Spring 1990

Forest Prescription

Forest Land Mgmt & Timber Sales ◆ Shared knowledge enhancing management of trust lands

Busy again

by Dave Zibell

Tired of playing phone tag, spending your time driving from phone booth to phone booth? Spending evenings making business calls for the department? Out on fire call or doing business when the radio operator is not working? A radio telephone interconnect (RTI) could be the answer to your problem.

RTI is now used in Olympic Region and parts of Northwest, South Puget, Central and Southwest Regions. With training, field personnel can access SCAN and local lines from their truck or hand-held at any time of the day or night. If you are already in an area serviced by an RTI, the cost of equipping present mobiles is about $200 and most hand-helds require minor reprogramming.

Our most advanced RTI, located near Olympia, can ring the desired person and has capabilities of paging, remote security detection, radio site monitoring and remote programing through a telephone-computer modem feature.

The future of RTI looks bright with advances in smart radio coming on the market. Plans for expanding RTI are dependent upon the individual Region needs. Want to let your fingers do the walking? Talk to your radio technician or call Dave Zibell. ◆

Dave Zibell, Communications Electronics System Technician, in Olympia. He installed most of Olympic Regional RTI system and the Capital Peak RTI system.

Salmon and trout

A fish habitat perspective

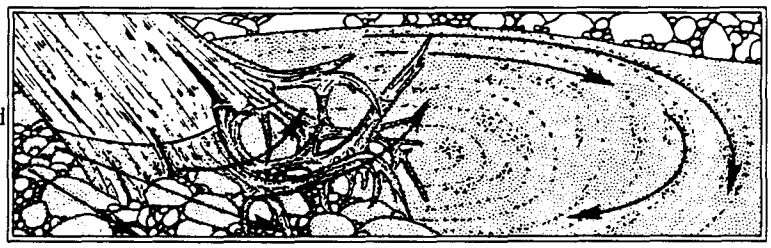
by Jeff Cederholm

Salmon and trout populations in rivers, streams, and lakes of the Pacific Northwest are a highly valuable and renewable resource. Basic habitat needs must be met to maintain the viability of the resource. Our activities on uplands can have a direct bearing on fish habitat.

Salmon and trout require:

- ❑clean, cool, highly oxygenated water
- ❑an assortment of stable and silt-free gravel
- ❑an abundance of large organic debris (LOD)
- ❑a food supply

Each kind of salmon and trout have exploited the aquatic environment differently. Usually, habitat segregation has resulted in an efficient use of space and food.



Backwater pool associated with root wad (LOD).

Adults often migrate long distances before arriving to their spawning grounds. Unfavorable conditions such as excessively low streamflows, high suspended sediment levels, and high water temperature will not only delay arrival on the spawning beds, but may cause avoidance of their natal stream. Adults need deep pools to hide in and some degree of overhead cover e.g. [LOD and undercut embankments].

Upon emergence from the gravel, young salmon and trout take up summer residence in riffles and pools. The riffles and pools are formed by the action of water around obstructions such as LOD and boulders. Gravel becomes trapped behind logs forming spawning riffles and pools for rearing. Generally, higher levels of LOD in streams have been correlated with higher numbers of salmon and trout. In the design of Riparian Management Zones (RMZ) consider leaving trees that will replenish the LOD. Research is now underway in our department to guide LOD enhancement.

When streams shrink and water temperatures become high in summer, living space becomes limited. Water temperature can have beneficial as well as detrimental effects. The optimum range is probably between 46 and 63 degrees Fahrenheit, depending on the species. RMZ's should provide both shade and openings to maximize food productivity.

During fall storms, stream dwelling fingerling salmon and trout immigrate into overwintering ponds and swamps, which are places of refuge and good growth. Coho salmon fingerlings that use these overwintering habitats (termed wall-base channels), have improved ocean survival compared to non-immigrants. It is crucial that wall-base channels be identified during the pre-sales stage to properly protect them. Departmental research is underway to find ways of improving these crucial habitats.

A video is available from FLMD.

Illustration from: Bisson et. al. 1987

STEWARDSHIP FEATURE

Wildlife trees and safety

by Deborah Lindley

One of the DNR's stewardship wildlife objectives is to provide long term wildlife habitat diversity. Block planning is a key element in operational integration of wildlife habitat management. We can examine and document the ability of alternative silvicultural practices to protect or enhance elements of stand structure important to wildlife. Innovative management opportunities also exist for individual unit plans.

Art McCoy with a snag

Dead and defective trees are a structural component that add diversity on-site. About 1/5 of all Washington's wildlife species use standing dead and defective tree habitat. Three-fourths of these snag users (about 65 species) depend on cavities in standing dead and defective trees for nesting or denning, yet only 16 of these species (the primary excavators) can create their own holes in trees. The remaining 50 or so species must rely on nature and the primary excavators to provide their homesites. An additional 80 species on the westside (116 eastside species) use down wood.

Cavity users are vulnerable. We know that the presence or absence of snags determines whether a viable population of snag users will exist. We also know that there is a scarcity of **large** snags in most managed forests, both even and uneven-aged. Large snags (> 17 inches dbh) are needed by about 45 species.

Dead and defective trees benefit the forest ecosystem as a whole. They add structural diversity, contribute to long term forest productivity, and house birds and bats that eat destructive insect pests. So what's needed? Biologists give a general rule of thumb: maintain an average of 3 snags, 3 green trees and 2 down logs per acre, of the largest available, distributed across the planning area. Green recruitment trees can be low value, defective trees. It is best to aim for uniform distribution, but small, well distributed clumps are also useful. Snag management doesn't have to occur on every acre. A good balance would be to manage 65-75% of the planning area to maintain 3 snags/acre through time.

"...maintain an average of 3 snags, 3 green trees and 2 down logs per acre, of the largest available."

The big challenge is how to do it. There is no question that human safety is the top priority. Four agencies struggled with this question and in 1985 signed a Memorandum of Understanding that, with proper planning and training, snags could be safely retained during logging operations. This sounds nice, but we all know implementation can be difficult. The logger often feels stuck between a rock and a hard place, encouraged to leave snags by the DNR and cited for misconduct by Labor and Industries (L&I).

"The key to safe snag management is the safety plan."

There is a way to intercept the cycle. Management of dead and defective trees must be deliberate. With some forethought, snags can be safely and economically retained. Whether the harvest will occur on an individual unit or in a larger basin, planning preserves flexibility. The key to safe snag management is the safety plan. State safety code requires the operator to have a safety plan before harvest begins. The operator should include strategies for retaining snags in his safety plan. We can facilitate this by inviting an L&I consultant to the pre-work conference to review the operator's safety plan.

In addition to cooperative education and training efforts, L&I Voluntary Services offers on-site consultation and assistance with safety plans. "Consultants invited to visit a work place will evaluate the site for potential hazards that may lead to accident and injury, and suggest ways to correct the hazards. Even though the consultant looks for the same hazards an L&I safety and health inspector would cite as violations, no citation is issued and no fines are levied. Serious hazards must be corrected, but the findings of the consultant are confidential and are not referred to safety and health inspectors." (The Guyline. Department of Labor and Industries, March 1988). This is a good way to learn how to develop site-specific snag retention plans that will be compatible with safety regulations and can minimize compliance time. Consultations may be requested directly from L&I Voluntary Services either by phone or in writing through the use of the L&I request card "Request for WISHA Services." If you need L&I request cards contact Deb at FLMD. ♦

Deb Lindley, Wildlife Biologist, has worked 11 years in wildlife with the USFS and DNR. She has been the major contributor to the Upland Management Area (UMA) policy and guideline.

See the Spring 1989 issue for Wildlife Tree Programs and other available assistance, or call Deb at FLMD or Tom Sturza at TSD.

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STEWARDSHIP FEATURE

Creating alternative approaches to management

The changing perspective

by Jerry F. Franklin

A revolution is occurring in forestry. Alterations in our perspectives on foresty occur about every half-century and one of those is in progress now! Society is identifying some new priorities and concerns. Science is spewing forth a lot of new information, some of which challenges the core of traditional forestry perspectives. While such revolutionary times are stressful, it provides exceptional opportunities to demonstrate our ability as foresters to accommodate a broad array of societal objectives.

Integrating maintenance of ecological values and production of commodities is the heart of the New Forestry. Forests remain an essential source of raw materials but, responsible stewardship requires increased attention to sustainable productivity, biological diversity, and the forests' resilience in the face of altered environmental conditions.

Fortunately, two decades of basic research on forest ecosystems and landscapes provides a wealth of information relevant to modification of forest practices. Natural forests turn out to be far more complex than we had imagined. Their richness in organisms and processes mocks an earlier view of these forests as biological deserts. Many organisms are part of an "invisible" diversity (insects and fungal species) critical to the productive functioning of the forest. Certain parts of the forest, such as canopies and belowground, are proving especially complex. The complex, multi-storied canopies provide extended diverse habitats for animals and behave as gigantic sky combs scavenging the atmosphere for moisture, dust, and other materials.

Structure is the key to the health and diversity of the natural forest. They are typically very diverse in structure with a wide range of tree sizes and conditions, snags, down logs, multiple canopy layers, and varied understory conditions. Even young stands have high levels of structural diversity under natural conditions because of "legacies" of living organisms and large wood structures (snags and down logs) from the preceding forest. Structural diversity relates directly to diversity in species and the forest's ability to carry out important functions, such as in conservation of soils and nutrients and streamflow regulation.

Recognition of the importance of landscape-level forest issues is also very recent. We now understand that forestry practices can have cumulative effects on hydrology and erosion. Similarly, forest fragmentation is recognized as a problem, particularly where dispersed patch cutting practices have been utilized. Small, isolated forest patches do not provide the habitats needed by interior forest species and are often vulnerable to wind. We now understand the need for analyzing effects of management practices at the drainage level; effects of stand treatments can no longer be considered in isolation.

Many of these scientific findings are disconcerting. They are contrary to previous assumptions about forests and how they work. They signal a need for us to stand back and take a fresh look with the likely outcome of significant change in forestry at both the stand and the landscape level. Fortunately, the seeds of a "kinder and gentler" forestry which reduces the conflicts between commodity production and ecological values are also present in this recent research.

New Forestry attempts to incorporate the new (scientific findings and additional societal objectives) with science and experience encompassed in traditional forest practices. At the stand level, the primary objective of New Forestry is maintenance of higher levels of structural and species diversity in managed stands. Techniques include:

- ❑ retaining various groups and sizes of green trees, snags, and down logs on a continuous basis
- ❑ creating young stands of mixed species, including cedar and hardwoods
- ❑ delaying canopy closure in young stands

The major concern of New Forestry at the landscape level is to plan and assess management activities over larger areas and longer time scales than has been traditional. Issues include:

- ❑ location, sizes, and connections between reserved areas within the commodity landscape
- ❑ appropriate sizes for harvested and reserved areas
- ❑ aggregation vs. dispersion of management activities within a landscape

As DNR employees, you are at the forefront of changes in forestry. Practicing forestry daily on the ground you have the opportunity to take objectives, such as a structurally more diverse forest, and find practical approaches for achieving them. Developing ways to accommodate ecological values while maintaining high levels of commodity production is the greatest legacy you could leave future generations. ♦

Jerry F. Franklin is Bloedel Professor of Ecosystem Analysis, College of Forest Resources, University of Washington and Chief Plant Ecologist, USDA Forest Service Pacific Northwest Research Station.

FOREST INSITES

Forest managers should...*know their duff*

by Richard Bigley

How come one of the most valuable and easiest features of the forest to examine when trying to determine a site's response to management is one of the most overlooked? A quick look at the forest floor (what some call duff) can tell you much about timber productivity and general response of a site to management such as slashburning or fertilization with nitrogen. Foresters have been using interpretation of forest floors to make the distinction between higher and lower productivity sites for over a hundred years. All you have to do is know your duff.

Most of us realize that the forest floor (the layer of organic matter at or near the surface of the mineral soil) serves major functions in soil stability and site productivity. By reducing the impact of rain and increasing infiltration, the forest floor protects the soil from erosion as well as protecting the soil from extremes of temperature and helping retain moisture. In many forests, most of the nitrogen used to support timber growth comes from the forest floor. The forest floor acts as a nutrient reservoir storing nutrients accumulated in the forest over the years and slowly releasing them through decay.

Just as tree growth gives us an index of site productivity, the construction of the forest floor gives us an index of nutrient availability and the impact of different management practices. Forest floors, like most natural features we try to classify, are a continuum of intergrading forms developed by many aspects of the environment that vary in their influence from place to place. The two extremes at either end of the forest floor continuum are called mor and mull. Between these two forms are a variety of intermediate types which reflect different types and amounts of litterfall, soil animal and/or soil fungal activity, moisture and temperature.

In general, a mor type forest floor has relatively thick litter and partially decomposed litter layers that lay directly on the surface of the mineral soil with virtually no mixing. A mull type forest floor has a thin layer of litter overlaying decomposed organic material that is well mixed with the surface horizon of the mineral soil. Table 1 compares and contrasts these two forest floor types.

Table 1. General characteristics of the two extremes in forest floor types

	Mor	Mull
Structure		
Thickness of partially decomposed litter	Thick	Thin
Transition between forest floor and mineral soil	Abrupt	Intermixed
Prevalence of large amounts of fungal hypha	Characteristic	Lacking
Prevalence of earthworms and other invertebrates	Lacking	Characteristic
Location (very generalized)		
Moisture conditions	Dry/very wet	Moist
Temperature conditions	Cool	Warm
Elevation of occurrence	High	Low
Example Plant Indicators		
Mor	Salal, Bunchberry, Thin-leaved huckleberry, False Huckleberry	
Mull	Youth-on-age, Enchanter's nightshade, Lady-fern, Salmonberry	
Function		
Decomposition rate	Slow	Rapid
Major decomposer	Fungus	Bacteria
Nitrogen availability	Low	High
Nutrient availability other than nitrogen	Relatively low	Relatively high
pH	Relatively low	Relatively high
Interpretation		
Site quality	Relatively low	Relatively high
General response for nitrogen fertilization	Excellent	Variable
Susceptibility to nutrient losses with fire	Very high	Low
Ease of displacement with soil disturbance	High	Low

Inspecting the forest floor to make site and management interpretations is as easy as scuffing through to the mineral soil with your boot. Checking the depth of organic matter accumulations, the degree of decomposition and amount of mixing with the mineral soil tell most of what is needed to start making interpretations of the site's productivity and response to management. Inspection of the forest floor should always be a part of the process when considering burning. The amount of air pollutant emission and chemical changes in the soil (e.g., nutrient loss) are usually closely related to the amount of forest floor consumed. Since the decomposed organic matter in a mull type forest floor is mixed in the mineral soil, fire is far less likely to burn off this nutrient reserve than with a mor type forest floor that is perched on the mineral soil surface. Sites with a mull type forest floor are likely to have a less than satisfactory, or at least variable response to nitrogen fertilization because nitrogen is already relatively plentiful.

Thoughtful care and maintenance of forest floors is a part of managing sites for future timber productivity. For more information on how forest floors can help us interpret site conditions and improve our understanding on sites we are managing, call Richard Bigley at FLMD. ♦

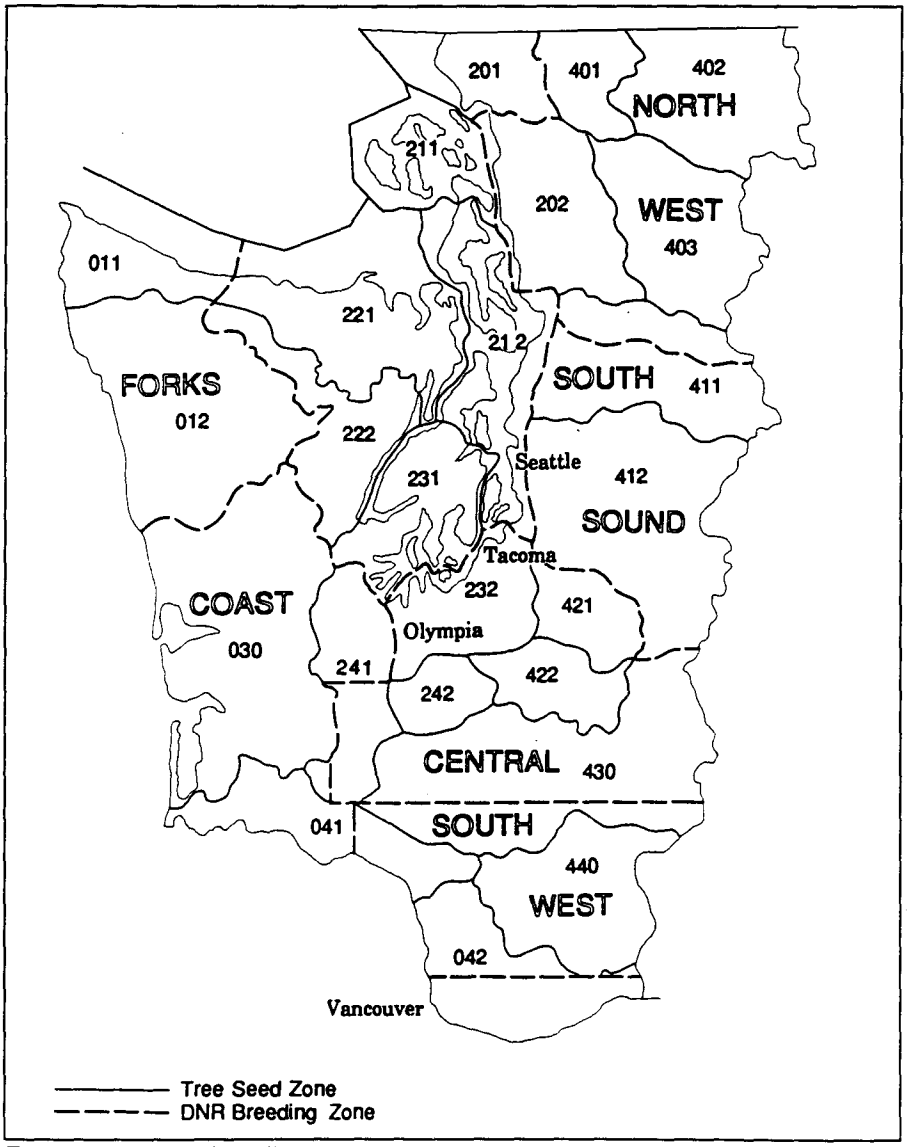
UPDATE

Improved seed available now!

by Boyd Wilson

The DNR seed orchard is producing significant quantities of Douglas-fir seed. The 1989 crop was 110 pounds, up from 64 pounds in 1988. This seed is available to western Washington Regions for operational reforestation and is listed on the seed inventory. Because the ages and maturity of the various orchard blocks vary, large amounts of seed are not yet available for all breeding zones. Some Regions can expect a greater supply than others. But, in the next few years, higher production is expected throughout the orchard.

The goal of the tree improvement program is to produce faster growing trees and an ultimate increase in stand volume. But, that goal cannot be realized until improved trees are actually planted. It is in the best interest of the Trusts to reforest with improved seed, and it makes sense to use all the seed that is available. There is no reason to use field collected lots if suitable seed orchard seed exists. **So use up that improved seed!**



Tree improvement breeding zones

There are six breeding zones in western Washington which make up the DNR's tree improvement program (see map). Each of these breeding zones encompass all or part of several seed zones, and despite some similarity in name, have different boundaries than the Regions.

Improved western Washington Douglas-fir seed is intended for use within the appropriate breeding zone at elevations below 2,000 feet and on high site lands. High site means Douglas-fir 50-year site index 100 and higher. Do not move improved seed higher than 2,000 feet elevation, or out of its breeding zone.

The use of large breeding zones spanning 2000' may seem in conflict with seed zones and 500' elevation bands. The difference is that seed orchard seed is from interbreeding the best parents found throughout the breeding zone. Field collected lots represent a local gene pool or pools. Also, there is a growing body of evidence showing that the best trees are broadly adapted within a breeding zone.

We are optimistic but, cautious about our use of improved seed. Field testing will verify our expectations.

So what's the best strategy for using this seed orchard seed within a breeding zone?

- ❑ Use seed orchard seed if it is available.
- ❑ Use it on your high sites first.
- ❑ Then use it on other sites.

Gains from tree improvement are expected to approach a ten percent increase in volume. To confirm this prediction and to further increase the quality of seed orchard seed, both nursery and long term field tests are being conducted. These tests will provide actual performance data to fine tune the use of this seed. ♦

Boyd Wilson, Geneticist at FLMD, since 1962 has been involved with the tree improvement program from its onset. Boyd is available to talk to you about using improved planting stock.

THE TOOLBOX

Shakey business

by Bill Lewis, Olympic Region

The shake and shingle industry on the Olympic Peninsula is old grass-roots free enterprise. These businesses vary from single saw "ma and pa" type mills to huge mechanized operations with sorting yards, palletizers, and several saws.

The majority of the products are derived from purchased logs delivered to the mill site. The mill is then faced with the large problem of disposal of mill debris, and usually accomplishes this with a burner.

A smaller portion of the products are derived from blocks delivered to the mill. The landowner then retains the majority of the debris in the form of spaults. Spaults are the thin rough outsides from when the "splitter-man" takes a 24 inch long round and squares it into a block. Usually, the spaults are discarded in the field wherever the blocks are split. These types of operations which often follow logging are referred to as cedar salvage. They are labor intensive and usually involve helicopter yarding. On flat ground it is often difficult to see results of the harvest from the road.

The Olympic Region prefers to optimize both commodity production and ecological values. Some of our operational restrictions include:

- ❑relocating spaults in draws to a stable location
- ❑no snag salvage
- ❑no salvage in wetlands
- ❑no activity permitted within ordinary high water mark of any water course
- ❑others unique to specific sales

Western redcedar is an amazing tree. It is famous for its resistance to decay and aromatic qualities. Both of these are linked to its chemical properties. These chemical properties discourage fungi, insects, and other processes of deteriorations.

I wonder, is it best to scatter this debris in the form of spaults or smoke? I welcome your ideas and comments. Please call or write. ♦

Bill Lewis, Olympic Region, was recently appointed Region Cedar Salvage and Sales Specialist. Bill, a Husky alumni, is a 12 year DNR vet.

Yields...The 2nd key to sustainable harvest calculation

by Chuck Chambers

To calculate the board foot volumes necessary for a sustainable harvest calculation, acres and timber yields need to be known. The winter "Forest Prescription" outlined the acreage base; now for the timber yields. **The yields are broken down into three major categories. They are:**

- ❑old growth conifer
- ❑natural second growth conifer and hardwood
- ❑intensively managed second growth conifer

Old growth yields are for stands 100 years and older. The assumption for these stands is the mortality equals growth, thus the yields are held constant over time. The original estimates of the old growth yields came from the 1960's inventory and have been updated based on the timber sale cruise volumes. The yields are further broken down by region, zone, trust, and age. For example, the yield for Olympic Region, western hemlock zone, other than forest board and 160 years plus is 48,000 BDFT/Acres.

The natural second growth yields, covering age classes 30 to 90 years, are by far the most important of the three categories. The present standing inventory for western Washington is nearly 21 billion BDFT, in which the second growth conifer and hardwood stands accounts for over 80 percent. The natural stand yields are based on the department's empirical yield tables using the parameters age, site index and basal area to generate the yield for each stand type. These volume estimates (volumes = yield x acres) will need to support the sustainable harvest for the next 50 years. If wrong, the department will not be able to maintain the harvest presently calculated. Most of the inventory work scheduled for the summer of 1990 will be in this category.

The last, and most glamorous category, is the intensively managed yields. These yields are by far the least important of the three for supporting the sustainable harvest over the 50 years. Their importance will be in the future rotations. We don't want to be wrong, but time is on our side; a gift we don't have with the present natural stands. The yields are estimated from DNRIMPS for Douglas-fir, western hemlock and silver fir for different levels of stocking by tree per acre. We refer to these yields with different stocking levels and treatment as management regimes. It is not uncommon to have as many as ten management regimes per age class. The intensively managed yields will apply to the acres in the present 0 through 30 year age class, plus all the acres that will be logged over the next 150 years.

Let's not forget, I have only been talking about the conversion of the present inventory through harvest scheduling and how the different yields play a part in this process. I don't want to leave you with the idea that the intensively managed yields are not important. Remember, we must invest some of the harvest capitol back into the forest. We are investing in the present regenerated stands, not the ones we are about to harvest. ♦

Next issue: The assumptions

THE TOOLBOX

Vegetation control using sheep

by Louis Halloin

Grazing by sheep is a biological technique for suppressing plant competition in plantations by using competing vegetation as forage. Studies throughout the Pacific Northwest have demonstrated that grazing and forest regeneration can be compatible.

Going...

Benefits of Plantation Grazing

Well planned grazing in plantations has several benefits for the landowner. By reducing plant competition, grazing often results in an increase in available soil water, increased nutrient availability, and increased available light for conifer seedlings. Seedling growth rates commonly increase in grazed areas compared to ungrazed.

Other potential benefits to the landowner include noxious weed suppression, reduced rodent habitat, enhanced natural regeneration through site preparation, protection of riparian zones, improved winter range, and reduced fire hazard.

Potential Plantation Impacts

Grazing within plantations is often reputed to have adverse effects on conifer regeneration. Seedling browsing and trampling are often reported. However, a detailed literature review revealed that virtually all serious seedling damage caused by livestock was the result of grazing mismanagement.

Grazing Technique

Plantation grazing requires careful planning, execution, and monitoring to achieve the desired outcome. Close coordination between the landowner, the livestock operator, other resource agencies, and other resource users is essential for minimizing problems and promoting success.

To be effective, control of brush needs to start early in the regeneration period. With proper grazing management, damage to conifer seedlings can be minimal with no long term effects on growth.

Proper timing of grazing with regard to forage growth and stage of seedling development, correct forage utilization, and maintenance of livestock distribution are critical factors influencing success. With proper timing and utilization, it is possible to graze plantations having seedlings entirely within the reach of grazing livestock. If livestock are conditioned to graze good forage, tree seedlings will be avoided.

The Pilot Study

A suitable test plantation was located in the Klickitat District near Trout Lake. Two bands of sheep were being grazed nearby in the Gifford Pinchot National Forest. The sheep

going...

operator, William Rill from Heppner, Oregon, was interested and agreed to provide sheep for this project.

Smeltzer Mill (Unit 1), a 47 acre plantation, was the selected test plantation. The area was burned and planted with Douglas-fir in 1987. Brush competition was rapidly becoming a problem. Chemical and mechanical techniques for brush control were considered socially and/or economically unacceptable.

Prior to grazing, a series of forage sampling plots were established for purposes of monitoring and documentation. Major brush species were vine maple, redstem ceanothus, creeping ceanothus, and elderberry. Total available forage on a dry matter basis was estimated to be 1,475 lbs/acre. Target forage utilization was 70 to 80 percent of total available forage.

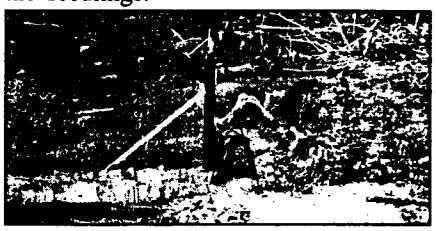
Available forage in the vicinity of each plot was categorized as low, medium, or high to enable stratifying the plantation into different levels of brush competition. A grazing enclosure was established in each level of brush competition.

Adjacent to each enclosure, a forage sampling plot was selected as the center of a larger plot for assessing seedling damage existing prior to grazing. All Douglas-fir seedlings within each plot were inspected and existing damage recorded.

A band of sheep consisting of 730 ewes with 950 lambs entered the plantation in August 1989. The sheep remained in the plantation until most of the available forage was consumed.

Average forage utilization was about 80 percent. Snowbrush and currant were the least preferred of the common shrub species and were little utilized by the sheep. Vine maple, redstem ceanothus, and creeping snowberry were almost totally utilized.

Browsing by sheep on Douglas-fir seedling was nonexistent. Some mechanical damage caused by trampling and head rubbing was noted, but affected less than one percent of the seedlings.



gone

Overall, the pilot study was a complete success. The most serious problem for the sheep operator was coyote predation. ♦

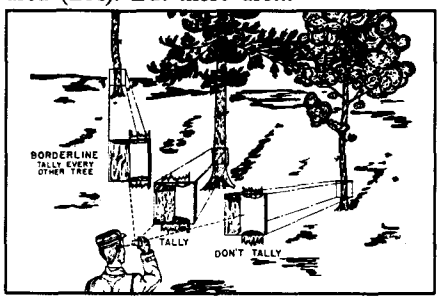
Lou Halloin is an FLMD scientist, located in Ellensburg. Lou has a keen interest in proving the operational value of sheep in plantation maintenance.

THE TOOLBOX

Basal area...the what & how

by Fred Martin

Some may think mensurationists have an unhealthy fascination with basal area (BA). But there are...



Three reasons why BA is important:

- **it is easy to accurately measure,**
- **it can be used to measure stand density,**
- **it is one component of stand volume - the other is height.**

This article presents the basics of BA, while a companion piece describes uses for BA. BA can be defined for an individual tree or for an entire stand. Tree BA is the cross-sectional area of a tree at breast height and can be visualized as the exposed surface area of a 4.5 foot high stump. Stand BA is the total of the cross-sectional surfaces of all trees on a given acre.

The BA of a tree, like the area of a circle, is calculated by squaring its radius and multiplying by pi (π=3.142). We do not usually measure tree radius, but diameter (DBH) is measured and by dividing the DBH in half we can compute BA. In symbols:

$BA = \pi \times r^2$ or,
$BA = \pi \times (DBH/2)^2$ or,
$BA = (\pi \times DBH^2)/4$, in sq. inches.

Since we usually measure DBH in inches, but want BA in square feet, we need to convert it by dividing BA by the number of square inches in a square foot (12 inches = 1 foot and 144 sq. inches = 1 sq. foot).

$BA = (\pi \times DBH^2)/4 \times (1/144)$, in sq. ft.

If π is divided by 4x144 we get our old Nemesis from Forestry 201, which is .005454. **So to get BA of a tree we multiply the squared DBH by .005454.**

Formula 1
Tree $BA = .005454 \times DBH^2$

By adding the BA of all trees on an acre we could get the BA on a per acre basis. In actual practice, however, BA for a stand is usually determined using a prism or Relaskop. These devices directly measure the BA per acre represented by a tree. Counting the number of "in" trees on a prism or Relaskop plot and multiplying the number of "in" trees by the BA factor (BAF) for the device gives the total BA per acre. For example, if six "in" trees are counted with a 40 BAF prism, then this plot represents (6 trees x 40 BAF) 240 square feet per acre of BA. This demonstrates the first reason for using BA, that is, measuring BA in the field is very easy.

See "Basal area...the why" for continued discussion of the value of basal area.

Trees per acre...

If, in addition to counting the number of "in" trees on a plot, the diameters of each "in" tree are also measured, then the number of trees per acre can be calculated. In fact, the number of trees per acre, BA and the "average" diameter form three legs of a triangle and, if any two are known the third can be calculated. For example, a 12 inch diameter tree contains 0.785 square feet of BA (122 x .005454). If this is one of our six "in" trees on the plot, then it also represents 40 square feet of BA per acre. If we divide the actual BA of the tree (0.785) into the 40 square feet per acre represented by the tree, we obtain the number of trees per acre that this one "in" tree represents. Our example "in" tree represents (40/.785) 51 trees per acre. If another "in" tree were 15 inches, it would represent [40/(.005454 x DBH^2)] 32.6 trees per acre. In symbols, the trees per acre (TPA) represented by each "in" tree is:

$TPA = BAF/BA = BAF/(.005454 \times DBH^2)$

If we perform similar calculations for each "in" tree on the plot and add up the trees per acre represented by each "in" tree, we get an estimate of the total number of trees per acre.

In contrast, if we know the total BA per acre and the total trees per acre, we can calculate an "average" diameter for the stand. In a stand with 240 square feet BA and 150 trees per acre, each tree contains "on the average" 240/150 = 1.6 square feet of BA. Using a little algebra on Formula 1 above, we find that:

$DBH^2 = BA/.005454$.

So, if we divide the average BA per tree by .005454, we get the square of the DBH. For our example, the "average" DBH is $\sqrt{(1.6/.005454)}$ = 17.1 inches. This "average" stand DBH is called the quadratic mean diameter. This is different from the arithmetic mean because it is calculated using squared diameters rather than actual diameters. The quadratic mean is usually slightly greater than the arithmetic mean. In forestry, it is the quadratic mean that is desired and not the arithmetic mean. This practice is thought to have arisen in Europe as a method for representing the tree of mean volume. ♦

"...the number of trees per acre, BA and the "average" diameter form three legs of a triangle and, if any two are known the third can be calculated."

Fred Martin, biometrician with FLMD, came to the DNR in 1987 from Port Blakely Tree Farms. Fred is interested in the application of quantitative methods to silvicultural problems.

THE TOOLBOX

Basal area...the why

by Fred Martin

Basal area, quadratic mean, DBH, and trees per acre (see "Basal area...what and how") can describe two important stand conditions - density and volume.

Density measures...

Either trees per acre or BA provide elementary measures of density. Most adequately stocked saw timber stands have at least 150 square feet of BA and some high volume stands have more than 350 square feet. Another density measure is to express the BA of a stand as a percent of some norm. This measure is called percent normal basal area (PNBA) and is used in DNR yield tables. The norm used is the BA found in well spaced, fully stocked stands of a given age. To use PNBA it is necessary to know stand age and then compare the stand BA to the normal BA for that age. Most westside DNR stands have a PNBA of 80. That is, our stands average 80% of the basal area of a fully stocked stand.

A more precise density measure than either BA or trees per acre is relative density (RD). This measure takes into account not only the total number of trees but also the size of the trees. The formula for computing RD is:

RD = BA/√DBH (where DBH is the quadratic mean diameter.)

Relative density is used by DNR as a measure of competition. Stands with RD less than 30 are considered in an open-grown condition with little inter-tree competition. Stands with RD greater than 50 are approaching full site occupancy and may need thinning. Stands exceeding a RD of 60 can be under excessive competitive stress and may not respond to thinning. When RD is between 30 and 50 stand growth is expected to be optimal.

Volume calculation...

Another use of BA is in computing volumes. If trees were perfect cylinders, we could compute volume using the standard formula for a cylinder:

VOL = π x r^2 x height = BA x HT.

Or if trees were perfect cones, volume could be calculated by:

VOL = 1/3π x r^2 x HT
= 1/3 x BA x HT.

Trees are not standard geometric shapes, but are instead highly variable. Even so, we have found a rule of thumb that works for a broad range of stands. If we use .35 as a cylindrical form factor (cylindrical form factor is the ratio of tree volume to the volume of a true cylinder; for a cone, form factor is 1/3) we can compute individual cubic foot tree volume by:

VOL = .35π x r^2 x HT
= .35 x BA x HT
(where HT is tree height.)

For a whole stand, cubic foot volume is the product of the form factor (.35) times the product of total stand BA and average stand height. In many even-aged stands tree height varies little among crown classes and can be readily estimated. Board foot Scribner (BFS) volumes can be calculated using board foot to cubic foot conversion ratios obtained from yield tables. For western Washington stands less than 100 feet in height, a conversion of three board feet per cubic foot provides a good approximation of BFS volume. Approximate BFS in a stand 75 feet tall with 120 square feet BA is:

BFS ~ .35 x 120 x 75 x 3 = 9,450

For stands between 100 and 150 feet, a BFS to cubic foot ratio of four is used and for stands greater than 150 feet the ratio is five.

With a little extra effort, BA and diameter provide the raw materials to compute a number of stand characteristics. These measures are more valuable in stand management decisions than just stand volume. ♦

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Blacktails and timber

A region perspective

by Mark Morrow, NW Region

Foresters in the Northwest Region are finding that good stewardship of the land often means finding suitable solutions for wildlife. In the woods just east of Darrington in northeast Snohomish County, part of that emphasis is on the blacktail deer.

Working closely with Department of Wildlife (WDW) biologists, Northwest Region foresters John Keller and Doug Lancaster are setting up future timber sales with an eye toward minimizing any negative impacts on the blacktail.

Keller and Lancaster learned that the blacktail use the deep valley north of Whitehorse Mountain for winter habitat when heavy snows make life nearly impossible at higher elevations. The valley is typical of terrain often found in eastern Washington, with high ridges surrounding it on three sides. The deer have no other easy way out of the high country for winter shelter and feeding purposes other than through the Darrington flats.

With that in mind, Keller and Lancaster have designed timber sales so that logging roads in this forested drainage area are closed for four months from December through March. This will ensure that the deer have several months of undisturbed access to the lower reaches of the valley.

Northwest Region foresters also are using results of hiding cover research. Some studies suggest that blacktail deer prefer not to travel more than 600 feet from the shelter of the trees. As a result, the upcoming Furland Flat and Kirk sales near Darrington are designed so that deer never have to travel more than 600 feet from any spot in a clearcut to reach hiding cover.

Region foresters and WDW biologists are hailing the plan as a good management strategy that balances the needs of a viable timber industry with those of wildlife. ♦

Mark Morrow is the public information officer in NW. Mark, a newcomer to DNR, joins us from the Department of Ecology.

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