Chilkat River Watershed
Review of Forestry Plans and Recommendations for a Way Forward
June 1, 2022

Herb Hammond
Forest Ecologist & Forester

WRITE

Contents

1. Introduction

The Chilkat River watershed is accurately described as “one of the continent’s great ecotones” (Carstensen, 2021). The Chilkat ecotone reflects the many ecosystem types that converge in this watershed: boreal forests, rain forests, saltwater, fresh water, wetlands, and a diverse range of landforms and topographic features. This convergence provides a rich variety of interconnected habitats and a very high level of biodiversity.

As an umbrella and keystone species, salmon offer an example of the interdependence and connectivity within the ecotone. Salmon move from saltwater to freshwater to, after spawning, into the forest transported by bears and eagles to enrich soil nutrients and provide water storage and filtration. At the large scale, the ecotone furnishes a link from coastal ecosystems to interior ecosystems. That link provides for the movement of animals, plants, and energy across regional and continental scales.

The effectiveness of the ecotone depends upon maintaining the natural ecological integrity and resilience of the ecosystems that comprise it. This connectivity and interdependence of ecosystems bridges scales of time and space.

The diverse nature of the Chilkat ecotone sets this watershed apart as a vital landscape to protect for the integrity of not only the Chilkat River watershed, but a wide area of ecological landscapes connected physically and biologically to the Chilkat. The biological diversity inherent in the Chilkat at a range of scales is also the basis for a diverse, community economy where subsistence activities play a more important role than timber management. For example, the Alaska Department of Fish and Game (ADFG) data shows that more than 90% of the households in the Haines area rely on salmon for subsistence. (ADFG, 2012)

In reviewing the Haines State Forest forestry plans for the Chilkat River watershed, a number of questions will be asked about the content of the plans:

- Do the plans recognize the unique nature of the Chilkat River watershed?
- Do the plans provide for the protection and, where necessary, the restoration of ecological integrity and resilience?
- Are the plans based upon information and assumptions appropriate to the biological and physical character of the watershed?
- Do the plans incorporate Lingit (Tlingit) knowledge, particularly ways of protecting and conserving the Jilkaat Heeni watershed? (Carstensen, 2021, Earthjustice, 2017)
- Do the plans consider the climate change and the biodiversity crises, and incorporate ways to mitigate and resolve these crises?
- Do the plans provide for sustainable supplies of natural resources, including timber (per HSF Management Plan)?

To address these questions and synthesize practical ideas for an appropriate relationship with the forests of the Chilkat River watershed, this review follows this path:

1. Introduction
2. Natural Character—important aspects for planning and activities

3. Current Condition—a modified forest landscape
4. Forestry Effects on Water and Watershed Functions
5. Climate Change predictions
6. Haines State Forest Management Plan (HSFMP)—important aspects
7. Five Year Forest Management Schedule 2022-2026
8. Questions for Plans—a summary
9. Nature-Directed Planning—a practical way forward

> Earth spaces are endangered. Because of their evolutionary creativity, Earth spaces are more important over the long run than the species abstracted from them. Without this insight, conservationists will keep slipping back into the language of saving organisms and their habitats, leaving the door open to those who argue that the solution is more and better arks. To plan the preservation of "biodiversity" at the land-water ecoscape level is to preserve more than that term initially suggested. It is to preserve the world.
> J. Stan Rowe, Global Biodiversity, 1997: 7(2)

2. Natural Character—important aspects for planning and activities

Natural character refers to the ecosystem composition, structure, and function in the absence of development by industrialized settler communities. Natural character includes indigenous management systems. For the Chilkat River watershed, Tlingit (Lingit) protection and management through millennia defined and maintained the character of the ecosystems that comprise the watershed, and the watershed as a whole.

The natural character of an ecosystem, watershed, or landscape provides for natural ecosystem function, ecological resilience, and biological diversity. The different spatial scales of natural character reflects the interconnected, interdependence of the components of ecosystems, from individual patches to large landscapes. Maintenance of natural character is vital for the protection and maintenance of a myriad of benefits from intact forests, including water conservation, carbon sequestration and storage, and rich biological diversity.

The Chilkat River watershed may be broadly described as *ribbons of forests in a sea of ice and snow*. Forests are found adjacent to the Chilkat River and its tributary rivers and creeks in broad to narrow floodplains that are part of the riparian ecosystems of these water bodies. Forests are also found on the lower slopes of the valleys connected to the the riparian ecosystems. However, these lower slope forests quickly give way to subalpine and alpine vegetation with snowfields and glaciers above. This character of the forests in the Chilkat watershed identifies them as climate limited forests.

TEXT

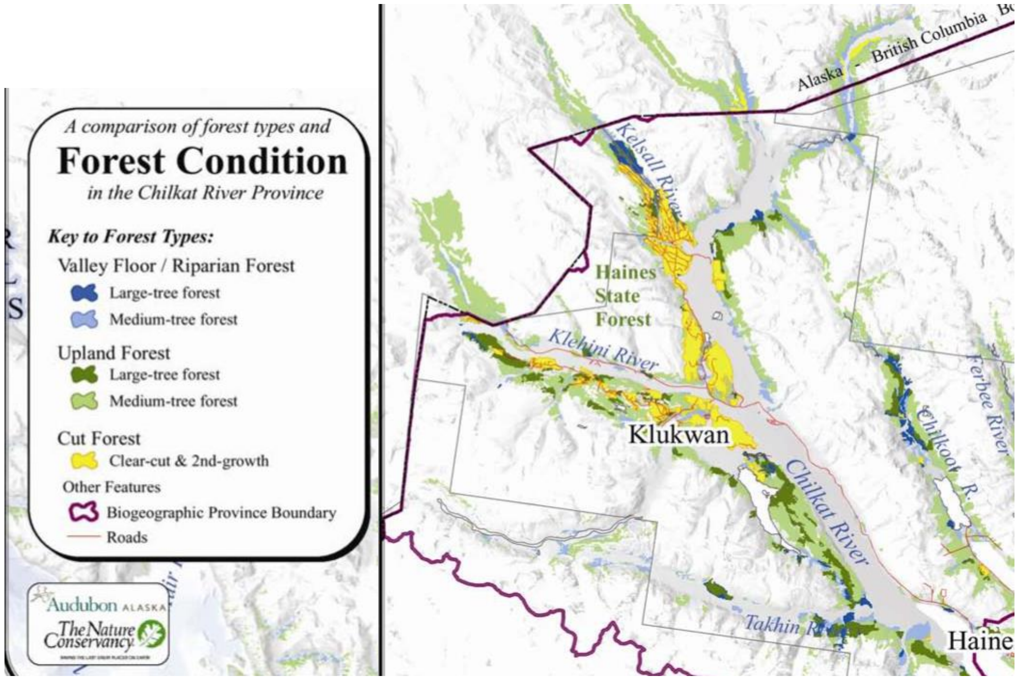


Figure 1: Depicts natural character of Chilkat River watershed as "ribbons of forest in a sea of ice and snow". Note the large area of forests that have been logged by the publication date of 2007. These logged areas are concentrated in rich alluvial forests that comprise portions of riparian ecosystems. Logging concentrated in these naturally rare ecosystem types removes habitat types, fragments connectivity, and results in loss of biodiversity and essential benefits of intact forests, like water management and climate moderation. (Schoen and Dovichin, 2007)

For two thirds of the year, January through April and September through December, temperatures are likely to fall below freezing. The average annual snowpack is approximately 20 feet, and comprises approximately 54% of the annual precipitation for the watershed, which averages approximately 46 inches at the Haines 40NW. As elevation increases in the watershed temperatures decrease, snowpacks increase and total precipitation tends to decrease. (U.S. Climate Normals, 1981-2010)

With the exception of the narrow floodplain forests where the most moderate climate occurs in the Chilkat watershed, all of these climatic factors make it difficult for trees to become established and grow at reasonable rates. These climate limitations to tree growth are evident in the patchy and open canopied nature of most forests in the watershed.

This pattern of growth in the floodplains is due primarily to well-drained soils being interspersed with river channels and poorly drained soils. However, the patchy open canopies of lower slope and mid slope forests reflect the difficulty of trees, as erect plants with a single main stem, to grow in an environment where year after year deep snowpacks bend and break the tree stems. With great difficulty, some individual trees grow above the snowpack, and provide shelter for subsequent trees to regenerate close to them. However, deep snowpacks prevent the patches of trees from joining, which results in the patchy open canopies of these forests. Such forests are often referred to as parkland ecosystems, denoting the transition area or ecotone between forest and alpine.

Another way to consider the character of the lower slope and mid slope forests of the Chilkat is as snow forests, where winter is the dominant season and snow is a dominant feature. Winter often extends from October through April and sometimes into May. During much of this time, trees are blanketed with snow, and the forest floor is covered by snow. Hence, plants, animals, and microorganisms of these snow forests have adapted to survive extended winter conditions.

For example, the small plants on the snow forest floor survive the drying and extreme cold of winter by being buried beneath an insulating layer of snow. Small mammals, such as marten, shrews, and voles, access this snow covered ecosystem and roam through subnivian runways beside snow covered fallen trees on the forest floor. (Lee 2002)

Even during the growing season, the snow forest may experience periods of adverse weather. Severe early season frosts may kill young buds and impair plant growth. Cold snaps at the end of the growing season can impact growth and reproduction in the next year if buds and seeds are not fully developed and prepared for winter.

While plants, animals, and ecological processes have adapted to survive in these climate-limited ecosystem cold, snowy climes, they all function at or near the margin of survival. Hence, plans for human activities, particularly extractive activities like logging, need to be particularly careful to protect the ecological composition, structure, and function of these forests from the patch to the watershed. Mistakes in such climate limited forests may easily result in long-lasting or permanent ecological degradation due to the climatic conditions.

The *Southeast Alaska Conservation Assessment* point out the character of the Chilkat that results from the ecotone of the overlapping of coastal and interior forests. Precipitation varies significantly within short distances, resulting in the rapid shift from coastal to interior conditions. The Chilkat contains fire-influenced tree associations of white birch and lodgepole pine (*Betula papyrifera-Pinus contorta*), which are unique in Southeast Alaska. The generally dry nature, and fire influence of the Chilkat is reflected in forests at sea level, which are western hemlock—Sitka spruce (*Tsuga heterophylla—Picea sitchensis*) rainforests at the dry end of the rain forest spectrum, and also unique in Southeast. (Schoen and Dovichin, 2007)

The Chilkat watershed ecotone results in:

- *Alaska's highest vascular plant species richness…*,
- *one of the highest value watersheds for salmon habitat in Southeast…*, and
- [the] *highest mammal diversity in Southeast*. (Schoen and Dovichin, 2007)

Of particular note in this rich ecotone are the riparian forests:

> *The riparian forest of the Chilkat and associated rivers provide some of the finest wildlife habitat in Southeast. The mix of cottonwood (*Populus balsamifera*) and spruce reflects the actively aggrading floodplain. Willow (*Salix spp.*), Red-osier dogwood (*Cornus nuttallii*), and highbush cranberry (*Viburnum edule*) are important browse species for moose which are abundant here.* (Schoen and Dovichin, 2007)

As may be seen in Figure 1, the riparian forests have been targeted for logging, which degrades the functions of individual forests and the overall ecotone of the Chilkat watershed.

3. Current Condition—a modified forest landscape

The riparian forests and adjacent lower slope forests of the Chilkat River watershed have been extensively clear-cut logged in the past. The Haines State Forest 5-Year Management Schedules for 2021 – 2025, and 2022 – 2026 propose extensive further clearcuts within the Chilkat River watershed. More than 2200 acres are scheduled for clearcutting, 140 acres for commercial thinning, and 250 acres for removal of cottonwood from a tree planation under the 2022—2026 Management Schedule. Many of the proposed clearcuts focus on removing remaining fragments of intact forests that exist between clearcuts, while some like the two Chilkat Ridge blocks will remove approximately 1300 acres of intact forests that join the Chilkat River bald eagle preserve and Chilkat Lake. Logging, particularly clear-cut forestry, has and continues to modify the forest landscape in ways that degrade ecosystem composition, structure, and function across spatial scales, from individual sites to watersheds.

Little to nothing about clearcuts can be equated to the characteristics of natural disturbance regimes. In the course of natural disturbances, trees are killed, but the bodies of these trees remain on site as snags and fallen trees that play vital ecological functions and are the foundation for future forests. Snags and fallen trees store and filter water, provide habitat for plants and animals, provide sources for nitrogen to enter the system, provide habitat for microorganisms that make soil nutrients available, and furnish habitat for fungi that provide underground connections between trees and all vegetation.

The focus on clearcutting riparian and lower slope forests in the Chilkat is particularly degrading. These forests makeup a large percentage of the intact forests in the watershed and play outsized roles in providing the foundation for rich biodiversity in the watershed compared to the remaining non-forested part of the watershed. Thus, the ecological integrity and resilience of the Chilkat River watershed depends in no small way on protection of the integrity of riparian and lower slope forests.

4. Forestry Effects on Water and Watershed Functions

4.1 Intact Natural Forests

To understand the effects of forestry, i.e. timber extraction and tree plantation management on water and watershed functions, we need to start with how *intact, natural forests* provide water and watershed functions. Our discussion focuses on the benefits that intact, natural forests provide for water quality, quantity, and timing of flow.

Intact, natural forests are also referred to as *primary* forests. All forests that have not been significantly altered by industrialized society's activities are referred to as primary forests. A hiking trail through a forest does not constitute significant alteration. A road and clearcut do constitute significant alteration.

Intact natural forests provide high quality water in moderate amounts throughout the year. In the Chilkat watershed, the water stored, filtered, and slowly released by forests is supported by meltwater from the snowfields and glaciers in the upper elevation portions of the watershed and its tributary watersheds. Water management by intact, natural forests improves as the forest ages. Thus, old/old-growth primary forests provide the best water. Why?

During a rainstorm, millions of liters of water fall on a forest canopy from a great height. During a snowstorm, hundreds of thousands of tonnes of snow collect in a forest canopy. The forest absorbs this energy and releases it… one drop at a time. Old and old-growth forests do this best, because they have multiple canopy layers. When water falls on an old forest canopy, the rain or snow is first intercepted by large, tall, old trees with millions of leaves. As the water in the form of rain or snow gently falls through the forest canopy, intermediate and shorter trees, shrubs and herbs, and, eventually mosses and lichens catch the water and slowly release it to the absorbent forest floor – soil, streams, rivers, ponds, and wetlands. This function regulates both the energy and volume of water released into the forest.

In the case of snow, which is a dominant feature of the Chilkat watershed climate, the multi-layered canopy and canopy gaps of old, intact forests collect and store snow throughout the winter, and protect the snow that reaches the ground. Once the warmth of spring returns, the forest canopy regulates the melting of snow and the corresponding gradual release of water by partially shading the snowpack. In this situation, the multi-layered canopy and canopy gaps of old, intact natural forests "meter" the release of water in the spring and summer, conserving water to provide for late summer and early fall flows, necessary to support the salmon, bald eagles, and a spectrum of other organisms that inhabit the Chilkat river and broader watershed.

However, the intact primary (old/old growth forests) that occupy the Chilkat watershed are only found in narrow strips that occupy the lower slopes and riparian ecosystems of the watershed. As such, these forests are naturally rare ecosystems and vital to the maintenance of the biological integrity of the watershed, both as irreplaceable habitat and vital water managers.

During precipitation events, both rain and snow, a significant amount of the precipitation is intercepted by the tree canopy, sublimated or evaporated back into the atmosphere, and moved to another location. This occurs when snow or rain is caught in the canopies of large trees and multi-layers of vegetation in the primary forests, particularly old forests, and is sublimated/evaporated by exposure to the energy of sun and/or wind. In a snow dominated older forest, 40% to nearly 70% of the snow is intercepted by the canopy, with a large portion of that precipitation returned to the atmosphere through the actions of sun and wind. (Helbig, 2020)

This function of old and old-growth forests is not only important for local and regional distribution of water, but also for regional and continental distribution of water. (Creed, 2018.

FAO, 2019) Some of the snow and rain that falls in the Chilkat watershed is relocated to support the water supplies of the interior boreal forests.

An old forest canopy slows the force of water falling during a rainstorm to maintain order and balance in the ecosystem. This means that during rainfall, soils are able to partially drain, giving them an ability to absorb the storm water as it falls and avoid surface runoff and erosion.

Large fallen trees decaying on the forest floor are characteristic structures in primary forests, particularly in old and old-growth forests. Decayed wood is the natural water storage and filtration system in forest ecosystems. Decayed wood holds many times more water than a given volume of most mineral soils. (Isaacson, 1985) These large dead tree structures found in intact natural forests function as "water storage and filtration systems" for hundreds of years.

Water storage and filtration in the decayed wood of an old forest is particularly vital for "late-season," or late summer and fall water. Therefore, even small first and second order streams need millions of tonnes of decayed wood distributed throughout their watershed to provide for healthy water quality, quantity, and timing of flow — flow that meets ecosystem and human needs throughout the seasons.

The multilayered canopies of intact old and old-growth forests, together with their large supplies of decayed wood, have an additional hydrological function. Cool temperatures and humid air, found from the upper canopy to the forest floor slow the evaporation of water, thereby conserving the release of water from the forest so that flows are moderate and dependable throughout the year. This hydrological role of natural, intact old forests will increase in importance as global warming increases.

In contrast to primary and old forests, young forests have many less leaves to intercept water, smaller crowns, single-layer canopies, higher air temperatures, less humid air, and declining supplies of decayed wood. These factors mean that young forests do not conserve water well. Forest landscapes dominated by young forests tend to have more frequent floods during storm events, faster and higher runoff periods in the spring, more sources of erosion and siltation, and more frequent and severe droughts, particularly in the fall. (Segura, 2020)

Maintaining the natural character of intact primary forests, particularly old and old-growth forests throughout the forest landscape is not only important to maintain today's water supplies, but will be even more important with the moisture stresses that grow as global warming increases.

Many of the primary forests in the Chilkat are embedded in a matrix that has been extensively modified by clearcut logging. In this context, the word matrix refers to the dominant patch type in the landscape. (Lindenmayer, 2002) Along the Chilkat and its major tributaries, logging and related forestry activities, like road construction have dramatically changed the matrix ecosystems, which were once dominated by intact old forests and are now regenerating clearcuts. This condition creates urgency to protect remaining primary forests and other intact natural ecosystems, and to reestablish connectivity between these patches to restore ecological integrity and resilience, Applying the concept of the matrix to watersheds, forest ecologists David Lindenmayer and Jerry Franklin explain the connections between natural, intact forests and water:

As the dominant patch type in most temperate landscapes, the matrix strongly influences the condition of aquatic ecosystems and water quality. Vegetation conditions in a watershed, especially the type and density of forest cover, directly influence the structure, environment, and diversity of associated aquatic ecosystems. Terrestrial vegetation also regulates the paths and rates of water movement, erosion, and sediment transport through a watershed.

Natural forests typically provide a stable landscape context for the development of aquatic ecosystems and organisms. Forest cover mutes environmental extremes, such as in-stream temperature fluctuations; provides energy and nutrient inputs; filters sediments; and provides large woody debris which is an essential structural element of many aquatic ecosystems. Forest cover can influence storm response such as by reducing peak flows. Forests can also extend runoff in watersheds, such as those dominated by spring snowmelt. Erosion is also minimized in natural forest landscapes, resulting in high-quality water with low levels of sediment and dissolved and suspended materials.

.
.
.

A central goal of matrix management is preserving aquatic ecosystem integrity and the hydrologic and geomorphological processes upon which much biodiversity depends. Given its fundamental importance to human societies, the maintenance of a well-regulated, high-quality water supply is (or should be) one of the chief objectives in the management of forest lands. (Lindenmayer, 2002)

4.2 Intact Natural Forests and Carbon

Carbon sequestration and storage are critical functions of forested watersheds. Sequestration is the capture of carbon from the atmosphere through the process of photosynthesis. Storage of carbon occurs above ground in leaves, twigs, branches, and main stems of woody plants. Because of their size, trees obviously sequester and store the largest amount of carbon in a forest, compared to other plants. Long term storage of carbon occurs both in the limbs and trunks above ground, as well as below ground in the roots and associated structures. Approximately 50% of the carbon stored in forests is found in the soil, including decayed organic matter, plant roots and the mycorrhizal fungal network that connects all plants. The older and more complex the forest structure and the larger the trees, the greater the amount of carbon that is captured and stored in the forest. Thus, intact primary forests, particularly old-growth forests are our most important terrestrial carbon sink.

Climate change and loss of biodiversity are widely recognized as the foremost environmental challenges of our time. Forests annually sequester large quantities of atmospheric carbon dioxide (CO2), and store carbon above and below ground for long periods of time. Intact forests — largely free from human intervention except primarily for trails and hazard removals — are *the most carbon-dense and biodiverse terrestrial ecosystems, with additional benefits to society and the economy. Internationally, focus has been on preventing the loss of tropical forests, yet US temperate and boreal forests remove sufficient atmospheric CO2 to reduce national annual* net *emissions by 11%. US forests have the potential for much more rapid atmospheric CO2 removal rates and biological carbon sequestration by intact and/or older forests. The recent* 1.5 Degree Warming Report *by the International Panel on Climate Change identifies* reforestation *and* afforestation *as important strategies to increase negative emissions, but they face significant challenges: afforestation requires an enormous amount of additional land and neither strategy can remove sufficient carbon by growing young trees during the critical next decade(s). In contrast, growing existing forests intact to their ecological potential — termed* proforestation — *is a more effective, immediate, and low cost approach that could be mobilized across suitable forests of all types. Proforestation serves the greatest public good by maximizing co-benefits such as nature-based biological carbon sequestration and unparalleled ecosystem system services such as biodiversity enhancement, water and air quality, flood and erosion control, public health benefits, low-impact recreation, and scenic beauty.*(Moomaw, 2019)

Moomaw and his colleagues clearly support the need to protect forested watersheds, particularly those with intact forests, as carbon sinks that play an essential role in mitigating climate disruption and assisting to keep global warming below 1.5° C. This essential benefit of intact forested watersheds supports the protection of the remaining intact forests in the Chilkat River watershed as carbon sinks, particularly given the fragmentation and habitat loss that has already occurred in the watershed from clearcut forestry and logging roads.

4.3 Forestry Effect on Water and Watersheds

As used in this context, "forestry" means conventional industrial forestry as practiced in the Haines State Forest. While forest professionals and timber interests often tout their protection of biodiversity, water, and the myriad of ecosystem benefits provided by intact, natural forests, these claims are not borne out in examination of the results of forestry. Clearcuts and tree plantations, based upon short rotations, or the periods between logging and logging plantation trees, dominate the practice of forestry. The result is the virtual exclusion of "kinder, gentler" forestry practices, where maintenance of ecological integrity and resilience are the priorities through the establishment of networks of ecological reserves. And, in some areas between ecological reserves, partial cutting is used to remove a modest amount of timber at periodic intervals to meet human needs.

Clearcuts degrade water. (Yu, 2019. Jones, 2020) Clearcuts degrade biodiversity. (Price, 2020) Clearcuts degrade ecological resilience. (Thompson, 2009) Clearcuts exacerbate climate disruption. (Weiting, 2019. Pojar, 2019) Then, why are they sanctioned by forest professionals in the employ of timber interests. One primary reason: Clearcuts are the cheapest and fastest way to turn trees, seen as "logs standing vertically," into monetary profits.

4.4 Removal of Forest Canopy—Forestry Effects

Clearcut forestry completely removes the multi-layered canopies that intercept precipitation, redirect some of the precipitation to other locations, and reduce the amount that reaches the forest floor. When it comes to the direct release of energy from a storm event, the energy from rain is significantly dampened as it drips through the canopy. In a snow storm, the canopy collects a large amount of the snow fall and releases it to the atmosphere to avoid development of snow packs that will overload the watershed during spring runoff.

In all places where intact forests have been removed, these water buffering effects are lost.

In the case of rain, the energy of falling water is released immediately during the storm. This often results in high levels of water saturation of soils, which may lead to erosion, including landslides, and floods.

In snow dominated portions of a watershed, openings like clearcuts and road corridors, collect approximately 40% + deeper snow packs than are found under the multilayered canopies of intact old and old-growth forests and other primary forests. In the spring and summer, the deeper snow packs in openings melt approximately 30% faster than the snowpack shaded by an intact, old natural forest. This process releases a large pulse of water in the spring and reduces the water available from a watershed in the late summer and fall. Thus, the absence of forests can result in spring floods and fall droughts, particularly in watersheds that depend upon snowpacks for water. (Yu, 2019. Wood, 2021)

Replacing the multi-layered canopy of large, dense foliage forest crowns is a slow process that requires decades of forest growth and development. (Owen, 2022) In the case of the Chilkat forests, this process will require in order of 150 years or more, which is well beyond the intended rotation length when plantation trees are scheduled to be logged. (Owen, 2022) Thus, forestry does not intend to ever replace the canopy of trees that once functioned so well in the conservation and management of water.

4.5 Loss of Decayed Fallen Trees—Forestry Effects

Protection of existing dead trees (snags and fallen) coupled with continuous replacement of dead standing (snags) and fallen trees are essential processes related to water conservation and overall health of a watershed. In primary forest ecosystems that are not disturbed by logging or other forms of clearing these processes function relatively smoothly through time, even with natural disturbance regimes changing the structure of the forest.

However, replacing large dead tree structures is absent from most approaches to “sustained yield” forest management, particularly those that employ clearcutting and short rotation plantations. Large living trees are all removed as logs. Even smaller trees beneath the size to qualify for a log are usually cut down in order to “efficiently” remove merchantable trees.

Clearcut forestry either removes snags as merchantable logs, or fells the snag to avoid dangerous working conditions. When trees are yarded or skidded from the forest to landing areas where logs are loaded on trucks, many fallen tree structures are broken apart and lose their water storage and filtration function. These fallen trees fall victims to a well understood principle of forest ecology: loss of the composition and/or structure results in loss of function.

The loss of a multi-layer forest canopy with large tree crowns able to intercept water, and the loss of the benefits of decayed wood from a continuous supply of large fallen trees, leads to decline of the water storage and filtration capacity of watersheds. The end result of this ecological degradation is overall loss of watershed integrity, including loss of water quality and timing of flows that vary from spring floods to fall droughts. In the Chilkat River watershed, these effects will negatively affect the persistence of the five species of pacific salmon that inhabit the watershed and act as keystone/umbrella species to provide for overall watershed biodiversity, both terrestrial and aquatic.

4.6 Concentration of Water—Forestry Effects

In an intact, natural forested watershed, water is dispersed through the vegetation cover of the forest, absorbed and transmitted through permeable soil, eventually emerging as surface water in springs, seeps, wetlands, intermittent creeks, year round creeks, ponds, lakes, and rivers. However, when forestry occurs in a watershed much of the water changes from being dispersed throughout the system to concentrated in particular locations, which often results in erosion, landslides, and siltation of water supplies.

By removing the forest canopy, forestry subjects the forest floor to being overloaded with precipitation in rain events and overly deep snow packs that melt rapidly in the spring. In both of these situations, the concentration of water on the forest floor may lead to degradation of soil and water. The chance for these effects to occur may increase with the intense storms and drought that accompany climate disruption. Prolonged drought may result in the development of hydrophobic soils that in intense storms may cause concentration of runoff, overland flow, and associated soil and water degradation. (Hewelke, 2018. Gimbel, 2016)

Other than in the infrequent situation of aerial removal of logs, forestry operations require the construction of access roads to reach areas that are scheduled to be logged. Many of these areas that are logged also require the construction of skid trails, or low quality roads through the logging area to drag logs to a road or log landing area, where logs are loaded on trucks. These roads and trails are oriented across the direction of slope, and usually have compacted, water-impermeable surfaces, which intercept the downslope movement of water, and concentrate water on their surface. Prior to forestry operations, this water was dispersed throughout the soil and moved down the slope to nourish plants, animals, microorganisms, and maintain ecosystem processes. Dispersed movement of water is the natural way of water in forests and does not cause detrimental effects to the forest.

However, water is concentrated by road and skid trail surfaces, ditches, and cross drains. Under circumstances of intense rainfall and/or rapid snow melt, both more common with climate change, road surfaces and the fill slope on which roads are constructed may become saturated with water, resulting in erosion and landslides. Fill slopes are at a steeper angle than the angle of the underlying natural topography and consist of unconsolidated material, both of which make them more subject to failure when saturated with water than the underlying natural soil profile. In situations where the fill slope fails, the natural soil profile beneath the fill slope usually becomes part of the landslide. Such events associated with roads often result in direct siltation of surface water supplies.

Forestry operations attempt to manage the concentration of water on roads by constructing ditches on the upslope side of roads and draining the ditches through culverts beneath the road at intervals along the road. Notably this type of water management does not occur on skid trails.

While ditches reduce water concentration on road surfaces, they also result in greater concentration of water that accumulates along the length of the ditch. That water is funneled through culverts onto slopes below the road, often resulting in saturation of the fill slope or natural slope, soil erosion and potential mass movement of soil.

Overall, the concentration of water that results from forestry operations poses many risks to both the integrity of the ecosystems that comprise the sites modified by forestry, and ecosystems that are down slope, and downstream from the forestry operations.

4.7 Decayed Roots and Slope Instability — Forestry Effects

After an area is logged in forestry operations and time passes, the roots that formerly anchored the trees on the slope and contributed to the movement of water and nutrients from the soil up into tree crowns begin to decay. As the roots decay and are incorporated into the rhizosphere, they leave behind hollow “pipes” where the roots were once found. These hollow pipes have “cemented,” water impermeable sides due to pressure from the growth of living roots. These hollow pipes become filled with water and form another situation where forestry concentrates water to the detriment of the stability of ecosystems and topography.

As water pipes beneath the stumps in a clear-cut spread across an area, the likelihood of soil erosion and landslides increases. The effect of water pipes concentrating water is most pronounced on moderate to steep slopes. Thus, precautionary forestry planning for moderate to steep slopes assesses the likelihood of concentration of water from roads, skid roads, and water pipes following logging. The results of this assessment may preclude forestry operations in these areas.

4.8 Loss of Carbon Sequestration and Storage—Forestry Effects

Logging intact forests in watersheds removes the carbon sequestration and storage function of the area where forestry operations occur. The trees extracted from the area logged are responsible for the largest loss of carbon conservation in forestry operations. In addition, clearcut forestry warms and dries out the soil and fallen trees, which results in an increase in the decomposition of these structures, and a corresponding rapid release of carbon from dead fallen trees and soil organic matter. (Pojar, 2019. Weiting, 2019)

More than 60% of the carbon stored in the logs that are removed is back in the atmosphere within 5 years. (Hammond, 1992) Thus, long-term storage of carbon in wood products is an inaccurate justification for logging. Even with the less than 40% of a log that reaches "long-term" storage, the length of that storage seldom exceeds 50-70 years, a much shorter lifetime than that found in the trees that once occupied the forest that was destroyed by forestry. (Pojar, 2019) Thus, as roads and logging progress through a watershed, the ability of the watershed to serve as a carbon sink declines, as well as its ability to mitigate the climate emergency and biodiversity crises.

Roads are permanently lost to carbon sequestration and storage. So, significant areas in the managed plantation "forests" created after logging are permanent carbon dead zones. (Pojar, 2019)

In the case of clearcut areas, it takes 13 years or more for the planted trees to absorb more carbon than is being released from the area due to decomposition of organic material. During that time the "managed forest" is a carbon sequestration dead zone. The forest has been converted from a carbon sink to a carbon source. That carbon source will last for a long time. (Weiting, 2019)

In the order of 150-250+ years of forest growth and development will be necessary to restore the level of carbon sequestration and storage that existed in the intact, natural forests of the Chilkat watershed before they were logged. This period of time is based on the past growth patterns of trees in some logged areas of the Chilkat, and on interior wet-belt forests in British Columbia. The Chilkat forests are more climate limited forests than interior wet-belt forests in British Columbia. Thus, this estimate is conservative for forest growth and development needed to restore natural levels of carbon sequestration and storage. (Harmon, 1990)

However, climate change calls into question whether forests in the future will follow past growth patterns. The growing stressors associated with climate disruption, like drought, insect epidemics, and extreme weather, may prevent natural forest development as existed in the past, and further reduce carbon sequestration and storage in managed forests.

4.9 Irrecoverable Carbon—Watershed Forests

The carbon stored in intact forested watersheds may be classed as "irrecoverable carbon". That is to say that the carbon lost during logging activities, the manufacture of short and relatively short life cycle (<70 years) products, and the transportation of logs and wood products cannot be recovered within timescales relevant to avoiding dangerous climate impacts. (Goldstein, 2020) For example, growing trees to replace the 150 year old trees that were cut and removed during logging will require at least 150 years, <u>and</u> assumes that replacement trees will survive the ongoing impacts of climate change.

Overall, Earth's ecosystems contain vast quantities of carbon that are, for the time being, directly within human ability to safeguard or destroy and, if lost, could overshoot our global carbon budget. Protecting these biological carbon stocks is one of the most important tasks of this decade. (Goldstein, 2020)

From many directions, there are clear indications that forestry exacerbates climate change through the large increases in greenhouse gas emissions that accompany conversion of intact, natural forests. Forestry is responsible for converting forests from carbon sinks to carbon sources. As forest management continues to be dominated by short rotation, clearcut logging and the establishment of tree plantations, one questions whether forest professionals and agencies responsible for forestry are upholding the public trust to keep people safe from the negative effects of climate change.

4.10 Forestry Effect on Water and Watersheds--Concluding Thoughts

From timber and mining to large-scale tourism, watersheds function best in a state undisturbed by industrial society's activities. As soon as these activities start to alter the composition, structure, and function of a watershed, the processes responsible for natural levels of water quality, quantity, and timing of flow begin to degrade.

Unfortunately, the natural integrity and resilience of primary forests often mask early impacts of water degradation, and create a false sense of security that logging and other developments in watersheds do not negatively affect water. This false sense of security is augmented by the reality that linear scientific research is unable to detect significant problems associated with watershed development until it is too late for restoration in a reasonable timeframe. As development activities proceed, this false security and the low level of assistance from scientific knowledge lead to small problems becoming large problems that are long lasting and degrade overall watershed function.

The moral of the story is protection of water means protection of the watershed from industrial society's development activities. Under precautionary Nature-directed planning that incorporates Indigenous knowledge and gives first priority to protection of water some low impact activities that maintain natural composition, structure, and function may safely occur on stable terrain.

Past and proposed forestry development in the Chilkat watershed does not meet the test of precautionary Nature-directed planning. Forestry development in the Chilkat and its tributary watersheds has, and continues to follow a timber-biased approach with few meaningful concessions to the protection of water. For example, proposed developments in the Chilkat do not provide networks of ecological reserves, use clearcutting or modifications of clearcutting to remove trees, and cutting rates are based on questionably sustainable short rotations for regrowth of trees.

Currently, most decisions about development activities in watersheds are based upon flawed *assumptions of convenience* about logging, forestry, and water supported by the timber industry and to government. These simplistic decisions are flawed, dangerous to watershed health and pose a threat to all life that depends upon healthy, intact watersheds. A critical review of these decisions, through the lenses of Indigenous knowledge, western scientific knowledge, or common sense reveals them to be flawed. The protection and use of watersheds need to quickly move to decisions based upon a precautionary approach, rooted in factual understanding of how forested watersheds function, and how forestry negatively impacts watershed function. Without this change we face a future with increased uncertainty about the reliability of adequate, healthy water supplies.

That future depends in no small way on an important principle: *Water may either transmit the essence of life, or magnify and transmit our mistakes*. The choice is ours.

5. Climate Change Predictions

Alaska is warming twice as fast as the rest of the United States. (EDF, 2022) This warming trend and associated effects of climate disruption has, and will continue to affect the forests and other ecosystems of the Chilkat River watershed.

In the Chilkat watershed average annual temperatures are projected to increase by more than 2 degrees F, more than 1 degree C by 2049, and annual precipitation is expected to increase by up to 3.9 inches by the same date. Along with the increase in precipitation will come a shift from precipitation falling as snow to rain. That shift will occur primarily in the valley bottoms and lower slopes of the Chilkat watershed. (Smith, 2016)

Climate change predictions forecast that a number of effects will occur in the Chilkat watershed, including:

- spatial redistribution of vegetation due to the shift from snow to rain in portions of the watershed,
- increased rain on snow events, which may lead to landslides and degradation of a variety of habitats and water quality, and
- changes in the timing and magnitude of peak and base flows, which may result in both flooding and drought, as well as changes to stream temperatures and nutrients. (Smith, 2016)

These effects of climate disruption will not only affect water and vegetation patterns, but also will affect habitat, both terrestrial and aquatic, for a spectrum of animals. Populations of the five Pacific salmon that inhabit the Chilkat River are at risk of being negatively impacted by the effects of climate change.

As the climate warms, insect populations are likely to grow and may result in high population levels that negatively affect trees. In the absence of the population control furnished by cold winters, insects like the hemlock sawfly (*Neodiprion tsugae Middleton*) and western black-headed budworm (*Acleris gloverana Walsingham*) are likely to have higher population levels that occur more often. This situation may lead to mortality in western hemlock.

Under past climate regimes, neither of these defoliators have caused significant mortality to western hemlock trees. Both insects play a variety of important ecological roles, from providing food for song birds to fertilizing the forest floor with their frass. Only when these two defoliators work in association have they resulted in significant tree death. (Graham, 2021)

As explained in Section 2, the broad ecotone of coastal forests meeting interior forests, and the smaller ecotones nested within this broad ecotone have resulted in some dryer, fire maintained ecosystems. This character of the forests in the Chilkat River watershed may result in more wildfire as the climate warms. Depending upon the extent and frequency of such fires, they may result in significant shifts in vegetation composition and structure.

The natural primary forests of the Chilkat watershed have ecological integrity and ecological resilience, which give them the ability to adapt as climate change progresses. While uncertainty exists as to the full extent of climate change effects and the ability of natural primary forests to adapt, maintenance of the remaining primary forests in the watershed is an important hedge against climate disruption. Unlike the natural, intact primary forests, clearcuts and tree plantations have very low ecological resilience and are expected to suffer significant tree and soil degradation under a variety of climate change regimes.

5.1 Climate Change Refugia—a Conservation Opportunity for the Chilkat Watershed

The context of the Chilkat watershed may be summarized as:

- The watershed contains important areas of intact forests that provide high levels of ecological benefits for water, biodiversity, and carbon management.
- These forests are nested in a landscape that is predominantly steep alpine slopes, snow and ice fields, and glaciers. This environment poses climate limitations to the growth and expansion of forests
- Significant areas in the watershed have been fragmented by roads and clearcuts that contribute to climate disruption and biodiversity loss.
- Plans for additional roads and logging, as expressed in the 5 Year Management Schedule 2022-2026, threaten the ecological integrity and resilience of the watershed, particularly in the climate emergency.
- Forestry and associated logging activities in the watershed are part of a non-sustainable cutting rate that exacerbates climate change and biodiversity loss.
- Alaska is warming faster than southerly regions in the U.S.A. and Canada. This means that projections for future climate disruption in the Chilkat may cross undesirable thresholds more quickly than other areas.
- Rural communities in the Chilkat depend upon the integrity and resilience of the watershed for subsistence needs and for ongoing water conservation.

Given this ecological, climatological, and social context, the Chilkat watershed plays important roles in mitigation and adaptation to climate disruption. These climate change related roles may be the most important benefits provided by the watershed in support of the broad public interest to reduce the effects of climate change and provide important forest benefits, particularly high quality water supplies, biologically diverse terrestrial and aquatic habitat, and reduction of greenhouse gases in the atmosphere.

To protect the important roles of the Chilkat watershed in the climate change era, the watershed may be designated as a *climate change refugia*.

Climate change refugia may be described as:

> *areas relatively buffered from contemporary climate change over time that enable persistence of valued physical, ecological , and socio-cutural resources.* (Morelli, 2016)

The climatological context of this watershed offers opportunity to designate the area as climate change refugia. The ecological context supports this observation and brings attention to the need to stop the loss of intact, natural forests—forests that are naturally limited in their extent in the watershed. The dependence of rural human communities on the forest benefits from this watershed also is a nod towards its designation as a refugia.

One might argue that ultimately most, if not all climate change refugia will fail to maintain current ecosystem composition, structure, and function. This conclusion arises from the relatively static definition of refugia. A broader interpretation of refugia is more nuanced and attempts to accommodate ecosystem complexity, while providing protection for sociocultural and physical resources. (Morelli, 2020)

The reality is that refugia will have varying lifetimes, or periods within which they are effective, and will serve different purposes. Thus, refugia have both a spatial and temporal aspect. Classification of refugia by how long they are predicted to play a chosen refugium function(s) leads to identification of refugia as "micro" or "macro" refugia.

Climate-change refugia exist along spatial and temporal continuums (figure 2; Keppel and Wardell-Johnson 2015), ranging from regional scales (where macro refugia can facilitate ecosystem persistence over centuries and even millennia), to landscape and local scales (where micro refugia can maintain particular species and communities for years and decades), to "hyper- local" scales (where refuges can provide temporary shelter for individuals) (Fey et al. 2019). In addition, disturbance refugia (Web Panel 1) can delay ecosystem transitions for decades or longer (Carlotta Chuck at Al 2020) (Morelli, 2020)

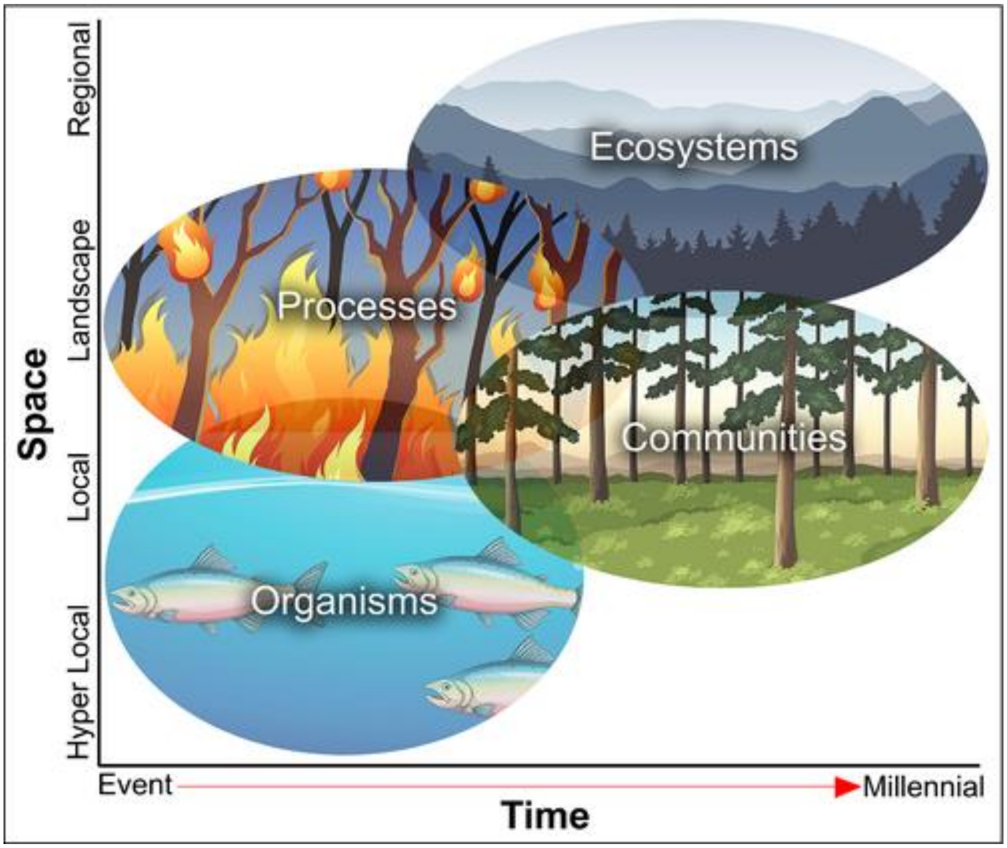


Figure 2: @regional scales, macro refugia can facilitate ecosystem persistence over centuries and even millennia. At landscape and local scales, micro refugia can maintain selected species and communities for similar lengths of time. At shorter timescales (days to years), hyper- local refuges can provide temporary shelter for individual organisms. (Morelli, 2020)

Climate change refugia are established in locations with ecological integrity, biological diversity, and ecological resilience. These types of complex ecosystems rely on their integrity and resilience to provide options for change to accommodate the stressors of climate change. By comparison, the degraded, simplified ecosystems that result from logging, tree plantations, and other forms of development have very limited resilience and options for change as climate change progresses.

A critically important function of climate change refugia is that they will provide for the persistence of important forest and other ecosystems benefits as climate changes progresses. The length of time persistence occurs will depend on the speed and types of change wrought by climate change. Changes will occur within the natural range of variability from natural disturbances for the ecosystems in the refugia. If changes from climate change reach points beyond the natural range of variability, the refugia will provide stepping stones to a new socio-ecological regime. This will result in a more orderly transition to a new ecosystem form, and, hopefully, bring with it some of the benefits from the previous ecosystem composition, structure, and function.

In these ways, designation of the Chilkat watershed as a climate change refugia will assist persistence of natural ecosystems, and their inherent resilience for as long as possible. As a refugia this watershed will meet community needs for as long as possible in the face of yet unknown changes in climate. The surrounding landscapes will also benefit from the maintenance of ecological integrity and resilience in the Chilkat watershed. This is important to the broad ecotone that the Chilkat is a part of, and the overall mitigation of, and adaptation to climate change.

6. Haines State Forest Management Plan (HSFMP)—important aspects with 1994 Forest Inventory, 2020 Timber Inventory, and Five Year Forest Management Schedule, 2022--2026

This section provides analyses and comments for various aspects of the Haines State Forest Management Plan (the plan) related to the ecological integrity and resilience of the Chilkat River watershed. As such, this section does not provide a complete review of the plan. Analyses of various aspects of the plan are followed by comments that address how the stipulations of the plan may affect the ecological character and condition of the Chilkat River watershed, and therefore the sustainability of activities under the plan.

Information and analyses of portions of the 1994 Forest Inventory and the 2020 Timber Inventory for the Haines State Forest are also provided in this section. Both of these timber inventories are closely tied to the specifications of the plan, and, therefore aspects of the inventories affect the likelihood that activities under the plan will provide for a sustained yield of timber and other resources.

The Haines State Forest Management Plan provides the context within which "multiple use" will be the dominant system to guide activities in the Haines State Forest (the forest). The plan lays out the legislative description of multiple use:

> *The primary purposes for the establishment of the Haines State Forest Resource Management Plan Area or the utilization, perpetuation, conservation, and protection of the local land and water, including but not limited to, the use of renewable and nonrenewable resources through multiple-use management, and the continuation of other beneficial uses, including traditional uses and other recreational activities.*

Creation of the State Forest also reflects legislative intent to dedicate state land to long-term management by the Department of Natural Resources (DNR) for the benefit of the public. (HSFMP, 2002, p 1 – 1)

Along with the requirement for multiple use, the plan also specifies that:

> *Renewable resources must be managed according to the sustained yield principles of AS 41 point 17.* (HSFMP, 2002, p 1 – 2)

"Sustained yield" is defined in the plan as:

> *The achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of forest land and water without significant impairment of the productivity of the land and water but does not require that*

> *timber be harvested in a non-declining yield basis over a rotation. (AS 41. 17. 950 (17)).* (HSFMP, 2002, p A – 10)

Along with other considerations, various aspects of the plan and forest inventories will be considered below as to how they may affect the achievement of sustained yield.

6.1. Sustained Yield Requires a Sustained Ecosystem—Forest

Sustained yield management of "various renewable resources of forest land and water without significant impairment of the productivity of the land and water" as called for in the plan sets the stage for conflict between interdependent, interconnected "resources" or ecosystems. Sustained yield is a human centred view of management of ecosystems. "Yield" means "something of use to people." (Hammond, 1992)

When forests are managed primarily for timber, as called for in the plan, other resources like Pacific salmon and carbon sequestration and storage lose the intact, natural forest ecosystems necessary to sustain them and many other organisms and ecosystem processes. This reality highlights a major flaw of a sustained yield approach: what do we sustain and what don't we sustain? Do we sustain timber yield at the expense of water, salmon habitat and carbon storage? Or, do we sustain high quality water, salmon habitat and carbon storage at the expense of timber?

Intact natural forests are dynamic systems that focus on the maintenance of their ecological integrity and resilience, not on a sustained yield of anything. Instead, intact forests focus on sustaining whole forests in highly variable patterns. By forcing forest ecosystems to produce a "resource," like timber that requires extraction of ecosystem parts, i.e. tree boles or logs, the practice of sustained yield forecloses on many Forest uses and alters the natural processes that sustain whole forests. In this way, sustained yield practices may actually degrade the capacity of the forest to sustain even timber supplies. (Nantel, 2003)

Comment:
By adopting a sustained yield approach, the plan and 5-year management schedules have not incorporated the broad move in forestry from management for sustained yield to management for sustained ecosystems through the maintenance of natural ecological integrity and resilience. (Luckert, 2005) The latter approach is variously referred to as ecosystem-based management and/or Nature-directed stewardship. The persistence of the plan and 5-year management schedules to apply sustained yield concepts results in various problems to other "resources" or ecosystem parts and processes that are negatively affected by timber exploitation. With reference to aspects of the plan, these problems are briefly explained below.

6.2. Multiple Use and Exclusive Use—State Forest and Chilkat Bald Eagle Preserve

The plan, page 1 – 2 identifies that the Haines State Forest will be managed for multiple use, in contrast to the Chilkat Bald Eagle Preserve which is managed for exclusive use of "the protection of bald eagles and their associated habitat, as well as the spawning and rearing areas of anadromous streams that provide food for the bald eagle population. The traditional lifestyle of the Haines community is recognized as an important value and its continuation is included in the management of the Preserve."

This explanation in the plan that differentiates between *multiple use* and *exclusive use* is an example of the problem of applying sustained yield and multiple use across the Haines State Forest. The aquatic habitat needed by Pacific salmon in anadromous streams is supported by the maintenance of the natural ecological integrity of watersheds that supply the Chilkat Bald Eagle Preserve and provide for the lifestyle of the Tlingit (Lingit) and settler communities of the Haines area. Natural ecological integrity of the watersheds of the anadromous streams has, and will be degraded by sustained yield forestry practices as described in the plan and projected in the 5 year management schedule, 2022 – 2026.

Comment:
The goals for the Haines State Forest multiple use and the Chilkat Bald Eagle Preserve exclusive use may both be better achieved through principled, ecosystem based management, as opposed to sustained yield management. Such a change in relationship with the forest landscape would benefit from the incorporation of Tlingit (Lingit) knowledge and management of the Chilkat River watershed and appropriate western science.

6.3. Sustainable Forests Maintain Natural Character

As described in section 2 above:

> *Natural character refers to the ecosystem composition, structure, and function in the absence of development by industrialized settler communities. Natural character includes indigenous management systems. For the Chilkat River watershed, Tlingit (Lingit) protection and management through millennia defined and maintained the character of the ecosystems that comprise the watershed, and the watershed as a whole.*
>
> *The natural character of an ecosystem, watershed, or landscape provides for natural ecosystem function, ecological resilience, and biological diversity.*

The description in the plan for the natural character of the Chilkat River Valley is found on page 1 – 5, and states:

> *The Chilkat River Valley is the largest drainage in the Haines area. It rises in a region of glaciers and ice fields located on the Alaska-Canada border approximately 38 miles north-northwest of Haines. The Chilkat River is characterized by a broad floodplain composed of deep deposits of sand, silt, and gravel alluvium, primarily of glacial origin.… The Chilkat River forms extensive tide flats, referred to as the McClellan flats, near its mouth.*

For all intents and purposes, this is the complete explanation of the natural character of the Chilkat River watershed found in the plan. This cursory description of the natural character does not provide the necessary foundation to understand the composition, structure, and function, as well as ecosystem processes that operate at a range of spatial and temporal scales to sustain the watershed through time.

Comment:
Without a clear understanding of the natural character of the Chilkat River watershed, and management practices to maintain the natural character, the plan and 5 year management schedule, 2022 – 2026 are unlikely to sustain the natural forests, from the stand or patch scale to the landscape level. This calls into question whether activities under the plan and management schedule will maintain natural forest functions throughout the watershed. Management based on maintenance of the natural character of the Chilkat River watershed will change numerous specifications of the plan and management schedule, and are necessary to achieve broad plan goals.

6.4. Sustainable Forestry requires Up-to-Date Forest Inventory

As explained, sustainable forestry requires a sustainable forest. In order to achieve this goal there is a need to have an accurate, up-to-date inventory of the *forest*. In this context, "forest" means the whole ecosystem, soil, climate/microclimate, topography/microtopography, aquatic and terrestrial animals, habitat needs and connections etc. are all part of a forest inventory on which decisions may be made that maintain natural character, while providing for community well-being. A forest inventory needs to comprise the spatial scales that make up the plan area. In other words, an inventory of trees, coupled with an estimate of their growth rates to produce timber, is not a forest inventory. Thus, the current forest inventories for the Haines state forests are more accurately described as timber inventories.

The "forest" inventory, or timber inventory used in the plan and 5 year management schedule is the 1994 Forest Inventory, which is described on page 1 – 11 of the plan:

> *the existing forest inventory fieldwork (completed in 1985, finalized and published in May 1994) was used in recalculating the annual allowable harvest level.*

This discussion in the plan goes on to state:

> *The division of forestry has requested funding to complete a new forest inventory for the Haines State Forest. When and if funding becomes available the inventory will be completed and the annual allowable harvest level updated.*

The "Timber Inventory of State Forest Lands in the Haines Area 2020" was completed more than two years ago. Thus, the specification in the plan to update the allowable annual harvest when a new inventory is available has not been met. While this timber inventory will not provide for the information missing from a full forest inventory, one would assume that the 2020 timber inventory will provide for a more accurate projection of timber growth and yield in the Haines State Forest, which would result in a better estimate of annual timber yield, but not an improved basis to protect forest ecological integrity and biodiversity.

Comment:
Given that there is a 2020 timber inventory for the Haines State Forest, the annual allowable harvest level provided for in the plan needs to be revised. This new harvest level needs to be reflected in the 5 year management schedule 2022 – 2026, which currently relies upon the 1994

forest inventory. Revision of the annual allowable harvest level provides the opportunity to define and incorporate standards that better protect natural ecosystem integrity across the plan area. To provide public assurance that forests and their multiplicity of uses will be sustained under the plan and management schedules, a complete forest inventory needs to be conducted and applied to plans and activities in the Haines State Forest.

6.5. Fish and Wildlife Habitat, Loss of Habitat, and Connections to Sustained Yield Forestry

For fish and wildlife habitats, the primary goal is to "minimize the impact on these resources, even in units classified as Forest Land". (the plan, page 2 – 2)

The plan goes on to say: "when loss of habitat production potential cannot be reduced, restore and rehabilitate the habitat that was lost or disturbed to its pre-disturbance conditions *where doing so is feasible and prudent*. (emphasis added) (the plan, page 2 – 2) This statement related to fish and wildlife habitat offers a significant discretionary clause that enables timber management to avoid restoration and rehabilitation of habitat, if it is deemed to be not feasible. Such discretionary clauses in the plan reveal the low likelihood that sustained yield provides for the protection of the spectrum of natural ecosystems and ecosystem processes. This problem is directly related to the failure of sustained yield to recognize the interconnections and interdependence within and between different ecosystems.

A related discretionary clause for fish and wildlife habitat is found on page 2 – 3:

> *When loss of existing habitat is substantial and irreversible and the above objectives cannot be achieved, compensation with enhancement of other habitats will be considered. In general, compensation with similar habitats in the same locality is preferable to compensation with other types of habitat or habitats elsewhere.*

Like the earlier statement about loss of habitat, this statement provides the discretion of "… will be considered." Thus, resolving habitat loss through protection of other habitats may or may not occur under the plan.

Another difficulty in restoration of fish and wildlife habitat is the idea of "habitat enhancement". In natural ecosystems, "enhancement" is a human centred way of viewing ecosystems. Enhancement infers changes to benefit human beings. Within the spectrum of natural ecosystem composition, structure, and function, ecosystems are fully functioning in their natural state, and the idea of enhancing their function is outside the bounds of nature.

Subsistence use of the forests of the Chilkat River watershed is another place where discretion is provided to sustained yield timber management. The plan states on page 2 – 4:

> *Potential impacts on subsistence will be considered in management decisions within the State Forest.*

Timber extraction may be planned and carried out, provided that impacts on subsistence are "considered." Impacts considered does not mean changes are made to planned timber extraction.

Comment:
One only needs to consider the extensive clear-cut logging that has occurred, and are planned to continue in the ecologically sensitive floodplain habitats of the Chilkat River and its tributaries to understand that discretion for fish and while habitat protection tends to err on the side of timber extraction. The integrity of these fish and wildlife habitats is vitally necessary to both Tlingit (Lingit) and similar communities. This problem with discretionary guidelines for timber extraction may be resolved through establishment of networks of ecological reserves at multiple spatial scales to protect ecologically sensitive areas and provide for protection and connectivity for the full range of habitats needed by a spectrum of species.

6.6. Old-Growth Forest Reserves, Long Timeframes for Timber Extraction, & Inoperable/Inaccessible Timber to Protect Wildlife Habitat

In an effort to minimize disturbance to wildlife habitat, the plan states on page 2 – 5:

> *One strategy used in the plan to accomplish this is to keep from harvesting some of the commercial old-growth timber, about 17,000 acres, and to spread the harvesting of much of the remaining 42,000 acres of commercial timber over a relatively long period of time. In addition, 29,000 acres of inoperable or inaccessible timber, which includes 17,000 acres of nonproductive forest will not be harvested. This allocation will provide a diversity of habitats.*

While this strategy will result in a "diversity of habitats," the big questions are what kind of habitats, what species do the habitats serve, and where are the habitats located? Making a commitment to not log a significant area of old-growth forest is important for a myriad of forest benefits, including wildlife habitat. Protection of inoperable or inaccessible forests, nearly 60% of which is classified as "nonproductive" will protect habitat for some species, and cause minimal disruption to timber exploitation. However, to be effective these protection measures need to provide for the needs of both a range of common species and species at risk, be interconnected, and provide for interior habitat values required for many species.

As to the strategy "to spread the harvesting of much of the remaining… commercial timber over a relatively long period of time," the "period of time" will be a rotation period. This length of time will result in the development of young stands of trees, often lacking the diversity of young forests, and will not provide for the development of old forests and their ecological and habitat resources. Young forests will do little to provide habitat for old-growth dependent species, protect water, and provide for high levels of carbon sequestration and storage.

Comment:
Protection of old-growth and other types of forests with commercial timber value to furnish wildlife habitat is a step in the right direction for wildlife conservation. However, to be effective for a range of species, the character and location of forest reserves needs to be carefully analysed and planned to meet the needs of a target group of species. This will be achieved through establishment of networks of ecological reserves at multiple spatial scales to protect ecologically

sensitive areas and provide for protection and connectivity for the full range of habitats needed by a spectrum of species.

6.7. Enhanced Productivity, Value-Added Wood Products, & Sustained Yield

One of the goals for Forest Resources, more accurately defined as timber resources, in the plan is to:

> *Enhance the productivity of land dedicated to the production of forest products through the planned harvest of mature and over-mature stands, regeneration of harvest sites, intermediate thinning and conversion of non-forested "brush" areas.* (the plan, page 2 – 6)

As explained in section 6. 3 above, enhancement of the productivity of natural ecosystems is a human concept, inconsistent with the functioning of nature. Enhancement infers changes to benefit human beings. Within the spectrum of natural ecosystem composition, structure, and function, ecosystems are fully functioning in their natural state, and the idea of enhancing their function is outside the bounds of nature. The land has an inherent productivity based on climate, landforms, and soil. Human use of the land, like sustained yield forestry, needs to understand and manage within that inherent productivity to achieve sustainable results.

The concepts of "mature" and "over-mature" stands or forests is a timber biased definition to encourage the cutting of old natural forests. Nature has provided human societies with these diverse, rich forests free of charge. Instead of seeing their removal as "enhancement," we need to see their extraction as degradation of essential forest ecosystem benefits, like climate moderation, biological diversity, and water storage and filtration.

Logging so-called mature and over-mature forests is a way for timber interests to get access to the highest quality wood produced in nature. In contrast to young trees, which contain 85 to 90% short fibred *juvenile wood* that warps and twists easily, contains many knots, and has low tensile or bending strength, old trees contain 85 to 90% *mature wood* made up of long fibers that provide clear wood with a high tensile or bending strength. Mature wood has a different lignin structure that, together with its long fibers, makes it easier to shape and join then short fibred juvenile wood. Thus, instead of viewing cutting of "over-mature" old trees as enhancement of the forest, we need to see such cutting as diminishing both the ecological value, as well as the timber value of the forest. (Forintek, 1989 in Hammond, 1992)

<u>Comment</u>:
Sustained yield forestry that furnishes high levels of ecological benefits contains ample supplies of old trees that also provide a source of high quality wood to support a value-added wood products industry. An important key to furnishing steady supplies of ecosystem benefits from old trees and mature wood through time is to manage forests on *ecological* rotations, rather than short *financial* rotations. Ecological rotations provide for natural growth patterns, furnish both young and old trees, and are best achieved through a forest management system that practices partial cutting, rather than clear cutting. (see Deal, 2001)

6.8. Clearcutting, Site & Landscape Degradation challenge Multiple Use & Sustained Yield

Clearcutting is designated as "the primary method of commercial timber harvest." Clearcuts are not to "exceed 160 acres without agency review and approval of the Commissioner." (HSFMP, p. 2 – 13). The maximum size specification of 160 acres results in very large openings, and the plan provides discretion for clearcuts that exceed the indicated maximum size.

As explained in section 4.3 of this review, clearcuts degrade water, biological diversity, and ecological resilience, and exacerbate the effects of climate change. In addition, clearcuts fragment the landscape, and result in the loss of connectivity, interior forest habitat, and natural ecosystem patterns that provide for ecological integrity across the landscape that contains the clear cut logging. There is no supportable reason for using clear-cut logging, compared to partial cutting silvicultural systems other than the low cost of logging with clearcuts.

The negative effects of clearcuts affect a wide variety of animals, plants, fungi and mircoorganisms, particularly those that rely upon the intact, interior habitat of primary/old-growth forests. In the case of the Chilkat River watershed these species include brown bears, moose, bald eagles, a variety of songbirds, Pacific salmon, a variety of food and medicine plants, and mycorrhizal fungi. Negative effects to these species and their associates cascade through the watershed, degrading overall function of the watershed ecosystem, and the organisms and processes that depend upon a healthy, intact watershed.

<u>Comment</u>:
The plan justifies clearcutting with this rationale:

> *Clearcutting is the best method of encouraging natural regeneration. Soil temperatures are increased and nutrient cycling improved. Increased light favors spruce, a relatively shade-in tolerant species. Losses from windthrow are minimized and damage to residual trees is avoided. The system is also appropriate for stands infested with hemlock dwarf mistletoe or other diseases. For over-mature, decadent stands, the system is especially appropriate from a wood utilization, safety, and harvest efficiency standpoint.* (HSFMP, p. 2 – 13)

Under scrutiny, these claims in support of clearcutting do not hold up. Research scientist, Robert Deal, investigated the effects of partial cutting on stand structure and growth of western hemlock — Sitka spruce in Southeast Alaska. Deal's findings revealed that

> *Partial cutting maintained stand structure similar to uncut old-growth stands, and the cutting had no significant effect on tree species composition. The establishment of the new-tree cohorts was positively related to the proportion of basal-area cut.… Concerns about changing tree species composition, lack of spruce regeneration, and greatly reduced stand growth and vigor with partial cuts were largely unsubstantiated. Silvicultural systems based on partial cutting can provide rapidly growing trees for timber production while maintaining complex stand structures with mixtures of spruce and hemlock trees similar to old-growth stands.* (Deal, 2002)

The many negative effects of clear-cut forestry call into question whether Alaska's requirements for multiple use and sustained yield will be met by the guidelines of the Haines State Forest Management Plan. To this point, there is sufficient evidence, both anecdotal and scientific that timber cutting would be best carried out through partial cutting, rather than clearcutting. To make this shift in management direction will require reduction of the allowable annual cut, and rethinking the rotation age. A longer rotation age will provide many ecological benefits, from maintenance of old-growth forest composition and structure to habitat protection for a range of species from large mammals to soil fungi. Sociological benefits from these changes will include improved conditions for subsistence activities, protection for many non-timber uses of the land, and improved wood quality to support a local value-added wood products industry.

6.9. Special Management Zones—a step in the right direction

Special Management Zones (SMZs) are designated by the plan for anadromous fish streams and lakes. "A 300-foot wide special management zone, as measured from the ordinary high water mark, is established on each side of all catalogued anadromous streams. A 500-foot wide special management zone is established around lakes containing anadromous fish.… The primary management objective for special management zones is to maintain or enhance anadromous fish habitat. Only activities that are or can be made compatible with this objective will be allowed in the zones." (HSFMP, p. 2 – 14)

Provided they encompass both the riparian zone and riparian zone of influence, which together comprise the riparian ecosystem, SMZs provide important habitat protection for anadromous fish. The width of these SMZs is generally sufficient to protect the habitat of many other terrestrial and aquatic species.

Comment:
As long as the SMZs are viewed as *riparian reserves*, and not just a place for "careful logging" and other development activities, they will play an important role in maintaining the integrity of the biodiversity hotspots represented by riparian ecosystems.

Establishment of SMZs to protect riparian ecosystems of anadromous fish lakes and streams provide an important component for a network of ecological reserves at multiple spatial scales. A network of ecological reserves, designed and implemented at scales from the large landscape and watershed to the small landscape and site, are necessary ecological frameworks to put in place to protect ecological integrity, ecological resilience, and biological diversity — all of which are the foundation for ecologically and culturally sustainable forest use. See section ** for an explanation of the components of a network of ecological reserves at multiple spatial scales.

Of note, riparian reserves of appropriate width need to be established around all water bodies, including wetlands, to protect water and biological diversity, and provide for important connectivity throughout a watershed or landscape. From the standpoint of fish habitat and the needs of anadromous species, many of the small water bodies will not contain fish. However, the temperature, chemistry, and turbidity of the water in small water bodies is directly influenced by the adjacent trees and forests. There are many more small water bodies that do not contain fish than water bodies that do contain fish. Thus, the characteristics of the water in non-fish bearing streams shape the characteristics of fish-bearing streams and lakes. In this way riparian reserves around all water bodies are needed to protect fish populations in fish-bearing water bodies.

6.10. Habitat Maintenance and AAC Reduction—insufficient protection

The annual allowable cut (AAC) is "reduced 3% for habitat maintenance within harvest areas." (HSFMP p. 2 – 7). Further protection measures exist outside harvest areas, and include Special Management Zones, and fish and wildlife habitat constraints. (see section 6.6)

The AAC is determined for areas classified as "operable" in the Haines State Forest (HSF). Operable areas contain the most biologically rich, productive sites in the HSF. Areas outside the operable forest are largely classed as inaccessible, non-productive forest, and/or non-forest. All of these "inoperable" land classifications contain significantly different ecosystem composition, structure, and function, i.e. habitat than the operable forest. Thus, protection of wildlife habitat is needed for the range of scales, from watershed to site, within the operable forest.

<u>Comment</u>:
The 3% reduction of AAC "for habitat maintenance within harvest areas," provides insufficient protection for habitat, for a variety of reasons:

- A percentage reduction is not linked to any particular species, habitat type, and/or location. To be effective, habitat reductions need to be spatially determined by species and habitat type for the specific ecosystem in question.
- Unless habitats are spatially identified, they become arbitrary, disconnected fragments within a harvest area.
- To provide protection for a reasonable range of habitats in a harvest area will generally require approximately 25% of the area in spatially connected habitat reserves.

To provide for habitat protection and maintenance there is a need to establish networks of ecological reserves at multiple spatial scales, with the finest scale reserve being defined for the site or patch, which is the spatial scale where timber management occurs. After spatially designed networks of ecological reserves are in place, AAC's that provide for adequate protection of habitat may be determined.

6.11. Rotation Age & AAC Determinations

The plan forms the basis for allowable annual cut (AAC) determinations by incorporating inventory data from the Haines State Forest Forest Inventory, 1994. In the plan, and the 1994 and 2020 inventories the *area control method* was selected as the most appropriate method to determine a sustainable AAC. The results of applying this method in the plan, and both 1994 and 2020 forest inventories have resulted in varying results.

The Haines State Forest Management Plan sets the AAC at 5.88 million board feet with a rotation age of 120 years. The AAC depends upon 41, 652 acres of operable timber landbase. (HSFMP, pg 2 – 17). This AAC reflects a reduction of 3% for habitat protection and 23% for conversion from short log scale to Scribner long log scale. These same reductions apply to the AACs from the forest inventories that are provided below.

The 1994 forest inventory describes an AAC of 6.96 million board feet with a rotation age of 120 years. This cut would occur from 49,231 acres classified as "forest lands operable and available for harvest." (1994 Forest Inventory, pgs 6, 12)

The 2020 timber inventory determines an AAC of 11.44 million board feet with a rotation age of 100 years. This cut would occur from 51,832 acres classed as "operable timber landbase." (2020 Forest Inventory, pgs 16, 17)

The Haines State Forest Five-Year Forest Management Schedule, 2022 – 2026 relies upon the AAC of 5.88 million board feet and the 1994 Forest Inventory to plan logging activities over the next five-years.

<u>Comment</u>:
There are notable differences between data used, underlying assumptions, and results for the AAC determinations between the Haines State Forest Management Plan, 2002, and both the 1994 and 2020 Forest Inventories. From the standpoint of ecosystem protection and sustainable timber extraction the plan sets the lowest AAC. While there are a number of other aspects of the plan that threatened forest integrity and resilience, use of a lower AAC compared to the forest inventories is a desirable decision.

There are several anomalies associated with the different AACs:

- Why was the rotation age reduced from 120 years to 100 years in the 2020 forest inventory, but not applied in the 2022 – 2026 Management Schedule? Does this imply that the AAC will increase in future years?
- Why wasn't the 2020 forest inventory used in development of the 2022 – 2026 Management Schedule?
- The plan states on page 4-6: *AS 41.15.320 (b)(a) states that "the management plan should be based on a current operational level inventory completed within the last 10 years and revised as future inventory information becomes available to the department."* Prudent forest management would apply the same requirement to the 5-Year Forest Management Schedule. Does this constitute support for using the 2020 forest inventory in the 2022 – 2026 Management Schedule?
- The area classed as "operable timber landbase" varies by more than 10,000 acres between the plan and the 2020 forest inventory. What is the basis for this discrepancy? Does the larger area of operable timber landbase in the 2020 inventory inferred that more area will be available for logging in future years in the Chilkat River watershed?

6.12. Rotation Age & AAC Foundations—projected growth

Two reports were relied upon for modeling of forest growth in the 2020 Timber Inventory:

- Farr, Wilbur A. 1984. *Site Index and Height Growth Curves for Unmanaged Even-Aged Stands of Western Hemlock and Sitka Spruce in Southeast Alaska*. USDA Forest Service. Pacific Northwest Forest and Range Experiment Station. Research Paper PNW-326. 32p., and
- U.S. Department of Agriculture, Forest Service. 2008. *Pacific Northwest Coast (PN) Variant Overview—Forest Vegetation Simulator*. Chad E. Keyser. Fort Collins, CO. Revised December 2012. 62p.

The 1984 report on site index and height growth curves by Wilbur Farr (Farr, 1984) was used to provide a growth and yield data to use as inputs to the Pacific Northwest Coast variant of the forest vegetation simulator developed by Chad Keyser and associates. Both the site index report and vegetation simulator for the Pacific Northwest Coast represent an amalgamation of data from widely varying climates, soils, and vegetative communities. As such, their applicability to the forests of the Chilkat River brings into play considerable uncertainty about the growth and yield predictions, and the subsequent use of these predictions to determine rotation age and allowable annual cut (AAC).

The broad area covered by the site index report is revealed in this excerpt from the Introduction:

> **The forests of southeast Alaska are part of the hemlock-spruce forest type that occupies a north-south range along the north Pacific coast, extending from near Coos Bay, Oregon, north and west to the Alaska Peninsula, a distance of about 1,800 miles. Within this type, mean site index of Sitka spruce decreases northward at the rate of about 2.6 feet per degree of latitude (Farr and Harris 1979).**
>
> (pg 1, Farr, 1984)

This 1984 site index report shows the locations of plots that were used to develop the site index curves and growth relationships for the wide-ranging western hemlock — Sitka spruce forest type. There were no plots located in the upper Lynn Canal. (See figure 1 — locations of site index plots in southeast Alaska, p. 3). This calls into question the accuracy of the site index/ growth and yield data used as part of the AAC determination in the 2020 forest inventory.

Similar to the 1984 site index report, the 2008 Pacific Northwest Coast vegetation simulator covers a vast area with a myriad of ecosystem types shaped by different climate and geological conditions. Here are some quotes from pages 1 — 3 that explain the general nature of the simulator and explains the recommended range for the original model. (USDA Forest Service, 2008)

> The Forest Vegetation Simulator (FVS) is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands.

.
.
.

In 1984, the Alaska Region, Forest Service, U.S. Department of Agriculture requested a variant be developed for the western hemlock-Sitka spruce forest type in southeast Alaska. The Alaska Region, Pacific Northwest Research Station, Forest Inventory and Analysis (Anchorage), and the British Columbia Ministry of Forests decided to include all National Forest and Crown land falling in this vegetative type regardless of state or country boundaries. This variant became known as the "AK" variant, covering Southeast Alaska and Coastal British Columbia.

2.0 Geographic Range

The AK variant was fit to data representing southeast Alaska coastal forest types, namely the hemlock-Sitka spruce forest type. Data used in initial model development came from the Juneau forest inventory, Stikine forest inventory, Sitka forest inventory, young growth stand exams (from throughout the area), young growth surveys (questionnaires), growing stock studies (Bill Farr, PNW), Makah Indian Reservation, Queen Charlotte Islands Forest Inventory, and Prince of Wales Forest Inventory.

.
.
.

The AK variant covers the southeast Alaska coastal forest types. This includes all or part of the Chatham, Ketchikan, and Stikine areas of the Tongass National Forest, corresponding Industry lands, coastal British Columbia, the Queen Charlotte Islands / Haida Gwaii, and the extreme northwestern tip of the Olympic Peninsula. The AK variant was not fit to other forest types in Alaska, but it is currently the best available variant for those areas. The suggested geographic range of use for the AK variant is shown in figure 2.0.1.

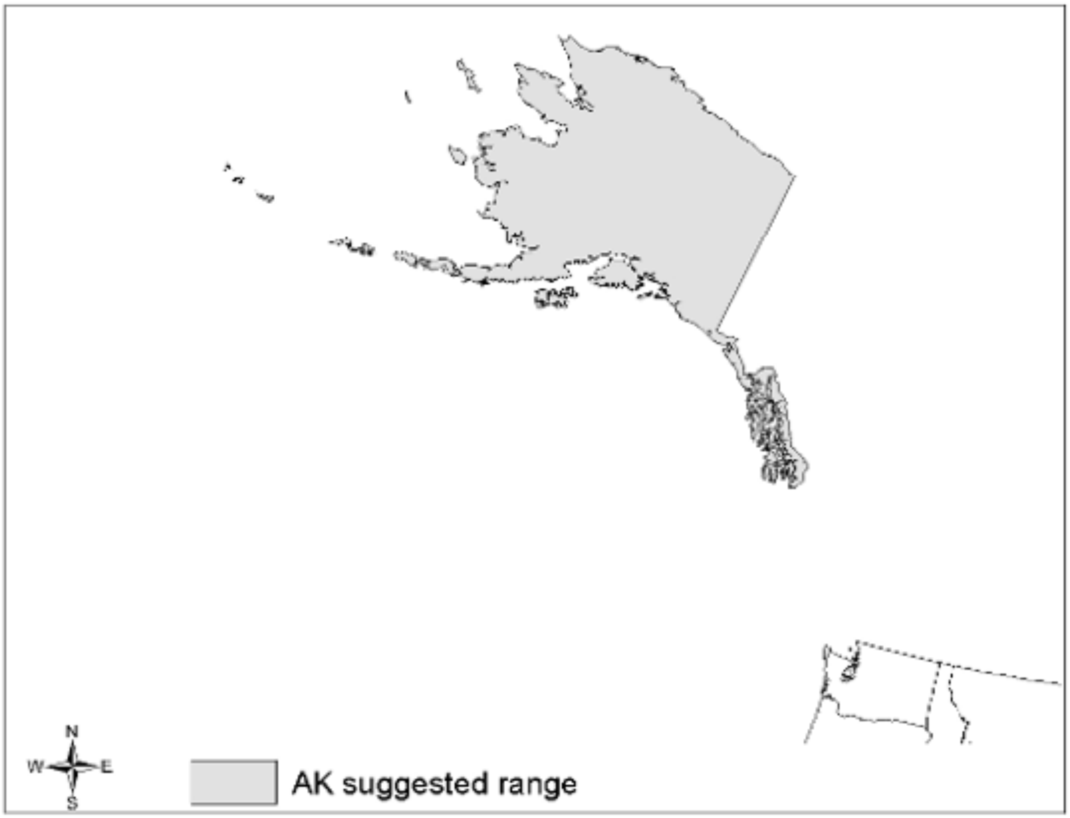


Figure 2.0.1 Suggested geographic range of use for the AK variant.

<u>Comment</u>:
As may be seen by the "suggested geographic range" for the 2008 vegetation simulator, this program is recommended for use throughout Alaska. In order for this approach to have meaning for the forests of the Chilkat River watershed, a specific model or simulator "variant" covering the upper Lynn Canal and Chilkat River watershed would need to be developed based on local data. To this point this expansion of the vegetation simulator has not occurred, and use of its outputs needs to be treated with considerable uncertainty in plans for the Haines State Forest.

This caution is particularly true for the Chilkat River, because of the broad ecotone of coastal to interior, and the finer ecotones that comprise this watershed. The finer ecotones are assembled in a rich landscape pattern that moves from floodplain forests, to lower slope forests, to topographically complex mid slope forests, to parkland forest ecosystems, and eventually to alpine, snowfields, and glaciers.

6.13. Rotation Age & AAC Foundations—projected growth—the Alaska Variant

A new Forest Vegetation Simulator is available for Alaska:

- U.S. Department of Agriculture, Forest Service. 2021. *Alaska (AK) Variant Overview—Forest Vegetation Simulator*. Mark Castel et al. Fort Collins, CO. Revised June 2021. 45p.

From the Introduction:

> The Forest Vegetation Simulator (FVS) is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands.
>
> New "variants" of the FVS model are created by imbedding new tree growth, mortality, and volume equations for a geographic area in the FVS framework. Geographic variants of FVS have been developed for most of the forested lands in the United States.
>
> From 2018 to 2021, new relationships were developed for twenty-three species commonly found in the coastal and northern boreal forest types of Alaska. As such, this variant should be used for all forested areas in Alaska, thus replacing the Southeast Alaska (SEAPROG) variant, which is no longer available.

This variant of the Forest Vegetation Simulator—the AK Variant still has a very wide range, which covers all of the forests in Alaska. However, the inputs to the model have been significantly expanded to improve its reliability, and, therefore, it should be used in place of the Pacific Northwest Coast Variant, 2008.

In order to specify variables that are specific to the locale in Alaska where a particular forest resides, a *location code* needs to be specified. The closest location code for the Chilkat River watershed would be 1005 — Tongass National Forest. While this may be an improvement over the Pacific Northwest Coast Variant, 2008, one still questions the incorporation of the dryer, snowier climate of the Chilkat River valley with the wetter, rainier climate of the southern Southeast Alaska area. Nonetheless, use of the Forest Vegetation Simulator — Alaska (AK) Variant to model the forest in the Chilkat River watershed.

<u>Comment</u>:
The Haines State Forest Management Plan calls for sustained yield in timber management for the Chilkat River watershed. Under Alaska statutes, sustained yield is defined as:

> *The achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of forest land and water without significant impairment of the productivity of the land and water but does not require the timber be harvested in a non-declining yield basis over a rotation.* (AS 41. 17. 950 (17))

To meet this definition of sustained yield, incorporation of more local forest data into the Alaska Variant would be helpful, not only in providing for a sustained timber yield, but also protecting the ecological integrity and resilience that are necessary to maintain sustainable uses of all types.

6.14. Rotation Age & AAC Foundations—projected growth and yield—Limitations of Site Index

Site index is relied upon as an important factor for determining site productivity, and growth and yield for the Chilkat River watershed, and the remainder of the Haines State Forest. This measure of site productivity for timber production has been widely used in forestry plans throughout the world. However, there are known issues with the reliability of site index.

The most prominent weakness of site index is that it assumes that future forest growth will occur in the same pattern as past forest growth. These predictions are based on existing site conditions and do not consider how trees might grow after disturbance such as clearcutting, or in particular climate change. (Vogt et al. 1989). This research finding comes from a climate limited, upper slope forest which makes their conclusions particularly relevant to the forests of the Chilkat River watershed.

Site index measurements have also been found to provide unreliable predictions of future growth and yield in uneven-aged stands, mixed species forests, and stands with less than full stocking. (Martin et al., 2006) All three of these variables, which result in problems with site index predictions, apply to the forests of the Chilkat River watershed.

Instead of relying on site index measurements, particularly those from areas removed from the forest in question, there is a growing consensus that growth and yield data for forest planning is best gathered from the specific area where forestry is planned. In order to accurately predict forest growth and development, forest measurements appropriate to this purpose need to be gathered in the various forest types planned for operations in the Chilkat River watershed. This information may be effectively used to predict growth through models that incorporate direct productivity-environment relationships based on specific forest data. (Bontemps et al., 2013)

Comment:
Problems with the use of site index as a measure of forest productivity, particularly as it relates to future growth and yield have likely occurred in the estimate of rotation age and allowable annual cut for the Chilkat River watershed in the Haines State Forest. This problem may be remedied by collection of local data that encompasses forest ecosystem variation in the Chilkat watershed. To this point, such data is missing from the Haines State Forest Management Plan and 5 Year Forest Management Schedule, 2022 – 2026. This places a significant level of risk on the ability of forestry practices in the Chilkat River to avoid ecological degradation and provide for sustained yield management.

6.15. Rotation Age & AAC Foundations—projected growth and yield—2020 Timber Inventory

While the 1994 Forest Inventory for the Haines State Forest was used in the development of the 5 Year Forest Management Schedule, 2022 – 2026, information from the 2020 Timber Inventory will undoubtedly influence forest management going forward in the Haines State Forest. Review of the 2020 Timber Inventory reveals some data and interpretations that seem inaccurate, unsubstantiated, and/or require explanation.

The 2020 Timber Inventory states:

> *ROTATION LENGTH*
> *The rotation period is the average time it takes to grow a commercial stand of trees. A 100 – year rotation has been established for Southeast Alaska and was used in this calculation. Growth within the second growth stratum as described below has a culmination of mean annual increment of 100 years.*

There is no explanation or data provided that supports the establishment of a 100 – year rotation in the Chilkat River watershed, or for that matter all of Southeast Alaska. If, as stated, this rotation applies to all of Southeast Alaska, the rotation will not provide an accurate estimate of the rotation length for Chilkat forests, most of which are climate limited compared to most of Southeast Alaska forests. Note: insert local radial/diameter growth from logged areas in Chilkat.

In order to determine a sustained yield allowable annual cut for the Haines State Forest, future growth and development of Second Growth — Strata 5 is modelled in the 2020 Timber Inventory. TABLE 9. STRATA GROWTH SIMULATION, page 13 provides the result of that simulation.

Year	Age	Trees/ Acre	Basal Area/ Acre	Average Height	Quadratic Mean Diameter	Net CF/ Acre	Net BF/ Acre	Net CF/ Acre Mean Annual Increment
2018	39	545	111	74	6.2	1,451	5,754	37.02
2020	41	545	116	76	6.4	1,571	6,231	38.14
2030	51	542	150	87	7.2	2,338	9,422	45.68
2040	61	533	179	97	8.0	3,184	13,099	52.04
2050	71	517	203	105	8.6	4,098	17,194	57.57
2060	81	496	223	112	9.2	4,968	21,309	61.19
2070	91	818	240	118	8.5	5,823	25,406	63.85
2080	**101**	**751**	**256**	**124**	**9.1**	**6,539**	**29,000**	**64.62**
2090	111	821	275	128	8.7	7,144	32,203	64.25
2100	121	753	285	132	9.2	7,594	34,698	62.66
2110	131	674	292	135	9.8	7,941	36,770	60.53
2120	141	605	294	138	10.3	8,302	38,873	58.80

TABLE 9. STRATA 5 GROWTH SIMULATION.

Column 3, Trees/Acre indicate that the density of second growth stands increases as the stand ages from 2018 to 2120. This is completely inconsistent with normal forest growth and development, where trees/acre, i.e. stand density decreases with age as trees become larger and occupy more growing space. The simulation relies upon this relationship to indicate that culmination age is reached at 101 years with 29,000 net board feet volume per acre. Simulating growth in second growth stands by showing that stand density increases with age is counterintuitive and needs explanation.

The "detail records" of site index for the various inventory strata in the 2020 Timber Inventory are a reflection of the amount of data acquired for each strata, and, therefore, a measure of the accuracy of the data that contributes to rotation age and AAC determinations.

Here is a summary of the detail records per inventory strata that show the total detail records for western hemlock and Sitka spruce:

- Strata 1 — Conifer High 15 to detail records for 15,944 acres
- Strata 2 — Conifer Medium 30 detail records for 24,484 acres
- Strata 3 — Conifer Low 8 detail record for 21,089 acres
- Strata 4 — Cottonwood detail records not provided
- Strata 5 — Second Growth 204 detail records for 10,830 acres

Source: Haines State Forest Management Plan, Appendix C, pgs C-1—C-9

An improved relationship, compared to western hemlock and Sitka spruce detail records, exists for DBH and height data with the large area covered by each stratum and the relatively small number of detailed records for the data:

- Strata 1 — Conifer High 220 detail records for 15,944 acres
- Strata 2 — Conifer Medium 418 detail records for 24,484 acres
- Strata 3 — Conifer Low 113 detail record for 21,089 acres
- Strata 4 — Cottonwood detail records not provided
- Strata 5 — Second Growth 1663 detail records for 10,830 acres

Source: Haines State Forest Management Plan, Appendix D, p D-2

However, even for Strata 5, which has the most detailed records for DBH and height, there is an average of 1 detail record for 6.5 acres in the stratum. Without examination of the location of the detail records in relation to the variation in ecosystem types, site/soil productivity, and past activities that may have affected tree growth, the reliability of this data for particular areas is unknown.

Comment:
What is the basis for the basis for the adoption of a 100 year rotation for Southeast Alaska? There is a wide range of climates and ecosystem types, including soil/site quality and growing conditions throughout Southeast Alaska. Given that situation, how can a single rotation period apply to such a large area, without placing in jeopardy the requirement for sustained yield? This question is particularly relevant to the many climate limited forests in the Chilkat River watershed.

The numbers of detailed records for growth and yield data are directly related to the accuracy of rotation age and AAC determinations. For example, if few or no detailed data are found in particular area, there will be questionable reliability of growth and yield projections for that area. To understand how well the detailed records relate to any specific area, like the Chilkat River watershed requires an understanding of the location of the detailed records, as well as what data is contained in the detailed records. This information is not available in the Haines State Forest Management Plan, 2002, nor in the forest/timber inventory reports that support the plan.

7. Five Year Forest Management Schedule, 2022—2026

Numerous aspects of the Five Year Forest Management Schedule, 2022 – 2026 (the forest management schedule) have been covered in section 6 of this review. In particular, timber/forest inventory information, rotation age, annual allowable cut, and management guidelines have been discussed in section 6 as they relate to the forest management schedule.

As discussed in section 6 there are many aspects of the timber/forest inventory information, rotation age, annual allowable cut, and management guidelines that call into question how effectively the forest management schedule is meeting the requirements for multiple use management and sustained yield. The most direct impacts on multiple use and sustained yield are found in the "proposed five-year harvest activities". Important aspects of these proposed harvest or logging activities are discussed below.

Use of the term "harvest" implies something that human beings have planted and nurtured with an express intent to harvest a product of their effort. In the case of the natural forests of the Chilkat River watershed and the rest of the Haines State Forest, these forests are gifts of nature, and have nothing to do with human management. Thus, from my perspective the management schedule provides for the exploitation of these forests by logging.

7.1 Proposed Harvest Areas: Map 1

Past and proposed logging south of the Klehini River is shown on "Proposed Harvest Area" Map 1. Situated between Walker Lake and porcupine Creek are numerous old regenerating clearcuts, and four proposed logging areas: map locator 1, 4, 8, and 15. Each of these proposed logging areas is also given a timber sale name:

- 1: Walker 1 — 20 acres — clear-cut
- 4: West Herman V — 20 acres — clear-cut
- 8: Porcupine Junction 1 — 20 acres — clear-cut
- 15: Porcupine Junction 2 — 36 acres — clear-cut

These four proposed logging areas total 96 acres of additional clear-cut logging in the Klehini River watershed. All four blocks are removing most of the last fragments of intact forest remaining in this small landscape south of the Klehini River and east of Porcupine Creek. As such, these proposed logging areas are clearcutting most of the last remaining natural, old forest habitat types, that are needed for protection of both terrestrial and aquatic habitat. This proposed logging further diminishes the connectivity degraded by past logging and roads.

In order to protect this important part of the riparian zone of influence of Klehini River riparian ecosystem, these proposed logging areas need to be rejected. To log these areas represents a form of "high grading," or designing logging to cut "the best of the rest timber", ignoring ecological and sociological consequences. Protection of these proposed logging areas will provide important benefits for Pacific salmon, brown bears, climate moderation, and many other habitats and ecological benefits associated with old/old growth forests.

7.2 Proposed Harvest Areas: Map 2

Past and proposed logging south of Mosquito Lake and southwest of the Chilkat River is shown on "Proposed Harvest Area" map 2. Situated along the Chilkat River, are extensive areas of past clear-cut logging, i.e. regenerating forest, with most of the forest removal located within the riparian ecosystem of the River. This management schedule proposes to further log portions of the land classed as "regenerating forests" in three proposed logging blocks: map locator 2, 7, and 11. Each of these proposed logging areas is given a timber sale name:

- 2: Ski Hill Opener — 100 acres — clear-cut
- 7: 4 Winds Opener — 100 acres — clear-cut
- 11: Ski Hill Ridge —two to four areas no larger than 30 acres (up to 120 acres) — clear-cut

These three proposed logging areas total up to 320 acres of additional clear-cut logging adjacent to the Chilkat River and within the riparian ecosystem of the River. All of these proposed logging areas are part of the local small harvest program.

Notably, all three of these proposed logging areas are found within areas designated as "regenerating forest," which implies that they have been previously clear-cut logged. The management schedule is silent about what trees in these regenerating forests will be logged. However, "re-logging" an area further degrades natural ecosystem composition, structure, and function.

Given the large size of the areas designated as regenerating forests, as well as their location within the riparian ecosystem of, and the upland forests adjacent to the Chilkat River, any remaining patches of natural forest ecosystems are valuable to protect. These remnant forests provide a range of ecosystem benefits, including water conservation, biological diversity, and mitigation of climate change impacts.

Rather than considering these three proposed logging areas primarily for commercial timber extraction, these areas would be best managed as "restoration forests." The remnant intact forests need to be designated as "restoration anchors" within the proposed logging areas. Ecological restoration of these regenerating forests builds from any remaining fragments of intact forest. Thus, these forest remnants or fragments are referred to as restoration anchors, as they anchor restoration practices.

7.3 Proposed Harvest Areas: Map 3

Past and proposed logging south of the Nataga Creek and the Kelsall River, and adjacent to the Chilkat River is shown on "Proposed Harvest Area" Map 3. Situated between the Nataga Creek, the Kelsall River, and the Chilkat River are extensive areas of regenerating forest that have been logged in the past. This management schedule proposes to further log significant portions of the regenerating forest in two widely dispersed logging blocks: map locator 3 and 6. Each of these proposed logging areas is given a name:

- 3: Kelsall Pocket — 140 acres — selective cut/commercial thinning

- 6: Kelsall 100 CW — 250 acres — remove cottonwood from regenerating forest

Based on the ortho image of map 3, proposed logging area 3 plans to selectively cut or commercially thin 140 acres that appears to have been partially logged in the past. If this proposed selective cut is high grading, or removing the remaining large trees from these areas, it will further degrade both the sites where logging occurs, and the adjacent landscape. However, if this selective cut focuses on restoration of natural, old forest composition and structure, the trees to be removed will be limited to smaller, lower canopy trees. A careful field assessment is necessary to determine whether an ecological restoration treatment that includes selective logging is appropriate.

Proposed logging area 6 plans to re-log 250 acres of regenerating forest to remove cottonwood. The management schedule provides no rationale for why the cottonwood needs to be cut. There are numerous factors to consider to determine whether removal of cottonwood is ecologically and socially appropriate:

- Cottonwood trees, i.e. *Populous balsamifera*, have large, expansive crowns. When these trees are cut and removed in a regenerating forest, significant damage to regenerating conifers is unavoidable.
- A mixed forest of cottonwood and coniferous trees is more biologically diverse and resilient than a coniferous forest alone.
- Much of the lower slope forests and riparian flats that comprise proposed logging area 6 would historically have contained cottonwood trees found either in mixtures with conifers, or in relatively pure stands. Cottonwood is well adapted to the moist/wet, moving ground water conditions found in lower slope and riparian forests.
- The leaf fall, or litter provided by cottonwood trees is slightly basic, and raises the pH of the soil where it is mixed with conifers. This function of cottonwood leaf fall improves humus production and raises productivity for the coniferous trees.

Based on the information provided by the management schedule, maintaining cottonwood in the regenerating forest described as proposed logging area 6 is a better choice than removing the cottonwood. This recommendation may be confirmed through a field assessment of the composition and structure of the forest stands in question, and a landscape level assessment that evaluates the ecological importance of these mixtures of cottonwood and conifers in the regenerating forest.

7.4 Proposed Harvest Areas: Map 4

Past and proposed logging along the riparian ecosystem of the Kelsall River is the focus of "Proposed Harvest Area" Map 4. The riparian ecosystem of the lower Kelsall River contains many past clear-cut areas, now classed as regenerating forest. This management schedule proposes to continue the logging of the Kelsall River riparian ecosystem in three blocks: map locator 9, 10, and 14. Each of these proposed logging blocks is given a name:

- 9: Single 15 — 90 acres — clear-cut
- 10: Canyon Creek — 125 acres — clear-cut
- 14 Turn Around — 200 acres — clear-cut

The Five-Year Management Schedule, 2022 – 2026 proposes to continue the clear-cut degradation of the Kelsall River riparian ecosystem. This plan will continue to damage the important aquatic habitat of the Kelsall River, which supports a threatened race of King salmon.

The remnant old-growth forests contained in proposed logging areas 9, 10, and 14 are vital to protect, not only for the riparian ecosystem functions and rich aquatic habitat of the Kelsall River, but also for the full range of benefits provided by old-growth forests. These benefits include:

- water conservation that maintains natural quality, quantity, and timing of flow of water,
- high levels of biological diversity that provide ecological integrity, and resilience to climate disruption,
- high levels of carbon sequestration and storage to moderate the climate,
- recreational benefits for local communities, as well as tourists, and
- cultural and spiritual values.

The management schedule alleges to adhere to the principles of multiple use and sustained yield however, if logging as planned for the Kelsall River proceeds, the requirements for multiple use and sustained yield resource management will be violated.

7.5 Proposed Harvest Areas: Map 5

Chilkat Ridge is situated between the Chilkat River riparian ecosystem that contains the Bald Eagle Preserve and Chilkat Lake. Two large proposed clearcuts are proposed on the ridge between the River and Lake: map locator 5 and 13. Each of these proposed logging areas is given a timber sale name:

- 5: Chilkat Ridge 1 — 750 acres (approx.) — clear-cut
- 13: Chilkat Ridge 2 — 560 acres — clear-cut

This gently sloping ridge that connects the broad riparian ecosystem of the Chilkat River with Chilkat Lake is an important intact, lower slope primary forest. This forest provides an important linkage for movement of plants and animals between the River and Lake, as well as furnishing habitat for a wide range of species. The type of lower slope, intact forest habitat is becoming increasingly rare along the Chilkat River and its tributaries due to clearcut logging.

The intact natural forests on Chilkat Ridge provide for essential water storage infiltration that feeds both the Chilkat River and Chilkat Lake. Thus, protection of this forest is integral to protection of salmon habitat in both the River and Lake. Chilkat Lake is a vital sockeye salmon spawning and rearing area that has extremely high ecological and cultural value for the Tlingit (Lingit), as well as settler communities.

The importance of Chilkat Ridge for a myriad of ecological and cultural values indicates that this area is not an appropriate location for logging. Instead Chilkat Ridge needs to be designated as a linkage within a network of ecological reserves to protect and restore the ecological integrity of the Chilkat River, Chilkat Lake, and portions of the overall Chilkat River watershed.

8. Questions for Plans—a Summary

At the beginning of this review of Haines State Forest forestry plans for the Chilkat River watershed, a number of questions were posed about the forestry plans, and related forest/timber inventories and management schedules. This section provides summary answers for these questions. Detailed answers for these questions may be found in appropriate sections in the body of the report.

These summary answers reflect the contents of the Haines State Forest Management Plan, 2002; Forest Inventory, 1994; Timber Inventory, 2020; Five-Year Forest Management Schedule, 2022 – 2026; and background material associated with these documents.

Question 1: Do the plans recognize the unique nature of the Chilkat River watershed?

No, the plans do not recognize the globally significant ecotone that comprises the Chilkat River watershed. The myriad of small ecotones that make up the Chilkat River watershed are not incorporated into the plans. Nor do the plans recognize the climate limited nature of the forests as it relates to protection of ecological integrity, and tree growth and development for commercial forestry. The negative impacts on the rich biological diversity of the Chilkat River watershed from past forestry practices, particularly clearcutting, are not taken into account in the plans.

Question 2: Do the plans provide for the protection and, where necessary the restoration of ecological integrity and resilience?

The ecological integrity and resilience of the ecosystems and overall watershed of the Chilkat River are not mentioned in the plans. Some *discretionary* buffers are described in guidelines for protection of streams, rivers, and lakes. A 3% reduction in the AAC is provided for "habitat maintenance" in cut blocks. However, the plans do not explain how this small reduction will be spatially applied during forestry operations. Overall the remaining ecological integrity and resilience of the Chilkat River watershed is placed at risk by the plans.

Question 3: Are the plans based upon information and assumptions appropriate to the biological and physical character of the watershed?

The plans state an allowable annual cut, and rely upon predictions of future forest growth and development that are derived from a 2008 vegetation simulator developed for Southeast Alaska and the British Columbia coast. As well, plans rely upon 1984 site index estimates for Southeast Alaska that contain no measurements from forests in the upper Lynn Canal landscape, including the Chilkat River. No clear basis is provided in the plans for establishment of a rotation age. Thus, the primary information and assumptions for the plans are based on information outside the Chilkat River watershed, and do not accurately consider the biological and physical character of the watershed.

Question 4: do the plans incorporate Lingit (Tlingit) knowledge particularly ways of protecting and conserving the Jilkaat Heeni watershed? (Carstensen, 2021, Earthjustice, 2017)

There is no mention of Lingit (Tlingit) knowledge in the plans or documents that support the plans. The plans also do not explain how Lingit cultural needs, including spiritual connections to the land and subsistence resources, will be protected under the goals and guidelines specified in the plans. The lack of incorporation of Lingit knowledge into the plans significantly reduces the likelihood that these plans will protect the ecological and cultural foundations of the Chilkat River watershed.

The *Millennium Agreement between the Federally Recognized Sovereign Tribes of Alaska and the State of Alaska*, April 11, 2001 specifies that Alaska acknowledges "Actions undertaken by the state of Alaska in relationship to the Tribes must be implemented in an informed and sensitive manner, respectful of the Tribal sovereignty and Alaska Native traditional and cultural values, beliefs, and principles…" By exclusion of Lingit knowledge from the plans, the Haines State Forest has violated this agreement.

Question 5: Do the plans consider the climate change and biodiversity crises, and incorporate ways to mitigate and resolve these crises?

There is no mention of the climate change and biodiversity crises in the plans, nor in their supporting documents. As a result, the plans sanction activities, like clear-cut logging, habitat destruction, and fragmentation of the watershed. All of these activities exacerbate the climate and biodiversity crises. When one reads the specifications of these plans, one would think that neither the climate nor biodiversity crises exist.

Question 6: Do the plans provide for sustainable supplies of natural resources, including timber (per HSF Management Plan)?

The plans have the stated intent to provide for sustained yield of a variety of "natural resources," However, they ignore the most fundamental aspect of sustaining natural resources: the need to protect and maintain natural ecosystem composition, structure, and function across spatial and temporal scales as the foundation for enduring ecological benefits. Instead, the plans call for activities that degrade, and often destroy natural ecosystem composition, structure, and function. Water conservation, biological diversity, climate moderation, Indigenous subsistence and cultural resources, and forest resilience all suffer under the specifications of the plans.

9. Nature Directed Planning—a Practical Way Forward

A complete "rethink" is needed for what we euphemistically refer to as *forestry*. As currently practiced in the Chilkat River Watershed and in most forest regions, forestry is little more than a front for logging, for degrading and in many cases destroying forests. Forestry gets off the hook of public scrutiny by many, because the timber industry is constantly reassuring the public that multiple use and sustained yield are the foundations, and "new forests" are quickly planted following logging. You can plant a tree, but you cannot plant a forest. Therein lies the fundamental disconnect between *forests* and *forestry*.

Society has always needed forests for their essential ecological benefits of air and water purification; interception and storage of water by tree crowns; storage and movement of water across continents; climate moderation; carbon sequestration and storage; biological diversity; spiritual renewal; and food and shelter, to name the big benefits. Cultures, like the Tlingit

(Lingit) that co-existed with forests recognized and protected these ecological benefits in their interactions with the forest. These cultures were rooted in a kincentric/Earth-centred ethic, not the destructive anthropocentric ethic that drives today's society, a society controlled and directed by corporate capitalism. (Martinez, 2018)

Kincentricity—Indigenous land care practices that entail reciprocal relationships laid out in "original compacts" between animals and humans; a way of life that includes relating respectfully to all life as kin and to the Earth as a nurturing mother. There are no "natural resources" when those beings are your kin who must be approached with respect before harvesting. (Martinez, 2018)

In this definition, Dennis Martinez is describing a regenerative approach, as opposed to a production, technology dependent approach like that employed in industrial forestry. The failure of the later approach in forest management's attempt to "control forests" has never been more evident than in the climate and biodiversity crises, and the lack of equity in society.

In another example of kincetric thought and action, Robin Wall Kimmerer explains the *honorable harvest* through the Potawatomi way of relating to Nature—to forests:

- *Ask permission of the ones whose lives you seek. Abide by the answer.*
- *Never take the first. Never take the last.*
- *Harvest in a way that minimizes harm.*
- *Take only what you need and leave some for others.*
- *Use everything that you take.*
- *Take only that which is given to you.*
- *Share it, as the Earth has shared with you.*
- *Be grateful.*
- *Reciprocate the gift.*
- *Sustain the ones who sustain you, and the Earth will last forever.* (Kimmerer, 2015)

Kincentricity and the process for the honourable harvest need to be the foundation for a new relationship with forests.

As forestry, read timber extraction and growing replacement trees (if planted trees survive climate change), approaches critical levels of forest removal and degradation of essential ecological benefits of forests, the need to redefine our relationship with forests takes on urgency. A new relationship with forests needs to focus on protection of remaining intact natural forests—primary forests, particularly old-growth, coupled with restoration of ecological integrity, biodiversity, and overall ecological resilience in forests degraded by forestry and other human exploitation.

These changes will not be made by following the path of today's timber-biased forestry analyses and planning. We need to put concepts like AACs (allowable annual cuts), rotation ages, second-growth, commercially valuable trees, free to grow etc. aside and focus on forests. This may be achieved by developing Nature-Directed Stewardship (NDS)
that provide networks of ecological reserves connected by linkages across landscapes, watersheds, and sites. Produced at multiple spatial scales, these networks use a precautionary

approach to define what needs to be protected and where restoration needs to occur. Once these networks are identified, we can talk about how to fit us into the forest picture in ways that protect the ecological integrity of forests. The locations where we fit are termed "human use areas."

Some of those human use areas will be for the removal of timber through a process that maintains continuous forests through the use of ecologically-based partial cuts. When human use areas for timber extraction are defined, we can talk about how much we may periodically cut (i.e. AAC) and how long trees need to be grown to provide their full ecological benefits (i.e. rotation age).

Nature-Directed Stewardship is not to be confused with land use planning, where people negotiate how to divide up the forest pie for human uses. Nature-Directed Stewardship is first about protection and restoration of *natural* ecosystem composition, structure, and function, and secondarily about human uses that are carried out in ecologically responsible ways. Nature-Directed Stewardship may be defined as forest conservation.

Nature-Directed Stewardship provides for as many, and often more meaningful jobs in forest protection and restoration, and in partial cuts compared to jobs found in industrial forestry in today's failing timber economy. An additional economic benefit of NDS is that it facilitates the development of diverse, community-based economies, where high levels of employment may be developed and sustained.

In order to develop a new relationship with forests, we will need transformational change. This will include shifting control of forests from timber interests to control by Indigenous Nations and local settler communities through a co-management arrangement that is governed by the philosophy, principles and process of Nature-Directed Stewardship.

As we make that shift we need to constantly remind ourselves that being captured by today's forestry theory, concepts, and jargon limits our creativity and abilities to change. If bound by the prevailing theories of forestry, we will not solve the problem, because we are treating symptoms not dealing with the problem. The problem is our misguided relationship with forests. Forestry as currently practiced is an outdated construct, defined and promoted by industrial interests through government, education, research, and effective lobbies.

A new relationship will emerge when we embrace a kincentric relationship with forests and implement the honourable harvest. Nature-Directed Stewardship plans will move us along the path to that new relationship with forests.

Appendix 1 provides the background and process for Nature-Directed Stewardship plans and activities.

10. Bibliography

Alaska Climate Adaptation Center. 2022. Climate Projections for Southeast Alaska [https://akcasc.org/about-us/climate-projections-for-southeast-alaska/]

Alaska Department of Fish and Game. 2012. Community Subsistence Information System CSIS. Haines [https://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest]

Bontemps, Jean-Daniel and Olivier Bouriaud. 2013. *Predictive approaches to forest site productivity: recent trends, challenges and future perspectives*. *Forestry* 2014; 87, 109-128, doi:10.1093/forestry/cpt034.

Carstensen, Richard. 2021. Introductory pages to Greater Chilkat Watershed atlas. Juneau Nature. 7p. [http://juneaunature.discoverysoutheast.org/content_item/chilkat-atlas-introduction/]

Creed, Irena F. and van Noordwik, Meine (eds.) 2018. *Forest and Water on a Changing Planet: Vulnerability, Adaptation, and Governance Opportunities*. A Global Assessment Report. IUFRO World Series Volume 38. Vienna. 192 p. [https://www.iufro.org/fileadmin/material/publications/iufro-series/ws38/ws38.pdf]

Deal, Robert L. and John C. Tappeiner. 2002. *The effects partial cutting on stand structure and growth of western hemlock — Sitka spruce stands in southeast Alaska*. Forest Ecology and Management 159 (2002) p 173 – 186

Deal, Robert L. 2001. *The effects of partial cutting on forest plant communities of western hemlock — Sitka spruce stands in southeast Alaska.* Canadian Journal of Forest Research 31: 2067-2079, DOI: 10.1139/cjfr-31-12-2067

Earthjustice. 2017. Defending the Chilkat River Watershed. [https://earthjustice.org/cases/2017/defending-the-chilkat-river-watershed]

Environmental Defense Fund (EDF). *How Will Climate Change Affect Alaska?* [https://www.edf.org/sites/default/files/content/regional_releases_alaska_web_version.pdf]

FAO. 2019. *Flying Rivers-how forests affect water availability downwind and not just downstream.* Forest and Water Programme. FAO. [https://www.fao.org/in-action/forest-and-water-programme/news/news-detail/ru/c/1190278/]

Farr, Wilbur A. 1984. *Site Index and Height Growth Curves for Unmanaged Even-Aged Stands of Western Hemlock and Sitka Spruce in Southeast Alaska*. USDA Forest Service. Pacific Northwest Forest and Range Experiment Station. Research Paper PNW-326. 32p.

Gimbel, Katharina F. et al. 2016. *Does drought alter hydrological functions in forest soils?*. Copernicus Publications on behalf of the European Geosciences Union. Hydrology and Earth System Sciences, 20, 1301-1317.

Goldstein, Allie et al. 2020. *Protecting irrecoverable carbon in Earth's ecosystems.* New York. Nature Climate Change. Vol 10. April 2020. 287-295.

Graham, Elizabeth. 2021. US Forest Service entomologist. *A tiny insect is causing major tree damage in Southeast Alaska. Scientists hope it's a blip.* KTOO Public Radio. Juneau, Alaska. [https://www.ktoo.org/2019/10/11/a-tiny-insect-is-causing-major-tree-damage-in-southeast-alaska-scientists-hope-its-a-blip/]

Hammond, Herb. 1992. *Seeing the Forest Among the Trees: The Case for Wholistic Forest Use.* Vancouver, B.C. Polestar Press. p. 104.

Haines State Forest. 2002. *Haines State Forest Management Plan*. Alaska Department of Natural Resources, Division of Mining, Land &Water, Resource Assessment & Development Section, Division of Forestry. 212p. (HSFMP)

Haines State Forest. 2022. *Five Year Management Schedule—2022-2026*. Alaska Department of Natural Resources, Division of Forestry. Haines State Forest. 20 p. (5YrMS-22-26)

Hanson, Douglas. 2020. *Timber Inventory of State Forest Lands in the Haines Area 2020*. Alaska Department of Natural Resources, Division of Forestry. 45p.

Harmon, Mark E., William K. Ferrell, Jerry F. Franklin. 1990. *Effects on Carbon Storage and Conversion of Old-Growth Forests to Young Forests.* Washington DC. Science. 247. 4943. p.699.

Helbig, Nora. 2020. *Snow processes in mountain forests: interception modeling for coarse-scale applications*. European Geosciences Union, Copernicus Publications. Hydrology and Earth System Sciences, 24, 2545-2560. [https://hess.copernicus.org/articles/24/2545/2020/#section6]

Hewelke et al. 2018. *Intensity and Persistence of Soil Water Repellency in Pine Forest Soil in a Temperate Continental Climate under Drought Conditions*. MDPI. Journal Water 2018, 10, 0; doi: 10.3390/w10090000.

Isaacson, Allen, forest hydrologist. Circa 1985. personal communication

Jones, Julia. 2020. *Effects of forestry on streamflow.* Corvallis, Oregon. Oregon State University. webinar. December 2, 2020.

Kimmerer, Robin Wall. 2015. *The "Honorable Harvest": Lessons From an Indigenous Tradition of Giving Thanks* in Yes! magazine. Winter, 2016. [https://www.yesmagazine.org/issue/good-health/2015/11/26/the-honorable-harvest-lessons-from-an-indigenous-tradition-of-giving-thanks]

Lee, Peter. January 2002. *Boreal Canada: ecology, threats, and strategic science and information needs for conservation planning and actions.* Unpublished manuscript prepared for Canadian Boreal Initiative, Ottawa.

Lindenmayer, David B. and Jerry F. Franklin. 2002. *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*. Washington DC. Island Press. pp. 12, 13, 18, 20, 22, 49

Luckert, M.K. and T. Williamson. 2005. *Should sustained yield be part of sustainable forest management?* Canadian Journal of Forest Research 35: 356-354, doi:10.1139/X04-172

Martin, Maria E. Blanco, Michael Hoppus, Andrew Lister, James A. Westfall. 2006. *Is There a Better Metric Than Site Index To Indicate the Productivity of Forested Lands?* Proceedings of the Eighth Annual Forest Inventory and Analysis Symposium. USDA Forest Service. Gen. Tech. Report WO-79.

Martinez, Dennis. *Redefining Sustainability through Kincentric Ecology: Reclaiming Indigenous Lands, Knowledge, and Ethics.* p139-174 in *Traditional Ecological Knowledge: Learning from Indigenous Practices for Environmental Sustainability.* edited by Melissa K. Nelson and Dan Shilling. 2018, Cambridge University Press.

Moomaw, William R, Susan A. Masino, and Edward K. Faison. 2019. *Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good.* Lausanne, Switzerland. frontiers in Forests and Global Change. 11 June 2019. [https://www.frontiersin.org/articles/10.3389/ffgc.2019.00027/full]

Morelli, Toni Lyn et al. 2016. *Managing Climate Change Refugia for Climate Adaptation*. San Francisco, California. PLOS ONE. August 10, 2016. [https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0159909#amendment-0]

Morelli, Toni Lyn et al. 2020. *Climate-change refugia: biodiversity in the slow lane.* Washington, DC. Frontiers in Ecology and Environment. Special Issue: Climate Change Refugia. June, 2020. pp 228-234. [https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2189]

Nantel, Patrick. Antoine Moreau. Sylvie Sougavinski. Frederik Doyon. 2003. *Ecosystem Management of Forest Resources in Canada: An Overview of Concepts and Current Experiences*. XII World Forestry Congress, 2003, Quebec City, Quebec Canada.

Owen, Brenna. 2022. *Logging in watersheds among stressors for declining Pacific salmon population, experts say.* Vancouver. The Canadian Press. Younes Alila interview. [https://www.theglobeandmail.com/canada/british-columbia/article-logging-in-watersheds-among-stressors-for-declining-pacific-salmon/]

Pojar, Jim. 2019. *Forestry and Carbon in BC*. Terrace, BC. SkeenaWild Conservation Trust and Hazelton, BC. Skeena Watershed Coalition. 42p.

Price, Karen. Rachel Holt. Dave Daust. 2020. *BC's Old Growth Forest: A Last Stand for Biodiversity*. Nelson, B.C. Veridian Ecological Consulting. 25p

Schoen, John W. and Erin Dovichin. 2007. The Coastal Forests and Mountains Ecoregion of Southeastern Alaska and the Tongass National Forest, A Conservation Assessment and RESOURCE SYNTHESIS. Chapter 4.5. Audubon Alaska and The Nature Conservancy. [https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/seak/era/cfm/Documents/PDFs/4.5_Chilkat.pdf]

Segura, Catalina et al. 2020. *Long-term effects of forest harvesting on summer low flow deficits in the Coast Range of Oregon*. Journal of Hydrology. 585 (2020) 124749. [https://fews.forestry.oregonstate.edu/publications/Segura_JoH_2020.pdf]

Smith, Melanie A. 2016. Ecological Atlas of Southeast Alaska. Audubon Alaska. 228p.

Thompson, Ian, Mackey, B., McNulty S. Mosseler, A. 2009. *Forest Resilience, Biodiversity, and Climate Change. A Synthesis of the Biodiversity/Resilience/Stability Relationship in Forest Ecosystems.* UNEP. Convention on Biological Diversity. Technical Series no. 43. 67p. [https://www.cbd.int/doc/publications/cbd-ts-43-en.pdf]

U.S. Climate Normals for Haines 40 NW, AK. 1981-2010. U.S. Climate Normals Quick Access. National Centers for Environmental Information. National Oceanic and Atmospheric Administration. [https://www.ncei.noaa.gov/access/us-climate-normals/#dataset=normals-monthly&timeframe=81&location=AK&station=USC00503504]

U.S. Department of Agriculture, Forest Service. 2021. *Alaska (AK) Variant Overview—Forest Vegetation Simulator*. Mark Castel et al. Fort Collins, CO. Revised June 2021. 45p.

U.S. Department of Agriculture, Forest Service. 2008. *Pacific Northwest Coast (PN) Variant Overview—Forest Vegetation Simulator*. Chad E. Keyser. Fort Collins, CO. Revised December 2012. 62p.

Vogt, K., E. Moore, W. Gower, D. Vogt, D. Sprugel, and C. Grier. 1989. *Productivity of upper slope forests in the Pacific Northwest*. in: Perry et al (eds), Maintaining the long-term productivity of Pacific Northwest forest ecosystems. Timber Press. Portland, Oregon

Weiting, Jens. 2019. *Clearcut Carbon*. Vancouver, B.C. Sierra Club BC. 20p.

Wieting, Jens and David Leversee. 2019. *Clearcut Carbon—A Sierra Club BC report on the future of forests in British Columbia*. Vancouver, B.C. Sierra Club BC. 18p.

Wood, Peter. 2021. *Intact Forests, Safe Communities: Reducing community climate risks through forest protection and a paradigm shift in forest management.* Vancouver, B.C. Sierra Club BC. 29p.

Yu, Joe YuJian and Younes Alila. 2019. Nonstationary frequency pairing reveals a highly sensitive peak flow regime to harvesting across a wide range of return periods. Elsevier. Forest Ecology and Management. 444 pp.187-206.

Appendix 1—Nature-Directed Stewardship

Nature-Directed Stewardship—Best Knowledge
Background and Approach

excerpted from

Nature Directed Stewardship Plans for Glade & Laird Creek Watersheds
Herb Hammond, Forest Ecologist
Martin Carver, Forest Hydrologist & Geomorphologist

March, 2022

Nature-Directed Stewardship—Best Knowledge—Background & Approach

> *Looking at life from a different perspective makes you realize that it's not the deer that is crossing the road, rather it's the road that is crossing the forest.*
> Author Unknown

Nature-Directed Stewardship ("NDS")[1] is a system of ecosystem protection, maintenance, restoration, and human use. It was developed by the Silva Forest Foundation to protect ecosystem integrity and biodiversity at multiple spatial scales, while providing for Earth-centred human use of ecosystems.[2] The first priority in NDS is maintaining (or restoring) *natural ecological integrity* — including biological diversity — across the full range of spatial (from very large to very small areas) and temporal (from short to long periods of time) scales.

NDS (otherwise known as "ecosystem-based planning", "ecosystem-based conservation planning", or "Nature-Directed Stewardship) is widely accepted by scientists and practitioners as the state-of-the-art approach to forest planning and use.[3] Indeed, NDS has also been successfully applied in many different types of terrestrial, aquatic, and marine ecosystems.[4]

1.1 Introduction

Nature-Directed Stewardship envisions people living as *a respectful part* of the ecosystems that sustain us. Our plans and actions are inclusive of the needs of all beings, *all our relations*. In this vision, ecosystems are seen as *identities to be respected, not objects to be dominated*, wisdom passed down by Indigenous elders and knowledge holders across Canada and elsewhere in the world. What people acquire from this relationship are clean air, pure water, climate moderation, healthy food and shelter, and respectful relationships with each other and Earth. People acquire well-being, while asking little from the ecosystems around them. Ecosystems are selfless—an important lesson for our species.

The vision of living as a respectful part of the ecosystems that sustain us is the starting point and constant touchstone for making ecosystem-based decisions or Nature directed decisions. Being a *respectful part* means recognizing that we are only one small, often ecologically insignificant part of the mosaic of natural ecosystems, and learning from and protecting those ecosystems we inhabit. Being a respectful part means being Nature directed in our thoughts, plans, and activities.

---

[1] The term *nature-directed stewardship* (NDS) is used interchangeably with *Nature-Directed Stewardship* (NDS), *ecosystem-based conservation planning* (EBCP) and *ecosystem based planning* (EBP), and has the same meaning.

[2] Silva Forest Foundation. 1997. *An Ecosystem-based Approach to Forest Use: Definition and scientific rationale,* Slocan Park, BC, Silva Forest Foundation. 1-25

[3] Kaufmann, M.R. et al. 1994. *An Ecological Basis for Ecosystem Management*. USDA Forest Service Gen. Tech. Report RM-246. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 1-22; Coast Information Team. 2004. *CIT Scientific Basis of Ecosystem-Based Management.* Victoria, BC. Coast Information Team. 9-61.

[4] Price, K, Roburn, Audrey, and MacKinnon, Andy. 2008. *Ecosystem-based management in the Great Bear Rainforest*. Forest Ecology and Management. 499; Doswald, N and Osti, M. 2011. *Ecosystem-based approaches to adaptation and mitigation—good practice examples and lessons learned in Europe*. Bonn, Germany. Bundesamt fur Naturschutz, Federal Agency for Nature Conservation. 1-49; Long, R.D., Charles, A., Stephenson, R.L. 2015. *Key principles of marine ecosystem-based management*. Marine Policy at ScienceDirect, Elsevier. 53-60.

Natural ecosystems function fully and flawlessly without us, but the converse is not true. Yet, from rural to urban landscapes, forest to grassland landscapes, and fresh water to marine landscapes, human beings have degraded and destroyed the very fabric of ecosystems.

Our ill-conceived actions have fueled climate change, water degradation, loss of biological diversity, and created many obstacles for human health and well-being. These results are not respectful of ecosystems and demonstrate the lack of a holistic, thoughtful, precautionary, and inclusive vision. Nature-Directed Stewardship is rooted in a vision that avoids recreating these problems, while providing a system to restore natural ecosystem integrity and resilience. NDS asks that we use the vision of people living as humble, respectful parts of ecosystems to reach for an inclusive future that provides for the well-being of all—human and non-human. The NDS vision is achieved through a practical, tested system of planning and ecologically responsible human use of ecosystems i.e. home systems—our home.[5] [6]

At the same time, it provides for ecologically and culturally sustainable communities and their economies. In other words, Nature-Directed Stewardship provides a picture of the ecological framework that is necessary to protect, and the ecological limits that constrain human uses in order for them to be sustainable.[7]

Ecologically and culturally sustainable management of ecosystems recognizes a hierarchical relationship between ecosystems, cultures, and economies. Economies are part of human cultures, and human cultures are part of ecosystems. Therefore, protecting ecosystem functioning provides for healthy human cultures, and the economies that are part of these cultures. This understanding is the foundation for, and guides the planning and implementation of Nature-Directed Stewardship/Nature-Directed Stewardship/ecosystem-based conservation planning.[8]

NDS offers a way to plan and implement *ecosystem-based use of forests*, and *ecological restoration of previously degraded forests and associated ecosystems*. Given the extensive nature and long history of human-centred forest-based activities, applying NDS in these landscapes often focuses on ecological restoration.

In our rush to exploit "resources" found in forests, we have forgotten that we are part of ecosystems supported by a bigger ecosystem — the landscape. By forcing our will on forests, we have degraded those ecosystems and the watersheds and landscapes that support them.

We know enough to do better. We have workable methods for protection of Nature, and for assistance for Nature to restore (where necessary) fully-functioning ecosystems. This change begins with an *Earth-centred approach* rather than a human-centred approach: we are part of ecosystems, and what we do to ecosystems we do to ourselves. We must focus on needs, not on wants. Consumption must be replaced by conservation embedded in a steady state economy. We must act on the understanding that Earth sustains us, we do not sustain Earth.

---

[5] Silva Forest Foundation. 2004. *The Power of Community: Applying Ecosystem-based Conservation Planning Across Canada*. Slocan Park, BC: Silva Forest Foundation. 1-24.

[6] Hammond, Herb. 2015. *Ecosystem-based Conservation Plan for Shawnigan Lake Watershed*. Slocan Park, BC: Silva Ecosystem Consultants. 1-120.

[7] Hammond, Herb. 2009. *Ecosystem-based Conservation Planning—a short definition*. unpublished paper. Slocan Park, BC: Silva Forest Foundation.

[8] *Ibid.*

1.2 The Challenge of Restoration—how to start and move to NDS

There is an inherent inertia in thinking about, let alone in undertaking, restoration of a reasonable semblance of nature — natural ecosystem functioning — to ecosystems and landscapes that have been degraded by industrial activities.

To avoid paralysis, we need to remember the wisdom of Lau Tzu: *The journey of a thousand miles starts with a single step.* That "first step" is changing our ways of thinking about the forest by adopting an Earth-centred, kincentric vision to guide our application of ecologically and socially responsible, practical planning and restoration activities.

Dennis Martinez, O'odham/Chicano/Anglo, developed the term "kincentric" and describes it in this way:

> *Kincentricity—Indigenous land care practices that entail reciprocal relationships laid out in "original compacts" between animals and human; way of life that includes relating respectfully to all life as kin and to the Earth as a nurturing mother. There are no "natural resources" when those beings are your kin who must be approached with respect before harvesting.*[9]

Kincentric thinking and ways of being are the foundation for Nature-Directed Stewardship. Without adopting this thought process we continue to be trapped in an anthropocentric way of being where ecosystems are seen as natural resources to be exploited for human wants, not identities to be respected in a regenerative, reciprocal relationship with Nature.

Nature-Directed Stewardship is most effective when it begins from as large a landscape as possible. Landscapes hold watersheds, and watersheds hold patches—the multiple spatial scales of interconnected, intedependent ecosystems. Thus, the character of the landscape shapes its component watersheds, and the character of each watershed shapes the patches within it.

Nature-Directed Stewardship provides a landscape vision that guides planning for smaller areas within the landscape in question. Integrated planning of this nature may be challenged by overlapping jurisdictions, the effects of past and ongoing development, and coordinating data analysis to synthesize a plan.

Just as large landscapes "hold" their component ecosystems, thereby influencing the character and condition of component ecosystems, a landscape may also be influenced, in part, from the bottom up. In other words, as the character and condition of component ecosystems change, so does the character and condition of the landscape.

Changing the character and condition of a single ecosystem within a landscape will not have as much overall influence as changing the broader character and condition of the landscape. However, working from the ecosystem, patch, or site toward the landscape may serve as an important catalyst for development of broad landscape visions and plans for protection and responsible use, and initiate important restoration activities.

Thus, starting with the restoration of a clearcut or road, a vision may be formulated for Earth-centred living that stimulates development and implementation of Nature-Directed Stewardship for a watershed or large landscape.

This approach offers a manageable, community-based way to initiate Nature Directed Stewardship. In other words, start with the small, but manageable forest patch or site, and

---

[9] Nelson, Melissa K. and Schilling, Dan editors. 2018. *Traditional Ecological Knowledge: Learning from Indigenous Practices for Environmental Sustainability.* New York. Cambridge University Press. Part III, Chap 9, pp 139-174.

keep "walking up" the scale to expand site protection and restoration efforts to become watershed and landscape protection and restoration.

Whichever route we take, at the beginning of our walk, we need to consider what we are interacting with and what we need to protect and restore—*ecosystems.* Understanding ecosystems means understanding where we started in forest activities: the natural *character* that was degraded and replaced by an unnatural *condition* that has resulted from human activities. In most cases, current condition comprises a forest landscape only marginally capable of supplying the ecosystem benefits that it once did.

1.3 What is an ecosystem?

A community of interacting species, taken together with the physical environment within which it exists and within which the species composing the community also interact, is an **ecosystem.** Ecosystems have the following distinguishing characteristics:

1. A web of interactions and interdependencies among the parts.
2. Synergy, which is the "behavior of whole systems unpredicted by the behavior or integral characteristics of any of the parts of the system when the parts are considered only separately"
3. Stability, a simple yet complicated concept that does not mean "no change" but rather is analogous to the balanced movement of a dancer or a bicycle rider.
4. Diffuse boundaries. Unlike an organism, an ecosystem does not have a skin that clearly separates it from the external world. Ecosystems are defined by connectance, and connections that extend through time and space, integrating every local ecosystem…within a network of larger and larger ecosystems that compose landscapes, regions, and eventually, the entire Earth. [10]

Thus, ecosystems are interdependent, interconnected living systems. The linkages between the parts and processes of ecosystems are seldom obvious, but they are always there. Recognizing the interconnected, seamless linkages both from large ecosystems to small ecosystems and vice versa, stimulates a large measure of humility about just how deep and far the impacts of our actions extend when we modify natural ecosystem composition, structure, and function—natural character. What we do to ecosystems, at any spatial scale, we do to ourselves.

Another way to look at an ecosystem is to consider the meaning of the first syllable of the term. *Eco* is derived from the Greek word *oikos* meaning the whole house or home.[11] Thus, ecosystem means *home system*. In other words, protecting and restoring the natural ecosystems that comprise a forest landscape or patch is protecting and restoring home—our home.

---

[10] Perry, David A. 1994. *Forest Ecosystems*. Baltimore, Maryland: The John Hopkins University Press. 1-2

[11] Boland, D.G. 1997. *Economics and Aristotle's Division of the Sciences*, in IEPS 1997 Conference. Sydney, Australia: Centre for Thomistic Studies.

Interestingly, the word *economy* has the same first syllable, *eco* as the word ecosystem. However, the second syllable –*nomy* is derived from the Greek *nomos* "management."[12] Thus, economy means *home management*, not the whole home system. Economies are therefore clearly part of ecosystems, and dependent upon the integrity of ecosystems for their survival.

1.4 Nature-Directed Stewardship—definition

Nature-Directed Stewardship means relating to and using the ecosystems we are part of in ways that ensure the protection, maintenance, and, where necessary, restoration of ecological integrity and biological diversity from the genetic and species levels to the community and landscape levels. An ecosystem-based perspective works at all scales, from the microscopic to the global. The priorities that guide ecosystem-based use of land, water, and air focus first on what to protect, and then on what to use:

> **First Priority:** *Protect or restore ecological integrity* . . . In other words, maintain and, where necessary, restore natural ecosystem composition, structure, and function at all spatial scales through time.
>
> **Second Priority:** *Provide for balanced ecosystem use across the landscape* . . . In other words, provide fair, protected landbases for all ecosystem users, both human and non-human. [13]

The methods and products of a Nature-Directed Stewardship are a synthesis of Indigenous knowledge, shared by Indigenous knowledge holders, and scientific concepts developed by leading edge researchers and practitioners in ecology, conservation biology, landscape ecology, hydrology, and ecological economics. Nature-Directed Stewardship not only provides for the maintenance and/or restoration of ecological integrity, but also for the development of diverse, sustainable steady state community economies.

Human uses are balanced, fairly distributed in *a portion* of the plan area, and carried out in ways that maintain ecological integrity. A significant portion of the plan area, usually 50% or more, is maintained as a natural ecosystem reserve. This part of the plan area is to provide for the needs of non-human beings and the processes that provide overall ecosystem benefits and support for the ecosystem as a whole. Ecosystem reserve areas may be used for Indigenous cultural and subsistence purposes, and some non-consumptive activities, subject to the ecological limits specified in a particular plan.

Nature Directed Stewardship is community focused, where communities are inclusive of many interests, share decision-making power, and take responsibility for their actions.

While Nature-Directed Stewardship is rooted in science, it is not a new idea. [14] [15] An ecosystem-based way of relating to the land and water has its roots in Indigenous knowledge and management systems, which are the result of thousands of years of meticulous, repeated

[12] *Ibid.*

[13] Hammond, H. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest*. Slocan Park, B.C. Silva Forest Foundation. 14.

[14] Kaufmann, M.R. et al. 1994. *An Ecological Basis for Ecosystem Management*. USDA Forest Service Gen. Tech. Report RM-246. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 1-22.

[15] Holt, R.F. 2001. *An ecosystem-based management planning framework for the North Coast LRMP*. North Coast LRMP, Victoria, British Columbia. 1-24. https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/land-use/land-use-plans-objectives/skeena-region/northcoast-lrmp

observations of how ecosystems function and their response to human activities. [16] [17]
Considering the degradation of natural ecological landscapes in the industrial age throughout the world, Indigenous management systems have been the only management systems that have been proven to be sustainable in the long term.
Hence, NDS is grounded in both western science and Indigenous knowledge. Thus, when people develop and implement Nature-Directed Stewardship, we are being *ecologically responsible*, and providing for both *ecological* and *cultural sustainability*.

Long-term ecosystem plans, not short-term development plans

Nature Directed Stewardship is built on *ecosystem* plans that have ecological timeframes that encompass full ecosystem cycles. The timeframe over which live and dead trees function and provide benefits in a forest, the ecological parts and processes develop that provide for water conservation, and soil development are examples of ecosystem timeframes. This is why plans for Nature Directed Stewardship have timeframes of 250-500 years and beyond. Nature Directed Stewardship provides plans with timeframes that generations of people will live through and modify as knowledge and needs change.
The timeframes for Nature Directed Stewardship are significantly different than in most human endeavours, including forest management plans of 1-5 years, election cycles of 4-5 years, or annual budgets of corporations and nonprofit organizations. In contrast, time cycles at the level of ecosystems range from very short to very long, and are often hard to identify because ecosystems—forests, grasslands, savannahs—are continuums in time and space. Thus, Nature Directed Stewardship needs to encompass the longest reasonable ecological timeframe, in order to maintain ecological integrity from the smallest site to the largest landscape.
Nature Directed Stewardship furnishes an ecological picture that provides a baseline understanding of what is necessary to maintain and restore ecological integrity, without presupposing any particular type of human use. In Nature Directed Stewardship, biology and ecology are put ahead of politics and short-term economic expediency.
Nature Directed Stewardship commits human communities to a long-term, responsible, regenerative and reciprocal relationship with Nature. Hopefully, application of this new relationship with Nature will, over time, serve as a catalyst for human beings to live as a respectful part of the ecosystems that provide for their well-being. Due to the extensive levels of restoration commonly needed to successfully implement NDS, ongoing restoration over extended time periods is a *keystone requirement* for success of a plan. Keeping the keystone in place will require lasting political and funding commitments.

Key Concepts

Four key concepts underlie development and implementation of Nature Directed Stewardship:

1. ecological integrity;
2. character and condition of ecosystem composition, structure, and function;
3. ecological limits; and
4. multiple spatial scales and "nested" networks of ecological reserves.

---

[16] Gadgil, Madhav et al. 1993. *Indigenous Knowledge for Biodiversity Conservation*. Stockholm, Sweden, Ambio, Vol. 22, No. 2/3. Springer on behalf of Royal Swedish Academy of Sciences. 151-156.
[17] Finn, Symma et al. 2017. *The Value of Traditional Ecological Knowledge for the Environmental Health Sciences and Biomedical Research*. Durham, North Carolina. Environmental Health Perspectives. 085006-1-085006-9.

Definition of each key concepts, along with an explanation of the context within which these concepts are applied in developing Nature-Directed Stewardship are provided below.

Ecological integrity

Ecological integrity may be defined as, "A system's wholeness, including presence of all appropriate elements and occurrences of all processes at appropriate rates". [18] A similar definition states: "the abundance and diversity of organisms at all levels, and the ecological patterns, processes, and structural attributes responsible for that biological diversity and for ecosystem resilience." [19]

A more detailed way to describe ecological integrity is through a set of goals for human use that would increase the probability of maintaining natural ecological integrity:

- maintain viable populations of all native species;
- represent, within protected areas, all native ecosystem types across their range of variation;
- maintain evolutionary and ecological processes—i.e., disturbance regimes, hydrological processes, and nutrient cycles;
- manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems; and
- accommodate human use and occupancy within these constraints. [20]

Character and Condition of Ecosystem Composition, Structure, and Function

Character and condition are closely related key concepts. Describing the **character** and **condition** of a landscape ecosystem or patches within the landscape is the starting point for development of Nature-Directed Stewardship and for designing networks of ecological reserves at multiple spatial scales.

The **character** of ecosystems refers to the natural composition, structure, and function of the ecosystems included within a planning area at a particular scale. In other words, describing the ecological character of an area means describing what it is and how it works in the absence of modification by industrialized human societies, but including modification through Indigenous management systems. The character of ecosystems at all spatial scales is described using composition, structure, and function.[21]

The **condition** of ecosystems refers to how the *natural* ecological composition, structure, and function have been *modified* or impacted as a result of human activities, including resource

---

[18] Franklin, JF et al. 2000. *Simplified Forest Management to Achieve Watershed and Forest Health: A Critique.* Seattle, Washington. National Wildlife Federation. 1-19.

[19] Coast Information Team—Compendium Team. 2004. *The Scientific Basis of Ecosystem-Based Management*. Victoria, B.C. Cortex Consultants. 13.

[20] Coast Information Team, MacKinnon et al. 2003. *CIT Compendium: A science compendium: ecosystem-based management, science and its application* March 31, 2003 draft. Victoria BC. CIT Integrated Land Management Bureau.

[21] Silva Forest Foundation. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest.* Slocan Park, B.C. Silva Forest Foundation. 34.

exploitation, settlement, urbanization, tourism, and other human activities; but excluding pre-industrial Indigenous management systems.[22]

Within these two key concepts are three important ecological concepts:

- **composition**: the parts of an ecosystem, e.g., the types and numbers of species that occur in an ecosystem;
- **structure**: how the parts of an ecosystem are arranged e.g. the patterns of vegetation types across a landscape, and the frequency and distribution of live and dead trees (i.e. snags and fallen trees) within a site or patch; and
- **function**: the processes that occur within an ecosystem and between ecosystems that depend upon their parts and how they are arranged, i.e., their composition and structure.[23]

Character and condition are scale-dependent terms. For example, describing the character and condition of a site or patch involves different variables and considerations than describing character and condition in a watershed. That is why incorporating analyses of character and condition of ecosystems at multiple spatial scales into Nature-Directed Stewardship is necessary to maintain ecological integrity of whole watersheds or landscapes.

The character of an ecosystem is a continuum in time and space. In other words, over time, an ecosystem is not static and unchanging. Natural disturbances constantly modify ecosystems as time passes. However, unlike disturbances from industrial activities, natural disturbances serve to maintain ecosystem function, enrich biological diversity, and provide biological legacies that connect one successional phase to another. The effects of natural disturbances maintain diversity while industrial resource extraction activities tend to simplify, homogenize, degrade, and often eradicate natural ecosystems.[24]

In a natural ecosystem, *natural disturbance regimes*, or the types of natural disturbances, may range from landscape level disturbances such as floods, fires and windstorms to the activities of insects and fungi at the site level. Large landscape level natural disturbances such as floods, insect epidemics, and windstorms are dramatic events; however, they are far less frequent in ecosystems than small site level events.[25]

For example, in a natural forest ecosystem, the most frequent disturbance or agent of change is the death of an individual tree or a small group of trees. Death may be from a wide range of causes, including bark beetles, root decaying fungi, small wind events, patch fires, heavy snow accumulations, soil erosion, or combinations of these and other factors.[26]

Thus, natural disturbance events result in changes to composition, structure, and function—different character of ecosystems/landscapes. In the time interval between successive disturbances, the character changes through a process referred to as succession. Unlike once thought, succession does not necessarily lead to a stable "climax" character. Succession is

[22] *Ibid*
[23] *Ibid*
[24] Lindenmayer, D.B. and Franklin, J.F. 2002. *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*. Washington, DC. Island Press. 55-60.
[25] Perry, David A. 1994. *Forest Ecosystems*. Baltimore, Maryland: The John Hopkins University Press. 101, 102.
[26] *Ibid*

highly variable, stochastic, and complex.[27] Describing the variability in ecosystem composition, structure, and function that occurs through the dynamic process of succession is often referred to as the "range of natural variability."[28]

As explained above, the condition of ecosystems refers to how the natural ecological composition, structure, and function have been modified or impacted as a result of human activities, including resource exploitation, settlement, urbanization, tourism, and other human activities. [29] It is important to assess and incorporate ecological condition into Nature Directed Stewardship, because the condition of an ecosystem:

- identifies areas in need of restoration,[30]
- identifies the type and extent of restoration that is needed,[31]
- helps to define areas that are more or less appropriate for networks of ecological reserves, and
- identifies limits for human economic development activities.

The condition of ecosystems is determined through analysis of maps, aerial photos, satellite imagery, lidar and other imaging data that show the location and characteristics of various activities or disturbances from human activities, excluding traditional Indigenous management systems.

Analysis of maps, aerial photos, lidar, satellite imagery, and/or other imagery data to describe condition, needs to be augmented by field assessments to accurately describe impacts to, and restoration needs of sites, watersheds, and landscapes modified by human activities, from urban development and manufacturing to timber and mineral extraction and agriculture.

Describing and comparing the character and condition — composition, structure, and function — of ecosystems at multiple spatial scales is the foundation for Nature-Directed Stewardship. This aspect of NDS is illustrated in Figure 1: the General Process to Develop Nature Directed Stewardship.

---

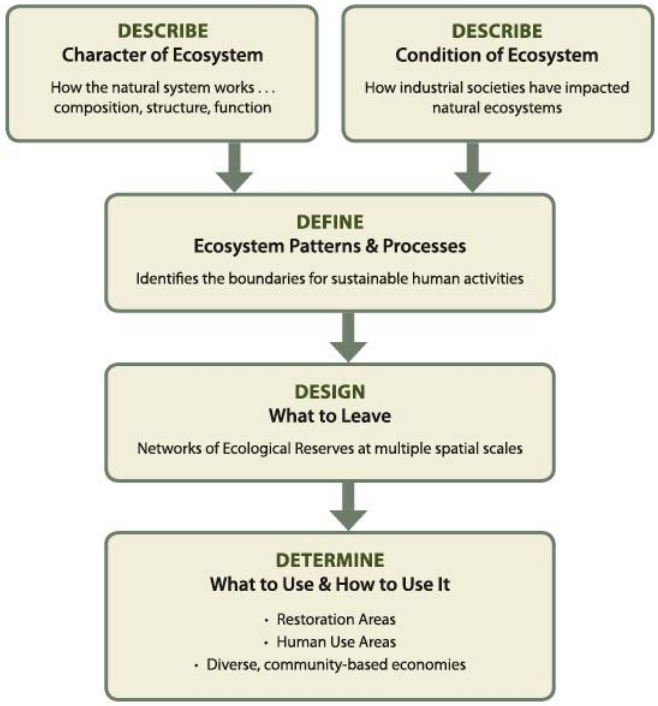
[27] Christensen Jr, Norman L. 2014. *An historical perspective on forest succession and its relevance to ecosystem restoration and conservation practice in North America*. Netherlands. *Forest Ecology and Management*. V. 330. Elsevier. 312-322.

[28] Landres, Peter, B. et al. 1999. *Overview of the Use of Natural Variability Concepts in Managing Ecological Systems.* Washington, DC. in *Ecological Applications.* 9(4). Ecological Society of America. 1179-1188.

[29] Silva Forest Foundation. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest.* Slocan Park, B.C. Silva Forest Foundation. 34.

[30] Eagan, Dave and Howell, Evelyn. 2001. *The Historical Ecology Handbook: A Restorationist's Guide to Reference Ecosystems*. Society for Ecological Restoration. Washington, D.C. Island Press. 2-11.

[31] *Ibid*



© Herb Hammond

Figure 1: General Process to Develop Nature Directed Stewardship [32]

Ecological limits

Ecological limits provide boundaries for human activities under Nature-Directed Stewardship. In other words, ecological limits to human activities define thresholds past which certain activities initiate fundamental, detrimental change to ecosystems, or thresholds beyond which ecological integrity is not maintained. Defining ecological limits is primarily a process of using scientific data with consideration of socio-political information.[33]

Changes to ecosystem composition, structure, and function that are beyond the range of natural variability of disturbances result in fundamental change to ecosystems, not fluctuation within the ecosystem such as those caused by natural disturbances.[34] The biophysical, climatic, or abundance thresholds past which species, ecosystems, and landforms suffer fundamental change, as opposed to natural fluctuations, are termed *ecological limits*.

The precautionary principle is applied to defining and respecting ecological limits in the process of developing Nature-Directed Stewardship. Once defined in Nature-Directed Stewardship, ecological limits prohibit development, or place constraints on development that err on the side of protecting ecological integrity. Both actions are taken to protect and/or restore ecological

[32] Silva Forest Foundation. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest.* Slocan Park, B.C. Silva Forest Foundation. 38.
[33] Morgan, Edward. 2015. *Understanding the role of science in defining ecological limits.* Powerpoint Presentation. Nathan, Queensland, Australia. Griffith University. 1-15.
[34] Holt, Rachel F. and Sutherland, Glenn. 2003. *Environmental Risk Assessment: Base Case: Coarse Filter Biodiversity*. North Coast LRMP. Nelson, B.C. Veridian Ecological Consulting Ltd. 4-13.

integrity. Through adaptive management applied over an adequate period of time, the results of ecological limits may evaluated and refined as required.

Examples of major factors that define the ecological limits to human use of ecosystems include the habitat and reproductive needs of species, the shape of the terrain, the slope gradient, soil depth, soil texture, the amount of moisture available (both wet and dry conditions impose ecological limits), and local climatic conditions.

Disturbances are needed in ecosystems, but disturbances that exceed ecological limits result in degradation to ecosystem functioning, not fluctuations within natural ecosystem functioning.

Nature-Directed Stewardship is predicated on the premises that ecological limits will be respected, and that human uses will be designed to prevent, as opposed to mitigate, damage to the ecological integrity of ecosystems. Thus, identifying ecological limits is an important starting point for the development of Nature Directed Stewardship at all spatial scales.

When ecosystem benefits, e.g. water, biodiversity, carbon sequestration and storage, and biological diversity become degraded, in most situations this means ecological limits have been transgressed. Thus, healthy ecosystem benefits are a good indicator that ecological limits are being respected.

An important ecological understanding that underpins NDS is that when ecosystems lose composition and structure from human modifications, they lose or significantly decline in their ability to function in natural ways. *Lose composition and/or structure: Lose function* is an important ecological relationship to respect.

Hence, whether or not managers are aware of the purpose(s) of particular arrangements of composition and structure, Nature-Directed approaches require that the natural range of composition and structure be maintained across spatial scales through time in order to ensure the maintenance of ecological integrity.

Hopefully, by maintaining the composition and structure that we can see, we will also maintain the composition and structure that we cannot see, particularly that found beneath the surface of the soil, and in the atmosphere. To respect ecological limits, there is a need for low risk management that sets cautious ecological limits in Nature-Directed Stewardship.

Multiple Spatial Scales and "Nested" Networks of Ecological Reserves

One of the distinguishing characteristics of NDS is that plans are prepared and activities carried out at multiple spatial scales. This characteristic of NDS is rooted in the sciences of landscape ecology and conservation biology, which explain that landscapes, both large and small, consist of interdependent, interconnected clusters of ecosystems. These clusters of ecosystems are found in repeated patterns across regions, subregions, landscapes, and watersheds.[35]

The repeating pattern of interconnected clusters of ecosystems found in ecosystems of varying sizes (i.e., large landscapes to small sites) has two implications for Nature-Directed Stewardship:

- the need for networks of ecological reserves across multiple spatial scales to maintain ecological integrity; [36] and
- the need for design of ecological reserves to start with as large an area as possible, such as subregions/territories and large landscapes. Planning then proceeds by designing

---

[35] Forman, Richard T.T., Godron, Michael. 1986. *Landscape Ecology.* New York, New York. John Wiley & Sons. 8-11

[36] Forman, Richard T.T. 1995. *Land Mosaics: The ecology of landscapes and regions*. Cambridge, U.K. Cambridge University Press. 310-319.

> ecological reserves for smaller areas and linking them to ecological reserves for progressively smaller areas, such as small landscapes, watersheds, and sites. [37]

This approach to Nature-Directed Stewardship ensures that ecological integrity is maintained across spatial and temporal scales. First, the ecological integrity of large areas, i.e. a watershed or multiple watersheds, in a planning landscape is provided for through designating large reserves. This design step is followed by the protection of the ecological integrity of the area outside of large reserves by establishing linked networks of ecological reserves that are nested within each other. [38]

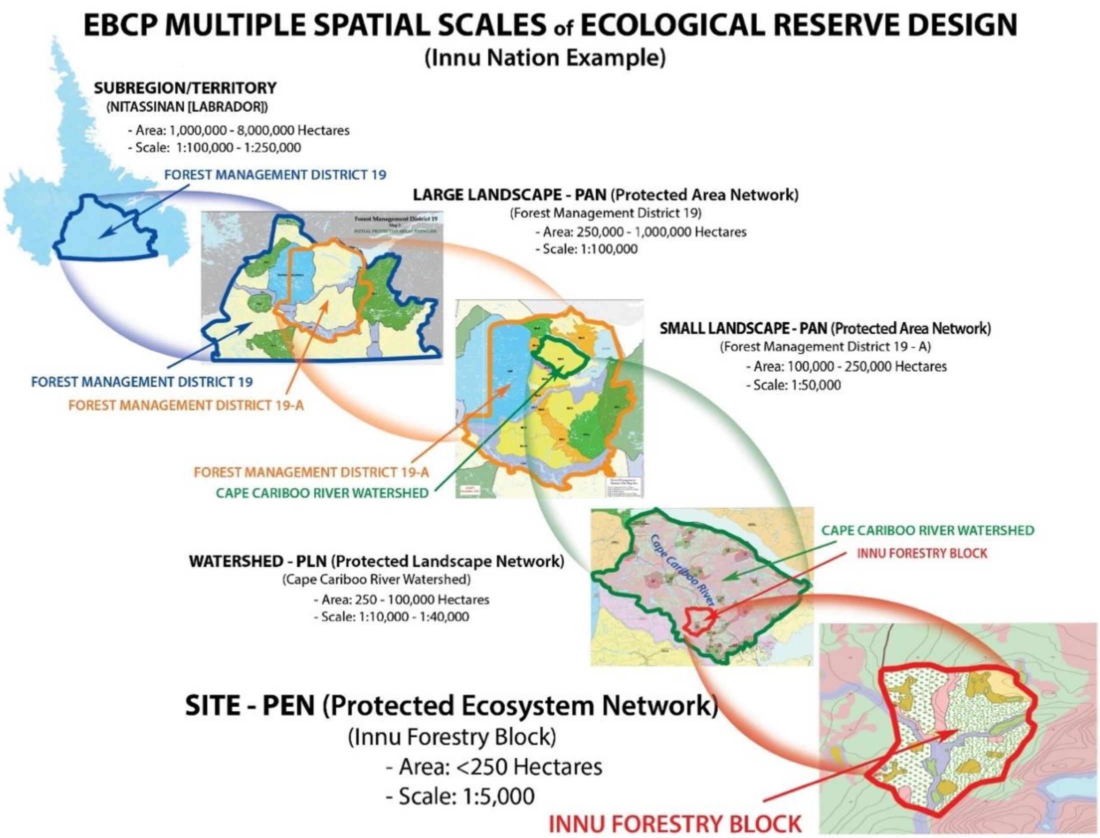
Nature-Directed Stewardship is carried out across scales, not only for ecological factors, but also for cultural, social, and economic factors. For example, NDS recognizes and supports the interconnected, interdependent nature of various portions of a watershed to Indigenous and non-indigenous culture, alike. NDS also recognizes that healthy regional economies are dependent upon the development and maintenance of healthy community economies. Like ecosystems, the interdependence and interconnections between regional economies and community economies go both directions.

The general planning scales used in Nature-Directed Stewardship are depicted in Figure 2. As shown in this diagram, networks of ecological reserves become finer and finer as planning moves from subregions and large landscapes to small landscapes, watersheds, and sites. Like "zooming in" on a telephoto zoom camera lens, increased detail and understanding of ecosystem composition, structure, and function is obtained as planning moves from large areas to small areas.

---

[37] Primack, Richard B. *A Primer of Conservation Biology*. Sunderland, Massachusetts. Sinauer Associates, Inc. 210

[38] Soule, Michael E. and Terborgh, John. *Continental Conservation: Scientific Foundations of Regional Reserve Networks*. The Wildlands Project. Washington, D.C. Island Press. 129-137.



© Herb Hammond

Figure 2: Multiple Spatial Scales of Nature-Directed Stewardship[39]

Watersheds ranging in size from approximately 100 to 100,000 ha are commonly mapped for use in defining NDS planning areas. The larger the planning area, the larger the watershed stratification that is appropriate. Small watershed units may be easily aggregated into large watershed units. Thus, stratifying a planning area by smaller watershed areas at the start of an Nature-Directed Stewardship planning exercise both ensures that unique aspects of small watersheds are captured in reserve design, and provides an efficient way to define watersheds for a variety of NDS planning scales.

When one considers that every crease on the face of Earth is a small drainage basin or watershed that connects to adjacent creases to form slightly larger watersheds and so on, one realizes that watersheds are either tiny or all of Earth.

Principles

Nature-Directed Stewardship consists of seven interdependent, interconnected principles.

[39] Silva Forest Foundation. 2018. *EBCP Multiple Spatial Scales of Ecological Reserve Design.* Slocan Park, B.C. Silva Forest Foundation.

- *Principle 1:* Focus on what to *protect*, then on what to use.
- *Principle 2:* Recognize the *hierarchal relationship* between ecosystems, cultures, and economies.
- *Principle 3:* Apply the *precautionary principle* to all plans and activities.
- *Principle 4:* Protect, maintain, and where necessary, restore *ecological connectivity* and the *full range* of composition, structure, and function of enduring features, natural plant communities, and animal habitats and ranges.
- *Principle 5:* Facilitate the protection and/or restoration of *Indigenous land use*.
- *Principle 6:* Ensure that the planning process is *inclusive* of the range of values and interests.
- *Principle 7:* Provide for *diverse, ecologically sustainable, community-based economies.*
- *Principle 8:* Practice *adaptive management*.[40]

Each of these principles is discussed in more detail below.

1. Focus on what to protect, then on what to use

The first priority of a Nature-Based approach is to maintain and/or restore natural ecosystem composition, structure, and function across all spatial scales through time. That is, Nature-Directed Stewardship protects ecological integrity.[41] Biological diversity is protected, including genetic, species, community, landscape, and regional diversity. Natural ecosystems are maintained and/or restored, ranging from small patches of trees or individual wetlands to large river basins or regions. Ecological integrity includes maintaining natural assemblages of species, and ecosystem patterns and processes across spatial and temporal scales.

After protection of ecological integrity is provided for, Nature Directed Stewardship provides for balanced, diverse human uses, which occur within ecological limits.

2. Recognize the hierarchical relationship between ecosystems, cultures, and economies.

Economies are part of human cultures and human cultures are part of ecosystems. Therefore, protecting ecosystem functioning or ecological integrity provides for healthy human cultures, and the economies that are part of these cultures.

This intuitive relationship between ecosystems, cultures, and economies, shown in Figure 3 is well grounded in both Indigenous knowledge and western science.[42] [43]

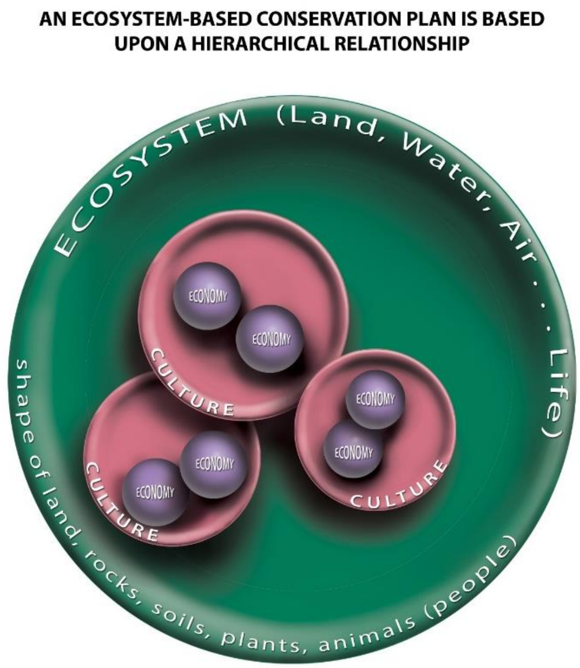
---

[40] Hammond, H. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest*. Slocan Park, B.C. Silva Forest Foundation. 23.

[41] Franklin, J.F. 1997. *Ecosystem Management:an Overview*. Chapter 2 in M.S. Boyce and A. Haney. 1997. *Ecosytem Management: Applications for Sustainable Forest and Wildlife Resources.* New Haven, Connecticut. Yale University Press.

[42] Gowdy, J., O'Hara S. 1995. *Economic Theory for Environmentalists.* Delray Beach, Florida. St. Lucie Press.

[43] Daly, H.E. 1991. *Elements of Macroeconomics.* Chapter 3 in R. Costanza (ed.) 1991. *Ecological Economics: The Science and Management of Sustainability*. New York, New York. Columbia University Press



©Herb Hammond

Figure 3: The Hierarchical Relationship that underlies Nature Directed Stewardship

In contrast to this hierarchical relationship, the "sustainable development" model portrays environmental, social, and economic factors as relatively equal. In the sustainable development model, where these factors "intersect" is where plans are considered to provide for sustainable activities. [44] I cannot think of any places where social factors are outside of the environment, or where economic factors exist outside of social factors.

From the standpoint of NDS, the sustainable development model is an *assumption of convenience* to maintain at least minimal levels of economic growth. In contrast, the NDS hierarchy constrains economic activities within the limits of ecosystems.

3. Apply the precautionary principle to all plans and activities.

The precautionary principle deals with uncertainties by specifying that decisions, interpretations, plans, and activities need to err on the side of protecting or restoring ecological integrity, as opposed to erring on the side of protecting resource exploitation.[45] In other words, if you're not sure that an activity will protect, maintain, or restore ecosystem integrity, then modify the activity so that it occurs within ecological limits, or do not do it.

Precautionary actions result from applying the precautionary principle. Precautionary actions are rooted in common sense (*e.g.* "look before you leap") and are taken where there is a lack of information or certainty about human impacts. They are cautious, conservative approaches and include leaving Nature untouched in the face of uncertainty. In order to prevent harm,

---

[44] Flint, R.W. 2013. *Practice of Sustainable Community Development: A Participatory Framework for Change.* Chapter 2: *Basics of Sustainable Development*. New York, New York. Springer Verlag. Springer Science+Business Media. 34.

[45] Keith, R.F. 1994. *The Ecosystem Approach: Implications for the North*. Yellowknife, NT. Northern Perspectives Newsletter. Canadian Arctic Resources Committee. 22(1) 3-6.

precautionary actions are taken only after cautious evaluation and decision-making that focuses on intergenerational equity. The burden of proof rests with the proponent of disturbing Nature. A full range of alternatives must be considered – again, including doing nothing. And decision-making is participatory, meaning decision-making is open to all potentially affected parties, informed by best information, democratic and inclusive of all potentially affected parties. Similar to the hierarchal relationship between ecosystem, cultures, and economies, applying the precautionary principle is one of the hallmarks of NDS. In order for plans to qualify as Nature Directed Stewardship, they need to be developed and implemented using precautionary assumptions and actions in all aspects of planning and activities.

4. Protect, maintain and, where necessary, restore ecological connectivity and the full range of composition, structure, and function of enduring features, natural plant communities, and animal habitats and ranges.

This principle is implemented by establishing nested networks of ecological reserves at multiple spatial scales.

Wholeness—ecological integrity—of ecosystems not only needs to be maintained across spatial scales, but also through time. This goal is achieved by incorporation of *ecological timeframes*, not human timeframes in NDS.

Ecosystems are timeless. Ecosystems are a continuum. Ecosystems do not "begin" or "end." Logical ecological timeframes include the functional roles of major components, e.g. a tree. Even in fire dominated forests, like the boreal, the functional lifetime of a tree, consisting of living tree, standing dead tree (snag), and decayed fallen tree may easily occupy 300 years or more. In a temperate rain forest this ecological timeframe may reach 2000 years.

5. Facilitate the protection and/or restoration of Indigenous land use

Nature-Directed Stewardship encourages Indigenous people to map and describe their land uses and/or cultural activities. Under the guidance and control of Indigenous people, this information may be combined with ecological reserve design (see Principle 4) to ensure the protection and/or restoration of Indigenous land use through the establishment of *protected networks of cultural areas*, or used in other ways specified by the Indigenous Nations(s) in the plan area. [46]

6. Ensure that the planning process is inclusive of the range of values and interests that fall within the definition of NDS.

Nature-Directed Stewardship provides for full discussion and debate of issues, based upon the best available information, by participants who represent the spectrum of values and interests that may be affected by the plan. Those representing various interests assume responsibility and accountability for accurately representing their interest, consulting with their constituencies, and assuming responsibility for the outcomes of Nature-Directed Stewardship. Shared decision-making by all participants characterizes a Nature-Directed Stewardship process, and provides an egalitarian approach to planning.

---

[46] Silva Forest Foundation. 2009. *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest.* Slocan Park, B.C. Silva Forest Foundation. 29

An inclusive, community-based approach to planning ensures that people affected by the plan are active, full participants in the development and implementation of the plan.[47] [48] The primary purposes of a Nature-Directed Stewardship are to ensure the maintenance or restoration of ecological integrity and provide for healthy communities within the plan area. These goals can only be achieved when affected communities develop and take ownership of a plan. Because Nature-Directed Stewardship, including the development of steady state, community economies, is often a shift from the status quo, public explanation, discussion, and community acceptance of the definition and principles of Nature-Directed Stewardship are essential for the success of NDS.

7. Provide for diverse, ecologically sustainable, community-based economies.

To be sustainable and provide for social equity, economies need to function within *ecological limits*, facilitate a diverse range of activities that focus on fulfilling individual and community needs, and protect and maintain ecological integrity.[49] Healthy communities both depend upon and maintain healthy and diverse ecosystems.

A healthy global economy results from development of healthy regional economies maintained by healthy local or community-based economies. Hence, Nature Directed Stewardship for local landscapes constitutes the foundation for healthy global economies by maintaining ecological integrity and providing for human well-being at local and regional scales. However, the reverse is not true. In other words, healthy global economies cannot be developed from the top down, because such plans are built upon centralized power structures that give first priority to maintaining the interests of power centers, as opposed to giving first priority to maintaining ecological integrity and developing healthy communities. [50]

The "healthy" economies referred to above recognize that economic growth is an anathema to the health of the biosphere and all who inhabit it. Thus, economies that arise from Nature-Directed Stewardship may be seen as both *steady state* economies [51] and as *regenerative* or *distributive* economies.[52] In both cases, healthy economies respect the hierarchy explained in NDS Principle 2: economies are part of societies or cultures, which are part of, and dependent upon ecosystems. Therefore, maintaining the natural integrity of ecosystems provides for the health and well-being of human societies and the economies that are a part of these societies. People are attracted to, and desire to live in beautiful, healthy environments. Economies thrive in healthy ecosystems, and through the protection of ecosystems by human communities. [53] [54]

---

[47] Owen, S. 1995. *The Provincial Land Use Strategy—Vol 3.* Victoria, B.C. Commission on Resources and Environment

[48] Maquire, L.A. 1999. *Social Perspectives. Chapter 19* in Maintaining Biodiversity in Forest Ecosystems, M.L. Hunter (ed.). Cambridge, UK. Cambridge University Press.

[49] Jackson, T. 2009. *Prosperity Without Growth: Economics for a Finite Planet*. London, UK. Earthscan. 173-77.

[50] McKibben, B. 2007. *Deep Economy: The Wealth of Communities and the Durable Future*. New York, New York. Times Books. Henry Holt and Company, LLC. 232 pp

[51] Czech, B. 2013. *Supply Shock: Economic Growth at the Crossroads and the Steady State Solution*. Gabriola Island, B.C. New Society Publishers. 119-20.

[52] Raworth, K. 2017. *Doughnut Economics: 7 Ways to Think Like a 21st Century Economist*. White River Junction, Vermont. Chelsea Green Publishing. 37-41.

[53] Power, T.M. 1988. *The Economic Pursuit of Quality*. Armonk, New York. M.E. Sharpe, Inc. 219 pp

[54] Power, T.M. 1995. *Economic Well-Being and Environmental Protection in the Pacific Northwest—A Consensus Report by Pacific Northwest Economists*. Missoula, Montana. Economics Department. University of Montana. 18 pp.

Once resources are depleted and all that remains is a degraded environment, the economy collapses and people leave.

8. Practice adaptive management.

Within the constraints of the precautionary principle and ecologically responsible actions, a variety of activities may be included as part of Nature-Directed Stewardship. However, all activities are continuously evaluated for their success in maintaining or restoring natural ecological integrity, including biological diversity, and in providing for healthy communities, both human and non-human. The results of evaluations are incorporated into future modifications of NDS—adaptive management.[55]

Adaptive management is a systematic approach to improving management, including restoration, and accommodating change by learning from the outcomes of human activities. It involves gathering and incorporating new information. It is more than trial and error, or learning by our mistakes, because it involves careful design, monitoring, evaluation, and feedback in order to improve management.[56] Adaptive management can be practiced in a variety of ways, on a continuum from passive to active approaches, which differ in their intensity, commitment, and cost.[57]

Active adaptive management includes deliberate, carefully designed management experiments that have scientific rigor, including replicated treatments, rigorous data collection, and sound statistical analysis. Because active adaptive management is expensive and time consuming, this approach tends to be reserved for major questions that are not well-addressed through passive adaptive management.[58]

Passive adaptive management involves careful monitoring of the effects and outcome of activities, and a subsequent comparison of these effects and outcomes to pre-activity predictions and conditions. Passive adaptive management, when well designed, is a practical, affordable way to learn from the results of management practices, including restoration activities. Examples of monitoring activities under passive adaptive management include photo points that are monitored through time, accompanied by careful measurements of the characteristics and condition of the ecosystems in question each time photo points are re-photographed.[59]

The practice of adaptive management, both active and passive, is fundamental to Nature-Directed Stewardship activities. Adaptive management provides for learning "what works and what doesn't," thereby encouraging design and implementation of a variety of approaches and techniques. Using a diversity of approaches and techniques that fit within the principles of NDS is necessary to protect and restore the *natural biological diversity* on which healthy ecosystem functioning depends. Thus, without the continual use of effective adaptive management, from planning through operations to monitoring, a plan and subsequent activities do not qualify as being Nature-Directed Stewardship.

---

[55] Noss, R.F. and Cooperrider, A.Y. 1994. *Saving Nature's Legacy: Protecting and Restoring Biodiversity.* Washington, DC. Island Press. 299-302.

[56] Gray, A.N. 2000. *Adaptive ecosystem management in the Pacific Northwest: a case study from coastal Oregon.* Wolfville, Nova Scotia. Conservation Ecology 4(2). 6. http://www.consecol.org/vol4/iss2/art6

[57] Williams, B.K. 2011. *Passive and active adaptive management: Approaches and an example.* Journal of Environmental Management, V.92, Issue 5. 1371-1378.

[58] Boesch, D.F. et al. 2004. *Adaptive Management for Water Resources Project Planning*. Washington DC. National Academies Press. 18-30.

[59] *Ibid*

Where landscapes, watersheds, and sites have high degrees of degradation from resource development activities, adaptive management is even more vital than in areas with undisturbed or only partially disturbed natural ecological integrity. Applying Nature-Directed Stewardship in degraded areas will be dominated by ecological restoration, which often brings with it many new situations, and/or infrequently encountered situations. Such circumstances mean that restoration treatments are breaking new ground, and evaluation of results is vital to successful restoration efforts.

Restoration goals will seldom be achieved with one or two treatments applied in a short time interval. Instead, ongoing restoration will be necessary to reach goals, often over extended periods of time. As the condition of watersheds and sites being restored changes, or does not change, with restoration activities, adaptive management to guide future activities becomes critical to the success of applying NDS.

Applying Nature-Directed Stewardship

NDS is most easily applied in relatively unfettered landscapes to maintain natural ecological integrity and biological diversity, while accommodating dynamic, often unpredictable natural processes of change that maintain diversity in a self-sustaining balancing act. Balance is the gift of diversity. However, without unpredictable change, diversity is not maintained. Without diversity, healthy ecosystems, from landscapes to small patches, do not exist.[60]

Ongoing and accelerating climate disruption challenges the integrity of all ecosystems and the validity of human planning processes that aim to provide human needs within ecological limits. As discussed in this report, identification of climate change refugia through NDS is a logical extension of the information and interpretation assembled in a plan for NDS. Maintenance of ecological integrity and biodiversity enable NDS to provide "stepping stones" to new socio-ecological regimes being forged by climate change.

[60] Hammond, Herb. 1992. *Seeing the Forest Among the Trees: The Case for Wholistic Forest Use*, Vancouver, BC, Polestar Press. 17.