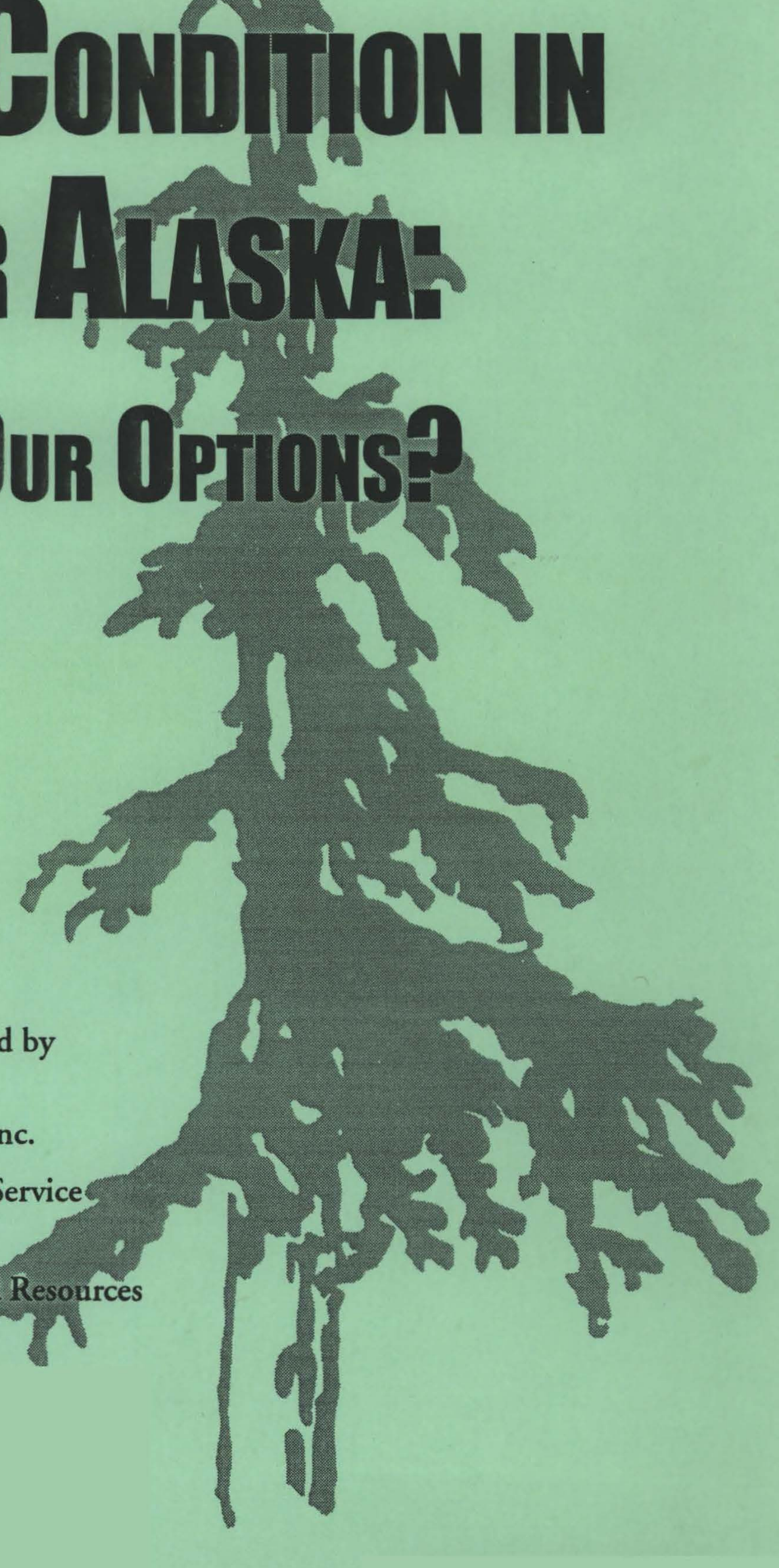
Conference on "Managing for Forest Condition in Interior Alaska : What are Our Options?"

MANAGING FOR FOREST CONDITION IN INTERIOR ALASKA: WHAT ARE OUR OPTIONS?



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INTRODUCTION

Bob Wheeler

I am Bob Wheeler, forestry specialist for the Alaska Cooperative Extension. I welcome you to our conference on "Managing for Forest Condition in Interior Alaska: What are Our Options?"

I must express my satisfaction in bringing together such an impressive collection of specialists. I am also pleased with the design for the conference which provides opportunities for extended discussion on issues. We will be recording the conference and Cooperative Extension will be preparing a summary of presentations and discussions.

Concerns and Desired Outcomes

A recent position paper on Global Change and Forest Health issued by the USFS suggests that in global warming (either short or long term) the higher latitudes are the most susceptible to warming effects, which includes the boreal forests of Alaska. They predict that warming trends would lead to more frequent outbreaks and extended regions of impact for both insects and pathogens and likely regional increases in frequency and intensity of wildfires.

As a result of extending forest mortality and controversy surrounding salvaging forests for forest products, the State of Oregon made the following statement: "There is a great tendency to fix past mistakes. However, unless more effort is devoted to looking forward toward prevention rather than backward toward correction, we will continually be trying to catch up."

There is little question that the Interior forests of Alaska are facing a period of change. Being proactive and planning for these changes and their effects are why we are gathered here. Developing an effective course of action that will further address the regional forest condition and needed to develop that course of action is a desired outcome of this conference.

During the development of the design of this conference it was envisioned that we actually would be staging two conferences in close proximity that would deal with aspects of natural resource management. The first conference would deal with biological assessment of issues regarding forest health in the Interior, and the second conference would deal with social aspects of resource management, developing community involvement and dialog on resource issues. I have been working with Kathyrine Baril from Washington State and others to assist with the Social Aspects Conference, which we are envisioning to occur sometime in May.

I appreciate your attendance here today and especially want to encourage your participation in each session discussion.

Message from the Organizers

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Forest condition, sometimes referred to as forest health, is a complex topic that means different things to different people. A definition of forest condition may focus on the structural mosaic of trees or stands across the landscape and physical descriptions of growth and vigor (tree density, height, and diameter). Alternatively, it could focus on how environmental factors (climate, soil, topography), natural disturbance events (fire, insects, pathogens), and human activities (logging, prescribed fire, clearing land for development) interact to influence forest processes such as succession and nutrient cycling. An inclusive discussion of forest condition should include both these perspectives.

If forest condition can be defined, then it seems reasonable that forests can be managed to achieve a specific condition or to meet a specific objective. That objective might be to maximize production of wood fiber on a given site for the next decade. Or it might be to maintain the diversity of endemic species, natural processes, and inherent structures of the forest (including areas "untouched by humans") for the next 10 generation of people. In the real world, society often asks forest scientists and managers to do both.

In the last 15 years, the boreal forest of southcentral Alaska has undergone dramatic change, potentially caused by a combination of natural and human-caused events. Widespread mortality from insect infestations, most notably bark beetles killing white spruce on the Kenai Peninsula and Copper River Valley, has prompted concern over fire danger and lost timber values by residents and heated discussions of how society should respond. Some Interior residents, including forest scientists, are concerned that similar changes may occur north of the Alaska Range.

Ongoing research in interior Alaska is suggesting that warmer and drier summers over the last three decades is stressing white spruce, setting the potential for widespread infestation by spruce bark beetle, spruce budworm, or perhaps other insects. The extent to which endemic pathogens, past fire suppression, and current harvest practices for timber would exacerbate or mitigate such an infestation are unknown. The long-term effects of current forest health on supply and value of timber (particularly white spruce), the forest products industry, and non-timber values in the boreal forest of interior Alaska are equally obscure.

This workshop was organized to address some of these concerns. It developed from ideas discussed among a small group of Interior residents beginning in January 1998. Dr. Janice Dawe (Executive Director, Alaska Boreal Forest Council) and Dr. Edmond Packee (Associate Professor, Forest Sciences Department, University of Alaska-Fairbanks) encouraged us to follow through with these ideas. We attempted, in short time and with minimal finances, to bring together scientists and managers knowledgeable on aspects of forest condition in interior Alaska. As the organizers, we accept responsibility for any oversights or omissions of topics in sessions or panels, but we feel confident that the diverse group will cover the important topics when all is said and done. We sincerely hope our efforts to better understand the complex issues that influence forest condition in interior Alaska will be of use to forest scientists, land managers, and the public.

This workshop was conceived partly to address concerns about how to manage the mosaic of forest stands across the Interior. The planning approach sometimes referred to as "landscape level analysis" seeks to provide for the diverse needs of society over time (commodities, recreation, forestry jobs, wildlife habitat, tourism) from the mosaic of stands while addressing problems in meeting some of those needs (mortality from insects, disease, and wildfire). The Interior has large blocks of public and private land ownership, so it is essential that the public be involved in the planning process to help define the objectives of forest resource management. Clearly-defined objectives allow resource managers and applied researchers to focus on the procedures to meet the needs of society from a diverse mosaic of stands. Defining a desired forest condition for the region can serve to focus these planning efforts.

This workshop will focus on understanding (1) what is known about indicators of forest health for the boreal region of Alaska, (2) what might be the most productive strategies for achieving specific objectives on forest condition, and (3) how researchers might secure funding to study these applied questions.

The goal of the workshop is some agreement on how to coordinate applied research between land managers and research organizations, with particular emphasis on understanding how human activities influence forest condition. If ecosystem management is adopted as the philosophy for the Interior, new emphasis would be added to coordinate management among ecological region having different forest structures and characteristics. A prime example of coordinating tasks is to lay out timber sales that are designed to achieve a forest condition that provides jobs and commodities while also allowing tests of scientific hypotheses on goals for forest health (including maintenance of biological diversity) within each ecological region. This type of ongoing adaptive management (design timber sales as experiments, researchers monitor stands before and after harvest, revise hypotheses, repeat) is long-term in nature but maximizes efficiency of funding expended by both agencies and researchers and continues providing commodities to society.

We sent to the speakers and invited attendees a list of five questions for discussion and resolution at the workshop, and here we add a sixth. However, we humbly acknowledge that there may be other important issues brought to light by the much larger group of people who will attend the workshop. Thus, this list serves as a starting point and may grow or decrease by group consensus.

1. Can we modify an exiting hazard rating system from a lower latitude to use in the boreal forest of Interior Alaska as a index to biotic and abiotic stresses on trees?
2. Can we define important criteria of designs and protocols to monitor forest condition in the Interior?
3. Can we define impediments to and strategies for securing research funds to conduct long-term monitoring and prevention-oriented studies (as opposed to short-term or crisis-response studies)?
4. Is there a role for tree growth models to improve forest management and forest condition in the Interior?
5. What is the best strategy for developing a working group on "Managing for Forest Condition" to carry forth ideas from the workshop and facilitate communication?
6. What information on processes influencing forest condition (e.g., insects, disease, fire) does the forestry profession believe is important for public education on risk assessment and planning?

CONCEPTS OF HEALTH FOR THE BOREAL FOREST

Skeeter Werner, U.S. Forest Service (retired)

Forest health has become the main issue in ecosystem management throughout the United States and Canada in recent years and needs to be of primary consideration in the management of boreal forests in Alaska.

What is meant by forest health? Most definitions imply that good forest health is a condition of the forest ecosystem which sustains diversity while still providing for human needs. Aldo Leopold described deteriorating forest health as widespread symptoms of land "sickness~ He advocated the practice of land health in order to maintain the sustainability of ecological conditions and processes by conserving the ecological integrity or diversity of the land. The Forest Service defines a healthy forest or ecosystem as one where biotic and abiotic influences do not threaten management objectives now or in the future. A healthy forest can also be viewed as one that is resilient to changes; however, the resilience of a forest cannot be quantified until that forest has undergone stress or disturbance from abiotic and biotic factors. Forest health has become such a biological and managerial complex that it is difficult to recognize and even try to resolve the benefits and adversities of a healthy vs an unhealthy forest. Systems that attempt to explain the relative health of a forest or forest ecosystem generally provide useful information for discussion of forest conditions relative to human needs and desires but often lack information on the needs of other organisms that inhabit the forest.

Boreal forests are under stress in much of southcentral and interior Alaska because of changes in forest conditions or pest problems. These stress factors such as warming temperatures, reduced precipitation, over mature forests, and the lack of management practices have caused a reduction in tree growth and increased tree mortality. Severe insect infestations, high incidence of root and stem decays, and high fuel loads with a related extreme fire hazard, have combined to cause a general condition of poor health in forests of Alaska. In addition to tree mortality, these conditions are disrupting long-term management plans and causing severe losses to a variety of other forest resources. Wildlife and fish habitat, water and air quality, biological diversity, and long-term site productivity are all affected by the deteriorating forest health conditions.

Forest insect outbreaks have increased in both frequency and severity in Alaska's boreal forests and western Canada during the last 20 years.

Throughout Alaska, hundreds of thousands of acres of forests have simultaneously become mature, stressed and more vulnerable to infestation by pests. Forest decline, fire, storms, frost, and drought also cause damage to boreal forests but the extent of the damage is difficult to quantify. All these factors are significant contributors to the unhealthy condition and depletion of boreal forests.

In southcentral Alaska, the spruce beetle has flourished uncontrollable for 15 years. Three million acres of forest land have been infested which have resulted in vast amounts of tree mortality and damage to wildlife habitat. This event is probably the worst forest insect outbreak ever recorded in north America. In interior Alaska, the first reported outbreak of spruce budworm infested over 200,000 acres of white spruce forests from 1990 to 1997. Severe defoliation in many areas, especially the Standard Creek area west of Fairbanks, has predisposed white spruce to attack by Ips engraver beetles. Populations of Ips beetles reached high levels in 1994 and 1996 which were comparable to the high population levels following the Rosie Creek fire in 1983 and subsequent ice damage to stands during the winter of 1984. Budworm defoliation was evident on seedlings to mature white spruce. Many seedlings never recovered.

In 1995, a high population of spruce coneworm was observed in the Tanana Valley. Coneworms were found feeding along side spruce budworm within the same bud. The spruce budworm population eventually declined because of competition with the coneworm and reduced nutrient quality from 6 years of continuous defoliation.

An infestation of the larch sawfly was first recorded in the Tanana Valley in 1993 and this infestation continued throughout 1997 with over 600,000 acres of tamarack being defoliated. This continuous defoliation has stressed tamarack to the point where they have become susceptible to attack by the eastern larch beetle, a close relative of the spruce beetle. Throughout the last 30 years, high populations of large aspen tortrix and spear-marked black moth have defoliated millions of acres of hardwood stands in interior and southcentral Alaska. The fluctuations in population levels of these hardwood defoliators appear to be on 10 to 12 year cycles. We do not know if the same applies to the defoliators of spruce and tamarack as the outbreaks were the first ever recorded in interior Alaska.

The short and long-term effects of these pest activities disrupt any forest management plans that are in place. They also disrupt local economies and cause residual damage to recreational sites, wildlife habitats, site productivity, and other natural resources. Both fire and the spruce beetle have probably combined as the disturbance factors responsible for the spruce forests in southcentral Alaska. The size and scale of the current spruce beetle infestation now suggests significant potential for major landscape-level changes such as changes in vegetation composition and plant diversity. A widespread wildfire in spruce beetle-damaged stands could severely increase the changes to ecosystem integrity and diversity.

Maintaining healthy forests requires a long-term commitment. Achieving a desired level of productivity, whether productivity is timber, recreation, wildlife, value-added products, or some mix of these resources, generally requires that forest vegetation be alive and healthy. Unfortunately, the spruce ecosystem throughout southcentral and interior Alaska are not healthy ecosystems. On the Chugach National Forest, the mortality rate, i.e., mortality volume/growing stock volume, exceeds the gross growth rate. Fully 65% of this mortality was caused by the spruce beetle.

There is no doubt that impacts are occurring to the spruce ecosystem on a massive scale. How can there not be when the spruce overstory in many places is being removed annually to some degree on hundreds of thousands of acres. Some may argue that there are positive aspects associated with these insect outbreaks, but most would agree there are also negative impacts. However, impacts can affect a resource positively or negatively depending on the management objectives. For example, some wildlife species such as red squirrels, pine martens, and northern three-toed woodpeckers depend on mature spruce forests and may be adversely affected when the mature spruce are killed by bark beetles or fire. In comparison, loss of timber resources and timber resource potential is of major concern to the Alaska Department of Natural Resources and can, to some degree, affect the Alaskan economy.

Forest health can be addressed through short-term tactical approaches and long-term strategies. The two methods should be integral with short-term actions conducted with long-term objectives. Solving the forest health problems in Alaska, will require an ecosystem management approach. Management practices must match the ecological capabilities of each site in order to create and maintain healthy forests. This is the focus of ecosystem management. The understanding of ecological capabilities is derived from the scientific study of the processes that maintained a given forest type during the past centuries. Forest commodity production and fire management activities need to accommodate these natural processes. Harvesting dead and living trees is among the treatments that, if applied carefully, could help meet goals of ecosystem management without sacrificing long-term health of the forest. However, timber harvest alone, especially salvage logging, will not address the fundamental problems of forest health. Ecosystem management must be applied in an integrated manner guided by the best science and silvicultural knowledge and the freedom to adapt this knowledge to local situations as determined by users of the forest and not by politicians.

Several basic management strategies were developed by the Forest Service and Alaska Department of Natural Resources for restoring the forest ecosystem to a healthy condition.

- Identify high-hazard landscapes rather than individual stands for remedial forest health treatment.
- Create a mosaic of stand conditions at the landscape level that represent the normal range of variation for the ecosystem involved.

- Favor early seral tree species in silvicultural prescriptions in order to develop pest resistant stands while ensuring desired ecosystem conditions.
- Thin stands to restore stocking densities and species composition to prefire control conditions.
- use prescribed fire to help maintain ecosystems that historically experienced frequent low intensity fires, thereby reducing fuels and preventing catastrophic wildfires.

The dying overstory of spruce forests has led to the invasion of competing vegetation, such as bluejoint grass, Calamagrostis sp., to become established in many areas of southcentral and interior Alaska. This perennial grass can occupy a site for more than 30 years at the expense of more desirable plant species such as birch, aspen, willow, and spruce for timber production and wildlife habitat.

Not all resource disciplines in Alaska have recognized the ecological significance of forest alterations by the spruce beetle and other forest pests. Loss of forested wildlife habitat and/or old-growth habitat has been raised as an issue in southcentral and interior Alaska. Very little information has been collected on the effects of widespread tree mortality on stream sedimentation and water quality, which in turn could affect salmonid spawning areas. Although the risk of potential wildfire is a major concern, little information is available on fuel loads or fire behavior potential. Lack of full recognition of the ecological impacts coupled with lack of a viable forest industry to provide cost effective management options has resulted in little direct action to address the problem of declining forest health. Only within the past year has a task force been formed to investigate the lack of adequate information on impacts from the spruce beetle in southcentral Alaska. About 25 years after Ed Holsten and I first approached the administrators of the Chugach National Forest about a potential spruce beetle outbreak starting on their forest.

Current research and development programs in forest health for Alaska are focused on short-term and long-term issues of forest pest management. Efforts emphasize strategies utilizing various options such as environmentally safe insecticides in "high value" stands and semiochemicals to reduce bark beetle activities Long-term strategies focus on silvicultural/management methods such as thinning and pruning to reduce susceptibility of host trees to insect pests.

Management strategies are emphasized that take into consideration a variety of resource values which are based on knowledge of interacting ecosystem processes and which seek improved forest health through enhancement of host resistance to disturbance factors. The Alaska Forest Health Initiative was developed for the western kenai Peninsula in 1995 by the Alaska Dept. of Natural Resources and is being implemented within specific spruce beetle impacted areas. Although the initiative emphasizes short-term strategies, it is a start in the right direction to educate and get public involvement in the decision-making process. The Division of Forestry in Fairbanks has invited public involvement in the development plans for the Tanana Valley. The Alaska Dept. of Fish and Game have worked with the Division of Forestry to improve wildlife habitat in the Standard Creek area and this type of cooperation is an example of ecosystem management strategies employed to meet the needs of specific user groups. In addition, various advisory boards have done the same and I emphasize that public involvement is a critical step in the planning process for any endeavor that effects public lands.

The health of boreal forest ecosystems is a complex issue that must be addressed within the context of ecosystem management and the goal of managing ecosystems for long-term productivity, and maintaining ecosystems that will sustain biodiversity and provide desired values, products, and uses. Forest health should also lead to long-term management strategies that will reduce the susceptibility of ecosystems to pest organisms but also promote the establishment of beneficial organisms that promote a healthy forest. Forest health addresses pressing environmental and resource issues that include biological diversity, landscape integrity, old-growth forest conservation, endangered and sensitive species viability, water quality, resilience to environmental stress, ecological restoration, silvicultural prescriptions, cultural resources, riparian management, wildlife habitat, resource sustainability, and social and cultural values. Natural resource managers need to develop ecosystem management plans that meet the objectives of the users including the general public and this offer includes maintaining unmanaged forests.

Questions and Answers

Q: *You mentioned that insect outbreaks in aspen can have a positive influence. Does that stress them in any way and leave them more susceptible to other insects or pathogens?*

A: It stresses them to a certain extent. Depends on the amount of defoliation. Recovers amazingly. We have found that the recycling of nutrients is good.

Bark Beetle History in Southcentral Alaska

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Historical

First, we've probably had spruce beetle outbreaks in Alaska, at one time or another, as long as we've had spruce. Earliest accounts: (1) 1920s, Copper River Basin along Copper River drainages between Chitina & McCarthy, 200,000 acre outbreak, extensive but not intensive, (2) 30's-Afognak Island and Mat-Su Valley, (3) 50's—on the Kenai Peninsula, near Anchorage, near Lake Clark; (4) 60's—Tiekel, near Copper Center, Chugach National Forest. Most of these past outbreaks, although they could have been extensive, appear to not have been as intensive as the ones we have now.

- 1960-80's: Periods of rapid expansion and equally rapid declines of spruce beetle activity throughout southcentral Alaska and areas of southeast and interior Alaska.
- Since the late 1980s there has been an exponential increase from a couple of hundred thousand acres in 1989 to more than one million acres of ongoing and new infestations mapped in 1996.
- As agents of disturbance, spruce beetles are one of the most important mortality agents of mature spruce stands in Alaska. In the last five years, more than 2 million acres of boreal forest have been impacted by spruce beetles to some degree. In southcentral Alaska, there are many pure stands of white, Lutz, and Sitka spruce that have "lost" more than 80% of the spruce component in two to three years! This almost equals what occured from 1919 to the late 1980s.

Why Southcentral Alaska?

Historically, we have had very few extensive or intensive outbreaks in southeast Alaska's maritime Sitka spruce forests. Maritime Sitka spruce forests are less susceptible to spruce beetle outbreaks due to climatic factors: (1) Lower temperatures—more 2 yr life cycle; (2) Cool, rainy springs—poor spring dispersal of attacking beetles; and (3) Sitka spruce are usually not water stressed. Thus, they are more resistant to spruce beetle attacks.

Southcentral Alaska has been, and is the "best" spot for spruce beetles due to a combination of favorable climatic conditions and available host material. In many areas of southcentral Alaska, soil temperatures are at freezing during beetle flight. Thus, beetles are attacking the tree when it is in moisture stress. Also, spring and summer temperatures are more favorable in southcentral Alaska for spruce beetle development. There is some indication that mean annual temperatures have been increasing in southcentral Alaska for at least 60 years. A correlation of this warming trend is the observation that more spruce beetle populations are undergoing a one-year life cycle vs. the more common two-year life cycle. That is, in many areas of southcentral Alaska, spruce beetle populations have been doubling each year. Likewise, with a warming trend, spruce beetle dispersal flight is occurring earlier, at a time when spruce trees are moisture stressed. Thus, we have seen more beetles attacking spruce when they are physiologically their weakest.

Although we have had spruce beetle outbreaks in interior Alaska, (along the Kuskokwim & Yukon Rivers), this area has not shown the aggressive spruce beetle outbreaks that we are experiencing in southcentral Alaska. In our interior spruce forests, we see spruce beetle populations being displaced by another beetle, Ips perturbatus, whose outbreak populations usually subside after three years. I do not feel that spruce beetle outbreaks will become as common in interior Alaska's white spruce forests as they are in southcentral. As spruce becomes more stressed due to increased warming and insect populations respond favorably to the same warming trend, we may see an increase in defoliator and Ips beetle activity.

Changes Associated with Spruce Beetle Outbreaks

First, change can be viewed positively or negatively. Whether there are impacts occurring and the degree of these impacts depends on stand structure (e.g. uneven age spruce stands, mixed spruce/hardwood stands, pure spruce stands); extensiveness of stand conditions; resource values; management philosophies and objectives; including the desired future condition of the landscape. Thus, not all spruce forests in southcentral Alaska have been impacted to the same degree.

Second, very few studies have been initiated in Alaska to quantify & qualify change to forest resources associated with spruce beetle outbreaks. From the results of studies conducted elsewhere, we can expect that with 50 to 70 percent canopy removal diversity of both plants and animals may increase. With 80 to 100 percent canopy removal, however, diversity may be expected to decrease. There is some evidence from the Kenai Peninsula that this may be occurring.

- In the short-term, impacts or changes are socioeconomic in nature and may dominate public discussion; these changes are seen as either "good" or "bad."
- Long-term changes are biological and ecological—They are neither "good" or "bad". . . they just are.
- Some of the changes associated with spruce beetle outbreaks may include, but are not limited to:
    - Reduction of merchantable value of beetle killed trees
    - Long-term stand conversion: spruce to hardwood, spruce to hemlock, spruce to open-grass, maybe spruce to alder.
    - Changes to wildlife habitat: Favoring some species, displacing others.
    - Change in scenic quality: especially near developed recreation areas
    - Increased large woody debris and grass cover thereby increasing hazard and risk of high intensity wildfires.
    - Changes in watershed hydrology and associated impacts to freshwater fish habitat (e.g.-removal of overstory, production of large woody debris, stream blockage, changes in peak flows, etc.)

This is a simple scale of diversity from low to high and disturbance intensity. If you have a pure spruce stand with very little mortality, overall diversity is low. As the amount of disturbance goes up, as in 50 to 60 percent of overstory killed by beetles, you increase the diversity. It increases the gaps for smaller plants and increases wildlife habitat. The intensity of the disturbance on some places of the Kenai Peninsula is quite high, where 90 percent of the overstory is being removed. In this case, diversity is going to drop off.

Concluding Remarks

Spruce beetle outbreaks are expected to continue in southcentral Alaska, but at a diminishing rate as host material is depleted. Spruce beetle outbreaks are not expected to increase significantly in interior Alaska, although I have been fooled many times before. However, I do expect to see an increase in defoliator and ips beetle activity.

With respect to boreal forest ecosystems, bark beetle outbreaks, and ecosystem change:

- The only constant in ecosystems seems to be change
- Both long-term and short-term changes need to be understood and are not easily distinguished from one another. Socioeconomic impacts cannot be fully assessed until the ecological impacts are understood. And long-term biological and ecological impacts may have socioeconomic consequences related to sustainability of forest resources.

Based on the intermediate disturbance theory and its effects on diversity, and disregarding short-term socioeconomic impacts . . . A healthy forest ecosystem may be one that is half-dead!

Questions and Answers

Q: *What would be the effect of a single year of favorable weather for beetle flight in the Interior?*

A: Up in the Interior, spruce beetles have a one-year life cycle. Skeeter's worked more than I have in the Interior. You have to have some condition to predispose these stands to attack. Along the Yukon River we had the combination of enormous flooding of the Innoko River, there was blow-down and there was beetle build up in the blow-down. Conditions are usually favorable for beetle flight. It's rare that you don't have favorable weather but it's warm and dry enough that they get out-competed inside the tree by other insects. Populations are rarely able to build up to large enough levels to cause massive outbreaks. Down in Southcentral they don't have the competition.

Q: *I'm still confused as to what you guys think the net effect of possibly warmer climate would be here?*

A: I think it will lead to other beetle outbreaks, not spruce beetle. Other researchers forecast and I agree that we'll see a lot more defoliator activity. For example, budworm and engraver beetles, and there's a close tie between budworm and spruce beetle outbreaks and increased frequency of fire following those outbreaks.

Q: *We need to get away from impact of beetle and get to long-term changes in forest.*

A: What we're dealing with now is not the beetle issue, it's past that. Now dealing with the changes.

Q: *Do you have reason to believe that ips beetle in the Interior has anything like the potential for landscape level outbreaks and mortality like the spruce bark beetle?*

A: I think it does have the potential. In the past we've had some very extensive outbreaks, covering thousands of miles. That species of ips is a tree-killer like spruce beetles.

Q: *How many eggs can an individual spruce bark beetle produce?*

A: Somewhere around 60 to 80. But when you get in a square foot or so up to 30 pairs of beetles and you start multiplying that around the circumference of the tree up to a six-inch top, a tremendous amount of beetles can come out of one tree—thousands and thousands.

Potential Effects of Fire Suppression

Joan Foote

Fire is an integral part of the natural ecosystems in interior Alaska. Fire is the primary agent that recycles nutrients and landscape diversity here in the Interior.

In the absence of fire, the vegetation of an area will move toward the later stages of succession and growth will stagnate. That means

1. The current vegetation will age,
2. black spruce, sphagnum and feathermosses will become more common on the landscape, and
3. young, vigorously growing aspen, birch, white spruce and willow will become less common.

Soils will cool, thus slowing rates of decomposition or nutrient recycling. This will cause growth and site productivity to decrease. Peat and duff will accumulate. Permafrost will develop on the black spruce sites or if already present the top of the permafrost layer will move closer to the surface of the ground.

The potential for large and/or severe fires will increase, at least for awhile. Natural fire breaks will be few and related to topography and/or the presence of rivers and streams. Site flammability will be high, limited only by moisture content.

Animals that prefer the later stages of succession will dominate Animals that need the younger stages of succession will become few and/or disappear.

Why is this so? First, a few words about fire.

Fire is a continuous series of oxidation events. It requires three things: fuel, oxygen and a source of ignition.

- Fuels can be any organic material (trees, shrubs, moss, sticks, logs, houses, duff, trash), living or dead, it doesn't matter. Fuels that are small in diameter, well aerated, dry, (under 15% moisture), warm, and have a rough surface are the easiest to ignite.
- The oxygen usually comes from the air around us.
- Common sources of ignition are lightning, matches, and an existing flame.

The products of fire are energy, smoke, and sometimes ash and charred matter.

Fire can take one of two forms:

- A moving flame front or
- A stationary glowing smoldering state

A single flame and/or glowing ember (the smallest unit of fire) will do the following:

- consume organic material, especially when it is aerated, pre-dried and warmed
- kill the living tissue it touches
- produce heat (energy) and smoke
- dies when either fuel or oxygen are gone. Fuel is usually exhausted first. OR
- Move to a new patch of fuel that is within flame length of the just consumed fuel.

Let's move on to a site on the landscape that is flammable. What can fire do on this landscape?

The immediate effects of fire on this landscape can be any, or all, of the following:

- It can consume the down, dead woody fuels, especially those under three inches in diameter. Small fuels are mostly consumed (removed).
- It can consume standing fuels, especially if dry and contiguous.
- It kills (and sometimes consumes) the living tissue it touches. If enough tissue on a plant is killed, the plant dies as well. If this material is not consumed by the flame, it becomes potential "new" fuel, that is, fuel for the next fire.
- It heats living tissue it does not touch. Sometimes this tissue (plant) dies. Other times this tissue (plants) is stressed.

- It heats dead material. You cannot make dead more dead, however, the heating of this material makes it more flammable.
- It consumes some (or all) of the duff and organic soil layers (consumed). This may expose patches of mineral soil.
- Sometimes the generated heat is sufficient to melt the silica in the mineral soil, placing a glaze on the soil surface.
- It produces ash. With ash production, nutrients are recycled to a more usable form. However, some nutrients are lost through volatilization.
- Fire frequently leaves a blackened surface.
- The list goes on.

Each fire is different. The size and severity of the fire will vary with

- The temperate and resident duration of the flame front (glowing ember), and
- The amount of energy behind the moving flame front.

It is also influenced by

- The quantity, distribution, and dryness of the fuels on the site, and
- humidity and wind.

The greater the moisture content of the fuels, the more energy it takes to pre-dry the fuel that is to make them ignitable. The moisture can come from rain, dew, surface and soil waters, or from the moisture content of living tissue.

These are, you might say, the tools of fire. OK, so what? Let's change our perspective.

A site remains vegetated only as long as

1. The living plants growing on the site obtain enough nutrients to sustain growth and
2. Replacement plants arrive faster than plants on the site die.

Growth requires nutrients.

Replacement plants come form either seed or vegetative shoots.

Death can be from old age, disease, browsing, fire, wind throw, avalanches. Plants can also be harvested by man. Likewise, a site remains vegetated only as long as it remains stable.

Fire can influence each of these processes in numerous ways.

Growth

- The usable nutrients in the newly created ash promotes growth in those plants that are best positioned to use it immediate following the fire.
- The fire-blackened surface within the burn absorbs radiation which warms the soil. This stimulates activity—chemical reactions, decomposition, etc.—thus growth.
- Fire kills some growing points, stimulates others. Some plants are removed, others expand rapidly.
- The stressed (heat damaged) plants tend to produce quantities of seed as soon as possible the next growing season.

Replacement Plants:

- patches of exposed mineral soil make excellent seed beds for the arriving seed.
- Patches of heat-sealed soil make poor seed bed; water runs off and new roots cannot penetrate the surface.
- Seed available for dispersal soonest after the fire has the best chance to dominate these surfaces. Live seed which is already on the site (survived the fire) or is easily carried by wind has the most chance of arriving first. Species like black spruce usually survive the fire in the tree crowns. Willow and fireweed seed is readily carried by wind.
- The seal on black spruce cones is broken by heat so seed starts falling onto the surface immediately following the fire.

- The date of the fire influences which species will invade the burned are soonest. Species which disperse seed in June tend to dominate early season burns. Seed which disperse later in the summer tend to dominate late season burns.
- Seed, especially heavy seed, may have a difficult time reaching the center of large burns.
- With the removal of the upper duff and/or organic soil layers, the previously buried roots and stems become closer to the surface. This places them in position to be stimulated to produce new shoots. (Stimulation can be by light penetration and/or hormone activity.) The depth of burn is important. If the fire killed all the roots and stems, then none are available to respond. If the depth of burn stopped just short of a dense layer of buried roots and stems, then the density of new shoots can be high. Buried stems and roots of some species do not have the potential to produce shoots when stimulated. Where this is the case, the depth of burn makes no difference.

Death

- When fire kills or removes a plant form the site it is effectively gone. If it is diseased, then that is gone as well. If it is an unwanted species then that is also gone. If it is a wanted plant species, well, it is still gone.
- Stressed (heat damaged) plants are susceptible to insect and disease activity.
- Young, even-aged sites are less effected by wind throw and avalanche. Fire, by encouraging young stands, removes the impact of these agents.

Site Stability

- When mineral soil is exposed, the possibility of erosion increases. This seems to occur most frequently on the fire lines that were created in the attempt to control the fire.
- When fire removes the covering of vegetation and especially the moss layer on a site, it removes the insulating layer that keeps the soil cold, at least on permafrost sites. When this happens, the permafrost layer then begins to melt. Sometimes this can lead to subsidence and surface breaks that are sufficient to make the site too unstable and/or wet. The new germinating vegetation is uprooted and/or the site is destroyed.

Ecosystem

A site is more than just the plants growing on it. It also includes all other organisms, animals, birds, insects, microorganisms that use the site. Fire impacts these species indirectly through the plants that meet their food or habitat needs.

- By promoting young stands it provides excellent browse material for hare and moose.
- Large burns may impede or divert the movement of migrating animals, i.e. herds of caribou.

Fire moves across the landscape, usually in an irregular pattern. Wind direction, fuel distribution, topography, and fire type all influence the direction and movement of the flame front and thus the final shape, size, and severity of the resultant burn.

There is no such thing as a standard fire. Even though the processes at work are the same, the way they interact varies from fire to fire and burn to burn. This helps create diversity on the landscape.

Questions and Answers

Q: How many years do we have before the material becomes wet enough and decomposes enough that the fire danger is reduced?

A: Depends on the climate. We don't have any good decomposition studies.

Packee's answer: At least 15 years.

Climate Change and its Ecological Effects in Interior Alaska

Glenn Patrick Juday

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At least three sources indicate that the climate of interior Alaska in the late 20th century has changed substantially compared to previous decades and centuries: (1) observational data from National Weather Service, (2) tree-ring data, and (3) soil temperature measurements. These records indicate that Alaska experienced an abrupt and powerful shift toward warmer conditions in the late 1970s, particularly in the Interior, and that precipitation at low elevations in the Interior has generally decreased in the summer and increased in the winter. Tree-ring samples from a variety of productive lowland white spruce stands across the central Interior of Alaska establish that the trees are experiencing extreme moisture stress levels unprecedented in the 20th century and very probably for a considerably longer period.

The observed mean annual temperature of the northern interior region of Alaska in the vicinity of Fairbanks has increased 1.4° C (2.6° F) during the 20th century. Tree-ring records and observational data indicate that the climate warmed in this region from 1850 to 1940, then cooled from 1941 to 1975, and has warmed significantly since 1976. The warming from the mid-1970s to the mid-1990s averaged 1° C per decade, totaling 3° C over this period. In addition, summer precipitation has decreased at the rate of 17% per 100 years during the period of record in the Fairbanks area. Snowfall totals at Fairbanks, on the other hand, are up 60% during the 20th century; heavy snow loads appear to be a major factor in tree canopy breakage. Injured pockets of trees attract wood-boring insects that can build up in numbers and, if climate conditions are favorable, cause widespread tree death.

Several important ecological consequences of the climate shift can be identified in forests generally capable of producing forest products. The growth of low-elevation forests in the interior of Alaska is directly limited by summer warmth and moisture deficit, as indicated by an analysis of the density and carbon 13 isotope content of tree rings. Tree growth in these white spruce forests has been reduced substantially, and growth of paper birch has significantly declined as well. This is more than a local effect in the immediate Fairbanks area. In addition, during the last 40 years, total area burned by forest fires in Alaska generally correlates with interior Alaska summer temperature.

Some people think that to believe what I'm telling you, you have to subscribe to the global warming/greenhouse gas theory. You don't. All you have to do is believe the evidence that's available. It might all reverse itself and go away tomorrow. But that's a different issue. It has happened and it is having these effects.

As long as these recent climate conditions persist: (1) the risk of outbreaks of insects that attack stressed trees is high, (2) frequency, extent, and intensity of forest fires are likely to increase, (3) tree growth rates (of wood) will continue to decrease, (4) groundwater storage and summer water levels will decrease, and (5) the possibility is increased of altered forest regeneration responses to natural and management disturbances.

There are a lot of different climates in the interior boreal forests. Alaska's climate is dominated by the long-term mean of sea-level pressure in the north Pacific—the air circulation around the Aleutian Low and the California High. This drags the warm air up to the north. The distribution of the boreal forest is tilted across the continent. This basic effect has been intensified in recent months. We now have one of the earliest breakups ever underway.

Over the last 30 years, the arctic has been warming—an enormous change in temperature. The best long-term data for the Interior shows that temperature trends are up and there is an abrupt shift between 1976 and 1977.

Many different effects of warming: it could be a change in maximum daily temperature, minimum daily temperature, mean monthly temperatures, frost-free period. Warming can come packaged in a lot of different ways. I found that an average summer day was about 11 percent warmer in the most recent 24 years than in previous 24 years.

The threshold temperatures that trigger the production of white spruce cone crops: the critical period is April 1 to end of July. The mean of maximum daily temperatures in this period recently have gone up. This is the really warm days and are very stressful days for boreal-adapted species.

Mean precipitation is about the same but is coming less as summer rainfall. Of the four earliest breakup dates on the Tanana River, three of them are in the decade of the 1990s.

X-rays through tree rings show density of wood. We discovered a correlation between densest wood growth and May and August temperatures. The warmer it is earlier in the season and later in the season, the more dense the wood gets. Literature shows that when the tree becomes moisture stressed, it stops its production of the early wood cells, which are big, loose, open cells, and starts producing late-wood cells. That's the ring that you see as a tree ring. So it produces more of its total growth of the year as late wood. So, lately the wood has been getting very dense, apparently because it's coming under moisture stress. The growth of white spruce from Chena River Recreation area correlates to the drought index extremely closely.

Well-established literature shows that more carbon-13 means that the plant produced that tissue under a more moisture-stressed condition. We checked the carbon-13 content of tree rings in the Bonanza Creek forest against the drought index and found another strong correlation.

Which trees is it getting? Basically, the smallest half of the trees in the stand are not very well predicted by the drought index. The biggest trees in the stand, the wildlife trees or the timber crop trees, are almost all highly correlated with the heat and drought index.

We now know that this effect is real, it's very strong, it's verified by three independent techniques, and what part of the stand it's hitting: the biggest trees.

Almost all of these examples have been from our most productive forests, not the most highly stressed sites. If we're experiencing that kind of an increase in stress, we face the prospect of changing the ecosystem. Canadian researchers have calculated that boreal forest will turn into aspen parkland with not much of a shift. If that were to happen, we would essentially cut the boreal forest in North America in two. This could be a major geographic problem.

Another effect of this climate change could be insect outbreaks. It's consistent to say that effect of spruce budworm is unprecedented in last 150 years at least. Have the insects increased in their outbreak potential to the point where they are a new factor now for the trees to contend with? Could be.

Finally, if the mean annual precipitation is staying about the same and it's going down in the summer, then it's got to be going up in the winter. Record snowfall and longest duration of snowfall have happened recently. Heavy snowfall builds up on the crowns of these trees that are thin and spindly, and they break.

Soils are warmer too and a lot of the permafrost is very close to thawing.

Questions and Answers

Q: *From a physiological standpoint, why would the climate change affect only the larger trees?*

A: My guess is, the suppressed trees within the stand that didn't show the climate effect are already being limited by the lack of light and poor competitive position.

INFLUENCE OF FOREST PATHOGENS

Lori Trummer

Plant Pathologist
U.S. Forest Service

I'd like to discuss the relationships among forest health, long-term forest productivity, and forest diseases. Pathogens have been vastly overlooked and underrated as agents of disturbance. A basic understanding of pathogens and their patterns can assist the land manager in achieving a desired level of pathogens in their managed forests. Forest pathogens are integral components of interior Alaska forests, contributing to forest health and long-term productivity in several ways. First, forest pathogens alter ecological successional processes and plant diversity and nutrient cycling. Second, tree deformation, mortality, and canopy openings create habitat and food resources for wildlife. Third, pathogens are agents of economic loss, growth loss, and reduced tree vigor. The consequences are different, depending on forest management goals: timber production as opposed to forests that are managed for other values, uses and outputs. When losses occur in the butt log (most prevalent), this is when there is the most economic loss. Internal decay of the butt log is the most prevalent form of defect in the Interior white spruce, and at times it is the most difficult to diagnose. Reliable indicators of decay provide land managers with valuable insight regarding internal tree defects. However, not all trees with decay have visible signs or symptoms, and certainly trees with root disease in Interior Alaska fit into this category.

Ecologically, pathogens alter forest structure, composition, and successional patterns. They increase nutrient turnover and availability, improving soil fertility. They provide important habitat for cavity nesting birds. Cavity-nesting birds selectively choose trees with heart rot or stem decay. Flying squirrels use witches' brooms created by spruce broom rust fungus. They also use interior cavities of birch or aspen that were created by stem decay fungi.

Forest pathogens are agents of small-scale disturbance, requiring years, sometimes decades, to spread and intensify. Annual mortality is low and unspectacular. It is the persistence of the pathogens on a site that requires attention by land managers. All trees are susceptible to attack by fungi. Land managers should be particularly concerned with the influence of management practices on wood decay fungi and root diseases. I will focus on these two types of fungi for the remainder of my talk.

Wounds provide entrance into the tree and make it susceptible to decay. Natural wounds include fire scars, broken tops, and dead twigs and branches. Human-caused wounds result primarily from mechanical logging injuries. All wounds are susceptible to decay, but tree species, size and location of wound, season of injury determine which decay fungus gain entrance and how rapidly the decay occurs.

Silvicultural practices affect risk of injury to other trees. Systems that require repeated movements in the stand pose the highest risk to residual trees. Group selection systems present the lowest risk of injury to remaining trees. Thinning operations is typically influenced by intensity. A light thinning results in the highest risk of injury to the remaining trees. Since injuries by natural causes increase with stand age, limiting rotation lengths will also help to reduce the incidence and severity of fungi.

The most important root disease of white spruce in interior Alaska is tomatosis (sp??) root rot. The pathogen transmits from tree to tree across the roots, at the rate of less than 10 inches per year. Disease centers appear to persist at least three decades. Older trees infected may survive for years before breaking off at the butt. Adequate reestablishment is affected on infested sites. Early recognition of disease on the site is key. Avoid planting close to infected stumps. Partial cutting should not be done for stands with root disease. Hardwoods are less susceptible.

Ecologically, root diseases create gradually expanding openings in canopy and a change to mixed hardwood-conifer stands. They may provide downed or stressed trees that may provide beetle habitat between outbreaks. Bark beetles may enhance the long-term survival of root diseases by attacking and killing spruce before they are uprooted. When trees are uprooted, the infected roots are effectively pulled out of the ground, removed from the soil, and the disease is prevented from spreading. Dead standing bark-beetle killed trees may enhance survival of the root disease because the infected roots remain in the soil.

However, these are theories. Research is underway on the interactions between bark beetle and root disease and to determine the extent and severity of the major forest pathogens in Alaska. Effective management of forests requires knowledge of those tree, stand, and site factors that determine hazard and risk of fungal infestation. I'd like to reiterate that the effect of forest pathogens is dependent on management objectives. It is up to the land manager to determine what a desirable level of disease is in their forest and to make decisions that concur with that desirable level.

Questions and Answers

Q: *Is the host specific to the organism? Do organisms on willow affect other trees?*

A: It depends on what organism you're talking about. In the case of the tomatosis root rot, it's the conifers that are impacted, not the hardwoods, but it is all the conifer species in Alaska. I have looked at willows, and the stem decay that occurs in willows is the same fungi that occurs in birch, but not in conifers. Some root diseases can occur in both conifers and hardwoods.

Q: *Is tomatosa related to armolaria (sp?)*

A: They are very separate fungi but they're both considered root diseases. Their actions are similar.

Q: *How extensive is tomatosa?*

A: The incidence is broad, but what is the severity? Varies. More extensive surveys are needed.

Q: *Is there more impact on lodgepole pine than native species?*

A: Research from Canada suggests that it is more susceptible.

Q: *How about larch?*

A. I don't know. There's nothing in the literature.

Q: *I've heard the theory that some of these diseases are in all the trees and then when the trees are stressed they show symptoms. Then the strategy of control would be different management from preventing infection to maintaining the health of the tree. Do you give any credence to those theories?*

A. The reason one tree has more disease than another may be from a wound, but the fungi a biotic organism and some things have to occur before fungi are able to get inside the tree and cause decay. There's a reason that tree is defective; we have to understand the reason.

Q: *The study on root rot in Canada didn't find a strong correlation between root rot and bark beetles. I'm wondering if that's more of a reflection on differences in moisture stress; British Columbia is a wetter climate. Do you think we might find a stronger correlation between tomatosa and bark beetles in the drier climates of southcentral or interior Alaska?*

A: I don't know. I'd like to prove a clear relationship but I don't know. I'd like to examine their methods. The root diseases are causing stresses on the tree and that may be a way the beetles are keying in on that tree.

Q: Is there any evidence of outbreaks of diseases similar to the spruce beetle phenomenon?

A: You don't see substantial mortality.

Comment: Introduction of exotic pests is climbed astronomically. We're picking up more and more either exotic pests or pests that have extended their range into Alaska. With the increase in world trade, the chance is greater.

Q for Stu Pechek: Do spruce killed by beetles rot quicker?

A: It's a difference in climate from southcentral to Copper Center. Copper Center is drier and not as susceptible to pathogens. Trees on Kenai Peninsula are hybridized and at the northern edge of their range. Sap rots and checking coming in within three years of the tree's been killed by beetles. We've seen that increase quicker now than it was 15 years ago and the correlation is that we've got more woodpeckers. The woodpeckers are taking the bark off almost the first season of attack, and now those trees are drying quicker so checking is coming on quicker.

Q: Those trees in the Copper River area produced the same quality of chips. As long as the tree remains solid, it's still useful for pulp wood.

Q for Ed Holsten: Are you suggesting that because the spruce species are at their range limits that you have a less vigorous tree in Lutz spruce hybrid?

A: I don't think they're at their limits; I think ranges will continue to move with this warming trend. I may be wrong, but intuitively they're at the end of the ranges of the two species they're less able to respond.

Q: Isn't there hybrid vigor?

John Alden: Lutz spruce is an unstable hybrid that has existed on the Kenai Peninsula for 2,000 years or less. You can find stands of almost pure Sitka spruce and of white spruce.

Engelmann Spruce Management and Spruce Beetle Activity in Utah

John Anhold

I'm going to speak about Engelmann spruce and some of the management we're doing and some of the spruce beetle activity that's going on in the Intermountain region and specifically there in Utah.

Engelmann spruce/subalpine fir stands run the length of the state from the southern border on the Dixie National Forest to the northern border on the Wasach Cache National Forest. Most of these stands are of similar composition with older, larger diameter, denser stands of Engelmann spruce. The spruce beetle began increasing 10 to 13 years ago in central Utah and has recently reached outbreak levels throughout the state on four national forests and adjacent state and private lands. Spruce beetle impacts are expected to last another 10 to 13 years.

A number of the spruce we have are older and mature. On one national forest, it was avalanches and earth movement that got these epidemics going. We had unusually high loads of snow and large avalanches. On the Dixie National Forest we had harvesting problems and then some wind events. Then on the Wasatch Cache National Forest it was an interesting wind pattern that came in and knocked down small groups of spruce throughout the landscape.

Current status: On the Manti-LaSal National Forest, this is the 10th year of an outbreak, with roughly 88,000 acres affected. This outbreak has caused 60 to 80 percent mortality on the spruce component. Some of these stands didn't have good regeneration. On the Dixie National Forest, it's the sixth year of the outbreak, about 45,000 acres affected. The Fish Lake National Forest has a new outbreak, four years old, about 8,000 acres. The most current episode is up north on the Wasach Cache National Forest, where it's about the second year and less than 1,000 acres. This is the area that we feel that we have the best chance of doing something, silviculturally.

A number of silvicultural strategies, including the use of pheromones, have been employed. We promote different treatments depending on the population of the beetle. Treatment success is related to current beetle population levels (endemic, building, or epidemic) and the size of the treatment area.

- Endemic populations=trap tree/planned harvesting
- Low population levels, building = sanitation and trap tree
- Epidemic population = large scale treatments (>1,000 acres)

When there's planned harvest, we ask the forest manager to look for signs of spruce beetle activity and try to manage that at the same time as the harvesting. That might include things like trap trees, removing currently infested trees, using baits on green trap trees, etc. The only national forest that has a lot of spruce that doesn't have a problem with beetle activity, the Uinta (sp?) National Forest, has done this for about 10 years.

Some other silvicultural strategies:

Thin to reduce 120 basal area or 40 percent of basal area
Reduce diameter to less than 12 inches average
Remove currently infested trees
Reduce clumpiness
Minimize stump heights (there's a load of spruce beetles in base of large trees)

Several studies have been undertaken to help understand the biology, attacking behavior, and management strategies associated with spruce beetle impacts and ecosystem health.

Pheromone implementation:

- Endemic populations: cluster baiting/one per 8 to 10 acres
- Small, building populations: cluster baiting/one per 4 to 5 acres
- Epidemic population: no pheromones

Current work/studies:

- Anti-aggregants (MCH) to protect recreation areas
- Spruce beetle development and phenology
- Spruce beetle colonization of downed spruce
- Determination of characteristics of spruce beetle activity centers—start seeing pockets of tree mortality. Why those pockets?
- Field tests of spruce beetle management strategies—mostly thinning
- Funnel traps to reduce small outbreaks
- Pyrethrin study—more friendly on the environment, fairly effective for one year
- Sub-pixel analysis to pick up fading spruce using satellite sensors

What We've Learned

- Landscape level treatments
- Be proactive—get it early
- Be aggressive with treatments
- Do not leave clumps
- Protective sprays on large trees

Questions and Answers

Q: What age trees are we talking about?

A: 250, 300 years.

Q: If you have a stand that's 200 years old, 200 basal area, and you take 40 percent out, what happens with windthrow after?

A: Depends a little on the soil conditions. If you have an area with too much wind, the trees will get knocked down. We had an area on a ski area that was thinned and within two years the whole thing got blown over. You'd think that those trees would be pretty wind-strong.

Q: What is the rule of thumb for cutoff of clumps (size)?

A: We try to do even-spacing thinning, not even have a dozen trees together in a clump. Where we've left clumps, all the trees were dead in a couple of years.

Comment from Skeeter Werner: We found pyrethroids were highly toxic to aquatic invertebrates.

Question on rotation plan for stands—when those trees are gone, what do you plan for next?

A: We try to promote other species. Regeneration of spruce is not there. Spruce needs mineral soil and there's too much needle bed for new starts.

Q: about what the percent of the national forest that is inaccessible? What can you effectively reach to treat?

A: Maybe 70 percent is accessible.

Q: If you have areas of thinning surrounded by national park land—how does that affect beetles? Do they move in from the national park?

A: We don't have the big seas of spruce that you have. We do have national parks: Cedar Brakes National Park is right in amongst the national forests. They won't do anything.

Q: Are you trying to promote aspen down there? With what success?

A: We let the spruce beetle do its thing some places to promote aspen.

Q: Did thinning operators have training to avoid damage to the remaining trees? With what success?

A: There was some thinning done last year on private land where they removed 80 percent basal area and everything over 12 inches and did a pretty good job. Just adjacent to that, the Forest Service had another thinning on 200 acres to 120 basal area to an average of 12 inches. Worked with the operator.

Q: At the ski area, was that national forest land leased to a ski area?

A: It was the Brianhead Ski Area. About half owned by ski area and half national forest. The spruce beetle outbreak was approaching community. We warned them but it was hard to convince them it was a problem. We sprayed, they didn't.

Q: Did they salvage?

A: The hazard were trees removed. Now it's a fire hazard.

Silvicultural Responses to the Spruce Beetle: Salvage And Sanitation

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What does one do with an aging forest that is ideal for spruce beetles? What does one do with a forest infested with bark beetles? My charge today is to address these situations.

Society must address the question, "What legacy do we wish to leave for future generations"? Ninety years ago, the French forester, Huffel argued, "public forest owners have only the right to income from properties and must pass the principal on to the future generations unimpaired." Income is a benefit of the forest. Thus, the argument can be restated: public forest owners have only the right to obtain benefits from properties but must pass the principal on to future generations unimpaired! If this is accepted, then society must take actions today that will ensure healthy, productive forests for future generations.

Objectives for which forests are grown are determined by the landowner(s). Objectives must be realistic—that is attainable or do able and fall within limits set forth by biological and ecological facts and concepts. This requires recognition that the Northern Forest ecosystem is dynamic, not static, and punctuated by disturbances or agents-of-change that are catastrophic at the individual tree, stand, watershed, or regional level. Additionally, forest stand dynamics and associated changes over time must be recognized and accepted. Development of the objectives requires supportive input from professionals, especially persons skilled in forest resource management.

The spruce beetle is only one of many agents-of-change. It cannot be considered in isolation. It normally acts in concert with other agents-of-change especially pathogens such as butt and root rots. The silviculturist in developing prescriptions must consider all agents-of-change associated with catastrophic disturbance—other insects, fungi, wildlife, fire, wind, ice and snow, flooding—in developing silvicultural prescriptions.

Silviculture consists of three basic areas:

- Stand replacement or regeneration, (regeneration cut, site preparation, regeneration, release)
- Stand tending (stocking adjustments or thinning and nutrition), and
- Stand health.

A major tool in stand replacement, stand tending, and stand health is the harvest of trees in an appropriate and timely manner. There are two basic harvest techniques—clear cut and partial cut. These are not to be confused with or used interchangeably with the following silvicultural practices:

- Thinning,
- Sanitation,
- Stand replacement achieved through a planned reproduction method, and
- Salvage.

Note the order of these actions. Salvage is the least desirable and I will begin with it.

Hawley and Hawes in 1912 used the term "'damage cutting,' [which had] the purpose of removing and utilizing material which has been damaged by wind, insects, fungi, fire... As long as [agents-of-change] cause extensive injury in the forests, damage cuttings are demanded as a regular part of management, to make the best of a bad situation." Damage cuttings can range from the removal of individual trees to clear-cutting.

Today the term "salvage cutting" is used in place of damage cutting. The Society of American Foresters defines salvage cutting as "[t]he removal of dead trees or trees being damaged or dying due to injurious agents other than competition, to recover value that would otherwise be lost." Essentially, salvage cutting is an attempt to obtain an economic gain before the trees have lost all economic value. Where management has not included silvicultural practices to minimize damage or the designed measures fail or are inadequate "it is sometimes desirable to conduct salvage cuttings to recover the values represented by damaged trees or stands." The effort is simply to minimize financial loss. Hence, salvage cuttings are not done unless the salvaged material will pay for, minimally, the cost of the effort. Procrastination therefore is simply unacceptable when considering the salvage option!

The Society of American Foresters defines sanitation cutting as "[t]he removal of trees to improve stand health by stopping or reducing actual or anticipated spread of insects and disease." Sanitation cuttings remove live trees harboring insects or pathogens or trees likely to be attacked by such agents of change in the near future; this latter category has been referred to as pre-salvage cuttings. Sanitation and salvage are often combined into one operation and should then be referred to as a sanitation-salvage cutting. Sanitation cuttings are often ineffective against root rots. Sanitation cuttings are designed to protect unaffected trees or stands; hence, they can be a management cost.

Sanitation, sanitation-salvage, and salvage efforts can and should be a component of stand improvement activities commonly referred to as thinnings. Stand improvement "compris[es] all intermediate cuttings made to improve the composition, structure, condition, health, and growth of even- or uneven-aged stands." A thinning is "[a] cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or to recover potential mortality." Thinning requires retention of the best trees for future growth; it commonly has as its main purpose the utilization of material that would be lost due to mortality associated with crowding of trees as well as the removal of inferior stems. Thinning is normally conducted on a break-even or for profit basis.

Stand at risk or mature and declining in health should be harvested using the appropriate silvicultural system. The silvicultural system should be designed to create healthy stands of desirable structure for future generations.

Good management policies and silvicultural planning, prescriptions, and actions should minimize the need for salvage. Extensive areas requiring salvage reduce management options, do not contribute to sustained yield nor the annual allowable cut, and are not sustainable resource management. Loss of fiber value, often 100 percent, means less financial support for good forestry including reforestation, ecosystem restoration, wildlife habitat management or enhancement. Quantities of dead fiber contribute to increased fire hazard and control efforts.

In conclusion, salvage cuttings, sanitation cuttings, sanitation-salvage cuttings, and thinnings require the harvest of selected trees. Extensive salvage cuttings are the result of poor planning which is often is a result of policy, budget problems, lack of understanding of ecosystem processes—it is not necessarily the fault of the forester in charge. However, Mike Dombeck, currently chief forester of the USDA Forest Service, but as director of the Bureau of Land Management he stated, "Managers are responsible for maintaining ecosystem health." The current health of much northern forest is a sad legacy to leave for future generations. As a professional forester and silviculturist, I am personally embarrassed and depressed by the continuing decline in forest health of Alaska's northern forest.

Questions and Answers

Q: *Regarding the comment Glenn Juday made that regeneration success is becoming less predictable. How does that alter your conclusions?*

A: I don't know what stands Glenn has been looking at, but the only place I have trouble with regeneration is where I have excess competition or the wrong type of seed bed.

Q: When you look at all the costs of management, does it make economic sense to manage these forests?

A: Sometimes you go in the red, sometimes you go in the black. How many national parks are run at a profit?

Q: How much should the public subsidize the national parks or public forests?

A: I don't know. It's a question we haven't really wrestled with. If we're going to take benefits off, as I suggested, how much should we put to the principal?

Q: In order to develop a risk assessment of the forest and appropriate silvicultural treatments to address the management of the forest, what sort of inventory is necessary?

A: There are two ways to approach it. One is to inventory the whole area in a much greater detail than we can do it right now. The other is to set up a situation where we take on units, sections of the valley or watersheds, and do a really good job of scoping out this one area.

Glenn Juday: Since the subject came up, I thought I'd give the background on just how unusual this current weather variability is. The indications are that the amount of warming is certainly unprecedented in the last 200 years, almost certainly unprecedented in the last 400 years, and over 1,000 years it probably has not occurred. The next likely target is about 6,000 years ago. I think you have to put this recent climate change period into the perspective of at least 1,000 years and very possibly into multi-thousand years.

A: I don't argue that we go in cycles. The forest in the Interior has only been here about 1,000 years. The long-term record has warmer and drier, cooler and wetter. What scares me is that we're so busy looking at the long term, we miss looking at the short term.

A REFORESTATION PROGRAM FOR MAINLAND ALASKA

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Introduction

Catastrophic wildfires and spruce beetle epidemics destroy more than one million acres of forests in interior and south central Alaska annually. Of the destructive agents, spruce beetles cause the most economic loss because, in epidemic numbers, they kill nearly all mature trees of spruce (*Picea A. Dietr.*), the only genus of major commercial importance on mainland Alaska. Loss of mature spruce trees terminates seed production and natural regeneration. In absence of young understory trees to replace the mature overstory, natural regeneration and migration (expansion) of the spruce forest continue again only after long periods in succession of seral species, sometimes extending into centuries. Because of low fecundity, infrequent seed crops, short seed dispersal distances, and long periods for sexual maturity, artificial reforestation is usually necessary to restore most conifers following catastrophic events, including excessive timber harvests. On mainland Alaska, more than one million acres of forests are destroyed by wildfire, and hundreds to as many as 500,000 additional acres of mature spruce forests in south central Alaska are lost to the spruce beetle annually.

Vigorous forests are important to the future economy of Alaska and the Nation. Demands for wood already exceed the current supply of about 18 billion cubic feet, but by year 2020, demand will exceed growth by 50 percent.[1] In addition to timber demands, vigorous forests are needed for sequestering atmospheric carbon dioxide', wildlife habitat, recreation, and amenity. Thus to meet societies demands, fully stocked forests of long lived tree species must be maintained on all sites capable of growing commercial quantities of wood. In North America, forests have commercial value if they grow 20 cubic feet of usable wood per acre annually. The productivity of managed forests in Alaska have not been determined. In Northern Europe, forests usually have commercial value if they grow one cubic meter of wood per hectare (14 cubic feet per acre) annually.

Reforestation Planning

The first step in initiating a reforestation program is to determine the area of commercial forest land that requires artificial regeneration at least one year in advance of planting or direct seeding. Investments in reforestation are justified only for commercial forest land.

Planting of seedlings is usually the most practical method of artificial reforestation. Broadcast seeding of spruce requires from one-half to more than one pound of seed per acre, and the results can vary from complete failure to an overabundance of seedlings. Seed spotting requires less seed than broadcast seeding, but stocking is also unpredictable.

For successful seedling establishment, timing of seeding can be critical. White spruce seeds germinate most rapidly (usually in 5 to 7 days) at about 20 degrees C. Temperatures above 300 degrees C for a few hours can be lethal if the seeds are fully imbibed with water. The seeds must be fully imbibed with water for germination. For seedling survival, surface soils must remain near or at field capacity for 2 to 4 weeks after seed germination. In dry climates, mineral soils are usually required for seedling survival, but in maritime climates, seedlings will survive on moss and even on decomposing wood.

1 F1 of dry spruce wood (25 lbs.) contains about 55% cellulose (44% carbon) and 33% lignin (65 percent carbon), or about 11 pounds of carbon. The 11 pounds of carbon are fixed from 40 pounds of CO2. Thus white spruce forests growing 50 $ft.^3$ of wood per acre/year sequester about one ton of CO2 per acre/year.

Species Selection

The second step is to select the species that best meets the objective of the reforestation program. For economic reasons, more trees are planted as wood production monotypes (one species) than for any other purpose. Species are rarely planted in mixtures, although special projects for wildlife habitat, soil and slope stabilization, and landscape values, for example, may require heterocultures. Planting species in mixtures is known as heteroculture, and a single species of the mixture is a heterotype. Heterotypes add diversity to the plantation. Heteroculture breaks the pattern of large contiguous stands of monotypes into small populations of different species. Species specific pests such as the spruce beetle are then forced to travel considerable distance to find their next food source. During extended flights, mortality from adverse weather, predators, and energy loss effectively reduce adult populations.

Of the six indigenous tree species in interior Alaska, only white spruce is of commercial value and is widely planted. The local broadleaf species reproduce vegetatively and usually do not require artificial regeneration. They are prolific producers of light weight seeds, which may be dispersed several miles by wind. The result is often extensive stands of overstocked natural regeneration of noncommercial hardwood species. Thus to increase species diversity, i.e., number of the commercial species, and maintain insect populations at endemic levels, it may be desirable to reforest pine and larch in heterocultures with the indigenous spruce.

Both lodgepole pine (*Pinus contorta* var. *latifolia Engelm.*) and Jack pine (*Pinus banksiana Lamb.*) provenances[2] from their northern ranges are well adapted to interior Alaska. The northern range of lodgepole extends nearly to 640 N. Lat. in central Yukon, and Jack pine reaches 660 N. Lat. along the Mackenzie River in Northwest Territories. Raviola larch, a well known strain of Western Siberian or Sukachev larch (*Larix sukaczewii N. Dylis*), appears well adapted to productive upland sites in Interior Alaska. Sukachev larch is a large tree that extends from the Ob River across the Ural Mountains to the White Sea of European Russia. Raviola larch was selected from several provenances in the western range of Sukachev larch during the eighteenth Century for ship building in the Gulf of Finland. As juveniles, lodgepole and Jack pines, and Sukachev larch grow two to three times taller and larger in stem diameter than our native white spruce on upland sites in interior Alaska. All foreign species should be provenance tested as both heterotypes and monotypes on many sites before they are introduced on a large scale, however.

Selecting Adapted Seed Sources

Seed zone and seed transfer guidelines should be followed in collecting, labeling, storing, and sowing of seeds and other propagules for artificial reforestation. Seed zones delineate geographical areas of relatively uniform and stable environments (climate and soils). Over several to many generations, uniform and stable environments select for local land races, usually ecoclines, but sometimes ecotypes.[3] Seed zones and transfer guidelines maintain the genetic integrity and structure of native populations, and reduce the risk of maladaptation from seed transfer. Seed zones are also used as breeding zones for tree improvement, and for matching environments in selecting the most productive provenances or provenance zone for introducing foreign species, varieties, and races.

A large seed bank should be maintained for reforesting unpredictable catastrophic events such as forests killed by wildfire, and species killed by insect and disease epidemics. Four hundred and eighty six seed zones averaging 270,000 acres each have been mapped for Alaska (2). Because seed crops and natural regeneration are unpredictable in continental and continental-transition climates, one pound of

2 Provenance refers to the original geographic source (native population) of seed, pollen or propagules of a species. Seed or pollen source refers to the locality of the collection, which may be from a native stand or non-native ancestors in a plantation.

3 An ecocline is continuous (clinal) variation in a population along an environmental gradient. An ecotype is a race that is adapted to a particular environment. Genetic variation is discontinuous from one geographical area to the next.

spruce seed should be stored per 100 acres of commercial forest land for each seed zone on mainland Alaska. This recommendation is based on the assumption that commercial forests will require artificial reforestation immediately following a catastrophic event.[4] To reduce costs and insure extensive (wide) out-crossing, open pollinated seed should be harvested only during better than average seed crops, i.e., when at least 50 percent of the seed bearing capacity of the cone crop has viable seed,[5] and more than 200 seeds fall per square meter under mature and fully stocked white spruce stands.[6] Vigorous seeds of white spruce will remain viable for more than 20 years if stored at moisture contents between 6 and 12 percent dry weight, and at -20° C.

Seed Tree Selection

To improve forest health and growth, only the most vigorous trees should be selected for natural regeneration and seed harvest for artificial reforestation. To meet reforestation objectives, seed trees should have desired traits and retain the genetic variation essential for adaptation to changing environments. For example, in reforestation programs for wood production and sequestering carbon dioxide, seed trees should have superior heights and bole diameters, narrow crowns, small branch diameter, and high harvest index (the ratio of harvest biomass to total biomass of the plant) while demonstrating disease and insect resistance, and superior fitness to a wide range of habitats.

Superior tree growth, vigor, and resin production should also be major criteria for selecting spruce beetle resistance (3). Resistance of host trees depends on their ability to produce carbohydrate reserves for resin production in response to attack. Heavy resin production often prevents adult beetles from depositing eggs, or may even kill the larvae if eggs are deposited. Resins of resistant trees may also contain terpenes and phenolic compounds that are chemical repellents and toxins to the insect.

In 10 year genetic variation studies on a low quality site at Delta Junction, and on a high quality site in Bonanza Creek Experimental Forest, estimated genetic gains for tree height and stem diameter from selecting the largest one in five seed parents (0.2 selection) ranged one percent for the low quality site to three percent for the high quality site. These gains double if the seed trees are propagated in a seed orchard where both male and female parents are selected and cross at random. The gains triple again to about 18 percent if the parents are re-selected at 0.2 intensity after progeny testing, and the orchard is rogued[7] of the inferior parents. The gains were estimated from only four percent tree heritability[8] at Delta Junction, and 13 and 10 percent heritability for height and diameter, respectively, at Bonanza Creek.

A large number of seed trees are necessary to retain the genetic variation of wild populations, especially low frequency genes that are essential for adaptation of local populations to new environments. For reforestation programs larger than 100 acres, seeds should be collected from at least 30 trees per lot for each provenance (population) or collection area. Statistically, about 30 random seed trees are necessary

4 Assumption: In operational nursery programs, one pound of spruce seed will produce 50,000 seedlings, and plant 100 acres at 500 seedlings per acre.

5 The seed-bearing capacity of white spruce cones average 50 or more percent when a sample of cones sliced through their longitudinal axis average more than 5 filled seed on one surface per cone.

6 Seed fall records maintained at the Institute of Northern Forestry from 1957 to 1994 showed that more than 200 seeds per square meter were produced by fully stocked and mature white spruce stands at about five year intervals. Heavy crops of more than 2000 seeds per square meter were produced only in 1958 and 1987, about every 30 years.

7 Rogue or roguing refers to culling genetically inferior individuals (genotypes) from a population such as an orchard, plantation, or stand of trees. In contrast, thinning is the removal of individuals (usually inferior phenotypes) to increase space and growth among trees in a population by reducing competition for light, moisture, and nutrients.

8 Trait heritability is the variation among trees in a population that is due to additive gene effects. One minus heritability is the variation that is caused by the environment.

for 0.95 probability of retaining a gene that exists in five percent of the trees in an infinite parental population; and 150 seed trees are necessary to retain a gene that exists in one percent of the population at the same probability. Any one rare gene, which by definition, occurs at a frequency of 0.005 or less, requires nearly 300 seed trees for 0.95 chance of being selected.

To insure that as much genetic variation as possible is retained in the seed collection, and to avoid selecting close relatives, seed trees should be widely dispersed throughout each provenance or seed collection area. Because pollen and seed dispersal distances are limited, natural white spruce stands are composed of local interbreeding populations of related individuals, or demes (4). The evolutionary advantage of the deme is unknown. Crossing among related individuals may increase homozygosity and habitat fitness of local populations, but it also results in inbreeding and depression of growth and vigor. Thus for reforestation and tree breeding, geneticists recommend that seeds are harvested from trees that are separated from each other by at lease 100 meters.

The location of seed trees should be mapped so they can be relocated for release and fertilization, and future cone collections. To insure high seed set during average seed years, three to six trees of the dominant crown class within 100 meters of each seed tree should also be released and fertilized for pollen production. If seed is harvested from dominant trees surrounding the selected seed trees, the stand becomes a seed production area. Seed production areas are young, vigorous, open stands that are managed as a source of low cost seed until tree improvement programs are in full production.

Finally, if seed can not be harvested from trees selected for size, and improved growth is an objective of the reforestation program, seed should be collected from the white spruce variety Porsild (*Porsildii Raup*) in preference to the variety Alberta or western white spruce (*Albertiana* (S. Brown) *Sarg.*) (5). Porsild spruce has larger stem diameter to height ratio, and may grow larger and faster than Alberta spruce. Both varieties are widely distributed in Alaska and are easy to distinguish in mixed stands. Porsild spruce has smooth grayish bark with pitch blisters when young, a relatively wide conical or ovate crown, green foliage with a bluish ting, relatively long and widely spaced needles, and larger cone diameter than Alberta spruce. The Alberta form has coarse, rough, furrowed, and reddish-brown bark, sometimes scaly when young, narrow pyramidal or spire-like crown, dense, dark-green foliage, short needles, and relatively small diameter cone.

The two varieties may have survived in different glacial refugia, and are now merging into one polymorphic species in Alaska. Field and greenhouse studies are needed to determine site preferences, crossabilities, genetic variability, and growth differences between the varieties.

Heritabilities and gains in growth and fitness traits should also be estimated for each variety.

Seedling Production

To minimize production costs and overwintering losses of containerized seedlings, white spruce, larch, and pine seeds can be sown in January or February and the seedlings out-planted in June and early July. After emergence, the seedlings must be grown under extended day length and optimum (luxuriant) nutrition. The goal is to produce seedlings that are about 20 cm tall (white spruce), 30 cm tall (pine) and 40 cm tall (larch) when transplanted. The seedlings must be sufficiently hardened to prevent injury when pulled from their containers, and handled during shipment and planting. If hardiness is inadequate, the seedlings should be exposed to reduced photoperiod (12-8 hours.), N/P,K ratios (<1), temperature (<15 degrees C day, S degrees C night), and moisture (<60% field capacity) for 30 to 45 days before shipment.

Although containerized seedlings are more costly than bare root seedlings, they require only four to five months to achieve adequate size for transplanting. Seedlings raised in outdoor nursery beds at high latitudes require two years to reach sufficient size for lifting and transplanting. In addition to cost savings, trees grown from bare root seedlings have less root malformation than trees grown from containerized stock. The root binding effects of containers are known to reduce survival and growth after planting, and probably reduce growth as the trees mature. Bare root stocks require productive sandy loam soils for optimum growth and lifting the seedlings from their beds without serious root injury. Other disadvantages of high latitude bare root nurseries are the short interval when stocks can be lifted between frozen soils and initiation of root growth, difficulties in handling and storing bare root stock, i.e., maintaining proper moisture content in storage, and proper root placement during planting. Nevertheless, the survival and production of bare root stocks should be investigated for large scale reforestation programs (more than 10 million trees) at high latitudes.

Site Preparation

To reduce site preparation requirements, forest lands should be planted as soon as possible after any catastrophic event that temporarily eliminates vegetative competition for light, moisture and nutrients, including timber harvest. Most forests can be planted within one or two years following intensive wildfires without extensive site preparation. However, once denuded sites are captured by early successional species, site preparation is necessary for establishment and growth of tree species.

On large scale reforestation projects, site preparation can be accomplished by mechanical scarification, or for removal of light surface materials, by blades or plows attached directly to tree planting machines. On cold soils, contour plowing perpendicular to the slope turns a mound of mineral soil onto underlying organic soils and surface litter. In mesic environments, trees planted on the mounds benefit from elevated temperatures, especially on south slopes. Nutrients are also released from accelerated decomposition of the underlying organic matter. Herbicides are also effective in reducing competition from herbaceous and wood vegetation, but because of environmental concerns, they are not widely used for site preparation in Alaska.

In afforestation of grasslands in Southwest Alaska, removal of the surface vegetation, sod, and the accompanying organic soil, exposes the underlying mineral soil to erosion, reduces long-term site fertility and increases frost lifting of recently planted seedlings. During winter, tundra, litter, and deep organic soils insulate the underlying mineral soil from repeated freezing, and prevents frost heaving of recently planted seedlings. Thus removal of the tundra and disturbance of the organic soils are not recommended for afforestation in subarctic maritime climates.

Large, two to four year-old planting stocks compete successfully with established herbaceous vegetation and may be used in lieu of site preparation. Transplant stocks from 45 to 100 cm tall in gallon containers may cost more than $500 per thousand, but they can be successfully planted on sites that can not be prepared mechanically. Large stocks can also be successfully planted in established vegetation among understocked regeneration.

Planting

Large reforestation programs can usually be accomplished at lower costs than small reforestation programs. On gentle slopes with deep fine-textured soils such as those in interior Alaska, a three person tree planting machine can prepare and plant 400 to 500 trees per acre on 25 to 30 acres per day. Slopes greater than 20 to 30 percent often must be hand scarified and planted at about one acre per man-day, adding substantial cost to the reforestation program.. Thus the most productive sites, i.e., those capable of growing 40-60 $ft.^3$ or more of stem-wood/acre/year (3-4 m^3/hectare/year), should receive first priority for reforestation. On most sites in interior Alaska, dormant or well conditioned white spruce seedlings can be planted between thawing of soils in May and freezing of soils in September with 80 percent or more survival. Losses from frost lifting can be avoided, however, if the seedlings are planted before mid July when active root growth begins to decline.

Summary

Mainland Alaska lacks reforestation programs for restoring commercial forests on more than one million acres of forests that are destroyed by wildfire and insect epidemics annually. Major objectives of the reforestation in Alaska are to (1) increase wood production and species diversity, (2) slow climate warming by sequestering atmospheric carbon dioxide, and (3) improve forest health, wildlife habitat, recreation, and landscape values.

Major steps in reforestation are (1) choosing the method and sites for reforestation; (2) selecting species, seed sources, and seed trees for seed production; (3) harvesting seed and producing seedlings for planting; and (4) preparing planting sites and planting the trees.

Success of reforestation programs depend on the staunch use of seed zones and transfer guidelines, and on seed quality. Reforestation of open-pollinated seedlings of the largest and most vigorous seed trees in adapted populations will increase tree growth and forest health.

A site productivity index based on the physical elements of the environment is needed for selecting the most productive sites and choosing appropriate species and provenances for reforestation. Research is also needed on the productivity of managed forests, growth and fitness of native and foreign tree species managed in mono- and heterocultures, seed collection and storage, seedling nutrition, and tree planting technologies.

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Forest Disturbance and Wildlife Habitat

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I'd like to talk about the integration of the forestry and wildlife professions. We need more appreciation of two professions for each other. Some people don't appreciate that forest health depends on disturbance. Lightning-caused wildfires are the largest disturbance in Alaska. Before the establishment of fire suppression, we were burning on the average of one to two million acres a year. Since that time we've been down to about 600,000. It's a rare stand of trees that is over 200 years old. As a direct result of four decades of fire suppression, it's the younger more diverse and more productive and more vigorous stands we're lacking. While we're doing a pretty good job of managing for spruce grouse and red squirrels, we're doing a dismal job of managing for early to mid-successional species like rough-tailed grouse, sharp-tailed grouse, moose, and the like.

That's why the Alaska Divisions of Forestry and Wildlife Conservation got together in 1995 to try to develop some cooperative projects. Our first project was the Creamer's Field birch firewood sale and slash burn. It was both for biological and educational goals. We prepared harvest and fire plans and worked with the citizens' advisory group for the refuge. We logged the site in winter, using draft horses to harvest. Perimeter fuel break was cleared, and slash was treated to less than 18 inches of the ground.

We ignited the fire in late May. Although a lot of smoke was produced, the smoke management plan worked fairly well to keep the smoke to the north. Objectives were achieved. We consumed a lot of the material on the ground, including the overstory. We left some snags standing for raptors and such. The response from birch and willow was immediate. The wildlife response was quick—we had foxes, sandhill cranes, moose, and tropical migrants. We built an extension on the nature trail so people could walk out into the area.

The next project was a regeneration cut of aspen on Nenana ridge for ruffed grouse. We cleared 200 acres of mature aspen forest in a checkerboard of six-to-eight-acre parcels. Grouse need mature aspen for winter buds and also dense saplings for hens for shelter from predators. We've cleared 160 acres in the last three years already. The initial response was a growth of 200,000 stems per acre. We want 10,000 to 12,000 stems per acre in 7 to 10 years. The secret to good ruffed grouse management is good aspen management.

Our greatest challenge has been to improve wildlife habitat conditions on white spruce sites post-logging. So we looked at the natural disturbances. Wildland fire is the natural disturbance. We realize that clear-cut is not the ecological equivalent of wildland fire, but it is economical. We are looking for stand replacement. We chose a 50-acre south-facing site for a slash burn after a logging operation. There was little slash left on the site, so we were actually concerned that there wouldn't be enough slash left to carry a fire. We had the operator put a fuel break around it, and in the middle of July we started a test fire. The fire was a success. The duff layer was reduced significantly. Shortly after the fire, shrubs coming back and bull moose came back quickly.

What can you do in addition to just burning slash? We tried willow (feltleaf is most important for moose) plantings. What you do is, cut the willows in March, stack them in a pickup all the same direction, bundled in ropes and heavy nylon straps. Haul them to a shady place and bury them in snow and wood chips. Dig them out in late June or July. Cut them in 10 to 12 inch sections. Put the lower part of stem down in the bucket because willows get confused if you plant them upside down. Plant them three-quarters of the depth in the dirt. In addition to producing browse for moose, the willows are a seed source for adjacent clear-cuts as well as protection for spruce seedlings.

This is not science, it's hands-on work. Next we need to quantify what we've done and get the costs down.

Questions and Answers

Q: What would you do differently to mimic riverside disturbance?

A: Whenever you have moss buildup, that's keeping the ground cold. Burn, or scarify at least.

Juday: A masters student who just finished up this December, Dan Reese, found differences in plant diversity in natural fire areas versus logging areas.

Q: Did the sticklings have to be in mineral soil, and does rooting take place in mineral soil or organic soil?

A: Mineral soil. Sometimes they look like they're viable but they're using the energy in that stem: no roots.

Public Perception of the Beetle Outbreak on the Kenai Peninsula

Bob Purcell

Fire chief, Homer

I've been working on issues with spruce bark beetle infestation in Homer for several years. The public is going through a grieving process. The grieving process starts with denial. The first reaction was that these trees weren't going to die. Now there is a change in public philosophy. We tried to develop community-based response.

We tried to think in terms of the dying cycle of the forest. Thinning, limbing, watering, all failed completely. Now we are logging while the trees still have value. Once they die, there are hazard trees to contend with, and the fire hazard. Then there is the regeneration issue. We tried to delineate the decision points, keeping in mind that not making a decision is in itself making a decision.

We had to bring in expertise from many agencies to provide the information to the public, in sort of an incident management approach. It was interesting for agencies, having to respond on a micro level to an individual community. There was a lot of potential for conflict that didn't develop. The whole process was positive. We did a Web page through the city of Homer on the Forest Health and Safety Project. We wanted to have information available to the public so that they could take action on their own property.

The Spruce Bark Beetle Task Force is formed of stakeholders, not agencies. The subgroups are charged with consensus action items. They are to look at the information available, not do another study.

It was easy to develop a consensus on safety issues, but harder on forest health issues. We are in the middle of that process. We are holding public workshops in Soldotna and Homer next week.

Through this process, we have seen new alliances develop. Environmentalists are in alliance with logging interests in the urban interface. The further you get from where people live, the less consensus.

It's interesting how the public is reacting to the loss of the forest. Some people buy a piece of the wilderness and see that as unchangeable, barring disaster. Now people who never envisioned cutting more trees than they had to are hiring loggers. The vista is the main reason people are in Homer; to see that disappearing is major. Tourism is the major industry on the Kenai Peninsula. So we try to turn it into an educational opportunity. They used to market pristine, green virgin forest. How do you market a spruce bark beetle epidemic? They try to diffuse the negative connotation. It's a not dissimilar reaction to the reaction to the oil spill.

Again, it is a grieving process. Someone ought to take a look at the sociological aspects of this kind of forest transition.

Questions and Answers

Q: *Do people have the view that outbreak is the result of society doing something wrong, and how does that affect their response to it?*

A: There are many different answers. When it first started, there was a lot of discussion about who was at fault. But when the infestation got to the epidemic proportions it is now, there was recognition that this was a natural phenomenon. There's not a large history of fire, so it's quite possible that the spruce bark beetle is the natural disturbance there. Homer has been particularly dry and warm with a receptive forest.

Q: *What issues should the forestry profession be educating the public on?*

A: Talk more to the people and less to each other. Public education is identified by the task force as providing the public neutral information. The public really appreciated it. We got well over 100 people per meeting.

Q: *What is your assessment of the fire risk? Is there a potential for a Miller's Reach-type fire in the Kenai Peninsula?*

A: The risk for a Miller's Reach-type fire is higher in the Kenai Peninsula than it was at Millers' Reach. I use the comparison of diesel and gasoline. Diesel has more BTUs, but which would you rather stand next to while I smoke a cigarette? The forest is more volatile; it lights easier. Fire behavior is aggressive and dangerous.

Panel Discussion

Jan Dawe:	Do you have any recommendations for us in the Interior for public involvement?
Bob Purcell:	The public responds to perceived threats. It is necessary to develop a community group that has an interest who are part of the community. Try to involve them in the process.
Bob Wheeler:	Has Utah done any testing on genetic diversity?
John Alden:	No
Ed Packee:	Question for John Alden: have you found any evidence of genetic resistance to the spruce bark beetle?
John Alden:	I saw a paper with some evidence there is. Greater quantities of pitch and the turpentine content of pitch kills the bugs. Ponderosa pine is more toxic to pine bark beetles. There are two types of resistance—one is immunity, which probably does not exist. But resistance itself through vigor of the tree could exist.
?:	Some spruce beetles are hitting other trees. Maybe they don't well, but they are hitting them.
Roger Burnside:	Do you see any response from other insects to thinnings?
Ed Packee:	The concern I have from sanitation and thinning in Kenai is beetles coming back for a second round and taking trees down to four-inch diameter.
Ed Holsten:	Back to resistance: I agree there is nothing in the literature demonstrating true resistance, but one variety of spruce is rarely attacked when populations of beetles are low.
Sam Patten:	There were big fires on the Kenai Peninsula in the 1960s, and there is a history of big fires. Is that influencing the situation down there as far as younger stands? After this mortality event, does this bode well for moose populations?
Bob Purcell:	I don't know.
Ed Holsten:	The earlier fires went through lot of black spruce and were late-season fires. They produced a lot of regeneration.
Dave Kelleyhouse:	From a wildlife perspective, you're getting persistent, thick bluejoint grass in there. That makes it difficult to get trees started.
Ed Packee:	There were few moose on the Kenai Peninsula in the 1880s. A 1916 survey talks about large fires on the Kenai Peninsula.
Dave Kelleyhouse:	I don't think the effect of bark beetles is the same as fire, but fire will follow.
Bob Purcell:	There's less lightning on the Kenai Peninsula. But there's lots more people now, so more sources of ignition. It's much more of a concern.
Doug Yates:	Question to Bob Purcell: Is HB 284 by Rep Hodgins, the beetle bill, well understood?
Bob Purcell:	I don't' think people know about it.
Bob Ott:	In reference to heteroculture up here: how practical is it? We don't have the susceptibility here. Would you really want to increase the conifer component?
John Alden:	Conifers are more economically valuable. They're better at sequestering CO_2. They have a longer life-span. But they may not be as good for wildlife. In my studies,

Siberian larch is growing 5 to 10 times faster than native spruce. If we allow white spruce to reach climax, we have a natural monoculture.

Ed Packee: I worked for a corporation that tried exotics. I am very concerned about disease brought in with them. Roger asked a good question. How much should we afford regenerating these forests? Will there be markets for this stuff?

Dave Kelleyhouse: I'm deathly against exotics, wildlife or plants. Moose eat Scotch pine.

??: Maybe it's better to learn to use what we have than try to replace spruce.

Skeeter Werner: Exotics are more susceptible to native insects than they were in their native place.

Tim Rob: What's the best way to reforest a windswept Tanana Flats clear-cut up to the edge of the river?

Ed Packee: Burn it. I look at fire as my preferred tool. Alternatively, a disk trencher will work, but not up to the side of the river. Look at trying to get poplar and spruce to grow right at the river edge. Grow large woody debris for input into river.

Richard McCaffrey: If there has been a step change towards a warmer condition that tends to eliminate permafrost, is that counterbalancing the normal process of forest building up, leading to more permafrost?

Ed Packee: With drier summers, fire is becoming more prevalent and soils becoming warmer. The problem is how dry are the soils going to become?

Dave Kelleyhouse: We don't know if it's long term or just a blip on the temperatures. One thing you don't get from burning is a mineral soil seedbed.

Glenn Juday: If conditions in last the 20 years persist—permafrost south of Yukon River is in process of thawing now—it will thaw. Our minds resist that volume of change in the environment in our lifetimes, but it's true. The area of productive forest land in Alaska would increase by fourfold.

Joan Foote: Depth to permafrost increases after a fire. If the climate is warm enough, permafrost may never reform. Tom has examples of spontaneous subsidence without disturbance.

Ed Packee: That's been going on for thousands of years.

Glenn Juday: It always has happened but there's usually been some disturbance. The new thing is it's doing it spontaneously without disturbance.

Doug Yates: In Nova Scotia there is a massive outbreak of tussock moth. Biologists there are proposing biological controls. Are there any biological controls for spruce bark beetles?

Skeeter Werner: It's not feasible. They are feeding inside the tree. A biological control has to locate the beetles, then enter, but the galleries are blocked behind the beetle. The best control is woodpeckers.

Doug Yates: What about raising woodpeckers and releasing them?

Dave Kelleyhouse: Wildlife has a home range and it's defended. Also, you won't be able to exceed and maintain a higher-than-normal population. Woodpeckers will breed and increase on their own.

Marty Welbourne: We had someone from Asia volunteer to bring us trained woodpeckers.

Ed Packee: Woodpeckers will find the beetles if they're available.

Jan Dawe: to Bob Purcell: the model that the task force is following is really interesting. (1) Is this a model you've seen elsewhere, (2) is there a plan for extending past June, and (3) is there a special consideration on handling a long-term subgroup?

Bob Purcell: We asked ourselves how are we going to do this? When you want a successful process, don't predetermine the outcome you want and don't predetermine the process. The task force identified the need for a science committee and drew up questions. As the group identifies the questions the science committee needs to address, we will gather people to get the best answer available at the time.

The task force was created with a grant from the U.S. Forest Service and was mandated to produce a report by June. You have to give yourself a timeframe or you won't get done. The only way to deal with it from ICS perspective—not that this is an emergency, but you can't wait for the definitive answer to everything, you have to make some assumptions. Granted, you may have to revisit it. The Kenai Borough is gathering funds to maybe continue it and maybe put in a coordinating position. This is for a couple of reasons: one, obviously this problem doesn't go away. The other reason is the public needs a point of contact. We are putting up a web site, coordinating with groups like libraries, and having a program in schools.

Tom Paragi: This evening we can do planning for public outreach for the Interior. We can break for a couple hours, and those who are interested can come back.

Bob Wheeler: Skeeter Werner did some research on turpines in spruce under attack. There was a question earlier on spruce resistance. There is a balance between spruce and bugs; they have coexisted for years. Bugs are attracted to chemicals from trees. When trees are attacked, they produce an induced response of turpines. Some are more toxic than others to beetles. But this normal mode of response doesn't work in epidemic populations of beetles. In an epidemic situation, fires are on trees' side. The risk of fire increases to the point of certainty with more dead trees, which eventually destroys the breeding population of bugs.

Ed Packee: That's why I like fire as a tool: burn my problems. Fire cleans up the area and prepares the seedbed.

Skeeter Werner: I'd like to try burning as way of stopping beetle infestation.

Dave Kelleyhouse: Are there beetles in the western Tanana Flats? It that a suitable place to try fire? Fish and Game wants to ignite a 50,000-acre prescribed fire for wildlife habitat.

Ed Packee: There are scattered patches, but it's at an endemic level. I think it's increasing.

Lori Trummer: I want to respond to Ed's fricassee theory of pathogens. In terms of native pathogens, heart rot goes after trees with developed heartwood. Fire may kill the trees that have heart rot, but it will move in again when trees have susceptible material. Until you have a really deep fire that moves through the soil and root systems, you will just exacerbate pathogens by causing wounds and having stumps.

Bob Purcell: Is the beetle migratory, or is what we're seeing a population explosion? If we somehow put up a huge net, would we stop the beetles?

Skeeter Werner: There's an endemic population everywhere. When conditions are right it will become epidemic.

Bob Purcell: There is a public misperception that beetle is spreading, marching.

Also, we have seen a lot of mold and other things that attack the trees. Are we seeing proportionate increases in those? I get comments from people that these trees rot a lot faster than they used to. Is it an accelerated process?

Lori Trummer: Blue stain doesn't cause decay; other things cause decay. Some of those sap rots are carried by the beetle. It's there at an endemic level and also there's more moving in from outside. There's more fruiting bodies of decay fungi and more susceptible material. If you have both heart rot and sap rot working on those trees, those trees are going to come down quickly. There is a proliferation of sap rot on the Kenai Peninsula.

Ed Packee: It's much moister on the Kenai Peninsula than elsewhere.

Dave Kelleyhouse: To Skeeter Werner: if you were going to burn, what month would you do it? When do the beetles fly?

Skeeter Werner: Down on the Kenai they fly from the end of May to the end of June.

Factors Influencing Regeneration

Trish Wurtz

Cooperative Forest Research Unit

People are fond of saying that white spruce is difficult to regenerate naturally. Of course, there is ample evidence all around us that it does regenerate naturally. What we don't know is how long it took to regenerate a particular stand.

It is easy to dream up scenarios in which, following a disturbance, a mature stand of spruce is replaced with another mature stand in 150 years, and it is also easy to imagine a scenario in which it might take 600 or 800 years, depending on the disturbance, the other vegetation, and the availability of seed. The goal of artificial regeneration is promote the return of a mature stand in the short term rather than the long term.

The first person who worked on spruce regeneration in interior Alaska was John Zasada, and at least initially, he concentrated on natural regeneration after harvesting. As a result of John's work, that topic is pretty well understood.

We know spruce seed is most likely to germinate on a mineral soil seedbed, that such seedbeds can be created as part of the harvesting process, and that in order for spruce seed to reach all parts of a harvested area, some thought must be put into the shape and size and orientation of the unit layout.

Finally, we know that mature spruce trees produce seed crops only sporadically. It is this last piece of information that makes natural regeneration of white spruce very unreliable from a forest manager's perspective. Because good seed crops are rare, forest managers can't schedule harvesting to take advantage of them.

There is only a short window in time before other species occupy harvested sites, and generally speaking, getting that short post-harvest window to coincide with the dispersal of a good seed crop is a stroke of pure luck, and it has been rare luck at that.

So, for the last few years I have concentrated my research efforts on artificial regeneration of white spruce by planting. Planting is the most certain means of regenerating white spruce.

This talk will have two parts: First, a brief description of three research projects that could be viewed as three attempts at helping planted seedlings overcome competition from the grass Calamagrostis Canadensis. Second, I'll switch gears and describe the overall regeneration outlook for the interior and southcentral regions in light of the beetle infestation and the harvesting that is also going on. I think it's important to be realistic about the factors that drive regeneration efforts. What's going on on the Kenai now can give us considerable insight into what might happen here with respect to regeneration.

Calamagrostis Canadensis is an aggressive competitor that colonizes harvested sites all over the state. It is also a very big impediment to regeneration of the boreal forest of Canada as well as Alaska.

The first research project was trying a mulch mat or a fabric mat for a physical barrier around a planted spruce seedling. We installed a study on the Kenai Peninsula about six years ago that examined four different kinds of fabric mats. We used four different types of materials: plastic, burlap, woven materials at five different sites. After five years we found that the fabric mats had no effect at all on the survival and growth. The survival and growth was very poor on all the seedlings. A researcher at the California station named Phil McDonald has published a lot on fabric mats as physical barriers to competing vegetation. I asked him why we got the results we did. He said the mats you used were too small. The California regeneration sites were using mats that were three meters square, about the size of a king-sized bed sheet. This method was extremely expensive. The cheapest method and also the most effective was herbicides.

The second experiment as using alder. Alder is a nitrogen fixer. I wondered if there was a nitrogen hot spot in the soil near an alder stand and if that would affect growth rates of spruce after harvesting. There were two questions: (1) how does the preexisting understory alder affect the regeneration of the forest after harvesting? and (2) could including alder in a crop tree plantation affect how the plantation grew? This study is going on right now at three sites, funded by the Alaska Science and Technology Foundation. The short description of the analysis is that we haven't found any relationship. The second question was could you use alder as a replacement competitor; could it occupy the site before Calamagrostis? In the short term, five years, alders have survived well and they haven't had really any effect on the vegetation at the site. Alder is not a vigorous enough grower to keep Calamagrostis out.

The last study was looking at stock types of white spruce seedlings. We put study sites very close together on the Cache Creek Road, trying different types of seedlings. Some grew better but had extremely poor survival, others grew more slowly but survived. We noticed that the vegetation on the sites that had poor survival had more Calamagrostis than the other sites.

All of these efforts cost money. White spruce was selling at about $1,200 per acre stumpage in the Fairbanks area. The Kenai trees were selling for about $400 to $500 per acre. Beetle killed are far less valuable than that. In Ketchikan a mixed hemlock and spruce acre is typically $5,000 and in the coast range of Oregon, second-growth of fir was going for $45,000 per acre. This puts it in perspective: what forest managers have to spend on forest regeneration is very low if they intend to break even.

Now I want to talk about regeneration scenario in light of beetle infestation. First, though the amount of acreage being harvested statewide has increased in the last 10 years to about 15,000 acres per year, this type of disturbance still pales in comparison to the amount of acres affected solely by beetles. If we estimate that a total of 150,000 acres has been harvested over the last 15 years, that still represents only 5 percent of the estimated three million acres infested. With respect to regeneration, the responses of land owners to the beetle infestation can be listed this way.

The option that's being used overwhelmingly is do nothing. In some cases, do nothing is an official policy, such as the Park Service approach for the infestation in the Wrangell-Saint-Elias National Park. In the case of the Chugach National Forest, do nothing is the fall-back position when they were met with public opposition to harvesting. In other cases, there is no response to the beetle infestation because the market conditions and the stand's location combine to make it economically unfeasible to harvest. In any case, the vast majority of acres infested with spruce beetles, and by that I mean greater than 95 percent, are being "managed" this way.

The decision has to do with value of spruce where you are, whether public or private, whether the trees are live or dead, and your commitment to spruce regeneration. Mostly either birch regenerates or no trees at all.

The spruce regeneration scenario on those lands depends entirely on the level of mortality caused by the beetles and the number of spruce seedlings already in the understory. In places where there are few seedlings and mortality of the mature trees is high, the spruce regeneration scenario is very poor.

Outlook for spruce regeneration in Alaska is grim. I'm trying to take a new approach to Calamagrostis. Did you know that Calamagrostis is sold as an ornamental grass?

Tree Susceptibility to Insects (Bark Beetles)

Roger E. Burnside

Forest Entomologist, AKDNR/Division of Forestry, Anchorage, Alaska

Introduction

My talk today covers stand susceptibility to insects. This is a very broad subject so I took the liberty to structure my talk to discuss bark beetle relationships in host susceptibility in the Interior; I will also describe other major forest pests of importance based on aerial surveys conducted by the joint U.S. Forest Service and State of Alaska, Division of Forestry over the past 6 years. Cumulative impacts from major forest pests (bark beetles and conifer defoliators such as spruce budworm) may be substantial given the recent changes in warming trends throughout Alaska to increase susceptibility of hosts in the region. [Briefly mention the collaborative role of Alaska Department of Natural Resources, Division of Forestry in forest research even though DOF's mission does not specifically involve forest research. DOF's mission for forest health management is to protect the forest while providing management options for state and private landowners to address and mitigate forest pest impacts.] My position works closely with other agency foresters (U.S. Forest Service, State & Private Forestry) and private nonindustrial forestry groups (e.g., Tanana Chiefs Conference, Fairbanks) to collaborate on research findings pertaining to forest insect management and control options; in addition, I receive a limited amount of funding via small grants to work primarily in the area of pheromone monitoring and beetle mitigation options for the boreal forest. I am currently working with mitigation options using semiochemicals to manage Ips engravers during harvest/thinning operations near Tok and along the Goldstream Valley (Standard Creek), and some limited work with semiochemicals to manage spruce beetle in Southcentral Alaska.

We have heard much concern the past day during this conference about potential changes in susceptibility and "resistance" to pests and pathogens brought about by global climate change in the interior boreal forest. Irrespective of whether there is climate change occurring, it is very important to emphasize that massive disturbance and change is natural in the boreal forest and that global climate changes will serve only to exacerbate and accelerate these changes, and thereby increase susceptibility ratings. Also, the term "resistance" should not be used in the purest sense when talking about host susceptibility to bark beetles since I do not believe that truly resistance species to conifer bark beetles will be found. What we have is a range of resistance where some trees may be able to produce defensive compounds to prevent population buildup in individual trees. However, as population levels of bark beetles increase from endemic (low level, naturally occurring) to epidemic levels, true resistance disappears—e.g., spruce beetle and Ips engravers. What I would like to propose is that in the interior boreal forest we have a range of variables at play during the successional process whereby hosts are susceptible to both insects and pathogens (fungi, etc.) at various stages of their development and also harbor different levels of some insects/pathogens with little apparent or observable effects. Several factors "predispose" (bring about susceptibility, make more susceptible) hosts to these agents at different times by making the host more vulnerable to an insect/pathogen or setting up conditions to increase levels of the insect/pathogen which then overwhelm the host's defenses. This variability is very complex and must be discussed by looking at the entire host, insect, pathogen relationship vs. the other factors that may be responsible for the change in host condition.

Therefore, please keep in mind that disturbance is a normal process in the boreal forest, plants can become more or less susceptible as a result of a combination of biotic, abiotic, and/or anthropogenic factors during their life cycle; and that dramatic changes in host condition in the boreal forest are part of the normal process for successional changes and host renewal.

Excerpts from *Beetle Pathogen Interactions in Conifer Forests,* T.D. Schowalter and G.M. Filip, Eds., 1993. Academic Press Ltd.

p. 73 (re: conclusions on abiotic and biotic predisposition)

"Tree condition and forest health are major factors influencing bark beetle and pathogen epidemiologies. A number of abiotic and biotic factors reduce tree vigor and increase susceptibility to invasion by these organisms. Major abiotic factors include moisture limitation or flooding, soil properties that limit nutrient availability, and injury resulting from storms or fire. Biotic factors include prior infection by pathogenic fungi or mistletoes, and infestation by defoliators or other insects that weaken host tree defenses. In addition, anthropogenic factors, such as atmospheric pollution and forest management practices, often stress trees and create susceptibility targets for bark beetles and pathogens. Global warming is likely to exacerbate tree stress, especially near the margins of species geographical ranges.

Management of bark beetle-pathogen interactions requires attention to predisposing factors. Identification of trees and susceptible condition is necessary to remedy stressful conditions, where possible, or to apply other management strategies, as appropriate...."

p. 234 (recommendations for future research)

"Rigorous scientific testing of hypotheses using experimental methods will require greater collaboration between researchers (including entomologists, pathologists, and forest ecologists) and forest managers."

The traditional emphasis in North American forestry has been on timber values. Increasing concern over sustainable forest health, preservation of biodiversity, protection of long-term site productivity, and the fate of future forests subject to changing atmospheric quality and global climate already is altering our management objectives and approaches. Our research efforts must be directed toward a better understanding of the roles played by bark beetles, pathogenic fungi, environmental factors, and their interactions, in meeting these objectives. Perhaps by incorporating or mimicking these natural roles into our forest management, we can accomplish our management objectives more efficiently."

Questions and Answers

Q: You showed that the distribution of pests in the Interior is largely on river corridors—why? It is because those are the most vigorous growing trees and are stressed under current climate conditions?

A: The ips beetle is responding to siltation and flooding that stress trees. The spruce beetle likes the largest trees that are in the best sites along river corridors. Budworm is widespread.

Comment from Ed Packee: On the Kenai Peninsula the bug is higher on the trunk than here. A lot of the times I find beetle activity not on the bole but on exposed support roots.

Skeeter Werner: I have seen it too for 20 years.

Ed Holsten: I wonder if the difference is the population levels are low here.

Impact & risk vocabulary for SAF terminology

Draft, February 1998 Comments to Ann Lynch, FAX 520 556 2130, aml@alpine.for.nau.edu

Damage. Usually (1) the significance of injury through a value system, usually by effects to forest commodity production or noncommodity forest attributes, but sometimes (2) the ecological effects of insects and diseases (or other agents) on forest growth, structure, and productivity or on ecosystem condition. See also effect, impact.

Effects. In entomology and pathology, the changes to forest growth, structure, and productivity, and to ecosystem condition, brought about by insect and pathogen populations. This term is often used in place of the traditional term "damage" in recognition of the roles insects and diseases in disturbance ecology.

Hazard. The degree of vulnerability of a stand to a particular pest, given that the insect is present (Coulson and Witter 1984). See also risk, susceptibility, vulnerability.

Hazard-rating system. A ranking of trees or forest stands according to the probability of damage or impact from one or more insects or diseases.

Hazard tree. A tree that would hit a target, usually people or property, if it or a part of it were to fall. See also damage and injury. Cumulative net effect of insect or populations on any or all forest resources. The concept is sometimes to those effects that require a management action now or in the See also damage, effect, injury.

Injury. An abnormal physical or physiological condition on a host resulting from the activity of a biotic or abiotic agent. See also damage and impact..

Pest. (1) An organism that is undesirable or detrimental to the interests of humans. (2) An organism capable of causing injury or damage. Although neither archaic nor inaccurate, this term has no ecological significance, and it's use today to describe insects and pathogens is sometimes discouraged, due to a better understanding of these agents' ecological functions. However, a simple connotation—free term has not emerged to replace it.

Resistance. (1) The ability of an individual or strains of organisms to survive normally lethal doses of pesticides, the ability having resulted from genetic selection over multiple generations of the population to repeated exposure to the toxicant (Pfadt 1985). (2) In entomology and pathology, the ability of plants to avoid, suppress, prevent, overcome, or tolerate insect or pathogen attack, or to adversely affect the attacking insects or pathogens. Resistance may be partial or complete, with immunity being the ultimate expression of resistance. See also susceptibility, vulnerability.

Risk. Generally, risks refers to the probability that an insect or pathogen population will occur in a tree or stand. However, because the population dynamics of defoliating insects, bark beetles, and pathogens are so different, and because for some insects and pathogens the presence of an aggressive species almost always results in significant damage, the following definitions may apply: (1) The probability that a tree will die within a specified time period. (2) with bark beetles, Shore & Safranyik. The short-term expectation of tree mortality in a stand as a result of a bark beetle infestation; it is a function of stand susceptibility and beetle pressure. Beetle pressure is the magnitude of a beetle population affecting a stand as determined by the number of currently infested trees and their proximity to the stand being assessed, with respect to the likelihood of a beetle population entering a given stand (Shore and Safranyik

1992). (3) The probability of an insect outbreak occurring in a particular stand, watershed, or forest, or of a particular tree being severely damaged, under a given set of conditions. The concept of risk does not concern itself with the extent of damage (Berryman 1986) . (4) The probability than an undesirable event will or will not occur; it is the product of the probability of the event taking place, the probability of being exposed to the event, and the probability of certain outcomes occurring if exposure takes place (Dunster and Dunster 1996)

Risk-rating system. (1) A ranking of trees or forest stands according to the probability of attack or outbreak by one or more insects or pathogens. (2) Prediction of the probability that a tree will die with a specified period of time.

Susceptibility. (1) The probability that a tree or stand will be attacked by, or incur an outbreak of, an insect or pathogen.??? See also immunity (if included here), resistance. (2) The suitability of a habitat for an insect or pathogen, or for populations of insects or pathogens. (3) Inability to avoid or withstand attack by a parasite, usually a matter of degree. See also tolerance, vulnerability.

Tolerance. (1) Ability of a plant to endure the development and survive invasion of a parasite or pathogenic organism with minimum symptoms of disease. (2) The amount of a pesticide that may safely and legally remain as a residue on a food plant or in meat or fat; also termed tolerance level (Pfadt 1985.

Vulnerability. Generally, the likelihood of tree or stand damage given that an attack or outbreak has occurred.

USING REMOTE SENSING FOR FOREST MAPPING AND ASSESSMENT

Carl Markon

USGS in Anchorage
Contractor for EROS Alaska Field Office

Generally remote sensing is (1) small format cameras/scanners (35 mm, 70 mm, digital cameras) good for site-specific. (2) Medium format cameras/scanners (standard 9x9 in photographic metric cameras and digital multispectral scanners)

Commonly Used Remote Sensing Products

- Photo-interpreted maps
  - measurement/identification of forest:
    - cover/density
    - volume
    - heights
    - species
    - areas (timber type, disturbance, management boundaries)
- Vegetation Maps
  - application of field based data for identification of cover classes (P.I. or digital analysis)
- Indices
  - NDVI—Normalized Difference Vegetation Index
    - most common
- Some combination
  - Digital classification-Aerial Photo P.I.-Digitizing
  - 'heads-up' digitizing
  - Multi-scale resource inventory
    - combination of satellite, small scale A.P, large scale A.P., field plot data

Advantages/Disadvantages of Using Remote Sensing Over Field Based Data

- Advantages
  - Allows spatial observation over the landscape
  - Generally repeatable over time
  - Not as time consuming or costly as field based estimates
  - Inventory large area for less cost
- Disadvantages
  - Not (normally) as accurate as field based data
  - Highly dependent on weather and sensor calibrations
  - Results dependent on field observations

Remote Sensing Systems

- Small Format Cameras/Scanners
  - 35 mm photographic
  - 70 mm photographic
  - Digital cameras
- Medium Format Cameras/Scanners
  - Standard 9 in x 9 in photographic metric cameras
  - Digital Multi-spectral Scanners

- Satellite Systems
  - Landsat Multi-spectral Scanner (MSS)
  - Landsat Thematic Mapper (TM)
    - (other similar systems)
  - Spot Panchromatic and Multispectral scanner
  - Advanced Very High Resolution Radiometer
    - (other similar systems)
  - New satellite systems scheduled for launch

Scale and Coverage Considerations for Different Remote Sensing Systems

Aerial Photography
- Large Scale Maps (1:25,000 and larger)
- Medium Scale Maps (1:25,000 to 1:250,000)

SPOT
- Large Scale Maps (1:60,000 to 1:25,000)
- Medium Scale Maps (1:60,000 to 1:250,000)

Landsat MSS and TM
- Medium Scale Maps (1:60,000 and 1:250,000)
- Small Scale Maps (1:250,000 to 1:1,000,000)

AVHRR
- Small Scale Maps (1:250,000 and 1:1,000,000)
- Very Small Scale Maps (1:1,000,000 and smaller)

System Comparison

	Aerial Photography	Landsat	SPOT	AVHRR
Altitude	Varies	705 Km	830 Km	833 Km
Repeat Cycle	Anytime	16 days	26 days	2-3 per day
Instrument(s)	Varies	MSS/TM	MSS/Pan	HRR
Swath Width	Varies	185x170 Km	60 Km	2400 Km
Resolution	Varies	80 and 30 m*	20 and 10 m*	1.1 km*

*nominal resolution

Land Cover Mapping Using Satellite Data

LEVEL 1	LEVEL 2	LEVEL 3
FOREST	Needleleaf	Closed
		Open
	Woodland	
	Broadleaf	Closed
		Open
	Mixed	Closed
		Open
SCRUB	Tall	Closed
		Open
	Low	Closed
		Open
	Dwarf	Closed
HERB	Dry/Mesic	
		Wet
		Aquatic

- Level 3 Categories
  - primarily dependent upon ancillary data (winter satellite data)
  - modeling
- Species Level
  - requires modeling (soils, topographic, hydrologic)
  - often site specific (different models for different parts of data set)

Land Cover Mapping Using Aerial Photography

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
FOREST	Needleleaf	Closed	Species level
		Open	
	Woodland		
	Broadleaf	Closed	
		Open	
	Mixed	Closed	
		Open	
SCRUB	Tall	Closed	
		Open	
	Low	Closed	
		Open	
	Dwarf	Closed	
HERB	Dry/Mesic		
	Wet		
	Aquatic		

- Mapping of different levels highly dependent upon
  - Experience of P.I.
  - Direct knowledge of area being mapped
- Products must go through some horizontal/vertical control
- Products must be digitized for digital access

Assessing Vegetation Condition Using Indices

- Calculated using multispectral scanner data
  - Primarily SPOT, Landsat, and AVHRR
- Based on correlations with bio-physical properties of vegetation at the time the digital data was acquired
- NDVI most commonly known
  - measure of "greenness"

Questions and Answers

Q: *In terms of indices, what about the application of those for detecting losing needles?*

A: Yes, you can use indices and take multiple shots over time. One problem with airborne flight data is that it's hard to match up flight lines.

Q: *One Canadian researcher is trying to assess early bark beetle outbreaks using infrared? Is there an opportunity to do that through satellite imagery?*

A: The problem is you don't have a satellite system in place to have regular overflights over big areas. If there's cloud cover, you can't get data. There's been a lot of work done using color infrared photography to detect stress in vegetation.

Q: *Sometimes we look at these tools as useful in place of us being present in remote areas. Rather than decreasing our information needs, it just throws out so much information going one way or another that we just have to go out on the ground and find out what readings mean. You can get into trouble if you make an inappropriate interpretation.*

A: That's why I said you still need the field-based information.

The Role of Disturbance in Ecosystem Management

Beth Schultz

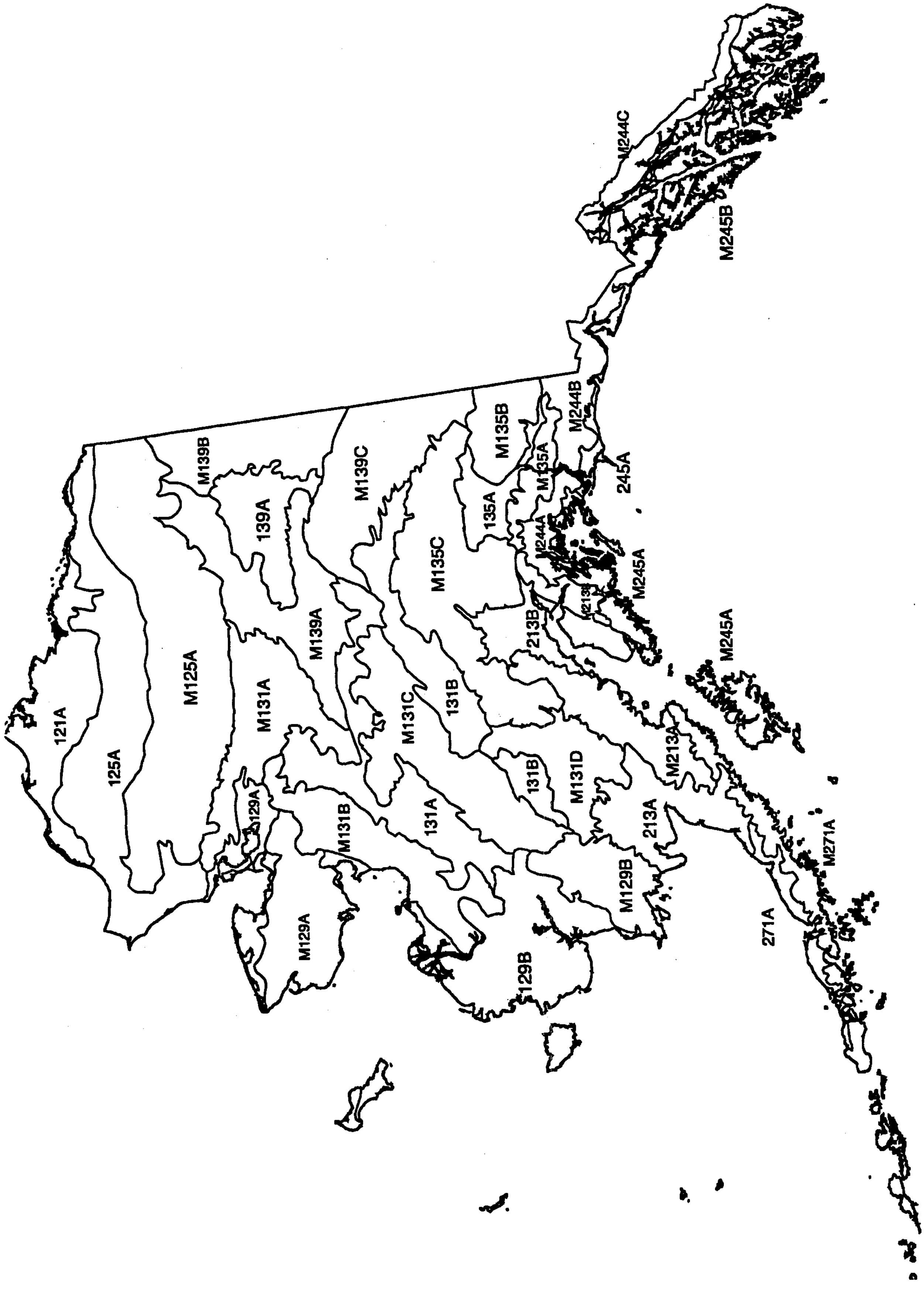
One premise of ecosystem management is that native species are adapted to the natural disturbances common to an area. Disturbance events are responsible for the way the current landscape appears and functions today, and will determine the structure and composition of future landscapes. In Alaska, glaciation, earthquakes, wind storms, fire, flooding, avalanches and landslides greatly affect ecological processes. These types of disturbances remove existing vegetation and often expose mineral soil for new plants to become established.

Disturbance events such as insect and disease outbreaks also result in shifting landscape patterns. These disturbances usually affect only a few species directly, while indirectly affecting the remaining species through reduced competition or changes in forest structure. Changes resulting from these types of disturbances often occur over varying time periods, but can be very dramatic and cover large areas. Spruce beetles have radically affected the landscape in a single decade, heart rots and other internal diseases operate for decades, whereas yellow-cedar decline has been occurring for nearly 100 years.

To a certain extent, we can predict what type of disturbance is likely to occur in a particular area: fires are frequent in interior Alaska and wind storm events are important in southeast. Spruce beetles are an important disturbance agent in southcentral Alaska. Disturbance agents and patterns are generally tied to geography, climate, and vegetation. When we understand the complexities of these relationships, we are able to predict and respond to natural disturbances and mimic the desirable effects with management activities. Ecological classification is one tool available to help us understand disturbance patterns.

Many useful systems of classification have been developed for Alaska's ecosystems and vegetation. Refining and standardizing these classifications across all ownership's will promote effective ecosystem management. ECOMAP (1993) is one system of ecological classification that the Forest Service has adopted and continues to develop. Within this hierarchical system, ecosystems are delineated at multiple scales using different sets of environmental factors. The levels established at this time include Domains, Divisions, Provinces and Sections. Domains represent subcontinental climatic zones. Divisions and Provinces represent climatic subzones as reflected by dominant life-forms (meadows vs. forests) and broad vegetation types, respectively. Sections are distinguished mainly by geomorphic and topographic features. The Section level is the first level of the hierarchy where analysis of insect and disease activity becomes applicable.

In this edition of the Forest Insect and Disease Conditions in Alaska, we introduce and make reference to the Ecosystem Sections of Alaska (Map 1). This map was developed in the Alaska Region (Nowacki and Brock 1995). Section descriptions are included in Appendix C with a list of damaging agents reported during the 1997 aerial survey. Only Sections that were covered in this year's survey are described. As the ecological hierarchy classification and mapping are developed to finer scales, they become more valuable as management tools to predict the impacts of various disturbances on forest resources.


M244C
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M131A
M131C
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121A
125A
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213A
M271A
M129B
M129A
271A
129B

The Sections included in this report are briefly described below, along with descriptions of the appropriate Domains, Divisions, and Provinces. The prefix "M" attached to codes represents mountainous Sections where soil and vegetational zones are present. Fire frequency classification at the section level is adopted from Gallant et al.. *(1995).* The classification categories are based on frequency of lightning fires and are as follows: very low (< 1 fire/yr), low (1-5 fires/yr), common (6-10 fires/yr), very common (11-20 fires/yr), and frequent (>20 fires/yr). Types of insect damage reported during the 1997 survey are noted for each Section.

100 Polar Domain: Climate is controlled primarily by polar air masses. Winters are severe and total annual precipitation is small.

- **130 Subarctic Division:** Climate has great seasonal range. Permafrost prevails under large areas. Despite low temperatures and long winters, the valleys were not glaciated during the Pleistocene. Boreal forests and open woodlands with abundant lichen predominate.
  - **131 Yukon Intermountain Taiga Province:** Series of broad valleys covered with alluvial deposits and low mountains and hills. The Province lies between the Brooks and Alaska Ranges, with Yukon, Tanana, Koyukuk, and upper Kuskokwim rivers providing drainage. The climate is semi-arid. Forest vegetation includes white spruce and hardwoods along river bottoms and uplands near rivers, and black spruce dominates on uplands.
    - **131A Yukon Bottomlands Section:** Closed forests of spruce, birch, and aspen on better drained sites, open black spruce forests on wetlands interspersed with willow thickets. Wetlands occupy much of the land cover, and permafrost is wide spread but discontinuous. Wildfire is frequent. Insect damage reported in 1997 includes spruce budworm, larch sawfly, large aspen tortrix, willow defoliation, spruce beetle, and Ips.
    - **131B Kuskokwim Colluvial Plain Section:** Forest vegetation includes spruce-poplar forests, open black spruce woodlands, and flood plain thickets of willow and alder. Wildfire is very common to frequent and river flooding frequent in the spring. Insect damage for 1997 includes larch sawfly, Ips, and willow defoliation. Surveys were hampered by poor visibility due to smoke from wildfires.
    - **M131A Upper Kobuk-Koyukuk Section:** Closed forests of spruce, birch, and aspen occur on well drained sites. Wildfires are common. The only insect damage reported in this Section was larch sawfly.
    - **M131B Nulato Hills Section:** Most of the area supports alpine tundra, but spruce-birch-aspen forests occur at lower elevations. Wildfires are frequent. No insect damage was recorded for the portions covered by the 1997 aerial survey.
    - **M131C Kuskokwim Mountains Section:** Open black spruce forests are abundant, alpine tundra cover the hills. White spruce - paper birch communities predominate on lower hill slopes. Wildfires are frequent. Insect damage recorded this year include larch sawfly, Ips, and willow defoliation.
    - **M131D Nushagak-Lime Hills Section:** Alpine tundra dominates the rounded to flat topped ridges, and spruce, aspen, and birch prevail in the broad and gentle sloping valleys. Wildfires are frequent. No damage was recorded in the areas covered by aerial surveys in 1997.
  - **135 Alaska Range Taiga Province:** This Province is composed of a broad basin surrounded by steep, rugged mountains of the Alaska, Wrangell, and Chugach

Ranges. Rivers originate in valley glaciers at high elevations and are often swift and braided with heavy sediment loads. The Copper River is the primary drainage. Forest vegetation includes open black spruce woodlands, with white spruce occurring on better drained soils and along riparian zones in the mountainous Sections.

135A **Copper River Basin Section:** The basin consists of rolling to hilly moraines and nearly level alluvial plains that occupy the site of a Pleistocene glacial lake. Elevation is 1000 feet or greater. Open black spruce forests are interspersed with large areas of brushy tundra. White spruce occurs on south-facing gravelly moraines. Cottonwood occurs on large flood plains. Fire occurrence is low, and flooding is an important natural disturbance. Damage reported in the 1997 aerial survey include spruce beetles, Ips, birch defoliation, willow defoliation, large aspen tortrix, and flooding.

M135A **Northern Chugach Range Section:** Forest vegetation is limited to spruce and hardwoods along the larger rivers. Snow and rock avalanches are common, wildfire occurrence is very low. Insect damage reported include spruce beetle and Ips along river drainage's.

M135B **Wrangell Mountain Section:** Forest vegetation occurs, but no portion of this Section was surveyed in 1997.

ML3SC **Alaska Range Section:** Steep mountain ridges are separated by broad valleys, where spruce and hardwood forests occur along riparian zones. Snow avalanches occur frequently, but wildfire occurrence is low. Insect damage reported include spruce beetle, willow defoliation, Ips, and birch defoliation.

.39 **Upper Yukon Taiga Province:** The Province contains the Yukon Flats Section, a flat marshy basin, and the surrounding the rounded mountains and hills. The climate is extreme with large seasonal temperature ranges. Winters are long and cold, and the short summers are hot and dry; some areas at higher elevations are moisture-deficit in summer. Wildfire is very common. Permafrost is semi-continuous, and highly subject to alteration from disturbance.

M139A **Ray Mountain Section:** Low mountains and hills to the west of the flats. Permafrost, surface water, hillslope, and wildfire interactions result in a complex plant community mosaic. Forests of white spruce, birch, and aspen dominate the lower slopes in the south and south-facing slopes in the north. Black spruce occurs at higher elevations, on north-facing slopes, and all but steep south-facing slopes. Wildfire is very common to frequent. This year's surveys report damage from birch defoliation, Ips, larch sawfly, and spruce budworm.

M139B **Ogilvie Mountain Section:** Forest vegetation occurs, but no portion of this Section was surveyed in 1997.

M139C **Dawson Range Section:** This section has steeper rounded ridges with some rugged peaks. Forest vegetation occurs at lower elevations. Open spruce forests are dominated with white spruce, with black spruce sometimes co-dominating. Birch and aspen also occur. Wildfire is very common. Damage reported include Ips, larch sawfly, spruce beetle, cottonwood defoliation, and willow defoliation.

200 **Humid Temperate Domain:** Climate is influenced by both marine and polar air masses.

210 **Warm Continental Division:** Distinct seasons with snowy winters and warm summers. Needle-leaf forests are common.

213 **Alaska Mixed Forest Province:** This Province has smooth and irregular plains and surrounded by high mountains. It is centered around Cook Inlet in southcentral Alaska. Climate is transitional between polar and maritime. This is reflected in the range of forest cover types: spruce - hemlock to mixed hardwoods. Permafrost is rare.

213A Bristol Bay Lowlands Section: Forest vegetation occurs, but no portion of this Section was surveyed in 1997.

213B **Cook Inlet Lowlands Section:** This broad basin has been shaped by many glacial events. Spruce/hardwood forests are most widespread across the level to rolling plains. Wildfire occurrence from lightning strikes is low, but fires resulting from human activity are very common. This area is heavily populated and has been influenced by agriculture, urban development, petroleum extraction, and human recreation. The 1997 survey reported damage from spruce beetle, large aspen tortrix, birch, cottonwood, and willow defoliation, spruce needle rust, Ips, and flooding.

M213A **Northern Aleutian Range Section:** This section contains steep, rugged mountains of volcanic origin. Large lakes occupy the glaciated valleys. Open spruce forests occur in well drained sites in some valleys and lower hill slopes. Avalanches are common, wildfire occurrence is low. Insect damage reported in 1997 was limited to spruce beetles in the forests adjacent to rivers.

M213B **Kenai Mountains Section:** This Section is dominated by the Kenai and western Chugach mountains. The area has been heavily glaciated. Forest vegetation occurs from mid to low elevations and along rivers and coast lines. Avalanches and flooding are important disturbance events. Wildfire occurrence from lightning strikes is low, but fires resulting from human activity are common. Past land clearing activities, including fire, have influenced the present landscape. Damage reported in 1997 includes spruce beetles and Ips.

240 **Marine Division:** This zone receives abundant rainfall from maritime air masses. Temperature ranges are narrow due to the marine influence.

244 **Pacific Coastal Icefields Province:** This Province stretches from the Coast Mountains of southeast Alaska through the St. Elias mountains up to the Chugach-Kenai Mountains. Glaciers and icefields cover the higher portions of the mountains. Rock, ice, and alpine vegetation prevails. The lower elevations support some forests of hemlock and Sitka spruce. Willows and black cottonwood are found infrequently along the glacial river beds.

M244A Chugach Range Section: Alpine vegetation dominates. Forest vegetation is confined to the lowest side-slopes and river bottoms. Hemlock, spruce and cottonwood are predominant. Snow and rock avalanches are common, and flooding events are significant. Wildfire occurrence is very low. Damage reported included spruce beetle, black-headed budworm, and flooding.

M244B St. Elias Range Section: Alpine tundra dominates, with forest vegetation confined to river drainages, mostly spruce and hardwoods. Avalanches and flooding are major natural disturbances. Wildfire occurrence is very low. Damage due to spruce beetles was reported in 1997.

M244C Boundary Range Section: This section straddles the international boundary with Canada. Forest vegetation of hemlock, spruce, and cottonwood only occurs along river corridors within mountain passes. Snow avalanches and landslides create large-scale disturbances. Wildfire occurrence is very low. Damages mapped during the 1997 survey include cottonwood leaf beetle, flooding, spruce beetle, windthrow, and porcupine damage.

245 **Pacific Gulf Coast Forest Province:** This Province consists of fjords and mountainous terrain. The Province has the mildest winters in Alaska and abundant precipitation. Hemlock, Sitka spruce, and cedar dominate the coastal rainforests.

245A **Gulf of Alaska Fjordlands Section:** The coastal lowlands feature alluvial fans, uplifted mudflats, moraine deposits, and river deltas. Spruce-hemlock forests occur on well-drained sites, whereas alder, willow, and birch dominate wetland areas, with cottonwood occurring along major river channels. Glacial outburst floods and earthquakes causing uplift and subsidence are significant disturbances. Strong winds also influence forest vegetation structure. Wildfire is rare. Damage reported this year includes black-headed budworm, spruce beetle, and flooding.

M245A **Gulf of Alaska Fjordlands Section:** Islands and headlands with steep cliffs from eroded bedrock characterize this section. They support Sitka spruce and hemlock forests. Landslides and avalanches are common and outer islands are subject to intense winds from winter storms. Wildfire is rare. Damage reported during surveys includes windthrow, flooding, cottonwood defoliation, black-headed budworm, landslide, spruce beetle, and thinning spruce crowns.

M245B **Alexander Archipelago Section:** The rugged islands and mountains of southeast Alaska are dominated by rainforests of hemlock, Sitka spruce, and cedar. Wildfires only occur during drought. Landslides and avalanches are frequent in the steeper terrain. The outer islands are subject to extreme winds from winter storms, and so windthrow is common. Damage reported this year includes windthrow, landslides, spruce beetle, hemlock sawfly, porcupine damage, black-headed budworm, spruce needle aphid, and some minor flooding.

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Summary
National Hierarchical Framework Of Ecological Units
ECOMAP, USDA Forest Service, Washington, D.C.

The National Hierarchical Framework of Ecological Units is a regionalization, classification and mapping system for stratifying the Earth into progressively smaller areas of increasingly uniform ecological potentials. Ecological types are classified and ecological units are mapped based on associations of those biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients which regulate the structure and function of ecosystems. These factors include climate, physiography, water, soils, air, hydrology, and potential natural communities.

The hierarchy is developed geographically from both the top-down and bottom-up; conditions that change at broad scales such as climate and geology are continually related to conditions that change at finer scales such as biotic distributions and soil characteristics. This approach enables scientists and managers to evaluate broader scale influences on finer scale conditions and processes, as well as to use finer scale information to determine the significance of broader scale influences. In this iterative procedure, Ecoregion and Subregion levels of the hierarchy are developed by stratification as fine scale field classifications and inventories are being completed.

This regionalization, classification, and mapping process uses available resource maps including climate, geology, landform, soils, water, and vegetation. In some cases, however, additional information is needed. Data bases and analysis techniques are being developed to provide interpretation of the ecological units.

Uses of the hierarchy vary according to management information needs and level of information resolution. These applications are summarized below. The hierarchical framework is largely a Forest Service effort, although there has been involvement by the U.S. Soil Conservation Service, Bureau of Land Management, Fish and Wildlife Service, U.S. Geological Survey, The Nature Conservancy and other national and regional agencies. Our goals are to develop an ecological classification and inventory system for all National Forest System lands, and to provide a prototype system acceptable to all agencies. Nationally coordinated ecological unit maps will be developed for Ecoregion and Subregion scales covering all U.S. lands.

Table 1. National hierarchy of ecological units

PLANNING AND ANALYSIS SCALE	ECOLOGICAL UNITS	PURPOSE, OBJECTIVES, AND GENERAL USE	GENERAL SIZE RANGE
Ecoregion Global Continental Regional		Broad applicability for modeling and sampling. Strategic planning and assessment. International planning.	1,000,000's to 10,000's of square miles.
Subregion	Section Subsection	Strategic, multi-forest, statewide and multi-agency analysis and assessment.	1,000's to 10's of square miles.
Landscape	Landtype Association	Forest or area-wide planning, and watershed analysis.	1,000's to 100's of acres.
Land Unit	Landtype Landtype Phase	Project and management area planning and analysis.	100's to less than 10 acres.
Hierarchy can be expanded by user to smaller geographical areas and more detailed ecological units if needed.		*Very detailed project planning*	

Table 2. Principal map unit design criteria of ecological units

ECOLOGICAL UNIT	PRINCIPAL MAP UNIT DESIGN CRITERIA[1]
Domain	• Broad climatic zones or groups (e.g., dry, humid, tropical).
Division	• Regional climatic types (Koppen 1931, Trewartha 1968).
	• Vegetational affinities (e.g., prairie or forest).
	• Soil order.
Province	• Dominant potential natural vegetation (Kuchler 1964).
	• Highlands or mountains with complex vertical climate-vegetation-soil zonation.
Section	• Geomorphic province, geologic age, stratigaphy, lithology.
	• Regional climatic data.
	• Phases of soil orders, suborders or great groups.
	• Potential natural vegetation.
	• Potential natural communities (PNC) (FSH 2090).
Subsection	• Geomorphic process, surficial geology, lithology.
	• Phases of soil orders, suborders or great groups.
	• Subregional climatic data.
	• PNC—formation or series.
Landtype Association	• Geomorphic process, geologic formation, surficial geology, and elevation.
	• Phases of soil subgroups, families, or series.
	• Local climate.
	• PNC—series, subseries, plant associations.
Landtype	• Landform and topography (elevation, aspect, slope gradient and position).
	• Phases of soil subgroups, families, or series.
	• Rock type, geomorphic process.
	• PNC—plant associations.
Landtype Phase	• Phases of soil families or series.
	• Landform and slope position.
	• PNC—plant associations or phases.

1. It should be noted that the criteria listed are broad categories of environmental and landscape components. The actual classes of components chosen for designing map units depend on the objectives for the map.

Table 3. Map scale and polygon size of ecological units.

ECOLOGICAL UNIT	MAP SCALE RANGE	GENERAL POLYGON SIZE
Domain	1:30,000,000 or smaller	1000,000's of square miles
Division	1:30,000,000 to 1:7,500,000	100,000's of square miles
Province	1:15,000,000 to 1:5,000,000	10,000's of square miles
Section	1:7,500,000 to 1:3,500,000	1,000's of square miles
Subsection	1:3,500,000 to 1:250,000	10's to low 1,000's of square miles
Landtype Association	1:250,000 to 1:60,000	100's to 1,000's of acres
Landtype	1:60,000 to 1:24,000	10's to 100's of acres
Landtype Phase	1:24,000 or larger	<100 acres

Desired Future Conditions in the Boreal Forest

Bob Wheeler

Abstract: The forests of the future in Alaska will be our heritage which will reflect the management we apply to them today. We are in the process of evaluating a new type of forest management referred to as Ecosystem Management for the Interior forest region. Through this process we hope to be able to provide an assessment of existing forest conditions and develop management prescriptions on a landscape level for desired future conditions of the forest. This process will involve developing a comprehensive inventory and assessment of existing conditions, analytical techniques for modeling future forest response to management and environmental changes, and a collaborative process for social input in the planning process and methodology for resolving conflict.

This presentation looks at various steps envisioned in order to achieve a successful ecosystem management program.

Introduction: Forest Planning

Managing the forest landscape for present and future generations is largely what forest planning is about. This process has traditionally focused on obtaining products or values from the forest stemming from various management activities.

Recently, with increasing concern over both protecting the environment from degradation while providing for an increasing demand for forest products and qualities, there has been an increasing interest in the application of Ecosystem Management.

Forest managers are forced to make management decisions in an increasingly difficult working environment, having to answer how the forest will be managed and for what. Recent research indicates that the planning process can be assisted by having a well defined desired future condition for the forest.

Ecosystem Management and Resource Planning:

Unfortunately, it has also been found that traditional approaches to forest resource planning have also created barriers to the implementation of the ecosystem management planning concept. This is partly seen as a result of concerns over providing complex resource assessment in a timely and cost effective manner and how to interpret the results once the assessment is done or the management has been conducted.

As we have seen, public involvement in the planning process is crucial to the success of the planning process. The results of litigation and extended reviews and controversy have lead in many instances to a de facto, " no-action" management which has created considerable concern over reduced production of forest products, increased insect and disease mortality, and increased risk of catastrophic wildfires.

Gridlock and Custodial Management

As Dr. Pfister states, " Gridlock is rapidly leading to the point where custodial management is becoming the norm, rather than multiple-use management for a wide range of public needs and uses." The nature of the NEPA process has in cases lead to a confrontational roadblock to forest resource management.

Success with current planning procedures can be limited by the following situations.

1. The public wants to be involved in the planning process prior to the statement of proposed action, otherwise the disenfranchised public is placed in the position of challenging the proposed action.
2. The benefiting public is placed in the (unenviable) position of defending the government.
3. The public resource managers become the beleaguered defendants of any proposed action.

4. The inability to represent the entire public.

So, how can we proceed toward managing for a desired future condition?

Steps toward managing for a desired future condition

Components for Landscape Ecosystem Management Planning.

1. Collaborative Planning
   Develop a planning process that incorporates the public with the resource specialists into the planning process once resource assessment has been achieved so that they are part of the development of the proposed action and management alternatives. How to achieve meaningful participation and dialog in this process is a focus of the follow-up conference we will be hosting in the next month.
2. Management goals and objectives:
   These will vary depending upon existing environmental, economic, social conditions and desired future conditions but must be clearly defined.
   The State of Oregon outlined a set of required actions or objectives to address management concerns for existing forest conditions which feature extensive mortality and growth reduction.
   a. Maintain appropriate stocking levels (reduce stocking if needed to maintain vigor of stands and reduce stagnation).
   b. Favor appropriate tree species and genotypes through stand modification and tree planting if necessary.
   c. Provide an increasingly diverse mix of tree species.
   d. Maintain or create the desired stand structure for the site.
   e. Implement suppression/eradication projects as needed.
   f. Coordinate activities with adjacent landowners.
3. Resource Assessment:
   An initial landscape assessment be conducted. A clearly stated summary of the existing conditions must be obtained. Both GIS and Remote Sensing play an important role in this work. The forest landscape needs to be classified. One method is to do so according to stand types or habitat types based upon tree and ground vegetation. This classification is entered into the GIS system for analysis and further interpretation.
4. Predictive Models:
   Stand growth modeling such as the Stand Prognosis Model or Twigs needs to be developed for the interior boreal forest along with a model to project vegetation changes will be necessary for the prediction of future forest conditions based upon existing stand conditions. We need to develop a model for predicting broad landscape vegetation changes in response to a changing environment and as a result of management applications with risk and probability functions.
5. Generation of Alternative Futures:
   Once you have obtained the existing conditions assessment the first step is to examine the effects of the "do nothing" option. This would be the first scenario to examine and would then be compared to other desired future alternatives to determine if this option produces the desired future condition for the landscape. A planning period must be established which is based on forest growth and environmental factors. Risk analysis of management choices would need to be included in this analysis.
6. Evaluation criteria for comparing alternative futures:
   Risk analysis of management choices would need to be included in this evaluation. Alternative futures could include choices such as:
   a. Maximize forest biodiversity
   b. Restoration of historical conditions

c. Production
d. No Action

7. Process for resolving conflicts to reach decisions.
   Management team must have rigid definitions for the alternative conditions and a process for conflict resolution.
8. Implementation: How can this begin?
   Possibilities:
   EPA proposal to conduct risk assessment of the ecological and economic impact of the implementation of a landscape level ecosystem based program for forest resource management in the interior region of Alaska.
9. Monitoring (adaptive management to achieve desired future condition)
   During the December 1997 forest products conference held here in Fairbanks, I gave a presentation concerning ecosystem management in Alaska. During my presentation I made the following statement:

> It is my belief that the university needs to instill a sense of urgency and direction for forest planning in Alaska. Given the state of our forests, we cannot accept a continued low level of stand management activity, which is the primary tool by which we are able to control the health and vigor of our forests.

EVALUATING SILVICULTURAL TREATMENTS

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Who should manage Alaska's forests? At present, how much of Alaska's Northern Forest is managed by natural agents-of-change—fire, insects, or pathogens? Agents-of-change vary from one region to another. Lightning-caused fires in the eastern Interior Northern Forest are much more common than in the Kenai Peninsula ecological region. Spruce beetles may be more important in ecological regions south of the Alaska Range and ips beetles and the budworm more important north of the range. When it comes to diseases, we simply know far less! What we are finding, however, is that root and butt rot pathogens are far more prevalent than anticipated ten or even five years ago. Further complicating the situation are short- and long-term climatic changes or events. They occurred in the past; they most likely will continue to occur in future.

Should the forest legacy we leave for future generations be one dictated by the agents-of-change? This is not saying eliminate completely all undesirable agents-of-change. In terms of fully functioning ecosystems they have important roles—some of their efforts are desirable or even essential to maintain both biodiversity and forest health. However, there is a threshold between what are acceptable and unacceptable levels of impact.

Salvage cuttings are merely responses to agents-of-change's efforts. The threshold has been crossed; something must be done before the loss is too great. Devastation has occurred; action is warranted. Salvage is simply reactive management—follow or clean-up after the agent-of-change.

Woolsey in 1920 stated "No great nation [society] can prosper without controlling forest destruction and without practicing forestry. Decadent [societies...] have no considerable areas of valuable forests, either in public or private lands. Under modern civilization, decadence and widespread, permanent devastation of an existing forest resource are inter-related..."

Rather than merely reacting and accepting financial and non-commodity value losses, a proactive approach is essential. Proactive planning and action can provide a legacy for future generations that ensure benefits from the Northern Forest similar to what we receive today as well benefits we have never dreamed.

Management policies or objectives must acknowledge ecological realities; two examples will suffice:

- Forests are not static but dynamic;
- In some cases, attacks by damaging agents, such as the spruce beetle or tomentosus root rot, are so chronic that they rule silviculture.

To minimize losses, the forest must become "regulated"; by regulation is meant "the organization of a forestry property for management and maintenance, ordering in time and place the most advantageous use of the property, with the aim of securing a sustained yield." The idea here extends far beyond timber—fiber production provides forest stand biomass and structure essential for many forest users.

To regulate a forest requires recognition that a forest consists of a mosaic of stands. This mosaic contributes immensely to biodiversity. "A stand is a contiguous group of trees sufficiently uniform in species composition, arrangement of age classes, site quality, and condition to be a distinguishable unit." Individual stands, not forests, are treated; forests are not clear-cut, but stands are. Treatment is based upon a stand prescription that best meets the objective(s) of the owner(s). The prescription is based on science, tempered by social and economic constraints. Stands must be delineated and mapped. Available knowledge concerning the Northern Forest must be utilized and adapted to Alaska. Additional knowledge must be developed. Silvicultural actions must be based on tree growth; "without knowledge of the rate of fiber production per acre, the regulator has little chance of giving correct answers to the various problems."

Replacement of trees in a forest stand requires the removal of existing trees. Stands of certain species composition and stocking and age structures can be thinned. This is one silvicultural option. Most stands in the Northern Forest of Alaska are mature, have structure that is not amenable to thinning, or have health problems including understory species components that will be positively or negatively impacted by thinning. Sanitation and sanitation-salvage cuts can be looked at as being similar to thinning. Often, however, partial harvests increase existing problems and add new ones.

Alternatives to thinning include stand harvests, especially if the stand is mature. The silvicultural objective of harvesting a stand is to replace it or components of it with healthy trees. Regeneration is the objective. To be really successful, one must visualize the mature stand of the future—the goal of regenerating the stand is what? The new stand must be monitored and silvicultural actions taken to keep the stand on the proper trajectory to reach the desired target condition—the one visualized in the prescription. This is a silvicultural system for the stand; similar stands commonly have similar target stands and prescriptions—a similar or the same silvicultural system. A silvicultural system is "[a] planned process whereby a stand is tended, harvested, and reestablished." Silvicultural systems are commonly named after the regeneration method used; it may be appropriate to modify the name to include the type of age structure desired.

The regeneration methods are:

- Clear-cut
- Seed tree
- Shelterwood
- Selection
- Coppice
- Coppice-with-standards (Coppice-with-reserves).

Rather than merely defining regeneration methods, I will place them in a framework of simple age class structures as laid out by the Society of American Foresters.[5]

Coppice Methods:

- **Coppice:** All trees in the previous stand are cut and the majority of regeneration is from sprouts or root suckers.
- **Coppice with Reserves (Standards):** Reserve trees are retained to attain goals other than regeneration. Normally results in a two-aged stand.

Even-aged Methods

- **Clear-cutting:** new age class from seedlings or seeds in a fully-exposed microenvironments after removal, in a single cutting, of all trees in the previous stand.
- **Seed Tree:** new age class from seeds in fully-exposed microenvironments after removal of all trees in the previous stand except for a small number of trees left to provide seed. Seed trees removed after regeneration.
- **Shelterwood:** new age class from seeds beneath a moderated microenvironment produced by residual trees during a series of distinct cuttings.

Two-aged Methods

- **Clear-cutting with Reserves:** Clear-cutting method in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

- **Seed Tree with Reserves**: seed tree method in which some or all seed trees are retained after regeneration established to attain goals other than regeneration.
- **Shelterwood with Reserves**: shelterwood method in which some or all shelter trees are retained, well beyond the normal period of retention, to attain goals other than regeneration.

Uneven-aged Methods

- **Group Selection**: age classes created by removal of trees in small groups, width of group cuttings being about twice mature tree height; small opening sizes provides microenvironments for seed germination.
- **Group Selection with Reserves**: group selection method in which some trees within group are not cut to attain goals other than regeneration.
- **Single Tree Selection**: age classes created in stands of uneven-age by removing individual trees of all size (age) classes more-or-less uniformly across the stand to achieve desired stand structure.

In using this type of an approach, it is important to describe in more detail the target stand desired and the purpose behind the prescription.

There are some who argue that the silvicultural systems are based on European forestry and are not applicable to North American forestry and, thus, should be discarded. In response, I quote Baker:

> [T]he misconception of silvicultural systems—as rigid affairs that may work in Europe but are no good in America—is widespread. The viewpoint is obviously unsound, for European systems really include every possible variant of silvicultural management; and so if we say that no European silvicultural system will work in America, it is tantamount to saying that no silviculture of any kind is possible. We have the systems confused with rigidity; actually they are just as flexible as silvical conditions require. To apply them flexibly requires a minimum of rules and a maximum of silvicultural art. America's failure to make the systems work is more due to the lack of silvicultural artists than fundamental unsuitability of European systems.

With the addition of the political process (or political micro-management at the stand level) as a major factor in stymieing the silviculturist as an artist, I believe Baker's statement published in 1934 is valid.

In conclusion, much information exists for the scientific management of Alaskan's Northern Forest. Undeniably, more information is needed. Silvicultural options do exist to manage forest stands in the Northern Forest for long term health. There is need to reduce political micro-management of forest stands and to allow the silviculturist to develop as an artist. The question is not "What do we want now; but what legacy do we wish to leave for future generations"?

Questions and Answers

Q: *I'm intrigued by the idea of leaving room for the silvicultural practitioner as an artist. It implies the same system as for barbers and doctors: apprenticeship.*

A: There are examples in the Alaska Division of Forestry: looking at leaving reserved trees. Tanana Chiefs is leaving pockets and laying them out like an artist's brush.

Q: *If the idea is valid, we should be developing a whole system around it, not just case studies, to capture the maximum benefit.*

A: That is the concept behind the silvicultural system.

Q: *This would be a system where somebody without the experience gets the experience; sort of apprenticeship training vs adaptive management where we don't*

A: The Canadians have such a system in place.

Q: *Forty years ago, the U.S. Forest Service stopped transferring everybody every two years so they could do this very thing.*

DISCUSSION

Glenn Juday:	For Roger Burnside: are the figures for the survey in the yellow report citable? What is your perspective on how unusual that is? Is it the most we've seen in 20 years, 20th century?
Roger Burnside:	I'd go back a 30-year period. 2.3 million acres in six years.
Glenn Juday:	Are we looking for something like a fire return interval for this? How unusual is it?
Roger Burnside:	We have data back to about 1989. Don't know otherwise.
Ed Holsten:	We did a tree ring analysis for the last 100 years on the Kenai Peninsula. There were events but they were fairly mild: 10 to 15 percent of the stand at a time.
Roger Burnside:	We don't have a method right now to sample longer terms. Last summer we saw the largest beetle flights any of the experts have ever seen on the Kenai Peninsula.
Glenn Juday:	Should we define it as a research problem, or is it essentially untrackable?
Ed Holsten:	I was reading about major stand-opening events in Colorado over thousands of years. There had been no fire so it was attributed to beetles.
Roger Burnside:	There was a major blow-down event of 25,000 acres last year in Colorado.
Skeeter Werner:	It is important to have historical perspective on this problem. It is important to public opinion. I'd like to isolate a research need for finding the products trees produce in response to beetles as an alias for beetle infestation.
Roger Burnside:	There are lots of variables. Working through the sediments it is very difficult to find relationships between pollen etc. and know what was associated with bark beetles.
Bob Wheeler:	Mike Weber from Canada is conducting research on emulating natural events by silvicultural means. We can use the turpine project I got funding for. I had this fear that nobody had looked at this.
Tom Paragi:	We need to look at impediments to funding for forest research or management. The Interior is outnumbered in population by Southcentral. Our timber output is low and the value is low. How do we generate more funding for research in the Interior?
Ed Packee:	Increase the cut. Charge on stumpage identified for research. How does Sweden cut boards and sell to Japan cheaper than we do? High-quality production is the answer. We have to produce a product in adequate supply that it enters the market. There has been a recent change in grading to separate spruce-pine-fir because spruce is better.
Bob Wheeler:	In Montana they found that planning for desired future in biodiversity actually stabilized and improved the cut.
Erik Hollend:	As a member of public when I hear "increase the cut" it disturbs me because it means asking the timber industry to come in. I'd like to know more about solutions to forest health that don't involve inviting the timber industry in.
Roger Burnside:	Pheromones won't solve the whole problem. If you don't have a system that's a steady market, how do you deal with fluctuations in insect populations and damage? We need an infrastructure to provide high value-added products and get away from feast or famine. We have to have regional planning that everyone understands.
Ed Packee:	I'd like to comment on how we increase the money available for research; my answer was increase the cut. That will finance research by the private sector. Don't hook together forest health and increasing the cut.

Erik Hollend: There's a bill in the legislature that ties them together very well.

Roger Burnside: We won't achieve consensus on this, but we need to respond to this issue.

Roger Siglin: We're currently cutting about 1,000 acres per year on the Tanana Valley State Forest. I hear some industry and professionals talking about cutting about 16,000 to 20,000 acres per year. The current management plan calls for logging over 90 percent of that white spruce forest along the river. What impact does removing that mature forest have on things like rates of erosion due to not having sweepers and logs into the river, and what is the impact on fish movement in the channels of the river? Where's the money coming from for that research?

Ed Packee: I've watched trees fall in as a boat wake washes up under cut-banks on the river. When those trees die, if it's gone to Calamagrostis, what's going to replace that? The goal is to reproduce trees; regenerate. Somehow we need new trees. We're not harvesting with the idea that there's no regeneration. This is not deforestation, it is replacing the trees on a sustained-yield basis.

Bob Ott: I'm putting together a research team to work on just that issue: riverbank erosion rates, how much wood goes into the river, etc. We're in the process of designing the project and getting funding.

Trish Wurtz: One possibility for research funding is the Alaska Science and Technology Foundation. When it was first formed, it put out a special request for forestry projects. The administration has changed since then so it's less receptive now. They want research that results in factories being built.

Pete Simpson: What other research has been done and how do we find it? Like Zasada's?

Trish Wurtz: It is an effort to keep the plots marked; usually when people leave the ability to follow that project drops dramatically.

Ed Packee: The cost to put in 10-acre plot is about $900.

Dave Klein: Forest management has evolved under the assumption that the climate is stable. Now how is it possible to manage for a moving target? Perhaps white spruce is no longer the target species.

Ed Packee: We covered exotics yesterday; that may not be the best way to go now. It's a valid question. Do we sit by and let everything collapse around us, or do we try to do something proactive? We want to keep the genetic base of spruce open.

Dave Klein: You're groping in the dark if you don't know the consequences of your actions.

Ed Packee: You can't wait until you have all the answers, so you do the best you can. It's the same problem with animals and fish and birds.

Meg King: Talk about what you would like as outcome of these two days. Do you want to prioritize the research needs? Follow up on public involvement? What do you want to see come out of these two days?

Q: What does the Boreal Forest Council have as mission for this conference?

Jan Dawe: The council adopted a strategic plan with three public service components. I see this discussion today fulfilling the plan for one policy meeting and one process meeting per year. What I'd like to see come out of this workshop is a working group that would continue these discussions. This is mostly the professionals, not the public outreach yet. I'd like to gratefully acknowledge the provost and the Alaska Cooperative Extension and the School of Land Resources Management Forest Science Department for money. If there is the will and desire for a working group, it's a greater challenge to work with a community that may not be aware of the problem lurking around the corner. We see a working group the four components: (1) what are the research needs and what are the avenues for funding research; (2) cross-ownership land manager forum; (3) how can we draw information from structures that already exist to get the word out? and (4) a values forum; how to get information out to the public and how to respond to questions from public.

Meg King: So a working group is one hoped-for outcome. What else? Research?

Glenn Juday: We need a more efficient way to capture what's going on here. This is not a very efficient way to transfer information. Publications, web sites, videos, etc.

Ed Packee: Good point, but it takes time. Who in this room has the time to commit? You're writing for different levels of people.

Glenn Juday: Let's find the right tool for information sharing.

John Alden: One working group is to bring together all the tools for bark beetle resistance: bring entomologists, tree selection, biochemistry, etc. into one working group.

Skeeter Werner: A scientific working group.

John Alden: But specifically for spruce beetles.

Chris Maisch: I'm very weary of these kinds of processes. They result in not much action on the ground. I'd like to see as an outcome "Action": just that one word. No funding for action.

Tom Paragi: What is the role of public and nonprofit organizations in this? We need technical advice from professionals.

Roger Burnside: It's not just a forestry issue, either. It involves other disciplines.

Ed Packee: We're talking about the past. Somehow we have to stop the clear-cutting of dollars with no regeneration.

Beth Schultz: There's been a lot of agency bashing. We're all getting cut. We have to get to the legislators and stop wasting our money in the courts.

Skeeter Werner: Ask the public. Information has to move both ways. If there's enough public involvement, the legislature will listen.

Glenn Juday: 1. Coalescence. Get together and agree on something.

2. Make some action-forcing mechanisms. Deadlines!

3. Empowerment. Empower the group that's set up. Make it representative. We can do this stuff and get out of this rut.

Erik Holland: This is a very valuable process because it is an opportunity for just a working person to learn.

Marty Welbourn: Imagine pulling together a group that had a specific question: if we were to manage the Tanana public forest in ecosystem management, what would it look like? What would the management practices be and what would those look like on the ground?

Bob Wheeler: That seems like a natural for that grant I was talking about with EPA. I talked with someone at EPA and described a cooperative effort between agencies and he thought it fell well in line with the guidelines.

UNCERTAINTY IN RESOURCE MANAGEMENT

John Fox

Department Head, Department of Forest Sciences
University of Alaska Fairbanks

I know I'm preaching to the choir about uncertainty. I seem to find myself talking about uncertainty a lot. One of my qualifications for talking about it is I'm uncertain myself; another may be working at UAF.

Sources of uncertainty:

- lack of knowledge and understanding of complexity
- natural variation
- apparent randomness of nature: chaos
- changing human perceptions/perspectives

The noose of uncertainty: you try to tighten the noose but you can't tighten it up completely.

An example of scientific uncertainty:

Old: Balance of nature

New: flux of nature

How to deal with uncertainty:

- Recognize it
- Embrace it, don't deny it
- Avoid it
- Control it
- Create contingencies
- Create redundancies
- Be cautious/conservative
- Experiment
- Be adaptable

Resource management = decision making

Conditions in which decisions are made:

- certainty (rarely occurs)
- uncertainty (many possible states of nature and outcomes; don't know the probability)
- risk (many possibilities, but do know probabilities)

Real resources, in real ecosystems, in real economies, in real communities.

Simple decision framework:

- alternative actions/decisions
- mutually exclusive and exhaustive possible states of nature
- consequences/payoffs of each action under each possible future

The challenge is to convert a situation from one of uncertainty to one of risk. Then you can approach the problem "rationally." Multiply probability times the consequence (risk is probability times consequence).

Need to ask questions in terms of probability.

More complicated risk analysis:

- Develop a model
- identify uncertain variables (ecological, economic social)
- Establish probabilities
- Analyze model with simulation
- Make a decision!

None of these frameworks make the decision for you.

Forest condition on Native corporation lands

Chris Maisch

Tanana Chiefs Conference

I'd like to refer to a couple of mail-order catalogs advertising forest products made from wood. First: for a walking stick: "old age has brought the tree down but the deep-grained wood will bring history alive for you." For a birch candle cluster: created by hollowing out pieces of logs "felled by acts of nature."

Next I'd like to refer to *A Primer of Forestry* by Gifford Pinchot, in his chapter on "Enemies of the Forest": these are man, grazing, trampling, browsing, forest insects, forest fungi, wind, snow, forest fires, historic fires.

Native corporations and most people fall somewhere in between. Up to just recently, on Native lands forest health was something that just happened. Now we can assess and take inventory. There is not a lot of proactive work right now.

The bark beetle is the main problem on Native lands right now.

Roger Siglin made a comment on riparian forests earlier and the rate of harvest on those forests. Up to the turn of the century, there were wood camps along the rivers because of sternwheelers. Harvesting took place right there in the riparian zone so the logs could be rafted on the rivers.

We have an unregulated forest right now. It hasn't gone through a full rotation—the period of years required to grow a timber harvest. When the average annual increase in volume (mean annual increment) begins to decline is the biological rotation. Site indexes are important. The average site we manage reaches 75 feet in 100 years. So the rotation age is 100 years; we add 15 years for forest regeneration to occur. Our philosophy has been to be conservative. In 120 years you produce a white spruce suitable for sale. The next thing to consider: some stands will be over 214 years old before we'll enter them for the first harvest to regulate and even flow of harvest, so we have to keep them healthy until then.

Have used work by entomologists, particularly the hazard rating system by Ed Holsten and Skeeter Werner, to see what danger they might be in from the bark beetle. We are monitoring stands carefully. We might make the economic decision to go in and take all the timber before it loses value. Economics is one of the main things we're managing for, since it's private land. Economics can influence the rotation period.

If you capture a big economic flow, you can put the money back into the property with things like replanting. A lot can be done by working with other land owners to work cooperatively across boundaries.

Incorporating Forest Condition in Forest Planning

Les Fortune

Employed by Dept. of Natural Resources 1969–present
Regional Forester at Fairbanks, 1976–present

The forests of Alaska are managed by many owners. The forests on state-owned lands are managed by a number of agencies. Most are managed by the Department of Natural Resources. Lands classified for forest management are managed by the Division of Land (DOL) with Division of Forestry (DOF) assistance. Lands set aside by legislative action in a state forest such as the Tanana Valley State Forest (TVSF) are managed by the Division of Forestry.

There are two types of plans that identify the management intent for these lands. The Area Plan or Tanana Basin Area Plan (TBAP) establishes the guidelines for the forest-classified lands. The TVSF Management Plan is a slightly more intensive planning document and sets for the guidelines for this legislatively designated acreage.

A third general plan exists that considers the guidelines in the above-listed documents. It is the fire management plan. It divides land into four suppression categories: limited, modified, full, and critical.

A fourth plan exists that must be developed for every proposed significant forest harvest activity. This is called the Forest Land Use Plan or FLUP. This is where "forest condition" really becomes an active part of the process.

What are we doing today? Much of the harvest in the past 15 years has been a salvage operation. Rosie/Bonanza Creek and other fires pumped timber into local operators. Insect problems as well as erosion have channeled our efforts to specific sites.

Clear-cuts of less than 100 acres and generally much smaller are the common harvest technique. Boundaries are no longer straight lines, and patches are often left to break up the visual pattern.

Reforestation became an issue in the early 1970s when visual surveys showed a lack of spruce regeneration. Radical site preparation has given way to hand preparation depending on site condition and silvicultural intent.

Will today's management of Interior forests guarantee we will not have a major event such as has occurred on the Kenai? The answer is an unequivocal no. The forest types and environmental conditions, on the other hand, make such a condition unlikely.

Is our "forest condition" in an extremely poor state, as some would have you believe? We have had a strong fire suppression function for the last 50 years. It has changed the natural regime. On the other hand, we have not been all that successful. We don't have that much area in older forest types. We need to break up stands, particularly near developed areas. In general, our stands do need to be managed to provide a more even break in ages.

How about insects and disease? We should change our tactics from chasing salvage to preventing situations where salvage is needed. Let's develop a forest with a wide diversity in stand types and age classes that serves our environmental, social, and economic needs.

Letting nature take its course may have been acceptable during the time nomadic tribes roamed the earth. Today, few of us would find nature's way acceptable. That is not to say we shouldn't gear our management to be in consonance with the natural pattern. To do otherwise is folly.

Harvest is one of our options for management activities. The current level of industrial development is inadequate to provide for use at a level that can put our forests in a vigorous condition. More industry isn't the answer. Diversification to an industry that can utilize all timber species and variations in quality is what we need.

Expansion of Local Value-added Processing

Ron Ricketts

I've worked with three or four companies that try to do value-added processing. One was a small company out of Oregon that manufactures veneer and veneer lumber for Japanese market. They felt there was a potential opportunity to do a similar project in Fairbanks. They would use birch and aspen, which are mostly unused now. What we do now is deck up hardwoods. This is not a good use of the resource. I felt this company could make a use of it. We sent a couple of loads of birch and aspen down to their mill in Oregon and they made veneer out of it. The Japanese customers were pleased with the product.

The idea was put together a sort yard operation where we would sell the spruce to local operators. The next question that came up was what to do with the chips and the other species like black spruce that we can't use? There is a chip operator down on the Kenai Peninsula that is using chips and selling them to Japan, so that would be logical to bring that operator up here. Then how would we get our supply? We thought there might be an opportunity with a bill in the legislature allowing negotiated sales of 10 million board feet. However, Japan's market went in the tank, housing starts went down, so there was suddenly no market.

In addition, there were the shipping logistics and construction costs for the mill. We were just starting to investigate that when project was put on hold.

We could sell some of the product locally, but production must be at a level more than our Alaska market would absorb, so we would have to ship it out of Anchorage or Seward. North Star Terminals is extending their dock in Anchorage into deep water to avoid mud and freeze-up problems. They're also planning an extension of a rail spur out that dock. When I first started talking to the railroad about shipping, it was like talking to stone wall. Now the management has changed, so it may be better now. All these things have to come together for a project like this to come together, but I think it's a feasible project.

Balancing Present and Future Opportunities

Jim Carmichael

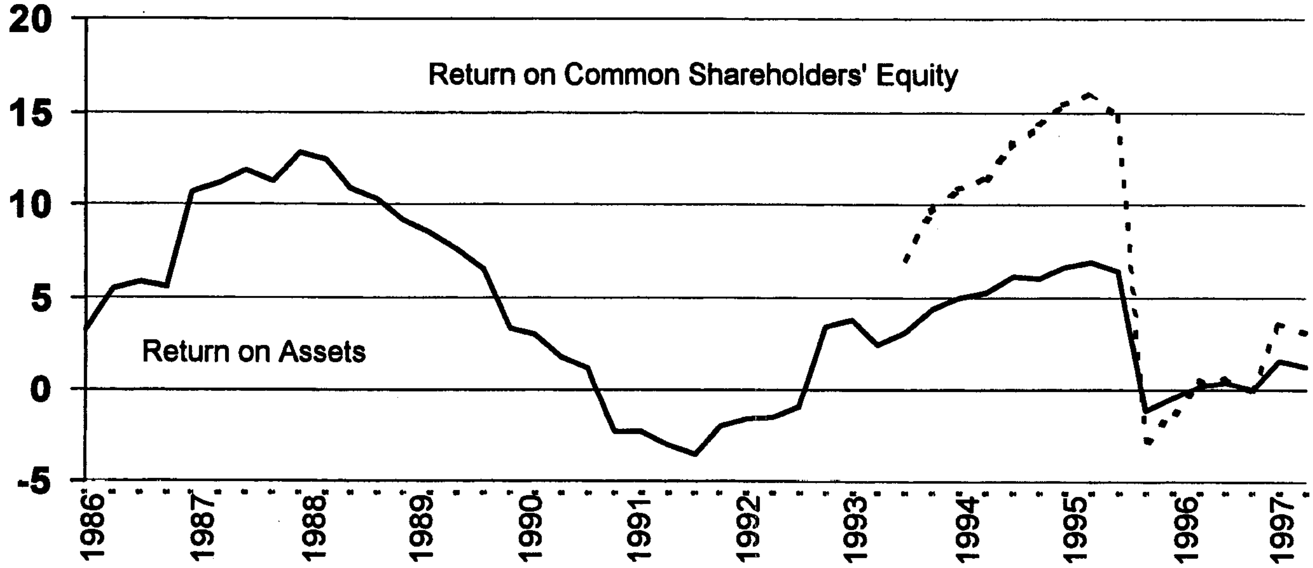
Marketing director, Afognak Native Corporation

Both industry and the forest owner have requirements. It's essential to look at the industries in forests in other countries. Canada has made a policy decision that they would not allow raw log imports, that they would only allow manufacturing. Politicians want to create jobs. Also, Canada is resuming log exports.

Scandinavia has a comparatively low mean annual increment. They have a very highly developed forest products industry. Why can they compete? They have a homogenous raw material and product and I think a low expectation of return back to the acreage. They have a huge unused allowable cut.

Forest products are cyclical commodity industries. Right now it's in the tank. The graph below is from Price Waterhouse in Vancouver, B.C. Notice the volatility of the lines. Timing is critical.

Western Canada Industry Return on Investment
Based on earnings for year-to-date September 30, 1997
Chart courtesy of Price Waterhouse, in vancouver, BC



I'd like to comment on value added. We need to recognize the alternatives and let things stand on their merit. Value added is often viewed too simplistically as a panacea. I think it's often a myth and that often value is subtracted. You can see that in mills that have gone broke in Washington.

The University of Alaska does not have a fiduciary responsibility to subsidize sawmills.

We're in a very globalized trade. I'm old enough to have seen a couple of market fluctuations. I'm selling logs in six countries: Japan, China, Korea. I can sell logs in India cheaper than in Seattle. My most recent sale was to a plywood mill in Oregon.

Sources of competition for my logs: (1) Russia. They have spruce, which is what we compete with. They have poor accounting and corruption, but they still exported more logs to Japan last year than North America. (2) Manufactured products coming from Canada and Scandinavia. (3) Logs from New Zealand and Brazil.

Forecasted softwood demand exceeds supply through 2035. Net Present Value analysis is an important tool in a business plan or decision making.

Investor requirements:

- Positive Net Present Value at hurdle rate Internal Rate of Return
- Favorable public policy and public consensus
- Forest yield and quality at competitive standards
- Commitments
- Land tenure (have access to that timber for time needed)
- Capital for modernization to be competitive (without competition, the industry gets old and arrogant; didn't modernize so can't compete)
- Infrastructure for competitive cost power and access to forest
- Efficiently priced labor
- Transportation to markets

Discussion

Q:	I have a question for Chris Maisch about old (300 years) riparian white spruce sites that are probably worth preserving because they are so unusual and not very high value. They can be a source of genetic diversity for the future. They were established three or four centuries ago and have survived many climate changes.
Chris Maisch:	I think finding stands like that is very exceptional. We are trying to use material from the site for reforestation later. Whenever we harvest we collect seed.
Ed Packee:	The stand is not 300-plus years old. In some stands there is a remnant of a 300-year-old stand—it might be a single tree in 100 acres.
Tom Paragi:	Jim Carmichael, you put up a graph of the fluctuations in managing for resource commodity. What is the Afognak policy for reinvesting in sites?
Jim Carmichael:	We should do some thinning. We've done some work with John Alden looking at other site improvements. Concor, our competitor next door, does some aerial seeding. I'd do hand seeding. It hasn't been very cost-effective in the past. We have gone through some of these economic cycles. During the low part of the cycle we just shut down for a few years; fortunately we were able to do it. During high years we plowed the money back into capital and didn't put it out in dividends to shareholders—we established a permanent fund. Now we can have a long-term view of the world and have money put away.
Glenn Juday:	From the substance of most of the presentations, I get a picture that's pretty bleak for a wood-using industry that's significantly bigger than we have now. Can Chris Maisch or Ron Ricketts comment on whether that is really the implication? And what direction do you see gives the best potential for expanding the wood industry?
Ron Ricketts:	The Japanese economy is in the tank right now, but it won't remain that way forever. In another couple of years we'll see a natural rebound. There are niche market products that can be looked into for the North American market, but that often uses only a part of the resource; we have to look at using all of the resource.
Chris Maisch:	We've refocused on trying to supply the domestic market and mills, with the caveat that stumpage price reflects the price we need to get to reinvest in land. We're not going to subsidize local mills at the expense of the land.
Lori Trummer:	What factors determine the stumpage value? What is the difference between second-growth Douglas fir and high-value spruce? Is there anything we could change?
Erik Hollend:	Second-growth Douglas fir is mechanically less strong.
Jim Carmichael:	There is an emotional market preference. Honshu in Japan prefers fir. Hokkaido prefers spruce.
Chris Maisch:	There's two ways we do appraisals on our sales. We use conversion return appraisals and we use comparison sales appraisals. Comparison sales is somewhat like real estate appraisals: you look at other houses that are similar. The conversion return method is looking at money back from the product and taking out costs. Part of it might be education. A private landowner can respond quicker to changes in the market.
Les Fortune:	Part of the pricing was a per acre price; spruce has a lot less board feet per acre. We're a lot slower. Some sales have been relatively high price, some have gone for the minimum appraised price over the counter. We're looking at new markets for local

timber through the grading system. Once the market understands that they can buy graded white spruce, no problem.

John Fox: You have to subtract out all the costs, including transportation costs.

Jim Carmichael: Compare U.S. and Canada approach to stumpage prices. Canada treated stumpage as a residual value, and a mill had an operating circle that gave them the right of first refusal. There's been a long and intense debate between timber interests. The result is there's now an export duty that the Canadians charge on lumber going into the U.S. U.S. sawmills claim that Canadians have an advantage because Canada subsidizes their logs.

Ron Ricketts: The international timber market is driven by housing starts. The market for timber will go back up.

Stu Pecheck: Going back to promoting good forestry research in Alaska: there's an uncertainty to funding and what types of research done in Alaska. Is there a good level of information sharing between agencies, Tanana Chiefs, and the university?

Les Fortune: I've always been critical of what it takes to get research information. We've had a good working relationship with the school, with Tanana Chiefs, and with the Institute of Northern Forestry. We share information well. What I don't get is the level of applied research I'd like to see. We don't give them much money.

John Fox: We're a relatively small community and we know each other and I don't think there's many barriers to communication, other than distance.

Stu Pecheck: The U.S. Forest Service probably has the most money.

Les Fortune: We have less contact with them here in the Interior; more in Anchorage. There is no national forest up here.

John Fox: There is a potential to build on that. The kind of research we've done hasn't always been directed toward the kind of problems the state has because of where the funding comes from. I would like to push at least starting with the problems.

Roger Siglin: The wealth of our public forests is hardwoods; what would it take to begin to use a large percentage of those hardwoods? Recognizing the need for public acceptance and that it must make sense economically and environmentally.

Les Fortune: The technology is there for many types of hardwood products, but it's not going to occur until it's economic. The wood's here. How much will the public accept? If we want an environment that has vigorous trees that are resistant to disease, then we have to harvest. We manage somewhat in excess of 2 million acres of productive forested state land. If you went on a 100-year rotation, you're talking somewhat in the range of 20,000 acres a year. We are not harvesting 20,000 acres per year. Now we harvest 1,000 acres a year.

Chris Maisch: We have calls all the time for the higher-end uses of hardwoods. Until someone cracks the economic problem, you're probably not going to see an increase in that.

Erik Holland: People have said that in interior Alaska that if we want a forest to hand to our grandchildren, we have to log it. That makes me uncomfortable. Is the timber industry's involvement really necessary.

John Fox: We need to get real. If you don't like what you're hearing, it may be that you're not facing reality. If you look at the age class distribution currently; that window of opportunity will be gone soon. The alternative to logging is to roll back wildfire restrictions and let it burn. There's a pretty good possibility that we'll have more grasslands and maybe a reduced biodiversity.

Erik Hollend: If we log it we won't have these things?

John Fox: I think we can use logging as a tool. When you can't make money logging you have to charge it against the cost of maintaining biodiversity. Ecological processes are going to continue unless there is some kind of disturbance. We will not have the same kind of forest we have now.

Bob Wheeler: Since I arrived last year I've had meetings with many people, trying to understand what are the limitations to Alaska having more contribution to local forest products industry. John Duffy at Mat-Su Borough office said "I have a backlog of timber sales on the shelf; want to buy?" Some local hardwood operators were saying they could sell a lot more than they could get logs. It didn't add up. Some people say log supply, others say transportation. I want each panel member answer what is the main reason.

Jim Carmichael: It has to do with balance; you need a market for the residual component. If we had a more active Alaskan economy, there'd be more trade. You need backhaul on the barge. It's a multifaceted problem.

Ron Ricketts: There's more than just one reason: transportation, cost of producing (both operating and construction cost). I don't buy supply being the only reason.

John Alden: Question for Chris Maisch on biological rotation and harvest rotation. How do they correspond? Is the biological rotation based on mature date?

Chris Maisch: Biological rotation means when mean annual increment drops off. That includes a factor for reestablishment of the trees. Harvest rotation means how used, etc., and many different reasons.

Harry Bader: To John Fox: What kinds of professional restrictions are there on you as a member of the Society of American Foresters?

John Fox: Forestry is an act of faith. It has long time periods. You have no idea who and what and why that tree will be used 100 years from now. Code of ethics is that we are doing what's right for society by sustaining the production of trees. What they're used for is almost irrelevant. As we project that there will be more people that will mean more housing, but also more demand for nonconsumptive uses of the forest. A land ethic says we do have to consider the ecological ramifications of our actions. We need to be honest and follow our conscience. We are members of the biotic community, and we have to interact with that community on a global scale as well as locally.

Meg King: I've created a template based on information from Marty Welbourne and Bob Wheeler. This may be a way to develop an action plan because there's a source of funding. A grant proposal is easier to get your arms around than ecosystem management.

Proposal due date: mid July

Preproposal before?No

Who needs to be involved? Reviewers, editors, etc.?

Bob Wheeler: Having talked to a representative of EPA, and he said the broader the collaboration the better. We should make it multi-agency; public and private and university system would have a better chance of success.

Jan Dawe: As an outcome of the EPA grant, look at ecological consequences.

Bob Wheeler:	I talked to John Fox the other day. The EPA is looking for impacts of ecology and economics. This could mesh with our interests if we were to focus on evaluating the implementation of ecosystem management in the Tanana Valley. We'd have to develop some models for risk analysis. I see support of a graduate student, $300,000 over three years.
Skeeter Werner:	Are we addressing the risk of going to ecosystem management or the comparative risks of ecosystem management alternatives?
John Fox:	The latter.
Bob Wheeler:	The key part is assessment of the forests we have and tying that into growth models.
Glenn Juday:	There's a post-doc who's working with Terry Chapin, Carolyn Malstrom at Berkley. She and I have been developing a forest development model and she wanted me to mention her availability and interest.
Bob Wheeler:	Cooperative Extension can help as a medium of exchange and contact, even help with further development of an ecosystem management plan. We're willing to step forward and help facilitate.
Meg King:	The gist I got was that people wanted some kind of action but resources were limited. That's why I developed these two flip charts for people to work on.
Glenn Juday:	There's a relationship between these two: if we had this grant we could work on that one.
Ed Packee:	We need public input on what they want to see for future generations. That is the social component of ecosystem management. There are a number of graduate students and interns who could be a real bonus, not necessarily working for UAF. My biggest concern, and this is based on the fact that I've been trying to teach this as a course for the last four or five years, is that this idea of ecosystem management doesn't just happen overnight. The target end date terrifies me because of the amount of preliminary work that has to be done. You need a three to five year target date.
Meg King:	That's why I wanted to focus on this grant thing, because it has a fixed target end date.
Marty Welbourne:	What I was talking about was scientific guidelines for ecosystem management. I realize there are social and economic components, but you need ecological information first.
Meg King:	"Public input for future generations." Where else can we go with this? On the flip chart it says "go talk to them (public)": who is them?
??:	Classrooms, schools, Boy Scouts.
Doug Yates:	Also what needs to be on that list is traditional knowledge, what the Natives know. There is the Cultural Heritage Education Institute.
Jan Dawe:	Mike Musick was here earlier. The council would like to build a speakers bureau. Mike mentioned that one way to do this is Arbor Day.
Meg King:	In order to develop a plan, we need to get input from them, not just get information out to them. Who are the folks that you really need to touch bases with?
Ed Packee:	That's my big concern. We're not looking at a soapbox. We need input. I don't object to trying to educate the public in the process.
Meg King:	When you write this grant, you can address this public process. Who's going to write this grant?

Ed Packee volunteers in the sense that he has a good database. Bob Wheeler also.

The Alaska Boreal Forest Council would like to be involved in writing and in the public process part of the grant.

Bob Wheeler: We have this social input conference coming up in May, and this could be the focus.

John Fox will be involved.

Meg King: We need someone from the business community.

Ron Ricketts will look into it. Do we want someone who doesn't have a relationship to the forest products industry?

Meg King: Not necessarily. How about land managers? Tanana Chiefs?

Ed Packee volunteers Marty Welbourne, Roger Siglin, Alaska Biological Resources.

Bob Wheeler: Alaska Cooperative Extension will do a proceedings and mail it to everyone who signed up. I think the conference overall was very successful, and I learned some things I didn't know. I look forward to seeing you at our conference in May.

Jan Dawe: Let's have a round of applause for Bob Wheeler and Tom Paragi for organizing the conference.

Flip Chart Pages

There is a great tendency to fix past mistakes. However, unless more effort is devoted to looking forward toward prevention rather than backward toward correction, we will continually be trying to catch up.

Session 1: Factors

1. Fuel management plans—Site specific
2. Disturbance—diversity
3. Reforestation and disease
4. Forestry Practices
   - Timing/treatments
   - spatial juxtaposition

Session 2: Response

1. Public education on risk assessment and ecological capabilities
2. Conflict/interaction among adjacent land owners (objectives)
3. Regeneration: heteroculture disrupts contiguous stands
4. Prescribed fire as aid to reforestation/sanitation
5. C-budget consequences of management plans
6. Exotic species? Biological control?

Public Education: Distinctions?

Interior	**Southcentral**
Ips, defoliators	bark beetle
more mixed forest (except riparian spruce?)	extensive uniform white spruce stands
no widespread mortality (yet) [UNAWARE?]	widespread mortality has occurred [GRIEVING]
Fire risk unclear in relation to beetle kill, so far. Otherwise, fire a major natural disturbance (lightning) well known.	fire risk understood "natural fire (lesser disturbance factor)

Differences are due to differences in climate, geology forces

Questions

1. **Can we modify an existing hazard rating system for the boreal forest of the Interior?**

   A: Yes: Englemann spruce in U.S.; white spruce in B.C.; USFS S&P, SB Expert system
   Would need to better incorporate bark beetle dynamics into models.

2. **Can we define important criteria of designs and protocols to monitor forest condition?**

   A: protocol already exists for U.S. (Forest Health Monitoring USFS system). Just need to implement.
   Basal area increment not simple radial growth.
   Radial growth—band dendrometers on a network.
   Weather/tree growth equations to predict/anticipate (cone crops, good years, bad years, bug years, etc.)

3. **Can we define impediments to and strategies for securing research funds for long-term studies?**
   - Exxon Valdez trust: monitoring/research reserve; endowed chair of forest ecosystems/management/restoration ecosystems.
   - Applied research is a higher priority and is being ignored compared to long-term ecological research.
   - Tie research dollars to harvest.
   - Look at other areas. Where do they get their dollars (industry?)
   - Alaska Science and Technology Foundation
   - Land cover/climate change research integrating biogeochemical cycles, remote sensing and field data (e.g., NASA)

4. **Is there a role for tree growth models to improve forest condition in the Interior?**
   - Yes, but need robust data set—data collection underway
   - One of the most important inputs—thin to relieve stress through life of stand

5. **What is the best strategy for developing a working group to carry forth ideas from this workshop?**
   - Model after Kenai Task Force—yes! c.f. Homer fire chief Bob Purcell
   - Ad hoc group of interests with technical committee (UA, consult, fed, SAF)

6. **What information on forest processes (insects, fire disease) is important for public education on risk assessment and planning?**
   - Consequences of no action
   - Uncertainty of scientific predictions
   - Understanding that the forest is always changing—the only choice we **don't** have is to keep it the same.
   - Also include information on past human disturbance . . . this land is **not** untouched by man.
   - Capture/update/distribute existing knowledge more effectively (web sites, publications—fewer meetings to learn stuff)
   - History of past beetle infestation

What Management Strategies Should be Used to Manage Forests in Transition with Uncertain Futures?

- Hedge bets—adaptive management
- Can be left unmanaged
- Mixed species/multi-aged
- All forests are in transition and there is no certainty.
- Trust professionals
- Look at the large picture—landscapes
- Go with the flow! Convert black spruce to white spruce! Now, with fire. (Can't do; re: soil, permafrost, drainage . . .)
- Think landscape level
- Be sure to recognize all agents responsible for the disturbance/transition
- If warming and drying is the trend, consider using seed sources from more southern and drier locations.

How do We Involve the Public?

- At all levels of planning!
- Not by ballot initiative

- Setting policies by their elected representatives
- Educate, inform
- Consensus isn't particularly efficient; people begin to lose interest, then only the sincerest stakeholders participate. But the "future search" process has kept its people involved for years.
- Not so much by public meetings—use more direct methods. Field trips, directed media articles.
- Experiment with novel ways to involve the public, like the "values jury" approach
- Call in radio show to debate topic
- Go talk to them

How can Foresters and Wildlife Biologists Conduct More Projects to Demonstrate Benefits of Cooperative Management?

- Hold some "brainstorming" meetings between forestry and wildlife agencies.
- Measure attributes useful to both professions (dbh, canopy cover, basal area, etc.)
- Specific species and habitat objectives are needed
- Secure a funding source by establishing a market for low-end and hardwoods: e.g. aspen and birch
- Other sources of additional funding
- Inclusive of non-game species in management
- Should maintenance of biological diversity be a goal of intensive forest management?
- Is it possible to manage for the long term future without being prophets of the future?
- Stop asking the timber industry to finance forest health initiatives. No wonder the public gets riled up!

What are the Research Needs?

- How can black spruce be converted to productive white spruce (take advantage of the warming)?—Start now!
- Develop landscape level models of forest succession dynamics (agree)
- Growth monitoring and habitat monitoring of forests
- Determine potential of the two varieties of white spruce for **both** commercial and ecological value.
- Field density-dependent yield model for Interior species
- Use of semiochemicals to manipulate ips beetle populations
- Develop use for aspen and birch
- Mixed stand (spruce/aspen/birch) silvicultural practices
- Changes in habitat for threatened/endangered species
- Need more applied research, rather than baseline research
- How to produce a commodity **and** maintain biological diversity
- Find out how unusual recent levels of forest insect activity has been
- Using background information from Canada, quantify ecology of Calamagrostis in Alaska conditions. (Persistence on sites based on site conditions.)

Ecosystem Management Plan Development

Target End Date: 3 to 5 years

First phase: scientific assessment 12–15 months from start

Who Needs to be Involved:

Conveners:

First Steps:

EPA Grant Development

One to three years, eco/economy: risk analysis, ecosystem management

Proposal Due Date: mid-July

Who Needs to be Involved (Reviewers/Editors): Council for public input; C. Mulstrom (Berkley)/ grad students, TCC. Public input for future generations (wish list). FNSB partners in science, traditional interests, Minto Cultural Heritage Institute, CAD, ABR, Environmental groups, user groups

Contact Recipient: UAF

Core Work Team (writers): Bob Wheeler, Packee, Council, Welbourne, Business, Roger Siglin, Fox

Outcomes

- Action/working group—four-prong
- More efficient information transfer
- Scientific working group—spruce beetle
- Action/$s
- What's the role of nonprofits? e.g. to get $s.
- How can we all work for $s?

What was Interesting to You (New)?

- Kenai Task Force
- Relative risk of increasing ips/budworm populations vs. bark beetle
- Varieties of white spruce
- Input on plant diseases—good stuff
- Ideas about broadening spruce seed sources for plantings (e.g., using seed from areas with warmer climate)
- Opportunity to attempt a meaningful integration (maybe for about the first time)
- Old age of existing managers!

Other Thoughts

- Collaboration is essential for obtaining current information—technology transfer of research/ study results
- Work for the good of the forest, not your own special interest
- Public is interested in factual information and want to be involved and learn.
- This is an incident not an emergency
- Unmanaged ecosystems are also important to biodiversity
- Do not get hung up on "rare" indicator species as they may be in natural lows dictated by climate—instead, concentrate on ecosystem processes.
- Maybe we have too many "systems," not enough action?
- Human responses to the present should be hedged in the future. Any one particular action (including no action) should not dominate a regional landscape.