TREE HAZARDS AND FOREST MANAGEMENT IN SOUTHEAST REGION CAMPGROUNDS

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Forests continue to evolve within developed recreation sites just like in surrounding timberlands. Diseases and insects damage and kill trees, and wind and snow make them fall. Insect and disease-caused injury and mortality may increase in campgrounds because campers cause tree stress and damage through soil compaction and tree scarring. In timberlands, insect and disease killed snags, damaged trees, or fallen trees are often assets, but in campgrounds they are hazards.

Tree hazards develop from a variety of causes. These causes include weather-induced damage, diseases, insect infestations, fire scarring, flooding and channel undercutting, and genetically induced flaws such as V-shaped crotches. Seldom does a single hazard-causing agent plague trees. For example, bark beetles commonly attack trees weakened by root disease, and they may be suffering from heart rot, too.

Hazards exist in two categories. One category is hazards that become risks to defined targets. The other category is hazards that become risks to replacement trees. For example, dwarf mistletoe infections in mature trees seldom cause serious risk to potential targets, but mistletoe is a definite hazard to juvenile replacement trees.

A few definitions will help ensure good understanding of this report:

> Hazard: Any potential tree failure due to a structural defect. For example, a tree weakened by heart rot is a hazard. A tree hazard may exist with little or no risk if a target is not nearby.
>
> Risk: The real possibility or chance of damage and loss caused by tree failure. For example, a dead tree leaning over a campsite is a risk.
>
> Target: Campground users, structures, and objects of value such as vehicles.

Hazards may become dangerous risks, but they also provide visually interesting diversity and valuable wildlife habitat. Perfect trees are fine from a strict timber production perspective, but camping in an absolutely safe plantation of perfect trees is probably not an especially inviting recreational experience.

It is important to recognize and understand that the probability of hazard development can often be linked to forest condition. Forest composition, structure, and stocking can be manipulated to minimize incidence of pest insects and certain diseases. This is the

foundation of long-term management for “healthy” forests. Don’t manage the pest; rather, manage forest conditions to avoid inviting or encouraging the pest. Clearly stated objectives are an essential part of this process.

Long-term plans for campground forest management are essential. Identifying and removing risk trees is one aspect of a plan. Selecting and managing replacement trees is more complicated, but clearly linked to the long-term value and utility of each campground. With good plans and management strategies designed to maintain tree health and vigor, tree hazards can be anticipated and mitigated before becoming unacceptable risks. Avoid simply cutting hazard or risk trees as a solution without understanding why these problems develop.

Causes of Tree Hazards

Insect and disease-caused hazards within Southeast Region campgrounds tend to be quite common. Hazard-causing agents include heart and butt rots, root diseases, dwarf mistletoes, bark beetles, defoliators, rust diseases, and sucking insects.

Seldom do diseases and insect pests occur alone. Usually, insects and diseases occur as a "pest complex". For example, bark beetles commonly attack trees infected with a root disease. In addition, the tree may be infected with dwarf mistletoe and suffering from heart rot. Mature trees are commonly suffering from multiple pests. Sometimes, the most obvious pest or apparent cause of damage is not the most serious cause for concern.

Careful hazard tree evaluation is very time consuming, and an abundance of time was not available for this project. Much of the hazard assessment was based on crown symptoms and bole signs. Extensive excavation and root boring to check for weakening caused by root disease was not done.

Heart and Butt Rots

Heart and butt rots are fungus diseases that decay already dead heartwood in mostly older timber. Infected trees need not be especially large. Crown symptoms are not apparent because the tree is not physiologically weakened by heart rot. Trees structurally weakened by rot are predisposed to windthrow and breakage.

Trees damaged by rots are common in all campgrounds. Many trees display conks or visible decay. The presence of rot does not always warrant immediate tree felling. The severity of hazard is linked to tree diameter and average thickness of sound wood.

Spores produced by rot-causing fungi enter the tree through natural injuries and human-caused injuries that expose heartwood or dead sapwood. Some rots enter only through tiny branch stubs. The key to minimizing damage by rots is avoiding tree damage. Generally, rot spores cannot enter sound trees or fast growing vigorous trees. Wounding caused by tool hacking, collisions with vehicles, and careless falling of adjacent trees help initiate new infections or stimulate dormant infections.

Structural weakening caused by heart and butt rot can be difficult to assess with complete confidence. Fruiting bodies, cavities, and exposed decay are reliable indications of rot, but they are not always present or conveniently visible. Heart rot damage in the middle or upper portion of the bole may not be apparent. Access to the boles above about 6 feet is difficult, costly, and time consuming. Complete hazard assessment requires substantial dedicated time.

Boring can be used to find rot and determine sound wood shell thickness in the lower 6 feet of bole. Candidate trees for assessment are usually mature trees. On some sites, most mature trees will have some degree of rot. External defects indicate a probable

entrance for heart rot spores. Avoid casually boring unlikely candidate trees once the pattern of rot-infected trees is established.

The basic standards for assigning hazard or risk due to heart rot are relatively simple. The presence of conks or fruiting bodies on the bole indicates high failure potential and the tree is identified as a hazard or a risk. In the absence of conks, risk trees with less than 20 percent average sound shell thickness are marked for removal. Trees with an open wound require at least 25 percent average shell thickness for retention. Otherwise, marked hazard trees are identified for monitoring rather than removal. These standards are applied with judgment. Accurately assessing sound wood thickness is not as easy as it appears.

Cutting large trees weakened by heart rot is a job for experienced fallers.

Identifying specific rots is not absolutely essential for hazard assessment and mitigation, but it makes the process more interesting and informative. Several heart and butt rots were identified in Region campgrounds. The most significant rots are probably Schweinitzii root and butt rot and Indian paint fungus. Following is a list that may be incomplete:

- Brown trunk rot (Quinine fungus)

  Hosts include western larch, Douglas fir, pines, and Engelmann spruce. Mostly an upper bole rot, but decay may occur anywhere on the bole. Conks are rare. A single conk indicates extensive decay. Attached conks were not observed. Fallen conks were noted in Island Camp and Snow Cabin.

1 Brown trunk rot decay weakens large old trees.

2 Perennial conk produced by brown trunk rot on Douglas fir.

- Mottled rot (yellow cap fungus)

  Hosts include grand fir, ponderosa pine, and Engelmann spruce. Most rot occurs in the lower bole. Fruiting bodies are commonly observed on old stumps. Mottled rot is probably present in all campgrounds.

4

Mottled rot fruiting bodies are commonly observed on old stumps.

- Indian paint fungus (brown stringy rot)

  Grand fir is the common host. Trees are infected through tiny branch stubs. Once overgrown, the infection becomes dormant. Stem and branch injuries reactivate the infection. A single conk indicates extensive decay. Indian paint fungus is common in Snow Cabin. Remove risk trees with even a single conk.

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Indian paint fungus conks are most common on grand fir at old branch stubs.

6

Heartwood decay pattern typical of Indian paint fungus

- Schweinitzii root and butt rot (Velvet top fungus)

  Hosts include pines, Douglas fir, western larch, grand fir, subalpine fir, Engelmann spruce, and western redcedar. This rot weakens trees relatively slowly. Schweinitzii persists in soil, but mode of spread is apparently uncertain (spores vs. mycelia growth between roots). Disease centers do not spread aggressively. Stump excavation is probably not a useful mitigation technique. Schweinitzii is probably present in all campgrounds. Fruiting bodies on the lower bole indicate high failure potential.

7

Blocky or cubical decay pattern typical of Schweinitzii. Note that only the dead heartwood is decayed.

8

Schweinitzii fruiting body. Look for fruiting bodies growing from exposed decay, too.

- Sulfur fungus (brown cubical rot)

  Hosts include Douglas fir, grand fir, pines, Engelmann spruce, western larch, and western redcedar. Usually functions as a butt rot. Presence of a conk indicates well-established disease and high hazard. Conks are rare and seldom occur on live trees. Presence of sulfur fungus needs further verification. Fruiting bodies attributable to sulfur fungus were observed on a single dead spruce in Tree Phones Campground. Presence of a conk indicates well-established disease and high hazard.

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Don't expect to find sulfur fungus fruiting bodies until the infected tree is dead and a hazard.

- Aspen trunk rot

  Quaking aspen is the host. A single conk indicates extensive decay. Most prevalent in Tree Phones Campground, but causes little actual risk except perhaps to tethered horses. Remove only hazard trees with conks that are also high risk.

10

Aspen trunk rot conks are especially abundant in aspen groves at Tree Phones.

- Annosus root and butt rot

  The main hosts are grand fir, subalpine fir, and possibly Engelmann spruce. Annosus is mainly a root disease, but infected trees often have extensive butt decay. Conks are seldom seen unless a tree is felled and found to be hollow. Remove dead trees and trees displaying thinning crowns or monitor annually until mortality is imminent.

11

Complete root decay caused by Annosus root and butt rot enables easy windfall.

12

Annosus conks are rare. Look closely for conks in old hollow grand fir stumps.

- Red belt fungus (brown crumbly rot)

  Mainly a decomposer of already dead trees, but apparently can infect heartwood of living trees. Conks are very common. Hosts include pines, true firs, Douglas fir, western larch, Engelmann spruce, and western redcedar.

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Red belt fungus conks are most commonly seen on down trees in cool, moist streamside areas.

- Yellow pitted rot (coral fungus)

  Hosts include grand fir, Engelmann spruce, and probably Douglas fir. Any part of the bole may be infected. A single fruiting body was observed in Snow Cabin Camp.


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Soft, delicate, creamy-white fruiting bodies last for only a short time.

- Hardwood trunk rot

  Host is black cottonwood and other deciduous species. While not specifically identified, hardwood trunk rot is the probable cause of rot in black cottonwood.

Conk representative of hardwood trunk rot.

Infected black cottonwood in campgrounds are often hollow and a potential hazard.

Root Diseases

Root diseases are persistent tree killers very difficult to eradicate. Disease centers continue to expand each year infecting and killing susceptible species. Simply cutting a dying or dead tree does not eliminate root disease. In fact, casual tree cutting may accelerate disease spread.

Large stumps remain a persistent source of disease inoculum for 50 years and longer until entirely consumed by decay. Small trees (diameter less than 12 inches) with consequently smaller stumps tend to rot out more quickly and are less likely to become disease centers. However, even small stumps may be a disease source significant in the campground context.

Areas of root disease are usually indicated by trees with thinning crowns, fading foliage, and by a pattern of mortality beginning with old rotten snags in a disease center. Diseased trees are not symptomatic until much of the root system is compromised. Anticipate "surprise" tree failures particularly in Ahtanum Camp. Remove risk trees infected with root disease and their nearest seemingly healthy susceptible neighbors. Otherwise, mark hazard trees for monitoring.

Pockets of root disease expand by root contact. A basic management strategy for all root diseases is to interrupt the root contact pathway between diseased trees and healthy trees thereby stopping disease spread. This is accomplished by cutting at least one healthy tree between the perimeter of the disease pocket and the adjacent healthy forest. Clearly defining the perimeter of a disease pocket is difficult.

Another technique for controlling root disease spread is stump excavation. Diseased stumps are removed with an excavator to reduce disease inoculum. Remove as much of the root mass as possible. Small diseased trees can be easily pushed or pulled over with a dozer thereby removing most of the root mass. Disease within the stump dies as the stump dries. Mark stumps with a saw cut or leave stumps tall for easy locating if removal is planned.

Airborne spores in addition to root contact spread Annosus root disease. Host species stumps larger than 8 inches across should be treated with borax or other name brand product (Sporax, etc.) to help prevent infection via spores. Borax treatment is not effective on stumps of trees already infected. Presence of infection may not be obvious; therefore, it is reasonable to treat all stump surfaces even though some may already be diseased. Apply a layer of borax approximately 0.1 inch thick to the stump surface immediately following cutting. The stump surface should be cut level, not slanting.

Several root diseases are present in Region campgrounds. These include:

- Armillaria root disease

  The major hosts are ponderosa pine and grand fir, but all species have a degree of susceptibility. Simply cutting a tree infected with Armillaria can accelerate the spread of the disease. Ideally, where the disease is present, choose replacement trees less susceptible to Armillaria such as Douglas fir and western larch. Do not expect complete success because even resistant trees can be infected.

15 White mycelial fan diagnostic for Armillaria. Look for fans beneath the bark of long-infected trees.

16 Armillaria rhizomorphs look like thin, black, flat shoelaces. Rhizomorphs spread Armillaria between nearby roots.

- Annosus root disease

  Grand fir and subalpine fir are the major host species. Engelmann spruce may also be infected. Annosus root disease ("s" or spruce/fir type) is probably the most widespread root disease. Fruiting bodies are seldom observed, but the pattern of decline and mortality in grand fir indicates Annosus is present. Note that pine type Annosus ("p" type) is suspected to exist in the Ahtanum vicinity.

  Ideally, where Annosus is present, choose less susceptible replacement trees such as western larch, Douglas fir, and ponderosa pine (in the presence of s-type Annosus).

- Tomentosus root disease

  Tomentosus root disease was not identified; but it is a common problem in Engelmann spruce on some sites. Fruiting bodies usually become visible in September and October to help verify disease presence; but none were observed. Tomentosus should not be ignored as a possible hazard causing pathogen in Region campgrounds.

Dwarf Mistletoes

Dwarf mistletoe is a parasitic plant native to western forests. It depends on its host for water and nutrients. Mistletoe has seeds, stems, flowers, and roots like other plants, but it survives only on living trees. When the host tree or branch dies, mistletoe dies.

Mistletoe survives by stealing water and nutrients from the host tree. The loss of water and nutrients weakens the host slowing its growth. Severely infected trees suffer topkill and often die. Other forest pests, particularly bark beetles, may attack mistletoe-weakened trees causing quick death.

Dwarf mistletoe infections generally don't cause serious physical hazards. It is possible for a heavy branch severely infected with mistletoe ("witches' broom") to break and fall on a sensitive target. Branch infections provide entrance courts for decay fungi that weaken the branch resulting in branch shedding. Use severe mistletoe infections as an indicator of possible heart rot especially in mature western larch and Douglas fir.

Mistletoe tends to be a host specific disease. For example, Douglas fir dwarf mistletoe only infects Douglas fir. The same is true for ponderosa pine dwarf mistletoe. Larch mistletoe may infect lodgepole pine, Engelmann spruce, and grand fir.

Mistletoe seeds disperse in late summer or autumn. Seeds are "shot" like tiny bullets powered by water pressure from within the fruit. The sticky seeds adhere to needles on nearby branches. On a proper host, mistletoe seeds slide to the base of the needle and lodge on the thin bark of young branches where they germinate the following spring, establish a root system, and become a new infection. Trees can be infected at any age or size, but infection is most probable when trees are at least 5 to 10 feet tall or older than 10 years.

Tiny pine mistletoe seed powered by water pressure may "shoot" 30 to 50 feet.

3

Seed dispersal distance varies with mistletoe species. Large ponderosa pine mistletoe 3plants can shoot seeds up to 50 feet and sometimes farther. Tiny Douglas fir mistletoe plants seldom shoot seeds beyond 10 feet. Larch mistletoe shoots seeds up to 30 to 40 feet. Overall, for all species except Douglas fir, most mistletoe seed lands well within 30 feet.

New infections not yet producing shoots are “latent”. The latent period lasts 2 to 5 years until new shoots appear. An additional 1 or 2 years is required for flowering, seeds are produced, and the infection cycle continues. Many successive mistletoe crops may be produced from a single infection site.

Mistletoe spread is fastest and most effective in layered or uneven stands where seeds shed from overstory trees fall on to susceptible understory trees of the same species. Disease spread is relative slow in even or single layer stands.

The greatest hazard with dwarf mistletoes is infection of campground replacement trees. Mistletoe seeds disseminate from overstory sources infecting understory trees. A small tree subjected to an annual rain of mistletoe seeds may never become a useful replacement tree.

The host specific nature of most mistletoe species provides an opportunity for management. For example, retaining a severely infected Douglas fir surrounded by ponderosa pine or other species effectively stops the spread of infection. Cut out all adjacent or understory Douglas fir within 20 feet of the crown edge of the diseased tree and replace with non-host species. Generally, old Douglas fir infected with mistletoe will be retained unless suffering from other risk-causing defects.

Mistletoe infected ponderosa pine can be isolated, too. Remove all ponderosa pine within 50 feet of the disease source measured from the crown edge of the infected tree. Replace adjacent ponderosa pine with Douglas fir or larch or other species if the infected tree serves a valuable role.

Mistletoe infections provide important components of wildlife habitat. Large mistletoe brooms are secure hiding cover and nest sites especially in Douglas fir. Avoid removing mistletoe infected Douglas fir unless other defects are significant. Larch severely infected with mistletoe become spires through branch shedding. Larch spires are excellent hard snags for wildlife use and they provide an interesting forest feature. Old larch spires often have heart rot that may make these trees risky, but larch spires commonly stand for years. Cut only if substantial risk is evident.

Juvenile trees infected with mistletoe can be pruned to remove infected branches once the overstory source of disease has been removed. Guidelines for pruning mistletoe-infected pine are available. Pruning is especially useful for saving infected ponderosa pine. Bole infections cannot be pruned. Pruning mistletoe infections (and gall rust infections) from juvenile trees should be a periodic campground maintenance task.

The common dwarf mistletoes in Region campgrounds are:

- <u>Ponderosa pine dwarf mistletoe (aka western dwarf mistletoe)</u>

  Ponderosa pine dwarf mistletoe seeds can disperse up to 50 feet. Usually, a dwarf mistletoe rating (DMR) greater than 3 indicates a cut tree.

17

Large, showy ponderosa pine mistletoe plants are easily detected. Large plants disperse seed up to 50 feet.

25

Dead ponderosa pine displaying skeletons of witches' brooms. Bark beetles killed these heavily infected trees weakened by mistletoe.

- <u>Douglas fir dwarf mistletoe</u>

18

Huge Douglas fir mistletoe witches' brooms provide excellent hiding cover and nest sites. Note the thinning foliage above the brooms.

32

Small, inconspicuous Douglas fir mistletoe plants are difficult to detect. Seed dispersal distance seldom exceeds 10 feet.

- Larch dwarf mistletoe

  Larch severely infected with mistletoe usually has heart rot, too. Larch mistletoe seeds can disseminate 30 to 40 feet.

19

Western larch heavily infected by mistletoe. Old infected larch branches, brittle with decay, break off under snow loading creating a hard long-standing snag useful to wildlife.

33

Stem infection by western larch mistletoe may kill this sapling.

Bark Beetles

Bark beetles tend to be a problem linked to forest condition. Overstocked stands are especially vulnerable particularly during drought years. In sufficient numbers, bark beetles cause quick mortality. Foliage turns red in the year following a mortal attack. Usually, bark beetles do not attack healthy vigorous trees in properly stocked stands.

The best strategy with bark beetles is preventive management. Maintain stand vigor through thinning and bark beetles are unlikely to be a problem for otherwise healthy trees. Conduct pine thinning during the period of July through October to avoid attracting pine engraver beetles.

Following preventive stand management, bark beetles are mainly a "mark-trees-when-dead" type of pest. Campgrounds should be checked annually for beetle-killed trees.

Western pine beetle is perhaps the most significant bark beetle. Western pine beetles prefer large, picturesque, low vigor ponderosa pine. These mature, typically low vigor trees are easily killed. Clumps or groves of old pine are especially vulnerable during drought periods.

Mountain pine beetles most commonly attack overstocked stands of lodgepole pine and ponderosa pine. This beetle can be an aggressive tree killer during drought periods. Patches of trees with diameters ranging from 8 inches to 14 inches are most vulnerable.

Pine engraver beetles usually attack trees with diameters of 4 to 8 inches. Larger trees may suffer topkill. Pine engraver beetles are mostly a problem following thinning. Beetles are attracted to and breed in fresh slash created during the first half of the year. Small diameter slash is not breeding material, but it does contribute an aroma attractive to pine engraver beetles. The new generation of beetles emerges and attacks nearby trees. All pine thinning within campgrounds should be done after July 1 to avoid pine engraver infestation. Creating a small amount of slash in the spring is probably not a problem. Trees cut before July can be sectioned and placed in open sunlight to speed drying lessening their value for breeding material. Stacking fresh pine firewood in a campground may attract pine engraver beetles.

Fir engraver beetles are present in almost all stressed or dying grand fir. Infested trees almost always have root disease. Fir engraver beetles simply accelerate mortality in already diseased trees.

Spruce beetle is a potential problem linked mostly to windfall. Down trees should be sectioned and removed quickly or converted to firewood.

Midsummer irrigation of selected pine groves or individuals will improve tree vigor. Resistance to pine bark beetles may be improved by potassium fertilization. Applying 200 pounds per acre elemental potassium is an appropriate rate, but achieving improved beetle resistance is uncertain. (((Verify with IFTNC.)))

The common (or anticipated) bark beetles in Region campgrounds include:

- Western pine beetle (mature ponderosa pine—primary tree killer)

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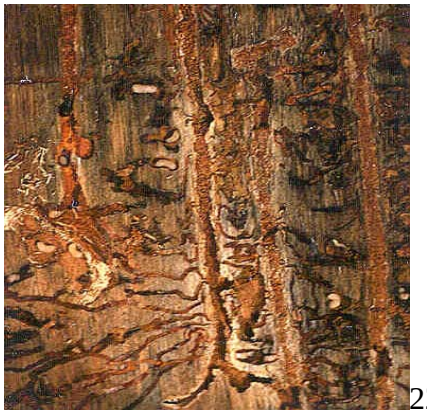
Winding pattern of egg galleries typical of western pine beetle.

21

Woodpeckers strip bark searching for emerging larvae. Pitch tubes are uncommon.

- Mountain pine beetle (lodgepole and small ponderosa pine—primary tree killer)



22

Vertical pattern of egg galleries typical of mountain pine beetles. Larval mines extend horizontally.

23

Pitch tubes on a small pine tree resisting an attack by mountain pine beetles.

- Fir engraver beetle (grand fir, secondary tree killer)

24

Horizontal pattern of egg galleries typical of fir engraver beetles. Larval mines extend vertically from the egg galleries.

- Pine engraver beetles (small lodgepole and ponderosa pine)

26

Pine engraver beetles kill patches of small diameter pine.

27

Branched egg gallery pattern typical of pine engraver beetles.

- Spruce beetle (Engelmann spruce—mostly following windfall)

28

Spruce killed by spruce beetles. Bark stripped by woodpeckers seeking larvae.

Defoliators

Defoliating insects are a landscape level problem. Western spruce budworm, the most serious current defoliator, is most damaging to Douglas fir and grand fir. As with other pests, forest condition is the key to causing and solving this problem.

Layered or uneven stands of host species are most vulnerable. Understory host trees become infested by needle-consuming budworm larvae that fall or drift down from overstory trees. These large larvae tend to eat more needles causing greater defoliation. Trees already stressed by overstocking recover slowly when the defoliator population subsides. The problem becomes especially significant if the defoliated trees are replacement trees in a campground.

Defoliators are inevitable pests, but the potential for damage can be minimized by maintaining tree vigor through stocking control and by providing diversity of composition. More specifically, where possible, replace a portion of grand fir and Douglas fir stocking with selectively retained pine or larch. Vigorous partially defoliated trees can survive and recover quickly even from seemingly significant damage.

Spruce budworm consumes new needles early in an outbreak. Successive attacks remove older needles and may kill trees.

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Rust Diseases

Usually, rust diseases are not perceived as a serious problem. The Region's coldest campgrounds have conditions conducive to western gall rust. Spruce broom rust and fir broom rust were observed, but these infections are not problems except where exceptionally abundant. Broom rusts provide diversity for viewing campers.

Western gall rust infects lodgepole pine and ponderosa pine. Branch infections are not a serious hazard. Old stem infections weaken boles causing a potential tree hazard.

Western gall rust gall on a small pine.

30

New gall rust infections are favored by high humidity. Thinning should help alleviate high humidity, but thinning encourages greater succulent tissue growth. New infections occur on current year's growth. Regardless, careful thinning is always good in pine especially if lower bole branch retention is desired for campsite screening.

Selectively remove trees with large stem infections near campsites and facilities. Only remove hazard trees that offer significant risk because bole infections are visually interesting features. Branch galls can be pruned. The disease cannot be eliminated; therefore, retain low-risk gall infected trees because they are different and interesting.

Sucking Insects

Balsam woolly adelgid is a tiny introduced insect pest that threatens grand fir and subalpine fir. Alone, adelgids can kill host trees by killing branch tips thereby preventing new growth. Together, adelgids and spruce budworm can be especially damaging.

Adelgids spread by crawling or wind drifting to adjacent host trees. There are no practical treatments other then removing host trees. Tree vigor is not a factor influencing infestation.

The potential severity of adelgid damage in the Pacific Northwest is not known. Adelgids may cause significant damage and mortality in the next 20 to 30 years.

The best strategy for minimizing future adelgid infestations is to avoid retaining grand fir and subalpine fir as camp ground trees if other healthy trees are available. True firs are poor candidate trees for campgrounds for many reasons. Don't arbitrarily remove all true fir, but be careful and selective when choosing retention trees.

Gouting, the swollen knob-like growths, at he ends of branches on true fir indicates adelgid infestation. The adelgid insect is very tiny and difficult to see.

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Other Causes of Hazard Trees

Hazard trees can develop for a variety of reasons in addition to diseases and insect attack. Wind damage, snow loading, lightning strike, flooding, soil compaction, and human-caused tree injury may contribute to hazard tree evolution. Miscellaneous tree hazards include:

- Leaning trees—determine cause and assess risk
- "V" crotch trees—weak under stress from snow or wind. Assess risk.
- Crooked stems—determine cause and assess risk
- Multiple tops—vertical drop hazard only under snow load. Assess risk.
- Undermined roots—consider removal if greater than a third of the root mass is undermined
- Frost cracks—examine for heart rot

The Campgrounds of Southeast Region

Southeast Region has five campgrounds that receive common use.

- Island Camp
- Bird Creek Camp
- Snow Cabin
- Ahtanum Camp and Meadows
- Tree Phones Camp

This list of campgrounds is in priority order for silvicultural treatment and maintenance beyond mitigation of risk trees.

Campground Forest Management Objectives

The management objectives for the campgrounds are similar; therefore, a single set of objectives is presented. Note that not all objectives immediately apply to each campground.

- Reduce or eliminate threat caused by identified tree hazards.
  1. Cut designated risk trees.
  2. Monitor progression of heart and butt rots.
  3. Monitor progression of root diseases.
- Maintain and improve tree and stand health.
  1. Adjust composition and stocking to improve stand vigor.
  2. Minimize losses caused by dwarf mistletoe, bark beetles, balsam woolly adelgid, and defoliators.
  3. Minimize soil damage.
- Maintain forest character.
  1. Preserve super dominant trees unless other objectives are compromised.
  2. Preserve larch spires for wildlife habitat unless other objectives are compromised.
  3. Preserve structural diversity (vertical and horizontal).
  4. Maintain visually interesting trees.
  5. Protect shrubs unless other objectives are compromised.
- Maintain campground purpose and appeal.
  1. Initiate or maintain screen trees near exposed campsites.
  2. Create opportunities for replacement trees as needed.
  3. Stabilize stream channels to reduce undercutting of tree roots.
  4. Fireproof campground area.

Island Camp

Island Camp is not heavily used, but it offers privacy and a shelter along with convenient access to surrounding forestland. Interesting geologic features are within walking distance. An excellent view of Mount Adams is nearby. The campground forest displays characteristics representative of a cool forest type after years of fire exclusion.

The Campground Forest

Forest composition is a mix of mostly Engelmann spruce, lodgepole pine, grand fir, and Douglas fir. Scattered large western larch and ponderosa pine are present along with a few black cottonwood.

Forest structure is variable, but best described as uneven.

Much of the campground forest is overstocked by conventional standards. All diameters are represented up to about 36 inches. Lodgepole pine in dense patches is losing lower branches. Shade tolerant grand fir and spruce are filling the understory in some areas.

The Causes of Tree Hazards

- Heart rots cause an immediate hazard. Rots are verified, but not all are specifically diagnosed. The following diseases occur in this vicinity:
    1. Brown trunk rot
    2. Schweinitzii root and butt rot
    3. Mottled rot
    4. Hardwood trunk rot
    5. Indian paint fungus

- Root diseases
    1. Annosus root disease is most prevalent in grand fir and spruce.
    2. Armillaria in old ponderosa pine and grand fir is likely.
    3. Tomentosus possible, but not verified.

- Dwarf mistletoes
    1. Western larch
    2. Douglas fir
    3. Ponderosa pine

- Bark beetles
    1. Large ponderosa pines are susceptible to western pine beetles.
    2. Mountain pine beetles are present in lodgepole pine and ponderosa pine.
    3. Fir engraver beetles in grand fir.

- Prolonged outbreak of spruce budworm causing topkill and mortality.

- Balsam woolly adelgid infesting grand fir causing increased topkill and mortality in conjunction with spruce budworm.

- Western gall rust stem infections weaken lodgepole pine.

- Streambank undermining.

Island Camp provides lots of opportunity for artful forest management. Each tenth acre is different. Thinning is the primary treatment needed in Island Camp following mitigation of risk trees. Expect to do multiple entries over several years to achieve proper stocking. This is a job suitable for WCC crews or fire crews. Island Camp has a good future if the forest is carefully maintained for sustained health and vigor.

Lodgepole pine, western larch, and Engelmann spruce are the preferred species to retain. Ponderosa pine is very desirable and should be retained where possible. Other species are acceptable, but avoid encouraging a large amount of grand fir and Douglas fir. Grand fir is susceptible to balsam woolly adelgid and both species are susceptible to defoliators. Healthy black cottonwood provides diversity and should be retained, too.

Encouraging new natural regeneration or planting seedlings is not necessary. Leave herbaceous vegetation intact unless thickets of lodgepole pine and western larch are desired. Disturbance may encourage snowbrush, a difficult to control evergreen shrub.

Recommended Forest Management Standards and Actions

- Candidate hazard trees are marked throughout the campground. Risk trees need to be specifically identified and removed. Risk trees within range of the shelter should be removed as soon as possible.

- Monitor annually for dead and damaged trees, unexpected risk, etc.

- Preferentially retain western larch, Engelmann spruce, lodgepole pine, and ponderosa pine. Select against grand fir and Douglas fir within the context of diversity.

- Thin during late summer and fall to avoid creating breeding material for pine engraver beetles. Remove thinning slash along roads to help limit fuel loading and enable pedestrian access through the campgrounds. Slash can be chipped or piled off site.

- Preferentially save trees with at least 40 percent live crowns.

- Average spacing target is 8 to 12 feet for trees smaller than 6 inches measured at breast height.

- Apply thinning gradually to avoid creating a “just logged” look that detracts from campground appeal. Sever juvenile trees close to the ground surface.

- Selectively remove lodgepole pine with large stem galls (western gall rust) if within falling range of a target. Branch galls can be pruned if desired.

- Select against trees with DMR’s greater than 2. Mistletoe infections may be pruned from small trees.

- Retain alternate species within 30 to 40 feet of super dominant larch infected with dwarf mistletoe.

- Avoid saving grand fir infested with balsam woolly adelgid.

- Avoid saving Douglas fir or grand fir with severe spruce budworm damage (>10 to 30 percent topkill). This is a judgment, not a rule.

- Save rub trees at all road corners and turns. Rub trees help prevent drivers from expanding turns.

Bird Creek Camp

Bird Creek Camp is easily accessible by car. The campground offers pleasant diversity in a typical Eastern Washington forest type. Gentle terrain makes for easy walking on nearby old logging roads and trails. Usage tends to be light, but there are lots of possibilities for developing forest education opportunities.

The Campground Forest

Forest composition is a mix of mostly ponderosa pine, Douglas fir, and grand fir. Western redcedar is common adjacent to Bird Creek along with some black cottonwood. A few western larch and lodgepole pine are present, too.

Forest structure is variable, but best described as uneven and somewhat clumpy.

The forested portions of the campground tend to be overstocked by conventional standards. All diameters are represented. Some Douglas fir and ponderosa pine have diameters of 30 to 40 inches. In places, shade tolerant grand fir and Douglas fir are slowly filling the understory. Trees in thickets are shedding lower branches.

The Causes of Tree Hazards

Trees weakened by heart rot or killed by root disease and bark beetles are causing immediate risk.

- Heart rots cause an immediate hazard. Rots are verified and diagnosed.
    1. Schweinitzii root and butt rot
    2. Mottled rot
    3. Hardwood trunk rot

- Root diseases are present, but currently not a great problem within the campground.
    1. Annosus root disease in grand fir
    2. Armillaria root disease in ponderosa pine and grand fir

- Dwarf mistletoes
    1. Douglas fir
    2. Ponderosa pine

- Bark beetles
    1. Western pine beetle is causing immediate risk.
    2. Mountain pine beetle—very light infestation.
    3. Fir engraver beetles—secondary pest.

- Spruce budworm is causing slight defoliation and minor topkill in Douglas fir and grand fir.

- Balsam woolly adelgid is causing minor damage in grand fir.

- Streambank undermining.

Bird Creek Camp offers lots of opportunity for maintaining a pleasant campground if some of the basic disease and insect problems are properly managed. Overall, not much work is needed. The forest is ready for some maintenance, but it is not in a crisis condition. Removing specific risk trees and some minor thinning are the only necessary activities.

Select healthy replacement trees early and keep them vigorous. Ponderosa pine and Douglas fir are preferred, but grand fir is acceptable, too. Minimize encroachment by Douglas fir and grand fir except as screen trees or near sources of ponderosa pine dwarf mistletoe. An abundance of Douglas fir and grand fir will attract defoliators.

There is not a need to plant seedlings or to encourage natural seeding. Robust, mistletoe free natural seedlings and saplings are preferred replacements. Avoid trying to recover slow growing spindly seedlings unless necessary. Thin replacement trees where necessary to promote the best specimens. Control competing vegetation to encourage growth and vigor. Treat herbaceous vegetation with Velpar (L or DF), Pronone 25G, or Oust applied to a spot around the target seedlings. Shrubs may require a basal application of a penetrating herbicide such as Garlon 4.

Thickets of small diameter ponderosa pine are susceptible to mountain pine beetles and pine engraver beetles. Thin to maintain vigor. Clumps of 2 or 3 trees are fine for diversity, but the individual trees must be vigorous to resist bark beetles.

Clumps or groves of large mature ponderosa pine, along with stressed isolated trees, tend to be attractive to western pine beetles. Trees stressed by drought and other diseases are especially attractive to beetles.

Ponderosa pine dwarf mistletoe is a serious problem threatening replacement trees especially in the north portion of the campground. Overstory sources of mistletoe quickly infect juvenile trees. Infected saplings are unlikely replacement trees especially when subjected to annual reinfection from overstory sources.

Eliminating mistletoe sources will require cutting picturesque super dominant pine. These old pines are attractive features that should not be casually removed just to eliminate mistletoe. Retaining large old ponderosa pine for visuals will necessitate conversion to Douglas fir within 50 feet of the disease source to mitigate disease spread. Equally important is removing mistletoe-infected pines within 50 to 100 feet of the campground boundary. Douglas fir dwarf mistletoe is less of a problem because sources tend to be isolated near Bird Creek.

The campground group area provides Mardon Skipper habitat, a State endangered butterfly species. Meadows with Idaho fescue are habitat. This is not an encumbrance for the campground, but it is an opportunity for educational signing.

Recommended Forest Management Standards and Actions

- Candidate hazard trees are marked throughout the campground. Risk trees need to be specifically identified and removed.

- Monitor annually for dead and damaged trees, unexpected risk, etc.

- Preferentially retain healthy ponderosa pine and Douglas fir along with incidental grand fir.

- Avoid disturbing deciduous shrubs. Vine maple is especially valuable for fall color and screening. Excess snowbrush, an evergreen shrub, can be controlled with Garlon 4 or Chopper herbicides applied during low use periods.

- Preferentially save trees with at least 40 percent live crowns.

- Average spacing target is 8 to 12 feet for trees smaller than 6 inches measured at breast height.

- Apply thinning gradually to avoid creating a "just logged" look that detracts from campground appeal. Sever juvenile trees close to the ground surface.

- Select against trees with DMR's greater than 2. Mistletoe infections may be pruned from small trees.

- Retain Douglas fir within 50 feet (measured from crown edge) of super dominant ponderosa pine infected with dwarf mistletoe.

- Retain all western redcedar, western larch and black cottonwood unless other objectives are compromised.

- Irrigate selected old ponderosa pine to help maintain vigor through summer.

- Apply potassium fertilizer (200 lbs. elemental K per acre) in the vicinity of selected old ponderosa pine to help maintain vigor and resistance to western pine beetles. (((Verify with IFTNC.)))

Snow Cabin

Snow Cabin is in a cool temperature forest subject to long winters with deep snow. The campground is most used during hunting seasons. Facilities are limited to outhouses. Tree hazards are common and potentially dangerous. Some risk trees have been cut, but others remain.

North Fork Ahtanum Creek is habitat for endangered bull trout, and the campground provides easy and immediate access to the channel.

The Campground Forest

Forest composition is a mix of mostly mature along with some juvenile Douglas fir, Engelmann spruce, grand fir, and western larch. Western redcedar and black cottonwood occur in the riparian area. A few lodgepole pines are present, too. Common evergreen shrubs include grouse whortleberry, Princes'-pine, and myrtle pachistima.

Most mature trees have diameters within the range of 16 to 30 inches. Both larger and smaller trees are present. Some grand fir and Engelmann spruce are filling the understory. The site is fully occupied, but not necessarily overstocked.

The Causes of Tree Hazards

- Heart rots cause developing hazard and immediate risk. Rots are verified and diagnosed.
    1. Indian paint fungus is common with conks present.
    2. Schweinitizii root and butt rot is common with conks present.
    3. Mottled rot diagnosed from fruiting bodies.
    4. Yellow pitted rot diagnosed from fruiting bodies.
    5. Brown trunk rot diagnosed from fallen conk.

- Root diseases
    1. Armillaria in grand fir and Engelmann spruce.
    2. Annosus in grand fir and probably Engelmann spruce.
    3. Tomentosus in Engelmann spruce based only on crown symptoms.

- Dwarf mistletoes
    1. Western larch dwarf mistletoe is abundant and probably infecting grand fir, Engelmann spruce, and lodgepole pine.

- Bark beetles are only minor pests at this time.
    1. Spruce beetle
    2. Fir engraver beetle

- Spruce budworm is causing slight defoliation and minor topkill.

- Balsam woolly adelgid is causing minor damage to grand fir and subalpine fir.

- Streambank undermining.

Snow Cabin may not have a great future. Heart and butt rots are steadily weakening the mature trees that make this campground attractive. Indian paint fungus and Schweinitzii root and butt rot cause the most serious tree hazards. Most mature trees are probably infected to some degree. The abundance of rots makes thorough risk assessment unlikely. The campground will probably contain risk trees even after it is deemed "safe".

The priority actions needed in Snow Cabin are risk tree mitigation and monitoring. Minor thinning can be applied to allocate growing space. Creating or enabling new replacement trees is not an essential action at this time, but the need for replacement trees should be anticipated.

The best site adapted replacement tree species are western larch, Engelmann spruce, lodgepole pine, and possibly ponderosa pine; however, any healthy tree can be retained. Established juvenile ponderosa pine and Douglas fir provide acceptable replacement trees especially near overstory larch infected with dwarf mistletoe. Note that ponderosa pine is easily damaged by snow loading.

Advance regeneration, mainly shade tolerant grand fir and subalpine fir, tends to be of limited value for replacement trees. Suppressed grand fir and subalpine fir are probably already infected by Indian paint fungus, and they are often damaged by spruce budworm and infested with balsam woolly adelgid. Usually, Engelmann spruce provides the best specimens of advance regeneration.

Possibly every larch is infected with mistletoe.

Recommended Forest Management Standards and Actions

- Candidate hazard trees are marked throughout the campground. The most hazardous risk trees have been identified and cut.

- Monitor annually for dead and damaged trees, unexpected risk, etc.

- Preferentially retain the most healthy western larch, Engelmann spruce, lodgepole pine, and ponderosa pine; however, any healthy tree can be retained.

- Preferentially save trees with at least 40 percent live crowns.

- Select against trees with DMR's greater than 2. Mistletoe infections may be pruned from small trees.

- Retain alternate species (if possible) within 30 to 40 feet of overstory larch infected with dwarf mistletoe.

- Carefully select advance regeneration for retention. Severely suppressed grand fir and subalpine fir are not preferred unless no other candidates are available. Where available, Engelmann spruce is usually a better choice.

- Conduct test planting of Engelmann spruce seedlings in the disturbed area adjacent to North Fork Ahtanum Creek.

- Avoid disturbing evergreen shrubs.

Ahtanum Camp and Meadows

Ahtanum Camp and Meadows are easily accessible by paved roads. Both campgrounds are heavily used especially during hunting seasons. Soils are extensively compacted. Trees tend to be stressed and are commonly damaged by campers. Despite heavy use, the campgrounds remain attractive for quick recreational getaways. The campgrounds are sited on lower terraces of Ahtanum Creek and Middle Fork Ahtanum Creek. The actual campground does not flood, but immediately adjacent areas are subject to flooding.

The Campground Forest

Forest composition is dominated by ponderosa pine along with a few Douglas fir and grand fir. All size classes are represented. Ponderosa pine tends to be the largest trees with fewer individuals in the smaller size classes. Douglas fir and grand fir tend to be somewhat more common in smaller size classes especially in shaded understory positions. Fewer small (or juvenile) pines are available as replacement trees compared to Douglas fir and grand fir. Very few western larch are present. Black cottonwood is common in areas of moist soil.

Stocking and forest structure are best described as irregular. Adequate, but not abundant, juvenile trees are available for replacing hazard trees. Most are grand fir and Douglas fir. Pine will be difficult to reestablish in root disease pockets.

The Causes of Tree Hazards

Trees weakened by root disease, heart rot and streambank undercutting are causing immediate risk. Many hazard trees have already been felled. Similar hazard tree problems exist in the nearby Snow Park.

- Heart rots are verified but not specifically diagnosed. Mottled rot is verified by fruiting bodies, but other heart rots are probably present.

- Root diseases
    1. Armillaria is verified in ponderosa pine.
    2. Annosus (p-type) may infect ponderosa pine if it is not already present.

- Bark beetles: Ponderosa pine is supporting a small population of western pine beetle and mountain pine beetle. These beetles seem to be acting as secondary pests attacking trees stressed by root disease and soil compaction.

- Streambank undermining.

- Hacking, nails, screws, vehicle impact, and soil compaction cause miscellaneous tree damage.

Campground forest management is mainly an exercise in monitoring for advancing well-established root disease and heart rot along with the removal of risk trees. Watch for foliage fading and imminent mortality. Cutting all possibly diseased trees is not especially desirable because much of the campground would be logged. "Surprise" tree failures are probable.

Replacement trees are a difficult proposition. Root disease and soil damage are serious problems where trees are needed. The best strategy is to protect seedlings and saplings already established.

Small-scale tree planting is acceptable to fill gaps. Note that most gaps are caused by root disease. Ponderosa pine is best adapted to the environment, but western larch and possibly Douglas fir are more resistant to Armillaria. Planted seedlings may not live to become mature trees, but pole-size survivors can help maintain campground appeal. Seedlings should be carefully planted and watered until established. Controlling competing vegetation will encourage survival. Use similar strategies to protect naturally established juvenile trees and encourage vigorous growth.

Stump removal to reduce inoculum may be useful as a site rehabilitation treatment. Fresh stumps are easy to excavate intact. Old stumps may be difficult to cleanly remove. Otherwise, treat stump surfaces with borax to reduce the initiation of Annosus root disease. Excavating stumps and treating cut surfaces with borax will do nothing to prevent the spread of root disease if remaining trees are already infected.

Potassium fertilization may help retard development of root disease and improve tree resistance to infection. Evidence is not yet conclusive. Applying potassium may not cause improvement, but it will do no harm and it is inexpensive. Potassium may increase tree resistance to bark beetle attack, too.

Recommended Forest Management Standards and Actions

- Candidate hazard trees are marked throughout the campground. Risk trees need to be specifically identified and removed.
- Monitor annually for dead and damaged trees, unexpected risk, etc.
- Apply potassium fertilizer (200 lbs. elemental K per acre) to help maintain tree vigor and resistance to pests. (((Verify with IFTNC.)))
- Protect and maintain established juvenile trees.
- Verify Annosus root disease (p-type).

Tree Phones

Tree Phones is a conveniently sited and appealing campground surrounded by thousands of acres of accessible subalpine forest. Spectacular views of the Cascade Mountains and foothills are only a few minutes away.

The Campground Forest

Forest composition is a mix of mainly Engelmann spruce, lodgepole pine, western larch, and grand fir. All size classes are represented, but spruce and larch tend to be the largest specimens with diameters up to 40 inches. Also present are a few Douglas fir, subalpine fir, mountain hemlock, and ponderosa pine. Moist areas support black cottonwood and quaking aspen.

Forest structure and stocking are variable. Some areas are more or less evenly structured. Other areas are open and uneven. Stocking is variable, but not especially excessive for a cool site with an abundance of shade tolerant trees.

The Causes of Tree Hazards

Trees weakened by heart rot cause the most immediate risk. Heart rot was observed in spruce, larch, grand fir, and lodgepole pine. Many probable risk trees have been felled.

- Heart Rots
    1. Schweinitzii root and butt rot—conks observed on spruce
    2. Mottled rot—fruiting bodies observed on grand fir stumps
    3. Sulfur fungus—probable on spruce
    4. Aspen trunk rot

- Root disease symptoms are not especially obvious. Regardless, it would not be surprising to find Annosus root disease in grand fir.

- Dwarf mistletoe is abundant in western larch and lodgepole pine. Lodgepole is probably infected by larch mistletoe rather than by a separate species. Some larches are so severely infected that almost all branches have been shed.

- Balsam woolly adelgid is a potentially significant pest. Adelgids are attacking grand fir and subalpine fir, and some trees are severely damaged.

- Bark beetles and defoliators are not a serious problem at this time.

- Ax-wielding campers have scarred many trees. Concentrated traffic by vehicles, ATVs, and horses commonly damages soil and shallow roots.

Tree Phones has little immediate need for silvicultural treatment beyond mitigating some risk trees followed by monitoring.

Stand vigor can be gradually improved by thinning from below in the area immediately west of the shelter. This action is not especially critical, but trees with less than 30 percent crown ratios will never contribute much and they compete for site resources.

Grand fir and subalpine fir will be steadily decimated by balsam woolly adelgid and intermittently by western spruce budworm. Gradually select against these species and favor Engelmann spruce, western larch, and Douglas fir.

Recommended Forest Management Standards and Actions

- Candidate hazard trees are marked throughout the campground. Risk trees need to be specifically identified and removed. Risk trees within range of the shelter should be removed as soon as possible.

- Monitor annually for dead and damaged trees, unexpected risk, etc.

Silviculture and Forest Health in Campgrounds

Susceptibility to insects and diseases tends to be a function of forest structure, stocking, and composition. Minimizing stress and maximizing vigor are basic strategies for healthy trees and forests. Artful, knowledgeable manipulation of structure, stocking, and composition can help a forest resist and survive damage caused by insects and diseases.

Structure

Forest structure is the vertical and horizontal arrangement of trees or the arrangement of size classes. Structural diversity makes a forest interesting. Trees can be arranged evenly or in thickets, groves, or as individuals. Structure is commonly described as even, uneven, or layered.

- Even structure indicates trees in mostly a single layer.
- Uneven structure indicates multiple sizes ranging from seedlings to mature trees.
- Layered structures usually have two layers such as mature trees over seedlings or saplings.

Structure is a particularly important consideration for the spread of dwarf mistletoes, root diseases, and defoliating insects.

- Mistletoe seeds shed from infected overstory trees infect understory host trees. Multiple layers or mixed sizes of trees are conducive to mistletoe spread.
- Root diseases tend to spread readily in uneven forests. Uneven forests managed with periodic harvest entries tend to encourage root disease because new inoculum sources are made available with each harvest entry. Root diseases live for decades in stumps continuing to infect nearby trees.
- Western spruce budworm, a defoliating insect, is most damaging in layered or mixed size forests of Douglas fir and grand fir. The larvae drift down from overstory trees to the understory continuing to feed and complete their life cycle. Without understory trees, the larvae fall to the ground where they die or are eaten by ants and spiders.

Forests within a campground need not be perfectly even to be healthy, but the potential consequences of uneven forest structure needs to be clearly understood when planning silvicultural treatments.

Composition

Composition is the mix of tree species. Composition is important because different tree species tend to have different susceptibilities to insects and diseases. Generally, the more shade tolerant species (grand fir, subalpine fir) are susceptible to more diseases and insect pests than are less shade tolerant species (ponderosa pine, western larch).

A forest composed of mostly shade tolerant grand fir will generally have more health problems than a forest with mostly pine, larch, and Douglas fir. This is a natural process. An unevenly structured shade tolerant climax forests tend to accumulate fuels caused by insects and diseases. Abundant fuel loading and fuel ladders are conducive to stand replacement fires that lead to forest renewal.

The composition factor is considered mostly for selecting trees least vulnerable to forest pests present in a campground or existing nearby regardless of the tree species role in forest succession. The many species in our campgrounds offer a variety of attributes. A species considered undesirable in one situation may be very suitable in another.

- Douglas fir: Old trees are majestic. Commonly fire scarred providing a glimpse of historic natural processes. Young trees are versatile growing in partial shade to open sunlight, but sensitive to frost. Susceptible to defoliators and commonly infected with dwarf mistletoe. Mistletoe brooms provide habitat and an interesting visual feature.

- Western larch: Color and diversity immediately come to mind. Generally resistant to root diseases. Provides durable snags for excellent wildlife habitat. Often forms a thicket on disturbed soils. Generally not a good screen tree except in thickets. Adapted to cool sites and frost. Commonly infected with dwarf mistletoe resulting in spires.

- Grand fir: Highly susceptible to root diseases, heart rots, and defoliators. Thin bark offers little bole protection. Excellent privacy screen tree because it retains lower branches. Tends to be common because it grows in shade. Deep rich foliage color. Soft snags provide excellent wildlife habitat.

- Ponderosa pine: Large old pines are perhaps the most visually pleasing trees in the forest. Often fire scarred. Old trees are vulnerable to western pine beetle, especially during drought periods. Highly susceptible to Armillaria root disease and Annosus root disease (p-type). Tends to shed lower branches unless widely spaced. Juvenile trees are easily damaged by snow loading.

- Lodgepole pine: Often grows in dense thickets. Establishes quickly following disturbance. Very susceptible to bark beetles where overstocked. Long overstocked thickets don't respond well to thinning. If stagnant trees are thinned, the leave trees are often damaged by snow loading. Adapted to cold sites and frost.

- Western redcedar: Soft foliage and subtle beauty. Easily scarred, but an excellent riparian component. Provides diversity. Retain wherever possible.

- Engelmann spruce: Versatile. Grows well in partial sunlight. Adapted to cold sites and frost. Tends to be somewhat resistant to common root diseases and insect pests. Good screen tree resistant to casual hacking by campers because foliage is stiff and prickly. Shallow rooting makes spruce susceptible to blowdown.

- Quaking aspen: Color and diversity. Very easily damaged. Susceptible to heart rot. Common carving tree for initials.

- Black cottonwood: Color and diversity. Very easily damaged. Susceptible to heart rot.

Stocking

Stocking or forest density is another forest characteristic that effects susceptibility to insects and diseases. Trees compete for limited site resources specifically water, nutrients, and light. As the number of trees increases, the probability of each tree getting enough resources diminishes and vigor declines. As vigor declines, trees become more vulnerable to insects and diseases and less able to recover from damage. The effects of overstocking are made worse by drought. Thinned stands tend to be vigorous because fewer trees are competing for site resources.

Overstocking occurs in clumps of trees, patches or groves, or in entire stands. Severe overstocking causes short crowns especially on less shade tolerant species such as lodgepole pine, ponderosa pine, western larch, and Douglas fir. When thinned, trees with short crowns (<30 percent of tree height) are slow to respond because they lack leaf area. Trees with short crowns have little taper; therefore, they lack stem strength provided by buttressing and are easily damaged by snow loading.

Overstocked pines are especially attractive to bark beetles. Lack of vigor decreases resin flow and the ability of the tree to "pitch out" attacking beetles.

Tree and Forest Treatments for Campgrounds

Thinning, pruning, and risk tree removal should not be considered one time events that completely fix problem conditions. Dedicated periodic maintenance of desired stand conditions is required to steadily improve the forest without creating the harsh visuals associated with thinning and logging.

Casual manipulation of structure, stocking, and composition won't automatically make a healthy forest. All stand treatments need to be linked to biologically sound objectives. Poorly planned and carelessly implemented management actions can quickly cause more problems regardless of good intentions.

Thinning

The greatest threat to future quality replacement trees is overstocking. Trees in overstocked patches lack vigor, shed lower branches, and steadily become unsuitable for use as replacements. Thinning is applicable to any size tree, but it is a treatment mostly applied to juvenile trees.

Ideally, trees selected for retention should have live crowns exceeding 40 percent of total tree height. Trees with full crowns are strong, well buttressed, and vigorous. Trees with less than 30 percent live crowns lack vigor, respond very slowly to thinning, and are easily bent by snow loading. In severely overstocked stands, save the best available trees with the longest crowns even though they don't satisfy standards for crown length.

Avoid retaining juvenile trees infected with dwarf mistletoe. Accessible branch infections can be pruned, but bole infections generally render a tree unacceptable.

Thinning should be artful. Thinning need not be perfectly consistent with exact spacing nor should imperfect trees be casually removed unless they are a risk. Clumps of trees, groves, and thickets are acceptable so long as the overall stand is vigorous. Imperfect trees are visually interesting to campers.

Simple spacing guidelines are adequate for campground situations. For example, touching or meshing branches of adjacent trees indicates overstocking. A simple guideline is the D+4 Rule. This rule is the diameter in inches expressed as feet plus an additional 4 feet. For example, a tree 6 inches in diameter would be spaced 6 feet + 4 feet from the next tree. Even simpler is simply maintaining 4 to 6 feet between crown edges for pole-size timber.

Avoid creating a "just logged" look. Small diameter stumps sticking up 6 to 12 inches or more are a hazard. Cut small diameter trees close to the ground surface. Don't leave lots of tall small diameter stumps to be tripping hazards.

Avoid casually cutting trees that have no future if they are not competing for growing space unless the tree compromises other objectives.

Tree selection for thinning:

- Preferentially retain trees with at least 40 percent live crowns.
- Maintain diversity of composition appropriate to site conditions.
- Select trees free of dwarf mistletoe if possible. Trees smaller than 6 inches measured at breast height should have DMR of 2 or less. Cut trees with bole infections.
- Free of bole damage and defects.
- Less than 10 percent topkill by defoliators.
- Healthy, vigorous and robust.
- Retain visually interesting trees.

Screen Trees

Screen trees interrupt sight distance within campgrounds contributing to a sense of privacy. Thickets are also useful screens. Thickets rely more on stem density than lower live branch retention to obscure site distance.

Any tree can be a screen tree, but usually shade tolerant trees are best because they retain lower branches even in partial shade. Grand fir, Engelmann spruce, and Douglas fir are most useful, but open grown pine can work well, too.

Avoid leaving juvenile grand fir lacking lower branches near campsites if other choices are available. Grand fir is especially vulnerable to damage by hacking and vehicle impact.

General References

Allen, E., D. Morrison, and G. Wallis. 1996. Common Tree Diseases of British Columbia. Natural Resources Canada. Canadian Forest Service.

Furniss, M. M. and J. B. Johnson. 2002. Field Guide to the Bark Beetles of Idaho and Adjacent Regions. Station Bulletin 74. University of Idaho, Moscow.

Hagle, S. K., S. Tunnock, K. E. Gibson, and C. J. Gilligan. 1987. Field Guide to Diseases and Insect Pests of Idaho and Montana Forests. Publication Number R1-89-54. USDA Forest Service.

Harvey, Jr., R. D. and P. F. Hessburg. 1992. Long-Range Planning for Developed Sites in the Pacific Northwest: The Context of Hazard Tree Management. FPM-TP039-92. USDA Forest Service.

Scharpf, R. F. 1993. Diseases of Pacific Coast Conifers. Agriculture Handbook No. 521. USDA Forest Service.

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12 Southwest Oregon Forest Insect and Disease Center—"Annosus Root Disease"
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14 Common Tree Diseases of British Columbia—"Yellow Pitted Rot:
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21 FIDL 1—"Western Pine Beetle"
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27 FIDL 122—"Pine Engraver in the Western United States"
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29 ??????????????????
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