ALASKA LEGISLATURE COMMITTEE FILES 1995-1996 8672

8711.1 HOUSE RESOURCES

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KENAI PENINSULA SPRUCE BEETLE
WILDLAND FIRE CONSEQUENCES

Prepared By The Alaska Department of Natural Resources
Division of Forestry
February 1993

The spruce bark beetle infestation has modified the Kenai Peninsula's forest health in a number of ways. Considerable attention is focused on the potential impacts from wildland fire because of the hazard presented by beetle killed stands of spruce. The following facts were collected from foresters, researchers, and fire behavior specialists to offer a realistic perspective on the situation.

1. The advancing tree mortality caused by the spruce bark beetle is causing establishment of a different vegetative type. Once healthy stands of timber are giving way to grass, brush and dead snags. This altered fuel type can burn very rapidly, under the right conditions, particularly in the spring and early fall.[1]

The fire hazard moderates after green-up usually around June 10th, and does not re-appear until the first hard frost.

2. The grass/brush fuel types can be dangerous under the right conditions. Most fatalities and loss of structures in wildland fires occur in these fuel types.[2] Rapid rates of spread can outrun a person, especially when the fire is being pushed upslope by the wind. These new fuel types present more danger to life and property during the pre-greenup and post frost stages than did the previous healthy stands of timber.

3. After the overstory (snags) fall or are wind thrown, the fire behavior will change again. The rates of spread will slow down, however, the fire may be too intense to effectively control unless controlled quickly. The reason for the decreased spread rate is the heavy fuels break up the continuity of the surface fuel bed, acting as a heat sink to the passing flames. If the downed timber is dry and the heavy fuels support combustion, the resulting fire intensity may alter the soil characteristics, enough to effectively prohibit re-establishment of the climax plant community (spruce/hardwoods) over a portion of the fire area. The spruce type may be lost for decades if this occurs.[3]

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[1] John W. See, Cooper Landing Spruce Beetle Fire Behavior Analysis February 23, 1990

[2] Carl C. Wilson, Some Common Denominators of Fire Behavior on Tragedy and Near-Miss Forest Fires, U.S.D.A. Forest Service, December 1976

[3] Rodney A. Norum, personal correspondence, February 1993

4. A "worst case" scenario will occur when a combination of events happen. Long term drying trends that span several years (drought) reduce fuel moistures in the heavy dead fuels to critical levels. Combined with a wind event, such as a weather frontal passage or subsiding air mass, referred to as "red flag" warning weather conditions, would create the conditions necessary for "worst case fire behavior".

The probability of experiencing the effects of a long term drying trend (drought) are one year out of every four years. "Red flag" warning weather conditions that would coincide with a drought to create this type of "worst case" fire behavior occurs once every five years.[4] "Red flag" weather conditions refer to a combination of low humidities (less than 20%), high temperatures (80 degrees or more) and high winds (generally over 25 mph). History supports this assertion considering the frequency of large wildland fires on the Kenai Peninsula. There has been a large fire on the Peninsula every 10 to 20 years.

5. Alaska's spruce trees burn more readily than other tree species such as encountered in the lower 48 states because of low foliar (needle) moisture content. Therefore, when a spruce tree in Alaska turns yellow or red after a beetle attack, it is not significantly more flammable than a healthy tree. Resins and other chemicals in the needles are also partially responsible for this phenomena.

Adjustments have been made by the fire suppression agencies to counteract the increased hazard. The retardant aircraft fleet has been modified to provide a 2000 gallon air tanker stationed at Palmer, Alaska. This aircraft has improved capabilities in the urban wildland interface areas of the Kenai Peninsula. Training sessions on urban wildland firefighting tactics have been developed and presented and a specialized wildland engine firefighter class has been developed and given to the rural fire departments that cooperate with the wildland fire agencies.

The federal, state and local fire protection organizations responsible for fire suppression must be prepared to effectively initial attack fires while they are small. In the pre-greenup scenario, initial attack response times cannot be compromised, especially when the reported fire corresponds with red flag warnings conditions. During drought conditions, additional suppression forces must be in-place to maintain the success of the initial suppression action.

If you have any other questions regarding this subject, please feel free to contact the Division of Forestry Office in Soldotna.

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[4] Neil Marchbanks, National Weather Service, Fire Weather Forecaster, personal correspondence, February 2, 1993

House and Senate Resources Committee Meeting
Agenda
September 27, 1996
Spruce Bark Beetle Infestation
1:00 PM

1) Call to order & welcome by **Co-Chairman Green**

2) Introductions by **Jerry Boughton**, Alaska Chairman, Society of American Foresters

3) Overview by **Dr. Ed Holstein,** U.S. Forest entomologist and forest health specialist

4) International Perspective by **Dr. Patrick Moore**, Director of the Forest Alliance of British Columbia & **F.L.C. Les Reed**, President, F.L.C. Reed and Associates Ltd.

5) Organization Perspectives: Status/Responsibilities (approx 8 minutes each)

   DNR Division of Forestry - **Tom Boutin** via teleconference
   Ninilchik Native Corp. - **Greg Encelewski,** Forester
   U.S. Forest Service - **Larry Hudson**, Forest Supervisor
   Alaska Coop Extension - **Mike Faustibend**, Extension Agent
   Alaska Forest Assn. - **Jack Phelps**, Exec. Dir.
   DF&G Division of Habitat - **Lance Trasky,** Division Director

6) Committee discussion and questions

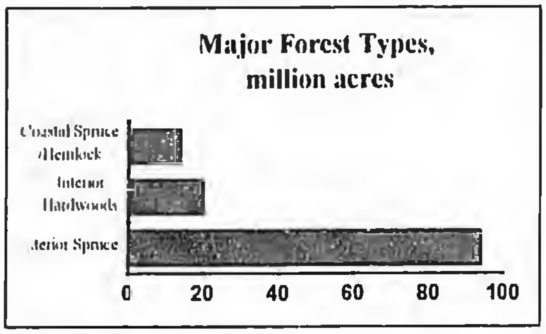
7) Adjourn

Alaska

Forest Health Highlights

The Resource

There are 129,000,000 acres of forest land in Alaska, which is approximately 27% of the total land area. Two distinct forest ecosystems make up these forests; the boreal forest ecosystem of south-central and Interior Alaska, and the temperate rainforest of southeast Alaska and Prince William Sound. The boreal forest is characterized by a mosaic of spruce and hardwoods (mostly birch and aspen). The coastal rainforest is mainly made up of spruce and hemlock.



Management Focus

Federal, State, and private entities all manage significant portions of this vast forest resource. An approximate breakdown of ownership and management focus is:

Federal (Approximate area):

46 million acres - National Park Service, National Parks primarily managed for recreation resources.

12 million acres - Bureau of Land Management, managed for multiple uses.

11 million acres - National Forests, managed for multiple uses.

7 million acres - Fish & Wildlife Service, National Wildlife Refuges primarily managed for wildlife resources.

State (Approximate area):

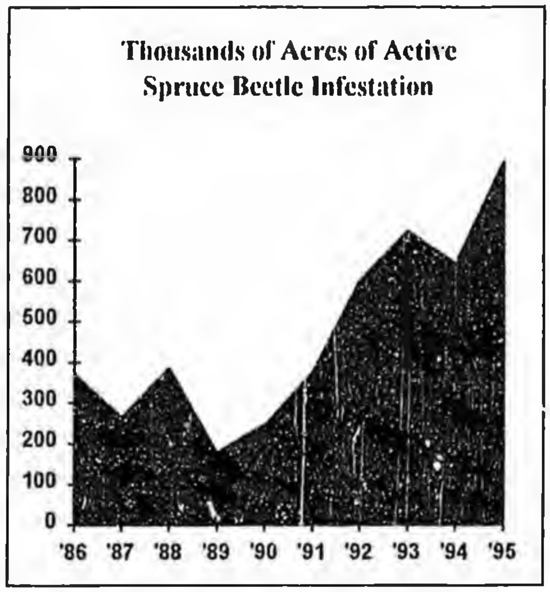
21 million acres - State forests and unclassified lands, managed for multiple use.

Private lands (Approximate area):

30 million acres - primarily native ownership.

Special Issues

Spruce Beetle: The spruce beetle outbreak is the largest recognized forest health issue in Alaska. This infestation has been on-going for over a decade, but has substantially increased in the last five years. It is estimated that 25,000,000 spruce trees died from this infestation in 1995 alone. In many areas entire drainages of spruce forests have been killed. Most current tree mortality is in the Cook Inlet/ Kenai and Copper River areas, but is also occurring in southeast Alaska. Impacts of this outbreak include: loss of old growth, long-term conversion to non-forest types, altered watershed characteristics, changes in wildlife habitat value, declines in scenic quality, merchantable value reduction of killed trees, and increased fire hazard.



Yellow-Cedar Decline: Decline and mortality of yellow-cedar is the most spectacular forest problem in southeast Alaska. About 595,000 acres of this decline have been mapped to date. Yellow-cedar is the principal victim of this decline as other tree species are largely unaffected. Yellow-cedar has extremely valuable wood; thus the problem has considerable economic impact. This tree species also has ecological importance and its wood and bark have long been used by Native people.

Decline occurs in forests that have not been visibly altered by timber harvesting or other human disturbance. While the cause of yellow-cedar decline is not understood, it appears to be naturally occurring and caused from some environmental stress. Excessive mortality of yellow-cedar may lead to reduced populations of this species due to its poor regeneration. Because yellow-cedar is resistant to decay, there is potential for salvaging dead trees.

Other Issues

Management of second-growth stands: In many areas of southeast Alaska, regeneration in harvested areas has gone untended, resulting in very dense young stands. These dense areas are not productive wildlife habitat for many decades. Altering of wildlife habitat to these conditions through timber harvesting is a growing concern and significant part of the issues pertaining to the amount and location of forest management on the Tongass National Forest. Appropriate silvicultural treatments to reduce this dense condition following timber harvesting can reduce this impact to wildlife habitat.

Defoliating Insects: Alaska has a number of periodic outbreaks of defoliating insects. These outbreaks often exceed 200,000 acres in size. While this magnitude of defoliation would cause considerable concern in other portions of the country, due to Alaska's relative inaccessibility, these conditions rarely induce management actions. These insects do not always cause tree mortality, but do stress host trees after several years of infestation. Large outbreaks have been recorded in coastal spruce/hemlock forests and interior aspen and spruce forests.

Dwarf Mistletoe and Heart Rot Diseases: These are very important diseases of trees in unmanaged, old-growth stands throughout southeast Alaska. Forest managers must recognize the potential for reduction in timber volume and value under various silvicultural scenarios, keeping in mind that these diseases contribute to stand diversity and structure.

Interior Hardwood Heart Rots: Considerable heart rot decay occurs in both birch and aspen in interior Alaska. Surveys are being conducted to determine the pathogen amount and severity. Defect in both species has an important bearing on potential utilization.

Regional Surveys

Insect and Disease Conditions

Insect and disease aerial surveys have been conducted in Alaska since the 1950's. These surveys are a cooperative effort of the Alaska State Division of Forestry and the U.S. Forest Service, Forest Health staff. Surveys are flown each year and the current level of insect and disease activity is mapped and described in an annual Insect and Disease Conditions report.

Forest Health Monitoring

There is a nation wide effort to systematically monitor forest conditions and assess change in all U.S. forest types. Due to Alaska's large size and overall inaccessibility, cost effective Forest Health Monitoring here will require different techniques than are being used in other portions of the country. The U.S. Forest Service and State Department of Natural Resources are working to design an appropriate monitoring effort for Alaska's forest types. Implementation of this effort is expected within the next few years and will require participation by all major Alaska forest ownerships.

For More Information Contact:

Forest Health Management
State and Private Forestry
USDA Forest Service
3301 "C" Street, Suite 522
Anchorage, Alaska 99503

907-271-2575
Fax 907-271-2897

Alaska Forest Management Education Alliance

Fire Danger from Bark Beetles

The Subject

Do beetle-killed trees increase fire danger or not? This issue has been a very misconstrued subject rampant with misinformation. Actual relationships of fire danger with changing fuels are well documented and easily understood. The key is to consider the changing forest condition using established fire danger factors.

Fire Danger

Fire professionals describe fire danger using the three factors of Hazard, Risk, and Management, related by the following formula:

Danger = (Hazard + Risk) - Management

Hazard = Fuel conditions (fuel loading)
Risk = Chance of ignition
Management = Capacity to reduce hazard or risk and to suppress fires

All three factors must be considered when thinking about how fire danger is changing in Alaska's forests.

Fire Hazard (Fuel Loading)

Forests and their fuel loading are constantly changing. Sometimes change is gradual. When insect infestation or other large disturbances happen, the change can be very rapid.

Birch Forests
Driving through the Mat-Su Valley you're aware of the birch forests. Yet walking through those forests and looking closely you will see:

- 20-40 white spruce per acre, many having been killed by beetles in the last ten years.
- Many of these spruce have fallen over adding large fuels to the ground.
- A number of the birch are over-mature and have dead or dying tops.
- This thinning forest canopy change allows more light to the ground and a substantial increase in grass, brush and other fine fuels.

These changes are much more subtle than massive beetle kill in solid spruce forests, yet can increase fire danger none-the-less.

White Spruce Forests
Most of Alaska's white spruce forests originated from fire and have trees of similar age and size. When beetle infested, often nearly all spruce trees are killed in three to five years. Fuel hazard changes drastically as the trees have their needles turn red and fall off, the trees fall over, and the ground vegetation increases from more sunlight getting to the forest floor.

The year after beetles attack a tree the needles will be red (a very flashy easily ignited fuel). The red needles will fall off the next winter and most small twigs will fall within two years.

Once the needles and twigs fall from the tree, a forest of dead sticks standing in the air remains. These large fuels do not present a large fire hazard when upright as there is so much air around them. However, fine fuels increase over time as the forest vegetation (grasses and brush) increase from more sunlight to the ground.

These dead trees break off and fall to the forest floor five to ten years after being killed. Large fuels on the ground can increase from 2 tons/acre in a healthy green forest to over 40 tons/acre in a forest killed by beetles (Schulz 1995).

As fine fuels increase and large fuels (dead trees) fall to the ground, fire hazard is increasing. The greatest amount of fine fuels mixed with the greatest amount of large fuels (i.e., highest fire hazard) happens seven to ten years after beetles kill the forest.

When these conditions ignite under the right climatic conditions, fires spread quickly, burn intensely, and can be very difficult to contain or control.

Fire Risk

Fire risk is the chance of ignition. The more fine fuels (easy to ignite) present, the more lightening strikes or people in these fuel conditions, the higher the risk. Alaska's increasing number of tourists is adding to our risk. This is particularly true on the Kenai Peninsula. Usual management actions to lessen this factor include things such as fire prevention signing to raise peoples awareness to be careful, limit people's access to the woods, burning ordinances, fireworks bans, etc.

Green Versus Dead Spruce Forest

Individuals who oppose forest management actions to deal with this problem have tried to convey that live (green crowned) white spruce forests pose more fire danger than dead spruce forests.

When the increased fuel loading is considered, together with the volatility created by the presence of mixed fuels, the greatest fire danger occurs after beetles have killed the trees and those trees are allowed to fall and lie on the forest floor. The presence of many people during hot dry summer days increases this danger.

Common sense examples:

Next time you have a burn pile, throw a green spruce bough on the pile. There is enough heat to volatilize the chemicals in the needles and the bough will flash and burn the needles. Hold a Bic lighter under another green bough and nothing will happen. Without intense heat from another source, green trees do not easily ignite.

Next time you're camping try starting your campfire with green boughs (without Coleman fuel). Then as you normally do, pile dead grass, twigs and large logs together. A flick of the Bic is all it takes to start an intense fire.

Forested acres with beetles killing trees (fuels building) has been rapidly rising since 1990.

1990 - 245,000 acres	1991 - 375,000 acres
1992 - 600,000 acres	1993 - 721,000 acres
1994 - 641,000 acres	1995 - 892,000 acres

Fire danger is increasing on hundreds of thousands of acres in Alaska. If we do not manage our forests to reduce this fuel buildup and prevent the certainty of wildfires, why spend millions to put the fires out once they start?

Over $16 million dollars was spent trying to control wildland fires this spring. The Crooked Creek fire alone burned 17,000 acres or the equivalent of 3% of the forest area that was killed by beetles in 1995.

Management Actions

Management actions are a factor that can reduce overall fire danger. These actions reduce the danger by reducing either the hazard on the site or by reducing the risk of ignition.

Taking management action that only addresses risk, is, pun intended, playing with fire. Fire managers readily acknowledge the complex fire danger in insect-killed forests. Fuel conditions following insect infestation coupled with weather conditions can together make fire danger extreme. Once a fire is started in extreme fuel and weather conditions, it will spread quickly and be very difficult to control. When this happens, containment efforts become more complex and expensive.

Preventing this situation from occurring by managing (reducing) the fuel problem is the only long term, cost effective, rational solution.

Summary

Spruce beetles are killing over 22 million trees each year in Alaska's forests. This dramatic forest change is increasing fire danger on hundreds of thousands of acres each year. This spring Alaskans saw the devastating impacts of wildfires. Taking no action to address this problem will result in spending millions of dollars trying to control wildfires, and even so seeing repeat disasters costing devastating property loss and possibly loss of life. Active forest management can reduce the fuel buildup that's happening and regenerate healthy new forests. The dead trees removed will often pay for the cost of these forest rehabilitation actions.

Copies of the fuel buildup study can be obtained from:

US Forest Service, State and Private Forestry
3301 "C" Street, Suite 522
Anchorage, Alaska 99503
907-271-2525

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Phone: 907-566-0931

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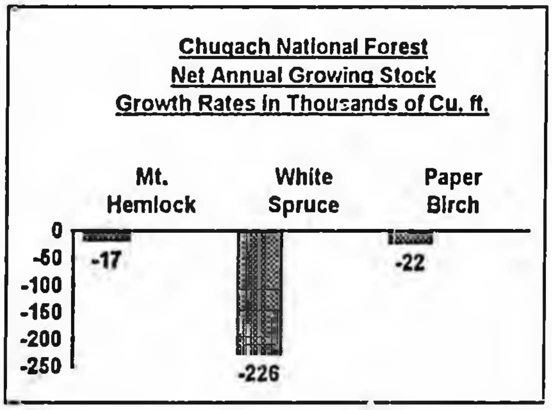
Forest Regeneration

Reforestation Summary

Disturbance is the key factor for regenerating our Northern forests. The tree species that makeup these forests are adapted to begin their life following disturbances. Fire, flood, insect epidemics, and erosion are examples of natural processes affecting forest death and rebirth. By using extensive fire suppression man is having an effect on natural regeneration processes. Research shows that Native peoples have used fire to open areas for hunting and wildlife forage for centuries.



The graph above shows that the trees growing on the Chugach National Forest are showing a net decline in fiber production. This is resulting from the trees getting old, rotting, having their tops die back, and from being attacked by insects. These forests are clearly saying.... "it's time for another disturbance." We can either stand by and accept whatever disturbance comes (many dead trees, followed by large fires) or we can provide managed disturbances needed to regenerate declining areas, and maintain a healthy forest that is not prone to disaster and provides all the forest values Alaskans want. Studies show that without these disturbances many areas may evolve to grassland and it could be centuries before spruce trees return. Allowing foresters to harvest and replant is one way we can assure our children that they will be able to enjoy a spruce forest.

In a forest the only constant is change itself. The major natural disturbances that influence forest birth, growth, and death include fire, floods, insects, disease, wind and erosion. Fire is the most common form of disturbance in Southcentral Alaska. Fire works well to perpetuate spruce and birch forests by opening the canopy, disturbing the ground moss and warming the soil. Fire prepares the seed bed by killing competing vegetation and allows seeds to fall on mineral soil where they can sprout and grow. Without some soil disturbance, vast areas may turn to grasslands.

By the active fire suppression we now have, we are by default managing our forests in a way that will not perpetuate a rebirth with these same tree species. Fires occur less frequently, burn more intensely in heavier fuels causing more damaging or disastrous fires. Foresters can simulate the natural effects of fire and perpetuate these forests in a controlled way by removing wood, providing planned disturbance, and replanting trees.

Regenerating Alaska's Forest

One of the tenets held by the forestry profession is: *"Do not cut a forest you cannot grow back."* Regeneration of the trees is, therefore, the first consideration in harvesting the forest. The task is sometimes done by mother nature and sometimes by man. Alaska has some unique regeneration opportunities that relate to the type of trees and cold soils we have. This varies from region to region in Alaska as well as with local conditions.

In the coastal forests of Southeast Alaska and Prince William Sound, regeneration following disturbance is almost always quick and profuse. Perhaps 95% of disturbed areas (including harvest units) seed-in naturally from surrounding stands. The species, primarily western hemlock and Sitka spruce grow quite rapidly.

In Interior and Southcentral Alaska, natural regeneration of the forest can often be achieved if the proper site conditions are prepared. In some areas, planting of trees may be necessary to ensure the forest is regenerated with the desired tree species. This is particularly true if all the large seed producing trees in the area have died before the regeneration action is taken. No seed means no natural regeneration. Natural regeneration is often preferred over planting. It is less costly and ensures regeneration with local seed well adapted to growing on that site. Most all of the tree species in this region regenerate best on newly exposed soil (such as that resulting from disturbances such as fires, slides, or planned tree harvesting).

Winter time harvesting results in little or no ground disturbance, and does not prepare the site enough for tree seeds to successfully grow. Having seed is only half the equation, the seed must fall on a properly prepared site to be expected to grow. Beetle killed areas that are allowed to stand will not have adequately prepared sites for seeds to grow, even if there are any trees left producing seed in the area. Often thick grass develops that keeps the soil too cold, and chokes out what few seedlings may get started. Grass seed penetrates moss present in spruce stands where spruce seeds cannot. Some hardwood species like cottonwood, birch, and aspen can reproduce vegetatively from sprouts.

If planting is necessary, it is best done in the spring as soon as the ground thaws to planting depth. Frozen soil is a frequent obstacle and cold soils insulated by grass retards growth. Competition from other plants often shade out or starve tree seedlings unless protective measures are taken. Planting seedlings raised from seed collected from local trees that had good growth and form characteristics can increase survival and growth resulting in obvious benefits.

The knowledge to successfully regenerate Alaska's Southcentral and Interior regions exists. Foresters and forest industries can work together to improve the health and composition of Alaska's future forests. The benefits to be achieved are related to many other living natural resources: fish, wildlife, other plants, and people. To achieve this healthy forest regeneration goal requires sustained and balanced harvests, mixed age classes of trees, harvesting overmature stands, and use of intensive forest regeneration techniques.

Alaska's goals of clean water, reduced fire hazard, increased wildlife, employment, and income all start with successfully maintaining the regeneration processes of our forests. Forest regeneration for Alaska's future will not happen without disturbance. For the sake of current Alaskans, these disturbances need to happen in a controlled way. Foresters have the knowledge to accomplish this task.

Next time you are in the woods we encourage you to look closely at the forest regeneration processes at work there. Particularly look closely at those areas that have been heavily impacted by bark beetles. If you have questions please contact your local Borough, State, Federal, or forest industry foresters. They can direct you to current literature and studies and are often available to answer specific questions.

Copies of the Forest Regeneration report can be obtained from:

USDA Forest Service, State and Private Forestry
3301 "C" Street, Suite 522
Anchorage, Alaska 99503
907-271-2575

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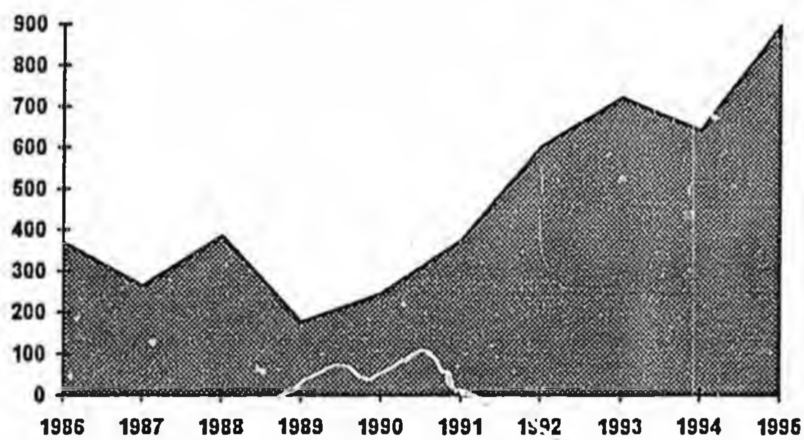
Alaska Forest Management Education Alliance

Alaska Spruce Beetle Situation

Alaska is experiencing the largest spruce beetle outbreak in North America. The spruce beetle population has risen at an alarming rate and remains at a very high level.

An estimated 22 million trees are being killed annually by spruce beetles.

Thousands of Acres of On-going or New Beetle Infestation



Source: USDA Forest Service Alaska Region Annual Forest Insect and Disease Conditions Report.

Over 3,000,000 acres have been impacted statewide by this infestation in the last five years. This infestation is substantially reducing forest resource values throughout Alaska. Mortality is most often extensive with large portions of entire drainages having essentially all mature conifer cover killed. Impacts to wildlife, water quality, and aesthetics are being recognized.

- Extensive loss of old-growth habitat, and lack of natural regeneration constitutes the largest ecological crisis facing Alaska's forest today.
- Potential for catastrophic fires from tremendous fuel loading poses a growing threat to property and human life.
- Loss of economic forest values will hinder Alaska's ability to diversify its economy and will increase the state's economic dependency on oil.

Amount of Timber Resource Affected by Major Ownership (trees that died summer of 1995)

	# of trees that died[1]	# of Million bd ft[2]	# of 3 bedroom home equivalents[3]
Chugach N.F.	747,000	33.6 MMBF	3,400
State of Alaska	8,665,000	389.9 MMBF	39,000
Native Corporation	4,597,000	206.8 MMBF	20,700
All Other Ownership	8,291,000	373.1 MMBF	37,000

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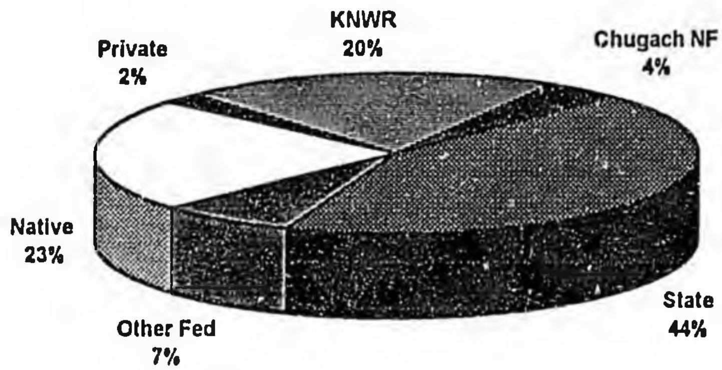
1 @ 25 trees per acre
2 @ 45 bd. ft. per tree (ave. 12" dbh)
3 @ 10,000 bd. ft. per house

Addressing this problem is complex due to multiple ownership, with some owners managing under a no treatment philosophy, and lack of an established forest industry to deal with the problem. Limited access to the infested areas presents additional challenges.

Active Spruce Beetle Infestation by Ownership



Major ownerships with infested acreage are the State of Alaska, the Federal government and Native corporations, in that order. Several Native corporations are actively marketing their timber and providing for reforestation. The state Department of Natural Resources has increased its timber sales in recent years, though all of them have been delayed by appeals. Much of the infested timber on Federal lands is in areas not managed for timber resources, but approximately 30,000 acres (4 percent of the total) is in the Chugach National Forest.

Markets can be developed to support forest management that would accomplish preventive and rehabilitation treatments. Selling values for recent sales have been sporadic, but can be a source of funding for reforestation and other forest health treatments, providing these harvests occur before the trees deteriorate.

- The ecosystems of Southcentral and Interior Alaska are ***demanding attention.*** Lack of action is contributing to increasing loss of forest values.
- Forest management with proper silviculture is a realistic method of addressing this problem.
- Timber sales can provide a vehicle to finance forest health restoration.
- Public awareness and desire for action are growing.
- Information about the changing forest situation is needed and desired by the public.

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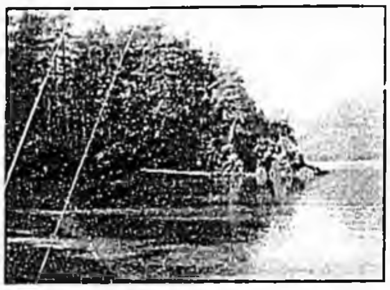


Alaska **F**orest **M**anagement **E**ducation **A**lliance

The Cost of No Action in Declining Forest Health

Summary

Alaska's dying spruce forests will have economic impacts to many resource values important to Alaskans. With all indicators considered, action to prevent the damage or to rehabilitate dead areas using the existing wood value to pay for treatments will be more cost effective than allowing continued deterioration of Alaska's forests.

The Setting

Nobody will say they desire an unhealthy forest. In two public opinion surveys (Daniels 1991 and ISER 1991) Alaskans recognized that spruce beetles are affecting scenic quality, wildlife viewing, and increasing fire danger. Further, they prefer management action to restore affected areas and support tree harvesting with regeneration, as opposed to allowing most trees to be killed by beetles.

It costs money to take action. Usually the value of the wood removed during forest health treatments can help pay for the cost of the treatment. However, too often economic comparison of action versus no action only looks at the value of the wood. Preventing and reducing losses while restoring the other forest values Alaskans want must be a part of the thought process.

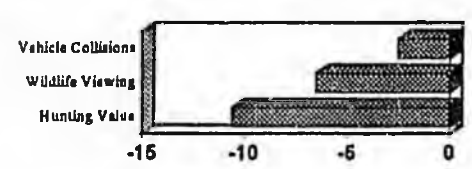
A report by the Alaska Department of Commerce & Economic Development (1996) looks at these values. Methods to determine how Alaska's forest values are being reduced by the beetle epidemic are discussed. "Costs" to Alaska by taking "no action" and continuing to allow our forests to deteriorate are summarized below.

Increased Fuel = Expensive Fires

Everyone is aware of the catastrophic impacts and high costs of wildfires. Our own recent Alaska examples bear this out. Besides the pain and suffering, insurance increases, as does personal loss to friends and neighbors. In the spring of 1996, more than $16 million dollars was spent trying to control fires in Alaska. The Crooked Creek fire burned 17,000 acres or the equivalent of 3% of the forest area that was killed by beetles in 1995. Typically, beetle-killed trees blow down within three years of dying. If this tremendous fuel loading is not removed, in the next ten years Alaskans could suffer many times the losses we glimpsed this spring.

Social Costs of Deteriorating Wildlife Habitat

Beetle killed forests being replaced with less diverse more grassy conditions (Holsten, Werner, Develice 1995) will impact habitat and numbers of several important wildlife species (such as moose and bear). Resident and non-resident hunting alone contributes over $188 million dollars annually to Alaska's economy. Wildlife viewing, a major reason tourists visit Alaska, contributes another $129 million. With beetles killing trees at the rate of 893,000 acres per year, a conservative estimate of a 5% impact on these wildlife value indicators amounts to an $18.4 million dollar annual loss to Alaska's economy.



Millions of Dollars of Annual Loss from Beetles

Altered Water Pattern Costs

Beetles indirectly affect water patterns by removing all the live trees over large areas. Beetles do not leave streamside buffers. Watershed models show higher peak flows during flooding and lower stream flows during drought when live trees are removed from the streamside. Nearly all the spruce forest in the upper Kenai River drainage (Cooper Landing, Russian River, Trail River, Moose Pass, etc.) has been heavily infested by beetles. If changing water patterns and fish behavior reduces sportfishing on the Kenai Peninsula by only 5.5%, it will cost the Alaska economy over $23 million dollars per year. Changing water patterns and stream flows that affect young fish survival and growth could have drastic effects on our commercial fisheries. The Copper, Yukon, Kuskokwim, and many smaller river drainages also have many trees being killed by beetles. Treatments to reduce or prevent further tree death and restore already dead areas can lessen this loss.

Real Estate Devaluation When Trees Die

Homeowners with dead or dying spruce trees must deal with the hazards and liabilities of falling trees, removing them, and the resulting reduction of property value. Professional tree removal can cost several hundred dollars per tree. Real estate appraisal techniques often attribute 7-15% of real property value to trees. A $200,000 Hillside home with 5 large beetle killed spruce trees could cost the homeowner as much as $30,000 in removal costs and property value losses. Professional or homeowner applied insecticide could protect those trees for as low as $200 dollars. Pruning may protect the trees, costing only a few hours of homeowner labor.

Recreation and Tourism

More than 800,000 visitors come to Alaska each year. The visitor industry provides the equivalent of 13,500 jobs in Alaska and $244 million in annual payroll. Over 52,000 Alaska jobs are directly affected by visitor spending. The total 1989-90 in-state spending by tourists exceeded $415 million dollars representing a significant portion of the state's economy.

Selected Sierra Club and Alaska River Journey's 1994 outings show individuals were willing to pay over $3,600 for an average 8.7 day outing in Alaska. Visitors willing to pay this amount undoubtedly have a high level of expectation for an amenity value from the outing and certainly considered other destinations than Alaska. Not meeting expectations, or even a perceived inability to meet those expectations, will result in visitors selecting other destinations or not returning to Alaska for another visit. This effect has been recently witnessed in the Mat-Su area where visitor days have been reduced due to perceived notions of what the Millers Reach fire did.

Many prime tourist areas are being heavily effected by beetles. Negative comments about the extensive areas of dead trees along the Richardson highway are common from both out of state and Alaskan travelers from Valdez. Large spruce tree death is very apparent along the Glenn highway. The Seward highway has tremendous tree death along its viewshed. Kachemak Bay spruce forests are now dead or dying on both the Homer and Seldovia sides. The west side of Cook Inlet is in rapid decline from heavy beetle infestations. For example, a 5% decline of visitor spending equates to a $20.8 million dollar annual revenue loss to Alaska's economy each year.

Parks, Trails and Roads

The Cooper Creek campground on the Kenai Peninsula did not receive preventive treatments, beetles killed all the large spruce, and the trees were removed before they became a safety hazard. Other campgrounds in the area did receive preventive treatments and still have live stands of spruce for campers to enjoy. Kincaid Park, an Anchorage summer and winter high public use area, has lost over 60% of its large spruce trees in the last two years.

Managers of public sites have a responsibility to provide for public safety. They can either pay a little now to protect the sites, or pay more later to provide for public safety. Preventive treatments are generally the most cost effective. Remedial treatments to remove hazards are very expensive ($25,000 per mile to remove hazard trees along the Seward highway in 1994). Liability lawsuits stemming from not providing public safety could potentially cost millions.

Copies of the 1996 Economic Indicator report can be obtained from:

USDA Forest Service, State and Private Forestry
3301 "C" Street, Suite 522
Anchorage, Alaska 99503
907-271-2575

The goal of the Alaska Forest Management Education Alliance is to provide the most current, objective, and scientific information about this and other forestry issues.
To obtain copies of current studies and literature contact:
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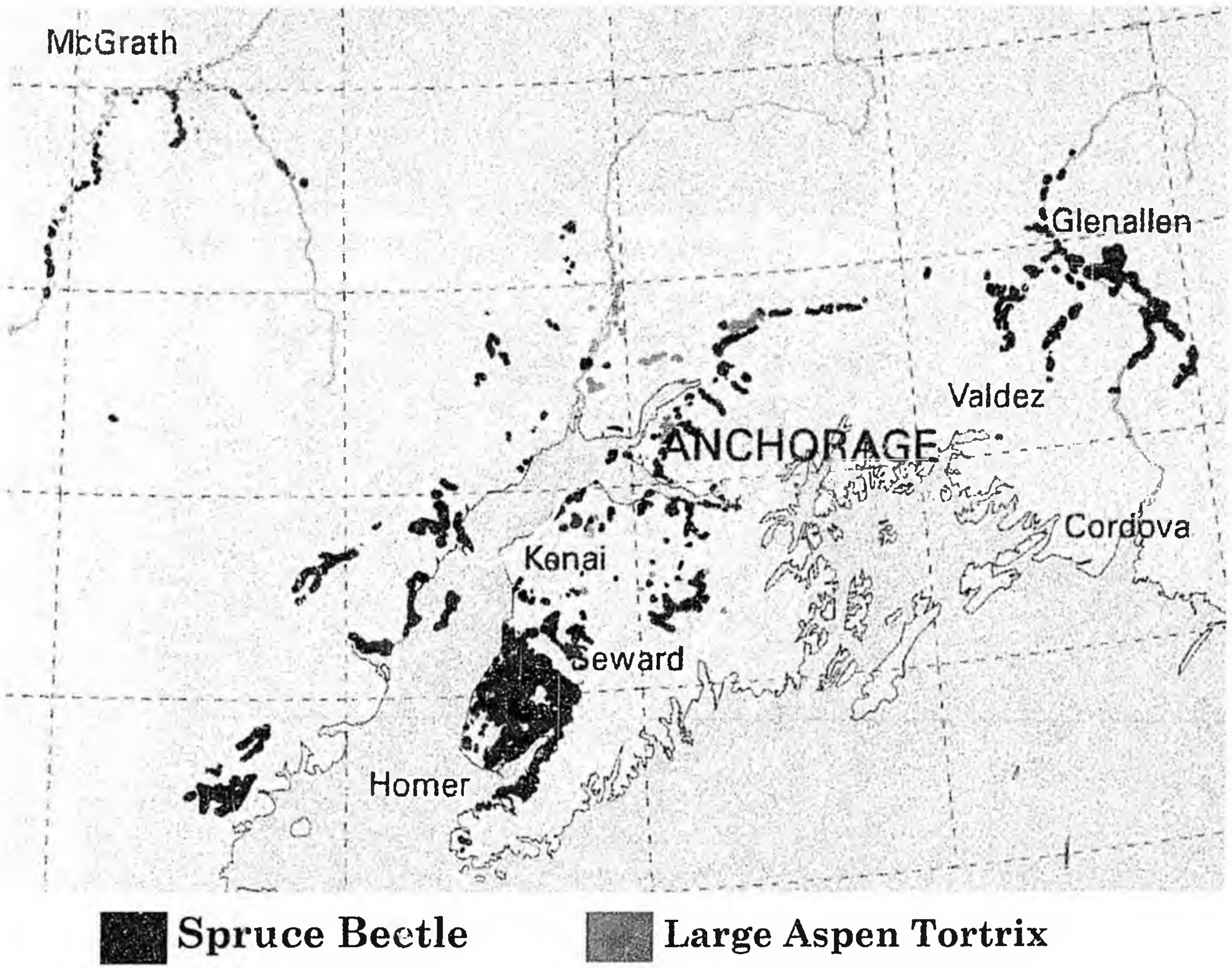
1995 SPRUCE BEETLE MAJOR INFESTATIONS - SOUTHCENTRAL ALASKA



Forest Insect & Disease Leaflet 127

U.S. Department of Agriculture Forest Service

The Spruce Beetle

Edward H. Holsten,[1] R.W. Thier,[2] and J.M. Schmid[3]

Figure 1—*Yellowish orange and reddish colors in the tops of trees are evidence of spruce beetle infestation in Arizona.*

The spruce beetle, *Dendroctonus rufipennis* (Kirby), is the most significant natural mortality agent of mature spruce. Outbreaks of this beetle have caused extensive spruce mortality from Alaska to Arizona and have occurred in every forest with substantial spruce stands. Spruce beetle damage results in the loss of 333 to 500 million board feet of spruce sawtimber annually. In the past 25 years, outbreaks have resulted in estimated losses of more than 25 million board feet in Montana, 31 million in Idaho, over 100 million in Arizona, 2 billion in Alaska, and 3 billion in British Columbia (fig. 1).

Spruce beetle outbreaks cause extensive tree mortality and modify stand structure by reducing the aver-

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age tree diameter, height, and stand density, leaving small, slow-growing trees and intermediate-sized trees to become dominant.

As mature spruce are killed, forage may increase, benefiting some wildlife species. But species that depend on the mature spruce for habitat may be adversely affected.

Indirectly, extensive spruce mortality can also affect water yields and result in water gains in rivers, lakes, and streams because of reduced transpiration from dead and dying trees.

Hosts

The spruce beetle infests all species of spruce within its geographical range (fig. 2). The more important commercial tree species attacked include white, Lutz, Sitka, and Engelmann spruce.

Evidence of Infestation

On standing trees, the first sign of spruce beetle infestation is reddish-brown boring dust accumulating at the beetle's entrance holes, in bark crevices, and on the ground around the trunk of infested trees. Masses of pitch may accumulate around the en-

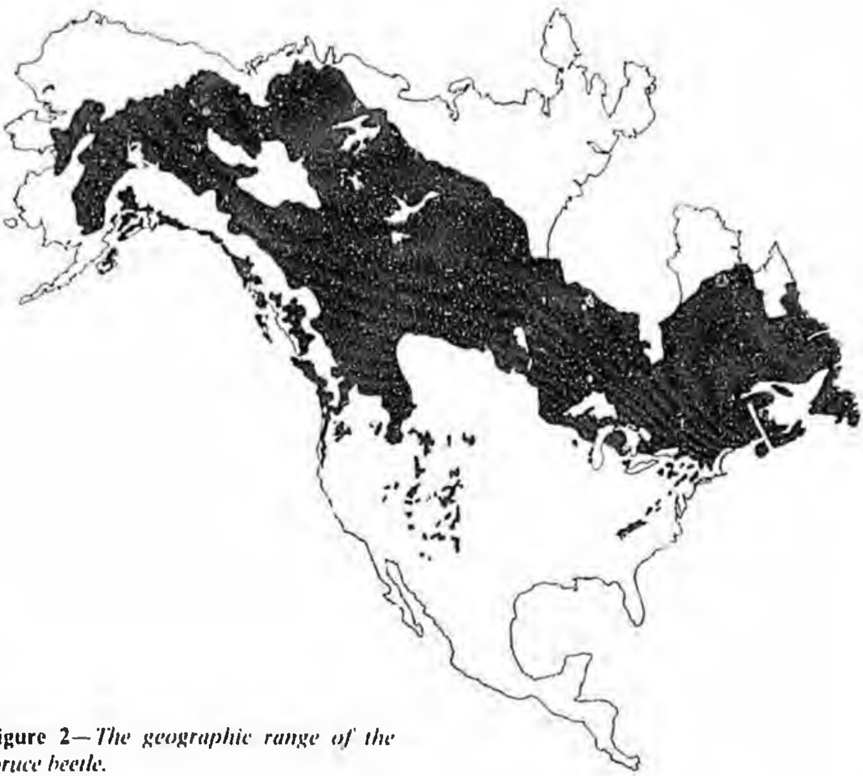

Figure 2—*The geographic range of the spruce beetle.*

trance sites. These signs are most visible the summer following infestation and become less noticeable months later.

On windthrown trees and logging residuals, spruce beetle attacks are readily detected on the lower surfaces of the material and should not be confused with *Ips* beetle attacks more commonly found on the upper surfaces.

Some standing trees may be attacked on only one side of the bole, creating a "strip attack." The infested area may die, but the tree usually remains alive, so the foliage does not discolor. Trees with "strip attacks" frequently are infested by subsequent spruce beetle generations and may host two or more generations simultaneously.

During the first fall and winter following spruce beetle infestation, one should look for trees "debarked" by woodpeckers (fig. 3). Partially debarked, green trees are easily noticed. However, on trees without significant debarking, one must be relatively close to see sawdust in bark crevices and around the tree base.

The needles of infested trees do not usually fade or discolor within the first year following attack. However, during the second summer following attack most needles turn yellowish. Some needles even remain green until the third summer, or up to 2 years after the initial infestation. The needles on separate branches of the same tree discolor at different times. Needles are removed periodically from the trees by wind or thunderstorms, leaving the upper crowns of exposed twigs with a yellowish-orange to reddish hue.

Figure 3—*Infested spruce debarked by woodpeckers.*

Identification of the Life Stages

Adult beetles are blackish brown to black with reddish-brown or black wing covers. The beetles are cylindrical, approximately 1/4 inch (6 mm) long and 1/8 inch (3 mm) wide (fig. 4).

Spruce beetles look similar to other *Dendroctonus* beetles and, if no host material is present, can be distinguished from them only by microscopic examination. At first glance, spruce beetles may also be confused with *Ips* beetles in spruce. It is important to remember that the posterior margins of the wing covers on spruce beetles are evenly rounded, while *Ips* beetles have wing covers with concave margins and teethlike projections.

CORRECTION

THE FOLLOWING DOCUMENT(S)
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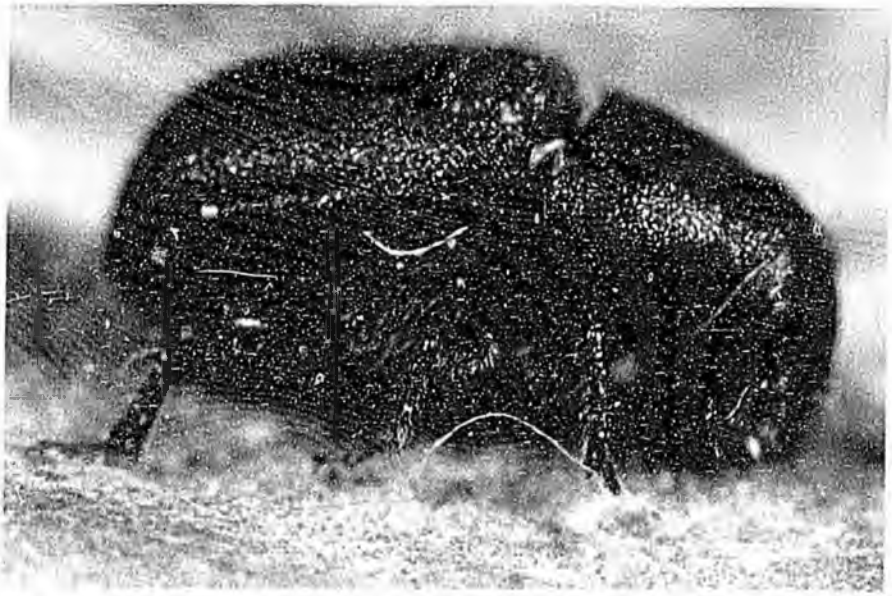


Figure 4—*An adult spruce beetle.*

The eggs of the spruce beetle are oblong, pearly white, and 1/16-inch (1.5 mm) long. The larvae are stout, cylindrical, legless grubs that pass through 4 larval stages (instars) and reach a length of 1/4 inch (6 mm) at maturity (fig. 5). The pupae are opaque white, inactive, and somewhat similar in size and shape to adults.

Life Cycle

Spruce beetles may complete their life cycle in 1 year on warm sites at lower elevations or take up to 3 years on cool, well-shaded locations on north slopes.

However, it generally requires 2 years for the spruce beetle to complete its life cycle. Adults may emerge any time from May to October, depending on temperature. The beetles attack host material soon after emerging. Adults that appear in August to October may represent a reemergence of parent adults or a movement of maturing brood adults to hibernation sites.

Figure 5—*Spruce beetle larvae.*

Figure 6—*Spruce beetle egg gallery and larval mines.*

To deposit eggs, female beetles bore through the outer bark of the host tree and create egg galleries in the underlying phloem tissue. Eggs are laid on either side of the egg gallery (fig. 6). Egg galleries are slightly wider than the beetle and, except for the terminal portion, are packed with frass and boring dust. Egg gallery length ranges from about 2.5 to 12 inches (6 to 30 cm). Eggs are usually deposited in short rows along alternate sides of the gallery in numbers ranging from 4 to 14 eggs per centimeter of gallery.

Most of the eggs hatch by August. The larvae bore outward from the egg gallery and feed as a group for the first and second instars. Third and fourth instars construct individual feeding galleries. The larval stage predominates during the first winter, although adults and eggs may also be present. During the 2-year life cycle, most larvae pupate approximately 1 year after attack. Pupation lasts 10 to 15 days and usually takes place in pupal chambers at the end of the larval galleries.

During the second winter of the 2-year cycle in standing trees, some beetles overwinter in their pupal sites. Other beetles—from 5 to 88 percent—emerge, move to the base of the tree, and bore into the bark near the litter line to hibernate. In windthrown trees, most adults overwinter in place. Approximately 2 years after attack, adults emerge from overwintering sites and attack new host material.

Stand Conditions Conducive to Infestations

Endemic spruce beetle populations usually live in windthrown trees (fig. 7). When beetle populations increase to high levels in downed trees, beetles may enter susceptible, large-diameter, standing timber. Most outbreaks in standing timber originate in windthrown trees.

In mature stands, large-diameter trees ($\geq 18''$) usually are attacked first, an obvious characteristic denoting susceptibility to spruce beetle attack. If an infestation persists in a stand, smaller diameter trees are attacked. Recent evidence from Alaska indicates that tree diameter is important in determining susceptibility only when coupled with less-than-average radial growth in the preceding 5 years. The proximity of uninfested standing spruce trees to infested hosts also denotes vulnerability to attack.

In the Rocky Mountain area, susceptibility of a stand to spruce beetle attack is based on the physiographic location, tree diameter, basal area, and percentage of spruce in the canopy. Spruce stands are highly susceptible if they grow on well-drained sites in creek bottoms, have an average diameter (d.b.h.) of 16 inches or more, have a basal area greater than 150 square feet per acre, and have more than 65 percent spruce in the canopy.

In Alaska, the susceptibility of a spruce stand is based on average tree

Figure 7—Windthrown trees and logging residuals—prime habitat for beetle populations.

diameter, age of the stand, condition of the stand, and proportion of white spruce in the canopy. A spruce stand of old-growth or damaged sawtimber is very susceptible to spruce beetle attack if the larger diameter spruce trees have a slower-than-average growth rate, have an average diameter (d.b.h.) greater than 12 inches, and if the stand has more than 70 percent white spruce.

Susceptibility of a spruce stand to spruce beetle attack in British Columbia and the Northeastern United States is based on criteria similar to that used in the Rocky Mountains and Alaska.

Hazard rating systems based on the stand and site conditions discussed above have been developed so that managers can identify stand susceptibility to spruce beetle attack.

Management Strategies

Forest managers can develop various strategies to avoid or reduce resource losses to spruce beetles. Before developing a strategy, the forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered because population levels will determine the priority of management actions and the type of strategy to be invoked.

The primary strategy should be silvicultural treatments of potentially susceptible stands in order to maintain their health with a moderate growth rate. The first step in this strategy is to hazard-rate spruce stands, which will indicate the most susceptible stands. The stands can then be treated with harvesting directed at the most susceptible stands. Infested logging residuals need never become a significant contributor to spruce beetle populations if stump height is kept below 18 inches (45 cm) and cull logs and tops are limbed, cut into short lengths, and left unshaded, unpiled, and exposed to sunlight. Silvicultural treatments have greater long-term effectiveness, because these treatments modify stand conditions.

The primary strategy assumes, in general, beetle populations are not immediately threatening resource values. If beetle populations are threatening, then strategies involving suppression methods are more appropriate. Suppression methods including silvicultural, physical, and chemical measures are available to forest managers for reducing spruce beetle populations. Some methods are suitable only for populations in windthrown host material; other methods are better suited for infestations in standing trees. Most suppression methods are short-term responses to existing beetle populations and, therefore, correct only the immediate situation.

Figure 8—*Green trees felled to capture emerging spruce beetles.*

Silvicultural Methods:

- *Sanitation overstory removal* involves the removal of all infested and susceptible spruce to encourage regeneration of a new vigorous stand.

- *Sanitation partial* cut involves the removal of infested and susceptible spruce to improve the growth of the residual stand. Sanitation partial cut removes most of the larger trees but may leave a residual stand that is below the recommended level of basal area. This residual stand may be more susceptible to windthrow.

- *Trap trees* are green trees with a diameter greater than 18 inches (d.b.h.) that are felled before beetle flight. Trap trees can absorb up to 10 times the number of spruce beetles that a standing tree will absorb. Once infested, trap trees should be removed from the forest.

Trap trees shaded from direct sunlight attract the most beetles. Spruce beetles attack cool, shaded portions of the trap tree boles (fig. 8). Felled trees should not be delimbed because limbs on the upper side of the bole provide shade while limbs on the underside permit the beetles to colonize the underside of the bole by keeping it off the ground.

Past ratios of trap trees to infested standing trees have ranged from 1:2 to 1:10. Current ratios vary with the size of the green trees to be felled as traps, with the number and size of infested trees in a stand, and with the existing beetle population.

- *Lethal trap trees* are green trees injected with a silvicide and felled before beetle flight. They are effective in areas where traps cannot be removed.

Physical Methods:

- *Solar heat* involves exposing infested logging residuals or windthrow to direct sunlight to kill inhabiting larvae. To maximize brood mortality, residuals should be cut into 5-foot lengths. All branches and debris shading the host material should be removed. The infested material should be rotated at 2-week intervals during the summer to expose all surfaces. While using solar heat is effective in the Rocky Mountains, it is not effective in Alaska, because summer temperatures are not warm enough.

- *Fire* involves piling and burning infested logging residuals and windthrow to destroy inhabiting broods. The infested material is usually green and difficult to burn, but only the bark has to be scorched to destroy the inhabiting brood.

Chemical Methods:

- *Pheromones* are chemical substances that influence insect behavior. Synthetic aggregating and anti-aggregating pheromones increase the attractiveness of trap trees, attract beetles into the trees to be cut, or discourage infestation of high-value trees. Aggregating pheromones are most efficient when used with trap trees. Methylcyclohexenone (MCH), an anti-aggregating pheromone, shows promise in discouraging spruce beetles from attacking trees; however, it has not yet been registered by the U.S. Environmental Protection Agency (EPA).
- *Insecticides*, such as Lindane and carbaryl, can be applied to the boles of uninfested trees to kill attacking adults. In Alaska, carbaryl applied as a 2-percent spray has provided 100-percent protection from attacking beetles for at least 2 years. Cacodylic acid and MSMA (monosodium methanearsonate) are silvicides that can be injected into standing trees, which become lethal trap trees when they are felled.

Assistance

More information about the management of the spruce beetle may be obtained from the State Forester's office or the U.S. Department of Agriculture, Forest Service, Forest Pest Management.

The publications listed in the references provide more information on the biology, ecology, and management of the spruce beetle.

References

Alexander, R.R. 1986. Silvicultural systems and cutting methods for old-growth spruce-fir forests in the central and southern Rocky Mountains. Gen. Tech. Rep. RM-126. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 33 p.

British Columbia Ministry of Forests. 1981. Spruce beetle management seminar and workshop. In: Proceedings, 1980 seminar and workshop; 1980 October 7-8; Prince George, B.C. Pest Mgmt. Rep. No. 1, Victoria, B.C., Canada: Province of British Columbia, Ministry of Forests. 16 p.

Gibson, K.E. 1984. Use of trap trees for the reduction of spruce beetle-caused mortality in old-growth Engelmann spruce stands in the Northern Region. Rep. No. 84-10. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region. 11 p.

Hard, J.S.; Holsten, E.H. 1985. Managing white and Lutz spruce stands in south-central Alaska for increased resistance to spruce beetle. Gen. Tech. Rep. PNW-188. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 21 p.

Hard, J.S.; Werner, R.A.; Holsten, E.H. 1983. Susceptibility of white spruce to attack by spruce beetles during the early years of an outbreak in Alaska. Canadian Journal of Forest Research 13:678-684.

Hodgkinson, R.S. 1985. Use of trap trees for spruce beetle management in British Columbia: 1979-1984. Pest Mgmt. Rep. No. 5. Victoria, B.C., Canada: Province of British Columbia, Ministry of Forests. 39 p.

Holsten, E.H.; Wolfe, R.L. 1979. Spruce beetle risk rating system for white spruce on the Kenai Peninsula. Tech. Rep. R10-11. Anchorage, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 21 p.

Holsten, E.H. 1990. Spruce beetle activity in Alaska: 1920-1989. Tech. Rep. R10-90-18. Anchorage, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 28 p.

Massey, C.L.; Wygant, N.D. 1954. Biology and control of the Engelmann spruce beetle in Colorado. Agric. Cir. No. 944. Washington, DC: U.S. Department of Agriculture. 35 p.

Schmid, J.M.; Frye, R.H. 1976. Stand ratings for spruce beetles. Res. Note RM-309. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Schmid, J.M.; Frye, R.H. 1977. Spruce beetle in the Rockies. Gen. Tech. Rep. RM-49. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 p.

Werner, R.A.; Baker, B.H.; Rush, P.A. 1977. The spruce beetle in white spruce forests of Alaska. Gen. Tech. Rep. PNW-61. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Werner, R.A.; Hastings, F.L.; Holsten, E.H.; Jones, A.S. 1986. Carbaryl and lindane protect white spruce from attack by spruce beetles (Coleoptera: Scolytidae) for three growing seasons. Journal of Economic Entomology 79:1121-1124.

Werner, R.A.; Holsten, E.H. 1983. Mortality of white spruce during a spruce beetle outbreak on the Kenai Peninsula in Alaska. Canadian Journal of Forest Research 13:96-101.

Wood, S.L. 1963. A revision of the bark beetle genus *Dendroctonus* Erichson (Coleoptera: Scolytidae). The Great Basin Naturalist 23:1-117.

Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

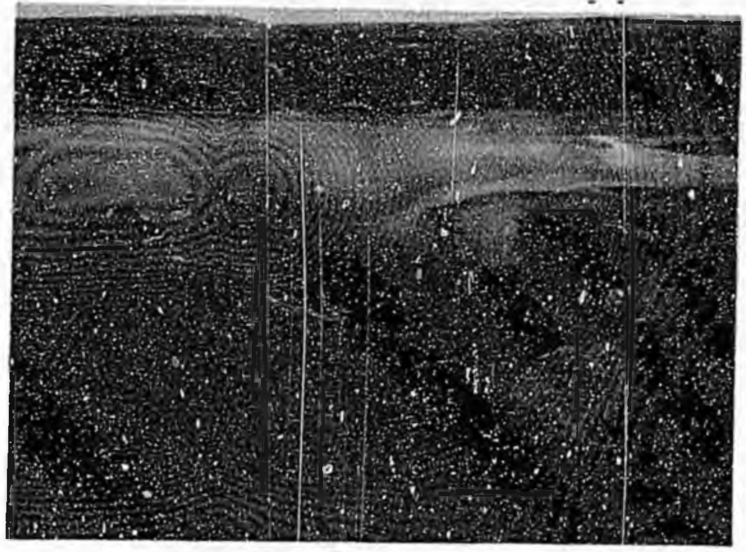
If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

Dangerous Recreation Sites

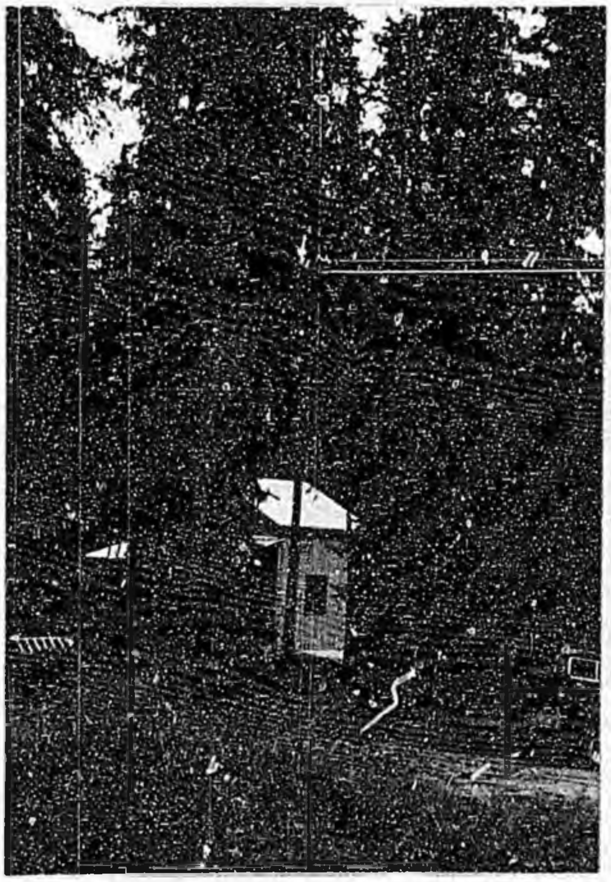
How many Alaskans will be hurt as these trees fall over?
or
How much money will be spent trying to remove the hazards from our public facilities?

Lost Tourism Dollars $$



How many tourists will not return because of all the dead trees in Kachemak Bay? A five percent decline in visitor spending equates to a $21 million revenue loss to Alaska's economy.

Real Estate Devaluation

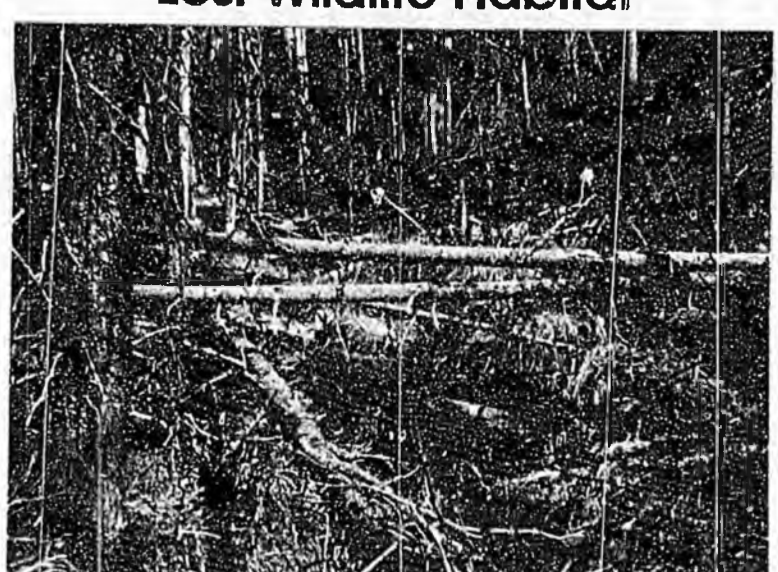


Seven to fifteen percent of home value is often attributed to trees. Note the lost tax revenues this year from the Big Lake area.

Fisheries Impacts

Beetles do not leave streamside buffers. A five percent decline in stream conditions equates to a $21.5 million annual economy loss from sport fishing in the Kenai area alone.

Lost Wildlife Habitat



A game species habitat decline of five percent could cost Alaskans $18.4 million annually.