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Danger Tree Mitigation Guidelines for Managers

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Danger Tree Mitigation Guidelines for Managers

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Introduction

Wildland fire safety awareness has brought about changes that have reduced injuries and fatalities. Safety awareness about danger trees is needed to help protect firefighters on incidents, employees in the field, and visitors on public lands. For example, the mountain pine beetle epidemic in the West is increasing the number of dead and dying trees on public lands (figure 1) and raises the risk for anyone in infested areas.

Marking and restricting access to areas where danger trees are located (a technique referred to as avoidance) can sometimes work. In other areas, removing danger trees is the appropriate decision, but it involves significant risk.

This report provides information to help managers evaluate three common methods of mitigating danger trees (blasting, mechanical felling, and manual felling with chain saws). Selecting a mitigation method requires careful analysis of the hazards associated with each method. After this analysis, managers can focus on logistical issues, expected production rates, and estimated costs. The cost estimates presented in this report are based on information provided (as of 2010) by U.S. Department of Agriculture, Forest Service employees, Forest Service contractors, and private industry.

Figure 1—Tubular masses of resin (pitch tubes) on the bark of this tree indicate a mountain pine beetle infestation.

Useful Terms and Definitions

Forest Service employees traditionally use the term "hazard tree" rather than danger tree. In this report, the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) term "danger tree" is used and has the same meaning as hazard tree.

Collateral Duties: Secondary work duties that are assigned in addition to an employee's primary work duties.

Danger Tree (or Hazard Tree):
A standing tree that presents a hazard to employees due to conditions such as, but not limited to, deterioration or physical damage to the root system, trunk, stem or limbs, and the direction and lean of the tree.
—Occupational Safety and Health Standards, Title 29 of the Code of Federal Regulations (CFR) Part 1910.266(c)

Any tree or its parts that will fail because of a defect and cause injury or death to people.
—"Field Guide for Danger Tree Identification and Response" (2008 edition), Forest Service, Pacific Northwest Region

Danger Tree Mitigation: Elimination or controlled avoidance of the dangers associated with a danger tree.

Diameter at breast height (d.b.h.): The average outside bark diameter of a standing tree when it is measured at breast height (4.5 feet above the forest floor on the uphill side of the tree).

Force Account Work: Work activities performed by permanent or temporary Forest Service employees rather than by outside labor.

Labor Intensive Service Contract (LISC): Contracts for on-the-ground services requiring extensive hand labor including, but not limited to, tree planting, tree thinning, tree pruning, cone collection, and other forestry-related services.

Qualified Person:
A person who has knowledge, training, and experience in identifying danger trees, their potential failure zones, and measures to eliminate the danger.
—"Field Guide for Danger Tree Identification and Response" (2008 edition), Forest Service, Pacific Northwest Region

Solid Biofuel: Commercial timber fuel product derived from logging debris (also referred to as biomass).

Stand Density: Number of trees (stems) per acre.

Stewardship Contract: A written agreement that can help achieve land management goals while meeting local and rural community needs. This type of contract focuses on the "end result" ecosystem benefits and outcomes rather than on what is removed from the land.

Additional information is available at <http://www.fs.fed.us/fstoday/091106/03.0About_Us/stewardship_brochure.pdf>.

Tree Complexity: According to the National Wildfire Coordinating Group's Hazard Tree and Tree Felling (HTTF) Task Group, the elements of complexity include:

- Felling Concerns—Amount/condition of material, size, bind(s), stability, defect, overhead and surrounding hazards, and potential for tree to hang up on other trees.
- Environment—Slope, weather, and condition of ground for footing.
- Secured felling/bucking area—Area that must be established, maintained, and restricted throughout felling operations.
- Equipment—Equipment available, needed, and used, and its condition.
- Human Factors—Assessment of risk, physical condition, individual experience, confidence, attitude, judgment, and ability to communicate.

Regulations and Policy

Each region, forest, and district has different forest management plans, policies, and ground conditions. For the purpose of this report, all Forest Service employees and supervisors should act in accordance with U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) requirements, the Forest Service Health and Safety Code Handbook (FSH 6709.11), and any other guidelines required by law, policy, or memorandum of understanding relative to a specific unit.

Tree Assessment and Method Selection

Tree felling is one of the most dangerous duties performed in the field. Any tree potentially can be lethal. All employees and supervisors must approach these assignments with a high level of situational awareness and understanding of the dangers involved.

Between 2001 and 2009, eight wildland firefighters were killed in danger tree accidents <http://www.nwcg.gov/branches/pre/rmc/summaries/fatalities_by_cause_1999_2009.pdf>.

During the same period, many injuries and near-misses involving Forest Service employees, contractors, and forest visitors occurred. To increase safety, extra actions, such as training and mentoring, sometimes are needed. An entirely different approach may be needed, such as selecting a combination of mitigation methods.

Of 107 logging fatalities between fiscal years 1996 and 1997 (<http://www.osha.gov/dit/ostat/reports/logging/logging_report_all-in-one.pdf>) that were investigated by OSHA, 82 involved individuals being struck by an object during logging operations (figure 2). Of these 82 fatalities, 64 involved individuals being struck by a tree (figure 3).

The felling of trees involves risks. All trees must be thoroughly assessed before felling. Managers need to understand the associated risks for each danger tree mitigation method and compare those risks before selecting a mitigation method for the specific work assignment.

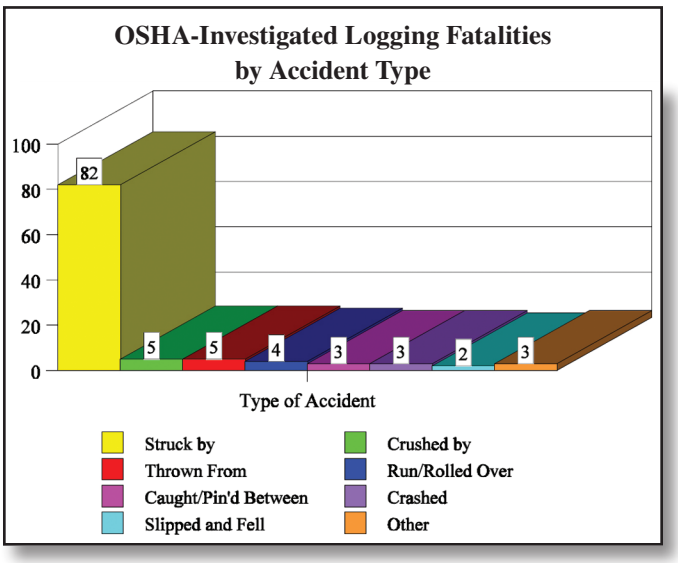

Figure 2—Logging fatalities investigated by OSHA (fiscal years 1996 and 1997) and identified causes. *Courtesy of the U.S. Department of Labor*

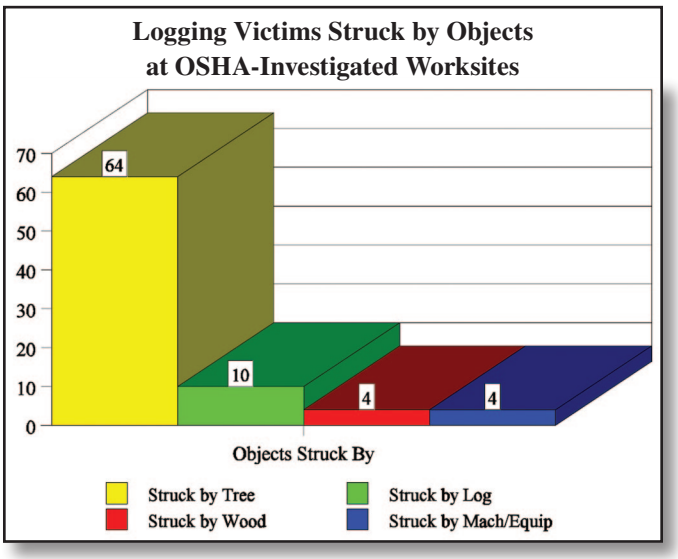

Figure 3—OSHA statistics for "struck by" fatalities for fiscal years 1996 and 1997. *Courtesy of the U.S. Department of Labor*

OSHA requires that employees and supervisors develop a Job Hazard Analysis/Risk Assessment for work activities (29 CFR 1910.132(d)). For danger tree mitigation, a Job Hazard Analysis/Risk Assessment should address the risks associated with sizing up danger trees and mitigation methods for each project area. All job hazard analyses (JHAs) need to be signed by the appropriate line officer and reviewed at least annually.

Blasting

Explosives provide a safe and reliable way to mitigate danger trees in both fire and nonfire environments. Blasting typically is used to remove trees that cannot safely be removed using chain saws or mechanical equipment. Felling danger trees with explosives has a number of advantages, which include:

- Time employees must spend in the danger zone near the tree is limited.
- Trees can sometimes be felled in a particular direction. This is important when it is unsafe or impractical to use a chain saw or mechanical equipment.
- Multiple trees can be felled at once (figure 4). This can be critical when a hazard includes several trees requiring a timed sequence of felling events.
- Hung-up trees (trees that are supported by other trees or objects) or trees under extreme tension can be felled safely.
- Explosives can be used in wilderness areas where chain saws and other mechanical equipment are prohibited.
- Blasting leaves stumps with a more natural appearance (fuzzy stumping) than when trees are felled by other methods (figure 5).

Figure 4—A stand of trees being felled with explosives.

Figure 5—Felling trees with explosives results in a natural look called “fuzzy stumping.”

Techniques

Explosives may be loaded externally, internally, or both externally and internally in some situations (figure 6).

External loading is far more common and typically is safer if the tree doesn't have existing holes or cavities for internal loading.

Figure 6—Two certified Forest Service blasters load a danger tree both internally (using woodpecker holes) and externally with fireline explosives and emulsion.

Internal loading requires fewer explosives than external loading. Loading explosives internally typically decreases the force of the air blast. Internal loading should be used on trees that have pre-existing holes or when trees are safe to drill. Drilling holes may decrease the structural integrity of the tree, reducing safety.

Internal loading should not be used in situations where the direction of fall is important. Loading explosives internally eliminates a blaster's ability to control the direction of fall.

Qualifications

As of 2010, the Forest Service blasting program had about 250 certified blasters with another 50 blasters-in-training. The blasting program has strict requirements for certification. Potential blasters must attend a weeklong course of classroom and field exercises that is followed by an exam. Students are considered blaster trainees after completing the course and passing the written exam. Blaster trainees cannot lead a blasting operation until they have been certified by their regional blaster examiner. Trainees take 1 to 3 years to become certified blasters, depending on performance and experience.

To retain certification, blasters must:

- Attend a certification class once every 3 years
- Participate in random drug testing
- Pass a background check
- Practice blasting at least three times per year

Certified blasters must have a "Hazard Trees" endorsement on their certification cards to fell danger trees with explosives. A commercial driver's license and a vehicle with proper placards (figure 7) are required when transporting blasting materials. Blaster examiners in each region are responsible for training, coordination, and management of regional blasting programs.

Figure 7—Vehicles used for transporting explosives must display proper placards.

Safety Issues

During fires, blasters working with felling teams can promptly mitigate trees that might be too dangerous to address by other methods. In nonfire situations, a person qualified to identify danger trees can use a global positioning system (GPS), flagging, or both to mark a number of danger trees, allowing a certified blaster to mitigate several hazardous situations quickly.

Time spent in the danger zone around a tree is limited, but the blaster must stand at the base of a tree to load explosives. Misfires are uncommon, but do occur. When a misfire occurs, protocol requires that only the blaster-in-charge may approach the explosives. In most situations, the blaster-in-charge must wait 30 minutes before approaching to assess and remedy the situation. If the explosives are smoking after the misfire, the blaster should not approach the explosives for 12 hours.

Debris from a danger tree explosion usually doesn't travel as far as rock that is blasted, but the air blast still can damage structures and vehicles.

A blaster must take special precautions when working near structures or private lands, evaluating each job individually. Blasting near a riparian area may require additional analysis. Contact your regional fisheries biologist before using explosives in or around a riparian area.

Logistics

Each region has a blaster examiner and at least two qualified blasters. Certified blasters can acquire explosives in most areas of the country. Explosives usually can be ordered and delivered onsite within 1 day on most national forests. Because regional examiners and forest lead blasters maintain a relationship with local suppliers, purchasing additional product rarely is a problem. Proximity to an explosives supplier can influence a project's cost. A portable explosives magazine can be rented if a forest doesn't have its own magazine and the project requires the blaster to work in an area for an extended time period.

The area must be secured before a blast occurs. Securing an area typically entails the use of signs and the presence of guards who restrict access to the blast zone. Guards aren't required to be certified blasters. The blaster-in-charge must ensure that the guards understand their duties and all communication requirements before blasting operations begin.

The cost per tree decreases significantly when a blaster mitigates several danger trees in an area. Prior to a blaster's arrival, locate and mark all trees that are scheduled for mitigation.

A blaster may request a fire suppression crew to be present at the blast site because certain types of explosives can start fires. In order to determine which blasting materials are right for a job, the blaster will communicate with local staff to discuss the job details, site conditions, and desired results.

Contact your forest's lead blaster or your region's blaster examiner if you have questions about blasting or if blasting is required in your area (table 1).

Table 1—Forest Service Regional Blaster Examiner Contact Information (current as of January 2011).

Region 1
- Pat Hart
  - ◊ 208–267–6732

Region 2
- Gary Frink
  - ◊ 719–856–5971

Region 3
- Tim Pasqual
  - ◊ 520–388–8412

Region 4
- Rich Young
  - ◊ 208–384–3247

Region 5
- Reggie Bowdler
  - ◊ 209–985–3434

Region 6
- Robby Watson (Bureau of Land Managment-BLM)
  - ◊ 541–679–5937

Region 8
- Gary McElroy
  - ◊ 479–964–7249

Region 9
- Jon Hakala
  - ◊ 218–365–7607

Region 10
- Robert J. Miller
  - ◊ 907–747–4208

Washington Office (WO) MTDC
- Bob Beckley
  - ◊ 406–329–3996

WO MTDC
- Dennis Davis
  - ◊ 406–329–3929

WO Engineering
- Dan Hager
  - ◊ 703–605–4612

Expected Production Rates and Estimated Costs

Production rates when blasting single danger trees can vary from one to three trees per hour (see table 3), depending on terrain and tree complexity. The amount of explosives required for each tree depends on the tree size, species, and tree complexity.

One case of fireline explosives (FLE) typically costs between $253 and $313. A case of FLE usually provides enough explosives to fell between 1 and 20 trees. Blasting caps with 8-foot leads typically cost between $6 and $7 each. A 1,000-foot spool of 50-grain detonation cord costs about $265. The number of blasts per spool of detonation cord varies, depending on the distance the blaster needs to be from each explosion.

Portable magazines rent for $50 to $450 per month. Rental companies may charge $1.75 to $2.50 per mile to transport the magazine. Companies that transport magazines for a flat rate may charge from $1,000 to $2,000 for the transportation and rental of a magazine.

Blaster pay levels may range from General Schedule (GS) 4 to 12 because employees are paid based on their primary duties. Blasting is considered a collateral duty.

Excluding travel costs, mitigation of a single tree can range from $100 to $2,000. Variables will include pay level, number of guards required, amount (and types) of explosives needed to complete the job safely, specific tree location, and general terrain.

Mechanical Felling

Felling danger trees with mechanical logging equipment is a commonly used method. Managers may select this method after considering operational costs, terrain types, and machine availability.

Some benefits of mechanical felling are:

- Equipment has protective features to increase operator safety and shield the operator from inclement weather.
- Equipment can have climate-controlled cabs that minimize operator fatigue.
- Equipment, operators, and work crews typically are available year round.
- Equipment capability can increase productivity and efficiency.
  - o Felled trees can be stacked for removal.
  - o When equipped with lights, working at night is an option.

The Forest Service has a limited inventory of mechanical logging equipment and typically uses contracting for mechanical felling of danger trees. The availability of mechanical equipment may depend on proximity to the worksite of a forest products mill, a road construction company, or a land development contractor. Demand for raw materials drives timber sale bids even if contractors are near the worksite. A timber sale may not be an option if markets for house logs, saw logs, woodchips, or solid biofuels do not exist. In this case, a stewardship contract or a labor intensive service contract (LISC) may be an option.

Mechanical logging equipment ranges from small machines, such as skid steers with small mulcher (masticator) heads, to large machines capable of felling 32-inch diameter at breast height (d.b.h.) trees with a single cut. However, the majority of mechanical equipment is designed for 8- to 28-inch d.b.h. trees.

Because most mechanical logging equipment is privately owned, equipment modification is common. Equipment can be configured with many different attachments.

One type of machine used for felling is the feller-buncher. A feller-buncher can be equipped with different cutting heads:

- Continuous high-speed disc saws (also known as hotsaws) can fell multiple stems (trees) at a time.
- Buncher heads can build multistem bundles with accumulator arms.

Another machine used for felling is the harvester (figure 8). A harvester can be equipped with a boom-mounted bar saw head (also known as a processor head) to fell, delimb, and buck trees. This cutting head can be used in vertical and horizontal positions, which allows cutting severely leaning or "jackstrawed" trees.

Figure 8—A harvester felling and delimbing a tree.

Mechanical felling is especially useful when the timber can be sold. Feller-bunchers can transport and deck trees but harvesters require an additional piece of equipment for transporting the materials. According to "Mechanized Equipment for Fire and Fuels Operations: 2009 edition" (MEFFO), feller-bunchers and harvesters are the two most common types of felling machines used for mitigating danger trees <http://www.wildfirelessons.net/documents/YellowBook_LowRes_Cover.pdf>.

Conventional felling machines are classified by carrier type (tracked or wheeled) and cutting attachment type (swing boom or frame mounted). Some machines have self-leveling cabs. These features determine felling machines' stability and maneuverability.

Tracked machines with a cutting head (hotsaw or bar saw) attached to a knuckle or telescoping boom are common in the West (figure 9).

Figure 9—A feller-buncher grasping and cutting multiple trees.

Swing booms typically have a 360-degree swing that allows a machine to approach a danger tree from any angle. The boom can reach from 22 to 37 feet (figure 10). Boom length is important when a machine is operating in sensitive areas where soil disturbance is a concern. A longer boom can treat a larger area with less machine movement.

Figure 10—A feller-buncher extending its boom to reach a tree.

The most common tracked machine (feller-buncher) in the West has a 12-foot-wide excavator-style carriage and a swing boom with a 25-foot reach. Tracked feller-bunchers (figure 11) are designed to travel off road and some allow the operator to level the cab on steep slopes of up to 55 percent.

Figure 11—A pair of feller-bunchers felling and stacking trees.

Some site factors may limit machine mobility. These factors include:

- Slope
- Boulders
- Amount, type, and height of surface rock, cobble, or scree
- Density and orientation of trees on the ground
- Large, old growth stumps
- Rough, broken ground
- Surface depressions
- Unstable or boggy soils
- Frozen ground, ice, and snow

Equipment, such as bulldozers (with blades) and excavators (with buckets), can mitigate isolated trees by using techniques such as pushing, toppling, and grubbing.

The choice of equipment and mitigation technique depends on the logistics of the project (figure 12), alternate technique costs, and the desired end result. Criteria for mechanical equipment selection can be found in the “Logistics” section on page 12.

Figure 12—A mountain pine beetle-infested landscape in the West. Consider the logistical factors when selecting danger tree mitigation methods in this type of area.

Mechanical mulching can be used where removal of the material is not needed or when there is no market for the raw material. Suitable material is small-diameter trees (less than 12-inch d.b.h. and more commonly less than 8-inch d.b.h.).

Crushing may be a useful technique for large stands of dead, small-diameter trees (less than 12-inch d.b.h.). Trees are crushed by driving over them, usually with a large dozer, or by pulling a weighted drum (figure 13) with a blade to push over and chop the trees. Trees on sites with relatively gentle slopes (less than 25 percent), small-sized rock, and few obstacles are suitable for crushing. Crushing is effective when the entire stand is planned for removal. When residual stem spacing is a concern, crushing is not recommended.

Danger trees also may be eliminated by pushing them over with a blade (figure 14) or boom, or by pulling them over with a cable attached to a winch or large-tracked machine. Grubbing removes trees by pulling up their root system and is not commonly practiced in shallow soils.

Figure 13—A bulldozer pulling a crushing drum (top) and the end result (bottom).

Figure 14—A bulldozer pushing over a large danger tree.

Safety Issues

OSHA 29 CFR Part 1910.266(f) lists the general machine safety and operational requirements for mechanical logging operations. For more information, consult with your local timber staff or refer to OSHA's Web site at <http://www.osha.gov/>. Click on the "Regulations" tab at the top of the page, then click on the link for "1910.266-Logging operations."

OSHA requires that most "industrial forestry machines" meet the Society of Automotive Engineering (SAE) safety standards covering machine structures and materials. Safety features include operator protective structures (OPS), falling object protective structures (FOPS), and rollover protective structures (ROPS).

These protective structures do not guarantee complete protection. For example, not all FOPS are reinforced to withstand the impact of a large-diameter tree. Additional safety requirements, such as reinforced cabs, may need to be included in danger tree contracts, depending on the size of the trees at the worksite.

Managers who are planning danger tree mitigation may need to identify and include contract clauses requiring the protection of seen and unseen site improvements, such as powerlines, shallow or aboveground pipelines, fences, irrigation ditches, paved roads, and private property. For contract clause information specific to your area, talk to your contracting officer's representative (COR) or timber staff. Mechanical mitigation methods usually are the safest option in these situations because the equipment can control a tree's direction of fall.

Combining hand crews and equipment on a worksite is covered by Federal OSHA regulations that require crewmembers to maintain a safe distance from the equipment and falling trees. Equipment operators may have difficulty keeping track of the hand crews. Hand crews working in the same area as equipment must understand the dangers associated with each particular machine. Refer to the MEFFO 2009 guidebook for safety information on specific types of equipment.

When any type of equipment is used, fire precautions must be taken. Metal tracks, tire chains, or moving saw parts may produce sparks when they strike rocks. Friction or sparks can ignite woody debris lodged in saw guards. Hydraulic oil and debris can build up in the belly pan of some machinery and must be monitored. Contracts or permits issued for mechanical danger tree mitigation may require standard fire suppression equipment and specify operational fire control measures.

Logistics

The MEFFO 2009 guidebook has detailed information for equipment selection and ordering. The following criteria should be used:

- Scope of job
- Worksite location and accessibility
- Size of trees (include number and density of danger trees, as well as residual trees that need to be protected)
- Types of terrain and vegetation
- Project timeline and budget
- Operating season(s)
- Desired end result
- Proximity to private land (consider public safety and the protection of structures)
- Size of affected areas and potentially affected areas
- Required rehabilitation
- Availability of equipment
- Options for moving equipment to and from the worksite
- Site security for equipment left onsite

Mechanical equipment and operators typically are available during any season, but may be limited by weather conditions or agency requirements. Worksite proximity to a forest products mill is a consideration if raw materials will be sold. Costs may increase substantially if raw materials must be transported long distances. Decking and storing the timber onsite may be a temporary alternative if transportation costs exceed the timber's value due to market downturns.

If decking is used, associated risks to public safety and the potential fire hazard must be addressed.

Refer to the forest plan for the area where danger tree mitigation will occur. This plan typically outlines the limitations on use of heavy equipment and defines the applicable best management practices. Most equipment use limitations can be amended through National Environmental Policy Act (NEPA) analysis for a specific project, except in wilderness areas or other areas where equipment use is prohibited.

Contact your forest's timber staff if you have questions about or require mechanical logging in your area. If necessary, you can contact your regional mechanical logging specialist.

Figure 15—A tracked machine with a mulching head attachment.

Expected Production Rates and Estimated Costs

Mulching machines typically can mulch 2 to 4 acres per day (see table 3). Some machines can both fell and mulch trees in a single operation. Mulching costs range from $300 to $800 per acre. Mulching production and cost variables include the type of mulching equipment, the stand density, tree size, tree species, site conditions, and the desired size and distribution of the mulch. Mulching heads are available in a variety of sizes. The equipment size determines capability and production rates (figure 15).

Crushing machines typically can crush 2 to 4 acres per day. Crushing costs usually range from $150 to $200 per acre. Crushing production and cost variables include terrain type, tree size, tree species, and stand density.

Bulldozers and excavators (used for pushing, toppling, and grubbing individual trees) generally are less expensive than other mechanical felling equipment because they are more widely available. Costs (including an operator) vary based on site access, machine size, tree size, tree species, tree age, tree condition, rooting pattern and mass, and other subsurface variables. Because these techniques can cause site disturbance, the need for site rehabilitation should be considered.

Felling machines typically can fell 100 to 300 trees per hour. Depending on the type of felling machine, a tree may be moved, decked, or mulched after it has been felled. Felling machine costs (including an operator) range from $3,000 to $5,000 per day with a production rate of about 3 to 4 acres per day based on commercial silvicultural regeneration prescriptions. Costs and production will vary depending on slope, tree size, tree species, tree distribution, residual stem spacing, ground conditions, job size, site access, and transportation of the felling machine to and from the worksite.

Manual Felling

Sawyers on force account, such as those on local fire crews, can offer a convenient way to mitigate danger trees. Sawyers can improve their assessment and felling skills through "trigger-time" on a saw. Contract sawyers may be a viable alternative to using force account depending on the job and a unit's needs.

Sawyer Qualifications

Training to become a certified Forest Service saw operator includes the Missoula Technology and Development Center's (MTDC) Chain Saw and Crosscut Saw Training Course (0667–2C01–MTDC) or the National Wildfire Coordinating Group's (NWCG) S-212, Wildland Fire Chain Saws training course. Each course takes about 40 hours to complete and includes both classroom and field exercises. Completing MTDC's Chain Saw and Crosscut Saw Training Course does not certify a sawyer to operate in fire situations. A sawyer who completes NWCG's S-212, Wildland Fire Chain Saws training course, can operate in both fire and nonfire situations.

Safety Issues

Using sawyers may be the simplest and least expensive method for felling danger trees, but the worksite must be carefully evaluated for existing and potential hazards before operations begin.

Assessing weakness in a rotting tree is extremely difficult. A sawyer can "sound" a tree to test for structural integrity up to a certain height, but must stand in the danger zone at the base of the tree while testing.

Manually felling a tree also requires the sawyer to stand in the danger zone until moments before the tree falls.

Poor footing, unstable slopes, spring tension, binds, falling branches, and loosened root systems are some common dangers associated with manual felling.

Knowledge, experience, and situational awareness contribute to a sawyer's safety. A sawyer who understands the dynamics of a danger tree can reduce the potential for unsafe situations.

Trees in campgrounds often contain metal and other debris left by campers (figure 16). Bullets, nails, spikes, fencing wire, and other foreign objects in trees can become dangerous projectiles or cause kickback when a chain saw hits them. A sawyer has little protection against this type of hazard. When any type of machinery is used, fire precautions must be taken.

Figure 16—A metal nail left in a tree in a campground. Metal in trees can create a dangerous situation for sawyers and decreases the harvest value of timber.

Sawyers from different regions can be brought in to help mitigate danger trees, but doing so can increase safety risks. Sawyers unfamiliar with local terrain, soil types, and tree species require additional site-specific training to perform their duties safely.

Felling danger trees can be hazardous and less predictable than felling healthy trees. In fact, sawing operations with small danger trees can be more complex than those with large, healthy trees. Supervisors may need to provide additional direction to address tree complexity at the worksite.

Operational procedures between fellers and spotters vary throughout the Forest Service. Crews working outside their home regions should be informed of and follow protocol for areas in which they are working.

A copy of the JHA, the bloodborne pathogen exposure control plan, the material data sheets for products used on the projects, and the emergency evacuation plan must be kept onsite. Required personal protective equipment (PPE) is based on hazards identified in the JHA. To comply with 29 CFR 1910.95, employees need to wear hearing protection when working with equipment louder than 85 decibels (figure 17).

Figure 17—Hearing protection devices, such as earplugs, must be worn while operating a chain saw.

Logistics

Many Forest Service sawyers work on fire crews. Their availability fluctuates during fire seasons. Sawyers can be brought in from other regions or through a service or stewardship contract to assist with danger tree mitigation. Forest Service crews should increase their situational awareness by spending time with local sawyers or safety officers.

To estimate the number of sawyers that can safely work in an area, remember that sawyers are required to maintain a minimum separation of 2½ tree lengths while felling. The number of sawyers that can work concurrently is determined by the project area and the height of the trees in that area.

For additional information on the Forest Service chain saw and crosscut saw programs, contact your regional saw coordinator (table 2).

Table 2—Forest Service Regional Saw Coordinator Contact Information (current as of September 2010).

Region 1
- Dave Goodin
  - ◊ 406–329–3237

Region 2
- Grant D. Hamrick
  - ◊ 970–295–6780

Region 3
- Fred Hernandez
  - ◊ 505–842–3804

Region 4
- Brandon Cichowski
  - ◊ 208–347–0321

Region 5
- North operations—Pete Duncan
  - ◊ 530–283–7831
- South operations—Jim Tomaselli
  - ◊ 909–382–2978

Region 6
- Winston Rall
  - ◊ 509–395–3355

Regions 8 & 9
- Daniel J. Peterson
  - ◊ 218–365–7634

Region 10
- Austin O'Brien
  - ◊ 907–874–7575

WO Training Coordinator
- Bob Beckley
  - ◊ 406–329–3996

Expected Production Rates and Estimated Costs

Sawyer production rates vary with tree size, terrain type, weather conditions, season, sawyer experience, and whether trees must be felled in a specific direction.

During 2010 while working on mostly level terrain, each sawyer on a Northern Region force account saw crew was able to fell about 30 beetle-killed trees per day that were 12-inch d.b.h. and 60-foot tall.

The 10 sawyers and 10 swampers on the crew mitigated danger trees in five campgrounds. The estimated cost to mitigate about 688 danger trees was roughly $15,000. This cost included felling, bucking, piling, and burning.

In addition to salary, the cost of felling danger trees with trail or fire crews varies with the distance crews must travel to the worksite.

Avoidance

Avoidance is a controlled technique used when it is preferable to leave a site untreated. Avoidance may require closing an area to ensure public and employee safety. Accurate tree assessment is required to determine whether a temporary or permanent closure is needed.

A temporary closure is used when an identified problem may be resolved at a later date. For example, mechanical mitigation methods may be delayed until the ground is frozen and the potential for soil disturbance is minimized.

A permanent closure is used when a solution to an existing problem currently is unavailable. A permanent closure should be monitored to determine if anything occurs to change the status of the problem. For example, funding may become available that makes an expensive mitigation method more feasible.

Closure enforcement is important for public safety and environmental concerns. Closures can be controversial. They can require large amounts of time to administer and enforce. Managers should identify alternatives, such as seasonal or type-of-use restrictions, and discuss them in a public forum. Explaining workforce limitations, agency budgets, and the dangers involved with mitigation methods is part of an educational process that builds public trust.

Closures require an examination of legal and policy issues that are beyond the scope of this report. Contact your forest planner to discuss laws and regulations related to the avoidance technique.

Danger Tree Mitigation Along Powerlines

There are a number of concerns associated with mitigating danger trees along powerlines. Mechanical equipment can help control a tree's direction of fall, but site conditions may prevent mechanical mitigation in an area with powerlines. Sawyers using chain saws may provide a good alternative. Using chain saws to fell trees along powerlines can be dangerous and should only be attempted by experienced, qualified sawyers. Blasting along powerlines is the least preferred mitigation method because of the potential for flying debris and because explosives may make it difficult to control the tree's direction of fall.

Some utility companies work with the Forest Service to prevent trees from falling on powerlines (figure 18). These utility companies pay for the felling and removal of trees in some cases. A Forest Service COR must monitor the work to ensure contract compliance. New access sites to powerlines must be evaluated by an archaeologist and also must comply with NEPA.

Figure 18—An area where danger trees near powerlines have been mitigated.

Summary

Blasting, mechanical felling, and manual felling all are useful methods for mitigating danger trees. Each method has advantages and disadvantages.

Due to cost and efficiency, blasting usually is employed only when other mitigation methods cannot safely be used.

Mechanized equipment can treat large areas quickly, but may not be cost effective for smaller jobs. Mechanized equipment use also results in less overall exposure to the hazards associated with work under and around danger trees. Mechanized equipment usually is operated by only one person and can be outfitted with features designed to protect the operator from falling objects.

Using chain saws to fell danger trees often is the most convenient mitigation method, especially for smaller jobs. Most national forests have a workforce of trained sawyers. Felling with sawyers is considerably slower than felling with mechanized equipment. Felling also increases overall exposure to danger trees for more people over longer periods of time. Manual felling is the only mitigation method that requires a worker to be standing next to the tree as it starts to fall.

Variables such as worker safety; forest conditions; availability of equipment, workers, or contractors; expected results; available funding; job size; location; and proximity to a forest products mill are factors that help managers determine the best mitigation method. Correctly matching a mitigation method to a danger tree situation can increase employee safety, improve project results, and increase cost efficiency. Table 3 compares production rates, estimated costs, and associated variables for each mitigation method.

Safety considerations, such as operator proficiency, communication consistency, and familiarity with local terrain, will increase the safety of employees mitigating danger trees.

Table 3—Expected Production Rates, Estimated Costs, and Production/Cost Variables of Danger Tree Mitigation Methods and Techniques.

	Production Rates	Estimated Costs	Variables
Blasting	1 to 3 trees per hour when blasting single trees	$100 to $2,000 per tree	Pay level, number of guards required, amount and types of explosives, tree complexity and location, and terrain
Mechanical Felling	3 to 4 acres per day	$3,000 to $5,000 per day	Tree size, species, and stand density; ground conditions; cutting prescription; job size; slope; site access; and transportation of felling machines
Mechanical Mulching	2 to 4 acres per day	$300 to $500 per acre	Type of mulching machine, stand density, tree size and species, site conditions, and desired size and distribution of mulch
Mechanical Crushing	2 to 4 acres per day	$150 to $200 per acre	Terrain type, tree size and species, and stand density
Mechanical Pushing, Toppling, and Grubbing	2 to 4 acres per day	Less than $200 per acre	Site access, machine size, rooting pattern and mass, other subsurface variables, and tree size, species, age, and condition
Manual Felling	About 30 (12-inch d.b.h.) trees per day for each sawyer	About $2,000 per 100 trees, which includes felling, bucking, piling, and burning	Tree complexity and size, terrain type, weather conditions, sawyer experience, season, and whether the trees must be felled in a specific direction
Avoidance	N/A	Signage and closure enforcement as needed	N/A

Additional Tools and Information

These additional references and links may be useful in helping managers decide the best mitigation method for a particular situation.

Blasting

"Felling Hazard Trees with Explosives" (0867–2325–MTDC) describes the use of explosives to fell trees that are too dangerous for sawyers to fell. This tech tip is available at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0867 %202325>.

Mechanical Felling

Forest Service logging engineers often refer to the handbook "Harvesting Systems and Equipment in British Columbia" to determine the best equipment for a job. This handbook is available at <http://www.for.gov.bc.ca/hfd/pubs/docs/sil/sil468.htm>. Contact your local logging systems specialist or timber and fuels management staff to determine the equipment that best fits your danger tree situation.

Manual Felling

The Intermountain Region Chain Saw and Crosscut Program Web site provides a variety of hazard tree resources at <http://fsweb.boise-nf.r4.fs.fed.us/safety/hazard%20trees.shtml>.

Using a Recreation Facility Analysis for Danger Tree Mitigation

A forest's recreation facility analysis (RFA) provides land managers with helpful information to prioritize danger tree mitigation in recreation areas. An RFA defines the proposed actions for management of forest recreation sites in order to meet the desired future condition that aligns with the forest plan.

Written on a 5-year cycle, an RFA can be adapted annually to changes in available resources and funding. Detailed information about an RFA is available at <http://www.fs.fed.us/recreation/programs/rfa/>.

Using Geographical Information System Data for Planning Danger Tree Mitigation

Geographical information system (GIS) data can be used by resource managers to build an initial reconnaissance map of high-priority areas for locating danger trees and selecting appropriate mitigation methods (figure 19). The slope and road layers can help determine the types of tools, machines, or methods that are practical for danger tree mitigation. The same scale should be used for all maps and overlays requested. If no particular scale is available, start with the U.S. Geological Survey (USGS) 1:24,000 scale map.

Map layers should include the following:

- A recent orthophoto or satellite base layer.
  - ◊ Location—a township/range/section overlay.
  - ◊ Slope—a 40-foot contour overlay.
  - ◊ Machine capabilities—a slope grouping overlay with clear representing 0- to 40-percent slopes, yellow representing 41- to 55-percent slopes, orange representing 55- to 70-percent slopes, and red representing slopes steeper than 70 percent.
- An improvements overlay based on the motor vehicle use map, including closed roads, motorized trails, nonmotorized trails, closed trails, recreation facilities, powerlines, gas lines, water lines, sewer lines, and radio or communication sites.

- A decadent stands overlay, including old growth stands (brightly colored for emphasis).
- A potential problem vegetation overlay compiled to show the past 15 years of damage caused by insects, disease, wind, snow, and fire (brightly colored for emphasis). Combining overlays 3 and 4 also is an option.
- A Forest Service property boundary map overlay.

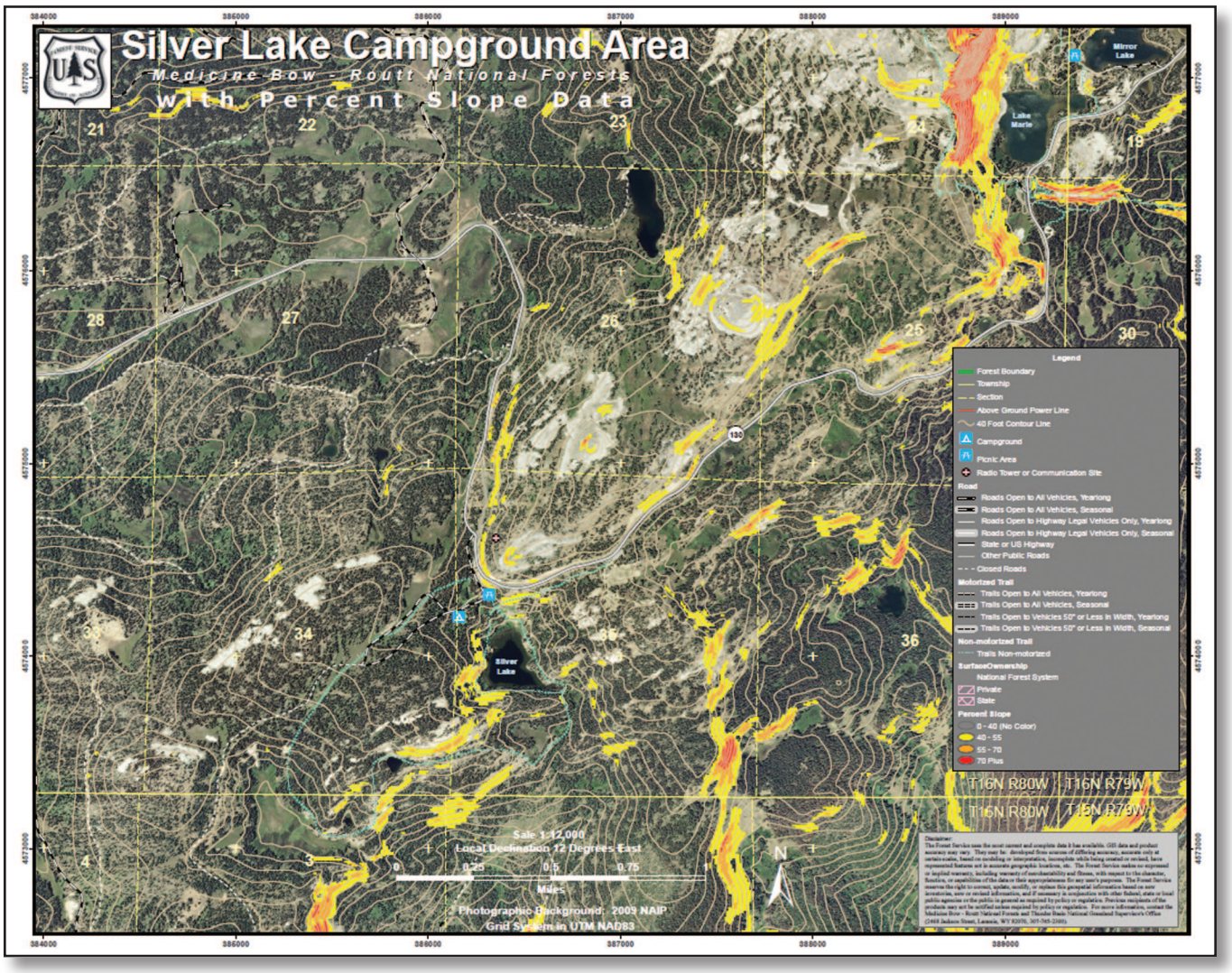

Figure 19—A GIS reconnaissance map used to identify high-priority areas for danger tree mitigation. *Courtesy of the U.S. Department of the Interior*

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About the Author

Damien Hoffman joined MTDC in 2004 as a student at the University of Montana. He worked as a Web development assistant until graduating in 2006 with a bachelor's degree in wildlife biology, when he took over as webmaster. Hoffman is the cache coordinator for the National Visitor Use Monitoring program and works as a project leader for the center. He also has a bachelor's degree in sociology from the University of Minnesota-Morris.

Library Card

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Danger trees present a safety concern for anyone working on or visiting public lands. Between 2001 and 2009, eight wildland firefighters were killed in danger tree accidents. Many injuries and near-misses involving Forest Service employees, contractors, and forest visitors occurred during the same period. A full understanding of three common methods (blasting, mechanical felling, and manual felling) and one technique (avoidance) can help managers determine the best way to address danger tree safety concerns.

Keywords: avoidance, blasting, chain saws, danger trees, hazard trees, manual felling, mechanical felling, mitigation, safety at work, training

For additional information about danger tree mitigation guidelines for managers, contact MTDC:

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Missoula, MT 59808–9361
Phone: 406–329–3900
Fax: 406–329–3719

Electronic copies of MTDC's documents are available on the Internet at:

http://www.fs.fed.us/eng/pubs

Forest Service and Bureau of Land Management employees can search MTDC's documents, CDs, DVDs, and videos on their internal computer networks at:

http://fsweb.mtdc.wo.fs.fed.us/search/