) will be most likely to yield a range of conditions that favors biodiversity and promotes aquatic and riparian ecosystem resilience (Bisson et al. 2009).

Other Learning Topics

The following learning topics will be pursued depending on funding and partnership involvement. These topics are not the primary objectives of the AMA, but contribute to assessing the effectiveness of forest and stream management.

True Fir Spacing Trials

This study that began in 1987 is evaluating the responses of young Pacific silver fir, noble fir, and western hemlock to a range of precommercial thinning levels (Curtis 2008, Curtis et al. 2000). To date, there have been two measurements of vegetative resonse. Four of the 18 stands involved in this study occur in the AMA. Other National Forests involved in this study are the Olympic, Gifford Pinchot, Mount Hood, and Willamette. This cooperative study is expected to continue with remeasurements on a 10-year schedule. The next remeasurement is scheduled for 2014 with tree measurements to be conducted by the Pacific Northwest Research Station and understory vegetation and down wood measurements accomplished by the Mount Baker-Snoqualmie National Forest.

Finney Creek Temperature and Channel Cross-Sections

Along with its partners, the Forest Service will continue to pursue monitoring the effectiveness of instream wood structures on Finney Creek in reducing stream temperature and improving fish habitat.

Marbled Murrelet Nesting Habitat

Although not fully explored during the development of the plan, there may be options to study the potential to encourage the development of lateral branches in younger trees to develop potential nesting habitat for marbled murrelets. This may be included as a response variable in the evaluation of treatments to restore some old-growth forest characteristics in upland forests described below.

Big-leaf Huckleberry Enhancement

The Tulalip Indian Tribe and the Forest Service are cooperating in studying methods to increase huckleberry production for the benefit of berry pickers and some wildlife species. This effort is evaluating maintaining non-forested openings in areas of 1960s timber harvest and by thinning young trees in stands harvested in the 1980s. Treatments occurred in 2009 and 2010 and will be monitored for huckleberry height and percent cover; tree canopy cover; and berry production.

Implementation Strategy

Uplands

Research Expectations

To learn if thinning (specifically variable density thinning) can be used successfully to affect development of taxonomically diverse, spatially heterogeneous, and multi-layered forests without substantially increasing risks of wind throw, fire, disease or other disturbances and while allowing the commercial harvest of trees and development and growth of large diameter trees of high commercial value in the Pacific Silver Fir Forest Zone.

To determine if stand responses from long-term silvicultural experiments in the Western Hemlock Forest Zone in other ecoregions are similar to responses that would occur in the North Cascades Ecoregion.

To refine the stocking level and various age relationships developed for the Forest-wide Late Successional Reserve Assessment (MBS 2001, pages 68-73) for the western hemlock forest zone and under development for the pacific sliver fir forest zone.

What can be accomplished with active management in these stands in terms of developing late successional forest characteristics to increase biological diversity while still providing for the long-term development of old-growth forests? In other words, can we make some temporary changes to stands that improve biological diversity, while still moving the stands forward into the future toward old stand structure?

Study Objectives

Test for the ability to change homogeneous young forest stands to mimic older ones in structure and test if accelerated development of the structures that are missing in the younger stands will increase the function of the ecosystem as habitat for marbled murrelets and small mammals.

1. Produce stands which differ in species composition and vertical and horizontal diversity.
2. Evaluate growth rates of overstory trees, stand differentiation, tree seedling establishment and variation in horizontal and vertical diversity.
3. Monitor population responses of plants (trees, forbs, shrubs, lichens, grasses) to implementation of various silvicultural prescriptions.
4. Accelerate development of characteristics associated with late successional forests.
5. Determine long term forest yields under different silvicultural regimes.

Experimental design

5 treatments, replicated 5 times in 2 different vegetation zones (PSF and WH), 50 plots, 16 ac each = 800 acres.

Treatment A: None (control used for baseline)

Treatment B: Emphasize the stocking at the lower end of stand densities not expected to result in significant tree seedling establishment in currently uniform stands. Within the PSF zone and the WH zone. Incorporate gaps ranging from 1 acre to 2 acres, smaller gaps have not resulted in increased understory plant diversity.

Treatment C: Emphasize the stocking at the upper end of stand densities where biomass accumulation is expected to be near maximum in currently uniform stands. Within the PSF zone and the WH zone. Incorporate gaps ranging from 1 acre to 2 acres, smaller gaps have not resulted in increased understory plant diversity.

Treatment D: Emphasize the stocking above the level at which old-growth forest conditions are expected to develop. Within the PSF zone and the WH zone. Incorporate gaps ranging from 1 acre to 2 acres, smaller gaps have not resulted in increased understory plant diversity.

Treatments E: Emphasize the stocking at which significant tree seedling establishment is expected to occur. Within the PSF zone and the WH zone. Incorporate gaps ranging from 1 acre to 2 acres, smaller gaps have not resulted in increased understory plant diversity.

Accounting for the likelihood of candidate stands occurring on unstable soils or other constraints that would preclude including them for experimentation, there are approximately 18,500 acres of young forest in the Pacific silver fir zone and 14,000 acres of young forest in the western hemlock zone to select stands from for experimentation (Figure 5). From these stands, an array of age classes can be selected which represent different conditions across the landscape in terms of aspect, plant association group, elevation and slope.

Criteria for Evaluating Results

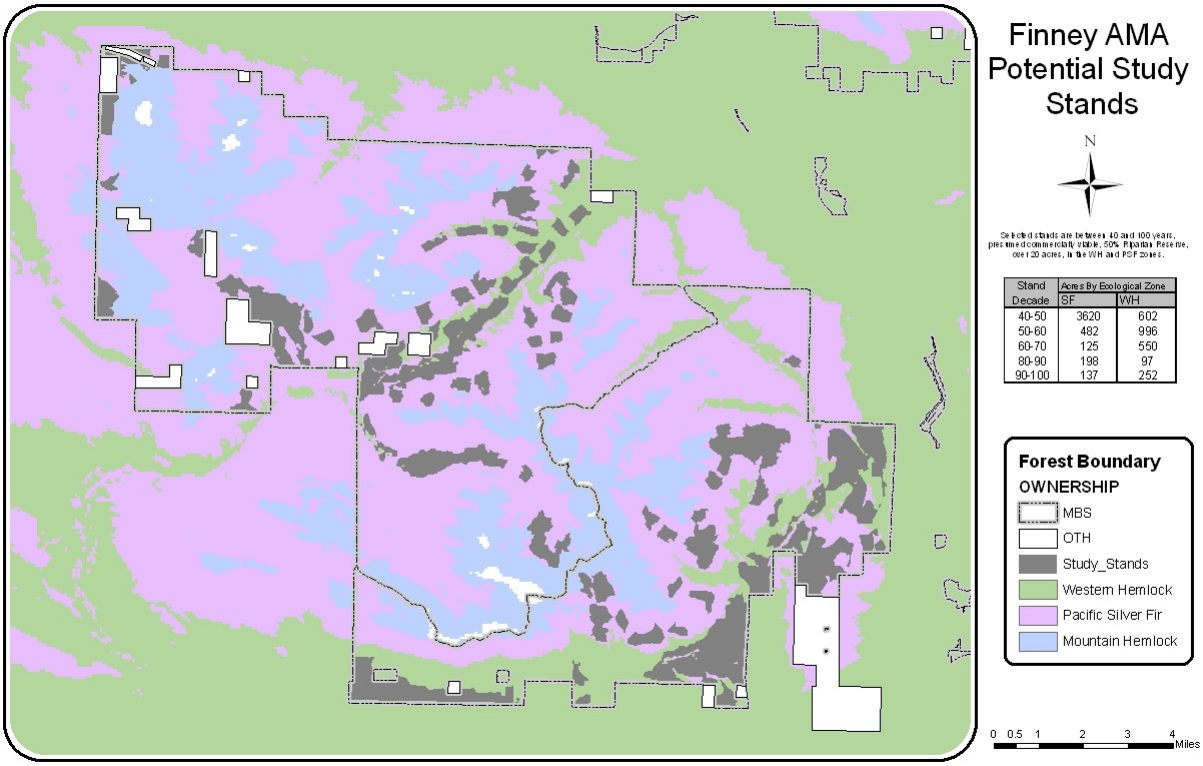
Monitoring will occur at permanent plots established prior to treatment. Before and after treatment, measurements will follow Carey and Harrington (1997) including:

- Plant species in thinned matrix (abundance and size by species).
- Diversity of plant species in and out of gaps (abundance and size by species).
- Change in tree sizes over time in thinned and unthinned stands. Measure diameter at 4.5 feet, height, height to live crown, crown width, canopy cover.
- Tree mortality and mortality agents.

The evaluation of the results for the various treatments constitutes effectiveness monitoring. They will be used to develop a strategy for conducting additional restoration treatments in mid seral stands and potentially form the basis for additional treatments worthy of further experimentation.

Validation monitoring of changes in biological diversity resulting from vegetation treatments may be pursued if funding for this additional research can be secured.

Figure 5. Candidate stands for adaptive management treatments in the Finney AMA.



Riparian Areas

Research Expectations

The longest running study of alternative riparian treatments on federal lands in the Cascade Mountains and Coast Range has been the BLM Density Management and Riparian Buffer Study – a cooperative research effort between the Bureau of Land Management and Forest Service (Cissel et al. 2006). Although the objective is somewhat different from the Finney AMA goal of promoting late-successional forest, protecting water quality and restoring fish habitat, the objectives are compatible and the conceptual design of treatments in the Density Management Study is relevant to the paired watershed approach proposed for Finney. The major difference between the Oregon study and what is proposed here is that, in Oregon, treatments were implemented along sequential segments of streams instead of being applied to entire small watersheds. For the Finney AMA, a whole watershed treatment design in which a single treatment is applied to one of each treatment/reference pair (instead of multiple treatments applied sequentially along a riparian corridor) is likely to yield less ambiguous results in terms of interpreting the effects of the treatments on riparian forest communities, water quality and fish habitat.

Two treatments are proposed, each of which would be paired with an adjacent reference watershed. In all treatments heavy equipment operation and timber harvest will be excluded from a 25 foot zone adjacent to the exposed stream channel or from the edge of the "inner gorge" if the channel is incised, whichever is the greater distance, in order to prevent direct damage to the stream channel.

Reference conditions. Upland forest management within these watersheds will employ the default Northwest Forest Plan Riparian Reserve buffers for perennial fish bearing, perennial non-fish bearing, and ephemeral/intermittent channels. No management actions will occur within these buffers. This will be the default management strategy against which the following treatments will be compared.

Treatment 1: Light thinning in outer part of buffer. This treatment comprises the least intrusive riparian entry. Light thinning (actual prescriptions to be determined based on site conditions) can occur outside of 1 site-potential tree height adjacent to fish bearing streams, 0.5 site-potential tree height adjacent to perennial non-fish bearing streams, and 50 feet adjacent to ephemeral/intermittent streams. Thinning would harvest smaller trees, with the largest trees left intact within the riparian buffer.

Treatment 2: Variable width buffer with patches. The intent of this treatment is to manage streamside vegetation to emulate a naturally disturbed riparian zone within a late successional forest characteristic of the area. This will involve the creation of openings (e.g., ~1 ac) that might result from the localized impacts of a strong wind storm, or relatively heavy thinning that might result from windthrow or root disease. However, because natural disturbance patterns are usually quite patchy, this treatment should also maintain some areas along streams where riparian vegetation remains largely intact and undisturbed by management activities. The design of the variable width buffer will depend on site topography, orientation relative to patterns of wind disturbance, soil moisture, and other factors. Particular attention will be paid to leaving intact vegetation adjacent to seeps, springs, and hillslope "hollows" (unstable headwall areas) that are likely to fail over time and deliver wood and coarse sediment to the stream network.

Study Objectives

Treatments involve different levels of thinning in and adjacent to riparian areas to accelerate the development of late-seral forest stands. They would be completed in "treatment" watersheds within a single year (although not all watershed pairs must be treated in the same year). Olson and Burnett (2009) have summarized the alternative buffer configurations in the Density Management Study (Figure 6).

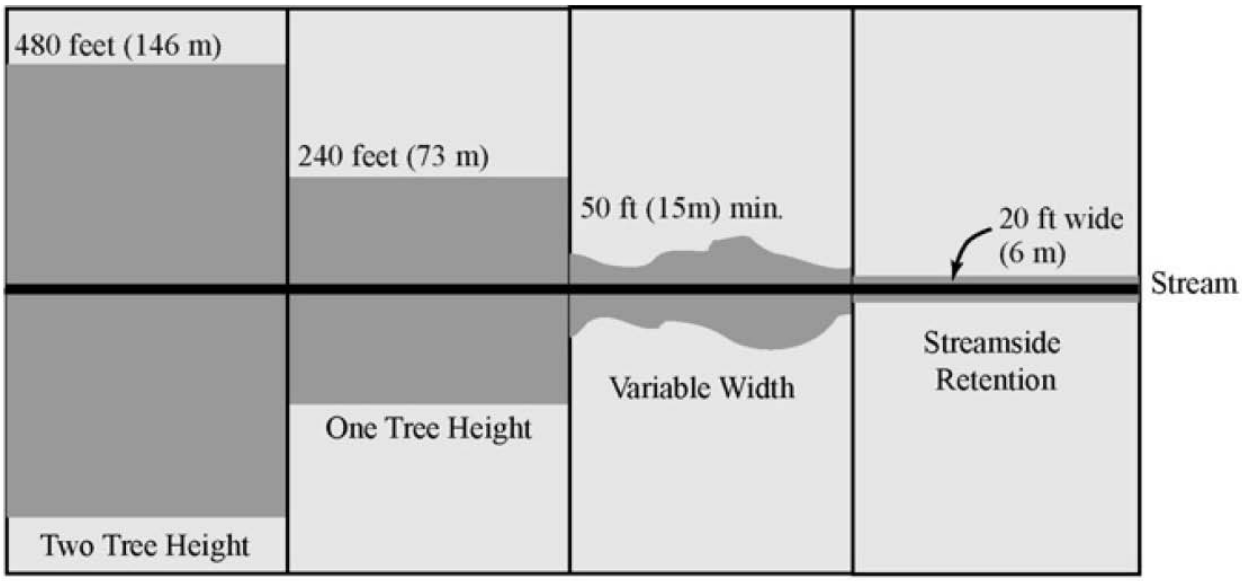
An additional difference between the Oregon study and the design proposed for the Finney AMA is that riparian buffers at the Finney Sites would consist of streamside vegetation in which some management actions are permitted. This is in keeping with the Forest Ecosystem Management Assessment Team (FEMAT) long-term goal of using Adaptive Management Areas to test silvicultural prescriptions that potentially accelerate the development of target forest conditions

(Sedell et al. 1994). The four buffer configurations in Figure 5 provide a useful conceptual diagram for treatments that would be applied to non-fish bearing streams in the Finney paired watersheds.

Experimental Design

Experiments at the scale of traditional silviculture plots are often too small to produce detectable changes in parameters of interest to fish and wildlife habitat managers. The most successful studies of experimental forest management relative to aquatic ecosystems have involved treating entire small watersheds. Where possible, investigators have employed paired watersheds in which forest treatments are applied to one watershed and the other is untreated to serve as a reference site. The experiments are often preceded by one or more years of pre-treatment monitoring in order to establish differences in baseline condition among the watersheds before a treatment is applied. How long the pre-treatment monitoring period lasts usually depends on the interannual variability of the response variables of interest, and in some cases a statistical power analysis (Thomas (1997) is needed to determine the number of years needed to detect a pre-determined significant difference between the treatment and reference site. The technique of using paired treatment-control comparisons following a pre-treatment monitoring period is termed a Before-After-Control-Impact (BACI) approach. Such an experimental design is appropriate for the Finney AMA.

Figure 6. Four buffer treatments employed in the Oregon Density Management Study (from Olson and Burnett 2009). The black line bisecting the center represents the stream channel and the dark shaded areas adjacent to the channel indicate the width of unmanaged buffer treatments. The lighter shaded area outside the buffers represents upland forests in which variable density thinning treatments have taken place.



The duration of the study will depend on design feasibility and funding for pre- and post-treatment monitoring. Ideally, pre-treatment monitoring should take place for several years in order to estimate the amount of annual variability in stream temperatures and other water quality

parameters of interest, as well as characterization of riparian conditions in experimental watersheds, before restoration actions are undertaken.

Criteria for Evaluating Results

Post-treatment monitoring should take place yearly for the first 3-5 years after treatments are applied, as changes in response variables will likely be greatest during this period. After 5 years, monitoring can be carried out at longer intervals, e.g., 5-year spacing, to document long-term changes and the success to which desired conditions have been achieved. Monitoring can also occur after unanticipated or highly unusual weather events if deemed necessary.

A network of recording thermistors will be placed in the streams. But most of the monitoring efforts involve characterizing changes in the composition and structure of riparian plant assemblages before and after treatments are applied.

Photo points. Photo points are one of the most cost-effective monitoring tools whose value is often underappreciated. Photo points will be established at pre-determined intervals along the stream network (e.g., every 200 meters) and at established locations in the riparian zone. Photo points in riparian zones will include locations near the stream (e.g., 10 meters) and at progressively greater distances (e.g. 50 and 100 meters). Digital photographs should be obtained yearly for the first 3-5 years after treatment application and thereafter at 5-year intervals.

Stream temperature. TidBit temperature loggers (http://www.onsetcomp.com/products/data-loggers/utbi-001) will be placed near the downstream boundary of each treatment and reference watershed. The loggers will be programmed to record year round at 4-6 hour daily intervals. All loggers will be carefully secured within the streams at a location where they will not be damaged during high flow events.

Vegetation surveys. Riparian and upslope vegetation surveys are critical to understanding whether the treatments have achieved the goal of promoting late-successional forests without contributing to water quality degradation. The methods used in the Oregon Density Management Study (Anderson and Meleason 2009) would be employed. Because the number of treatments proposed for the Finney AMA is fewer and treatments were interspersed with one another, the vegetation surveys will be less complicated. However, the basic method of establishing transects beginning at the center of the stream and extending through the buffer to the upslope stands would be employed. Several transects for each of the treatment-reference site pairs should be sufficient to characterize long-term changes in plant assemblages. In addition to noting standing trees along transects, surveys will include understory features (moss, herbaceous, and shrub cover, and small < 30cm diameter and large $\geq$30cm diameter down logs).

Other parameters. Fish population and stream habitat data including Wolman pebble counts (as a measure of sediment), bankfull width and depth, pool frequency and maximum depth, large woody debris frequency expressed in the number of pieces per mile by size class, fish abundance by species and size classes determined by snorkeling using the protocols established by Hankin and Reeves (1998), and possibly including mark-recapture would be collected. Experience with other long-term riparian monitoring projects suggests that such monitoring often requires intensive efforts over extended periods to produce information that is able to separate the signature of watershed treatments from environmental noise (National Research Council 2002).

Education of Participants

The Mount Baker-Snoqualmie National Forest will maintain information on implementation of research treatment on its web site. In addition, the Forest will encourage researchers to present findings in local communities.

Coordination Needs (including funding strategy)

The MBS Vegetation Manager will work with representatives of the timber industry, local Indian Tribes and the environmental community to secure grant funding to gather pre- and post-treatment measurements. The MBS Vegetation Manager will develop a partnership with a university or experiment station to conduct the data collection and evaluate treatment results. The MBS will produce an EA or EIS documenting the environmental impacts of the proposed research treatments.

The Skagit River System has expressed interest in offering their Tribal scientists to assist in monitoring results of experiments. Tribal consultation will occur regularly as learning themes are planned, implemented, and analyzed.

Timber Sale Plan

Implementation of the two primary learning themes is currently scheduled for 2013. The timber removed to evaluate the effectiveness of differing management strategies is expected to yield approximately 10 million board feet of lumber. There are no other timber sales currently planned in the AMA between 2011 and 2015.

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Appendix A

Community Recommended Learning Themes Developed at the April 23, 2008 Workshop

Summary of Finney Research Topics

The learning themes described below were evaluated for incorporation into the AMA plan. Some of the topics were evaluated in greater depth than others. The level of topic development reflects the level of interest and likely its potential benefit to the participating communities. These evaluations and other information used in the development of this plan are available on request from the Mount Baker-Snoqualmie National Forest Supervisor's Office.

FS Recommended

1. Late-successional Forest Restoration in the Western Hemlock and Pacific Silver Fir Forest Zones
2. Balanced Age Class Distribution
3. Stand manipulation to restore rain-on-snow hydrology
4. Riparian Area and Stream Condition DFC determination.
5. Habitat use and resource partitioning of barred and spotted owls.

Community Recommended

1. What stand densities respond to old growth development? This should be the basis for designing any manipulations and fits well in FS 1.
2. Are there thinning opportunities in mixed aged stands to promote owl habitat. Nearly all mixed aged stands are old-growth and not in need of restoration.
3. Management opportunities for hardwoods that promote old growth or riparian habitat. Are there concentrations of hardwoods in Finney that would allow testing?
4. Are road improvements having a positive impact on riparian areas? How have they impacted the rate of landslides, sediment delivery, and peak flow amount and timing. Finney too small to assess on a research basis. Some local monitoring happening and should continue. Peak flow aspect fits into FS 3.

5. Identification of wildlife habitats in need of restoration. This information is available but should be summarized and cited for the development of response variables.
6. How can active management of entire Finney (including DNR) improve LSR conditions in the long and short-term. Stand conditions have been identified for both ownerships. The remainder fits into FS 1, can stand manipulation improve the situation in the short-term and not compromise long-term development.
7. Determination of rates of carbon sequestration of various aged stands.
8. Comparison of restoration treatments on DNR and FS in creating habitat and economic benefit. Fits well into FS 1.
9. Improve knowledge of silver fir forest response to silvicultural manipulations. Fits well into FS 1.
10. Comparison of passive vs. active approaches to riparian forest management (reduction in hardwoods) on stream characteristics.
11. Evaluation of economics of restoration thinning and how this is affected by scale (amount of acres treated). Possible consideration of FS 1.
12. Identify structural characteristics of spotted owl and marbled murrelet nesting habitat suitability with and without stand manipulation. Possible response variables of FS 1.
13. Can thinning restore large woody debris amounts and sizes in streams?
14. Comparison of Aquatic Conservation Strategy and Timber, Fish, and Wildlife stream management zones on riparian function.
15. Effects of stand manipulations on carbon sequestration. Does this result in a net increase or decrease in sequestration rates
16. How is climate change affecting the various forest systems and how can the USFS best manage to adapt to climate change?