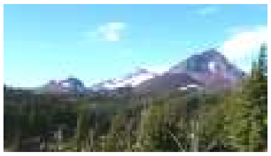

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Defining, Identifying, and Protecting Old-Growth Trees

By Mike Dubrasich

In order to solve our current forest crisis and protect our old-growth, it is useful to understand what old-growth trees are and how to identify them in the field.

At first blush this may seem to be a simple problem, but it is not, and much confusion and debate abounds over the issue. Old-growth trees are "old," but how old does a tree have to be to qualify as "old-growth"? And what is the difference between an individual old-growth tree and an old-growth stand of trees? Why does it matter?

Some rather sophisticated understanding of forest development is required to get at the root of these questions.

Frequent Fire and Multicohortedness

As we have discussed at SOS Forests numerous times, so-called old growth stands are actually multicohort, meaning separate and distinct age classes of trees coexist in the same stand. Typically the older cohort consists of trees that arose in the frequent fire era, while the younger cohort of trees arose after the frequent fire era ended.

The frequent fire era is more properly termed the anthropogenic fire era -- the last 6,000 to 12,000 years during which the indigenous residents managed landscapes with frequent, seasonal, deliberate burning.

That deliberate burning gave rise to an anthropogenic mosaic. The fires set by human beings may have sometimes been accidental, but by and large the fires were set intentionally to modify the vegetation for purposes of human survival. Carefully timed and located burning was used by the First Residents to develop and maintain berry patches, for instance. Some of those "patches" covered thousands or even tens of thousands of acres, so the word "patch" is an understatement in this case.

Deliberate burning also gave rise to oak and conifer savannas that covered millions of acres. Every year (or two or three) the inhabitants set the prairie grasses on fire. The fires were light-burning, but they killed most of the tree seedlings that might have been present.

Across the West, and in other regions of North and South America, trees readily establish themselves. But frequent anthropogenic fire favors grasses, not trees. Historically, only a very few seedlings survived the frequent fires. Perhaps one seedling per acre every 20 to 40 years survived the repeated burning and grew to a fire-resilient size. Over time, 5 to 25 large trees per acre comprised the oak and conifer savannas. Beneath the trees, grasses and other prairie plants dominated the "understory."

Those trees, now the older cohort, have the following characteristics:

* **Open-grown**. Wide growth rings near the pith, low height-diameter ratios, large limbs or evidence of large limbs on the lower bole, are all indicators of open-grown conditions. Older cohort trees were not stand-grown trees -- they were savanna-grown trees that had little or no tree-to-tree competition.

* **Persistence**. The old cohort trees persisted for centuries, reaching ages in excess of 500 years.

* **Fire scars**, indicating frequent fires, 1 to 3 years apart. Another way to state that is fires covered 33 to 100% of the landscape every year. That frequency and areal extent

is proof that the fires were anthropogenic, because lightning ignitions are too infrequent and too limited in spread.

* **Uneven-aged distribution**. Across any large acreage, older cohort trees are generally quite diverse in their ages.

The indigenous inhabitants suffered terrible population declines over the last 500 years, primarily due to introduced Old World diseases. Anthropogenic fires in Oregon and much of the West lessened in number and frequency, until they stopped entirely in the late 1800's.

In the absence of anthropogenic fire, a second cohort of trees has arisen in dense thickets of 500 to 1,000 trees per acre (or more). Second cohort trees are stand-grown with narrow rings near the pith, high height-diameter ratios, small limbs, no fire scars, and more or less even-aged distributions. Second cohort trees do not persist because stand-replacing fires are the norm in the fuel-laden stands.

Very often the cohorts are mixed together in the same stands. To clarify, an "old-growth stand" is a stand that contains some old-growth trees. But most of the trees in old-growth stands are not old at all! In fact, typically over 95 percent of the trees in so-called old-growth stands are younger trees that seeded in after the frequent fire era ended.

True old-growth trees became established prior to the end of the frequent (anthropogenic) fires, which occurred 100 to 200 years ago (or longer), depending on the landscape in question. Second cohort trees (young growth or second growth) are less than 100 to 200 years old.

Stand-replacing fires have reached a crisis level. Multicohort stands are burning up in megafires, the size and destructive intensity of which are widely recognized as a-historical and increasing every year. Over the last 10 years vast tracts of multicohort forests have been incinerated in the largest fires in state history in every state in the West including Oregon.

That is one reason why understanding forest development and what is and is not old-growth is critical. The older cohort trees are dying. If we do not comprehend what old-growth trees are, and how they got there in the first place, we cannot protect, maintain, or perpetuate them.

For more discussion on multicohort forest development, see:

http://westinstenv.org/sosf/2008/05/27/the-genesis-of-old-growth-forests-part-3/

http://westinstenv.org/sosf/2008/07/08/old-growth-trees-vs-old-growth-stands/

http://westinstenv.org/sosf/2008/07/08/the-mystery-of-the-older-cohort/

http://www.sosforests.com/?p=38

Distinguishing Between the Cohorts

Fourteen years ago I co-wrote, with Dr. John Tappeiner of Oregon State University, an unpublished paper entitled "**Stand development of multicohort stands in southwest Oregon**". Some excerpts:

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Abstract

Stand development of five structurally complex forest stands in southwest Oregon was studied by identifying cohort membership of the trees. Mixed conifer and conifer/hardwood stands across a range of sites were sampled for tree ages, tree characteristics, and fire history. Logistic regression analysis was used to categorize trees as members of the first cohort, those trees arising during the frequent fire era, or as members of the second cohort, those trees arising following the most recent fire. In the five stands the date of the most recent fire ranged from 75 to 134 years ago. First cohort trees carried scars from many fires, second cohort trees were unscarred by fire. The stands were backdated using increment core data and tree positions to create stand statistics for the stands fifty years prior to measurement. Then fifty year changes in numbers of trees and basal area were calculated for each cohort in each stand. First cohorts showed dramatic declines in both categories, while second cohorts showed equally dramatic increases. All five stands were used by northern spotted owls, (*Strix occidentalis caurina*), probably in part because the multicohort stand structures provide suitable habitat. As first cohort trees continue to decline and die, and smaller, more densely stocked second cohort trees predominate, these stands may become less suitable for owl habitat.

Introduction

Many southwest Oregon forests are composed of complex, multi-aged mixtures of conifers and hardwoods. Frequently such stands provide nesting, roosting, or foraging habitat for northern spotted owls (*Strix occidentalis caurina*). In the past, fires have had a major impact on these forests. Fires in southwest Oregon forests may sometimes be stand-replacing, but most fires prior to the 20th century did not eliminate all live trees. Prior to the 19th Century, Native American indigenous residents may have set fires every 1 to 3 years in Oregon interior valleys (Robbins and Wolf, 1993). These frequent fires helped to maintain prairies and savannas in the lowlands, and gave rise to upslope woodlands and forests that were relatively resistant to stand replacement disturbances (Douglas, 1914, Habeck, 1961, Morris, 1934). Following elimination of Native American burning and subsequent suppression of lightning fires, regeneration led to multi-aged, vertically diverse structures in current stands, quite possibly improving habitat for northern spotted owls.

A forest cohort is "a group of trees regenerating after a single disturbance", (Oliver and Larson, 1996). Trees may regenerate rapidly following a fire or blowdown, and/or continue to invade the site for many decades, leading to various possible age and size distributions within a single cohort. If living trees remain from the pre-disturbance stand, post-disturbance regeneration may be classed as a second cohort.

In this study we categorized trees that became established in the frequent fire era as the "first cohort". We categorized regeneration following elimination of fire as the "second cohort". ...

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If we realize that the older cohort trees arose during the anthropogenic fire era, and that they have the characteristics of open-grown trees, and that second cohort trees have quite different morphological characteristics, it is easy to distinguish between the cohorts.

In the aforementioned paper I reported my development of a logistic regression model for identifying cohort membership. Numerous variables were tested. The best model was found to be:

$$\ln(y/1-y) = a_1 + a_2(DBH) + a_3(RAD) + a_4(CR)$$

where DBH is diameter at breast height, RAD is latest 5-year radial growth in inches, CR is crown ratio percent, and the best values of the coefficients (a_1 ... a_4) were calculated through the use of general linear equations. Sampled trees with values of y/1-y greater than 1 were assigned to the older cohort, and trees with values of y/1-y less than 1 were assigned to the younger cohort.

The model successfully identified cohort membership for 96 percent of the trees sampled. It is an easy model to apply, because the measurements required are relatively quickly obtained.

The 4 percent of the trees misidentified were either small suppressed older trees or large open-grown younger trees. In those few cases, misidentification is not critical. In a restoration forestry operation designed to save the old-growth, it would mean that a very few small yet older trees might be accidentally removed, and some large yet younger cohort trees accidentally left. That would not affect the general goal of preserving trees with old-growth characteristics.

Furthermore, after a few hours of application of the model in the field, the user develops an eye for the cohortedness of the stand. It becomes fairly obvious which trees are old and which are young, and the measurements need to be applied only to borderline trees. Or not, because a borderline tree could and should be left standing anyway, whether it is truly an older cohort tree or not.

Restoration Forestry and Saving the Old-growth

The virtue of thinning out most of the younger cohort is also pretty obvious. If the fuel loadings are left at a-historically high levels, then stand-replacing fires will occur (have and are occurring) in the not-too-distant future. All the trees will be killed, old-growth and second growth alike. Reducing the fuel loading to the historically resilient levels is insurance against total stand destruction.

If we want to save old-growth trees, we need to reestablish the forest development pathways that allow trees to persist and reach old ages. Historically, those pathways did **not** include stand-replacing fire. They **did** include frequent seasonal, light-burning, anthropogenic fires.

For the last 20 years or so, we have suffered a crisis of megafires, the destruction of old-growth, the imposition of a-historical stand-replacing fires, the collapse of endangered species populations (namely spotted owls which are associated with multicohort forests), an avalanche of junk forest science (regrettably), failed forest policies based on that junk science (ditto), the near dissolution of our forestry institutions, economic catastrophe for the entire region, the perversion of the USFS mission, and the general decline of forest stewardship. Our priceless heritage forests are dying from a-historical competition, insect infestations, and catastrophic fires

Now, after 20 years of unremitting (and increasing) forest disasters, we seem to be still groping for answers.

There is a solution, however, and it is called *restoration forestry* [here]. Coined by Dr. Thomas M. Bonnicksen [here, here], restoration forestry is the art and science of returning forests to heritage conditions of fire-resilient, open and park-like conditions.

http://westinstenv.org/sosf/2008/10/29/restoration-forestry/

http://westinstenv.org/histwl/2007/11/11/america%E2%80%99s-ancient-forests/

http://westinstenv.org/resfor/2007/11/13/protecting-communities-and-savings-forests/

Our multicohort forests of today are often crowded thickets, overly laden with fuels, and prone to catastrophic fires. Restoration forestry removes the excess fuels by thinning out much of the second cohort and putting forests back into their historic condition, as they existed in the frequent fire era.

Restoration forestry is a silvicultural system, broadly speaking, but it is not tree farming. The objectives of restoration forestry include maintenance and enhancement of multi-aged, low density stands with a predominance of older, fire-resilient trees. Those are forest goals, not tree farming goals, but they are silvicultural. Restoring historical conditions sustains forests by protecting them from total mortality canopy fires, by maintaining fire-resilient old-growth trees, and by enhancing the capacity of forests to grow trees to old ages.

Restoration is also a landscape-scale endeavor. Not only forests but also ancient anthropogenic prairies, fields, and savannas are desirable conditions to restore. The *anthropogenic mosaic* is a term I use to describe the historical (heritage) arrangement of vegetation types across the landscape.

Germane to this discussion, restoration forestry protects, maintains, and perpetuates old-growth trees. That is, thinning the second cohort protects true old-growth (first cohort) trees by reducing competition and the risk of catastrophic fire. Follow-up prescribed burning maintains low fuel loadings to keep fire risk at minimal levels. Provision for the gradual establishment of new trees over time allows new old-growth trees to develop.

Restoration forestry seeks to reestablish the development pathways that lead to old-growth. Simply abandoning our forests to the vagaries of Mother Nature will not suffice. That's not how our old-growth came to be. There has been a significant human influence (stewardship) going on for thousands of years in the form of deliberate, intentional anthropogenic fire. Historical human influences created the conditions whereby individual trees persisted and grew to extremely old ages.

It is important to realize that old age is not a biological imperative for tree species. No tree species requires the survival of individual trees for hundreds of years to successfully reproduce. All tree species can and do reach seed-bearing capacity at ages less than 30 years. Old-growth trees are somewhat of an aberration, a fluke, an abnormal condition, in that great ages are not necessary for perpetuation of the species.

Some old-growth trees achieve huge sizes as well as ages. Trees 10, 12 and even 25 feet in diameter were present when pioneer botanists first explored the West. Fossil trees that size are not found in coal seams or petrified "forests."

That so many plant and animal species are found associated with old-growth (some observers count over 1,000 species found in old-growth stands) is testament to the resilience and adaptability of life, not to fragile dependencies. There are a lot of myths about forests prevalent today.

Some Recommendations for Saving Old-Growth

If we (society) wish to protect, maintain, and perpetuate old-growth, here are some suggestions (recommendations) to accomplish that:

1. Establish restoration forestry programs at every forestry college and forest research center.

2. Hire experts in forest development pathway analysis, forest history, historical landscape geography, ethno-ecology, historical anthropology, historical wildlife ecology, and especially restoration forestry, to teach and do research that explores the details of the historical human impacts and influences on our forests and landscapes.

3. Produce symposia, workshops, websites, journals, and newsletters focused on restoration forestry and associated disciplines to transfer findings to a wider audience.

4. Reconfigure the missions of our land management agencies, federal and state, to include restoration forestry.

5. Implement restoration forestry planning and teatments on a landscape-scale across the region.

Conclusions

In summary, or perhaps as postscript, here are some more extracts from the as yet unpublished **Stand development of multicohort stands in southwest Oregon,** 1996, by Michael E. Dubrasich and John Tappeiner:

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> **Discussion**
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> Fire has played an important role in the development of these stands. Frequent anthropogenic fires apparently maintained an uneven-aged, sparsely stocked first cohort for hundreds (perhaps thousands) of years. The range in ages of first cohort trees, and their low densities, is likely the result of frequent, low-intensity fires that maintained open stands. None of the stands showed evidence of stand replacement fires, such as a well-stocked, even-aged first cohort might indicate.
>
> In the absence of fire over the last 100+ years, there has been a dramatic establishment of a second cohort of conifers and hardwoods in all five stands. Today the second cohorts comprise 29 to 91 percent of the total basal area in these stands. First cohort trees are undoubtedly undergoing high levels of competition from the second cohorts, and in conjunction with insects, fungal pathogens, and periodic drought, experiencing lowered growth rates and increased mortality. Species compositions are shifting as large pines and Douglas-firs in the first cohorts continue to die. Shade-

tolerant conifers and hardwoods are the principal species in the second cohorts. Ironically, these stands are becoming younger and smaller with time as first cohort trees are replaced by second cohort trees.

Most Cohort I trees grew rapidly (2 to 8 rings per inch) during their first 100 years. Wide growth rings and large limb indicators close to the ground suggest that most first cohort trees were probably open-in their youth. Tappeiner et al. (1997) found that, in Oregon coastal forests, large, old-growth Douglas-fir trees also grew at low densities during their first 100 years. Second cohort annual diameter increments were not so rapid at young ages. Second cohort trees appear to have grown in a different competitive environment than first cohort trees, one that included stress from many neighboring and overtopping trees of both cohorts.

Despite dissimilar species compositions, all five stands were northern spotted owl nesting stands at time of measurement. Vertically extended canopies, with crowns distributed across a wide range of heights, may have contributed to selection of these stands by owls, (Dubrasich et al., 1997). All five stands also had large and tall snags and large woody debris generated from increased first cohort mortality. It is likely that these stands developed into spotted owl habitat as the second cohorts became established. However, these stands may not remain preferred habitat as the larger trees continue their rapid decline, and forest structures shift to smaller, denser size classes. In addition, the increasing density of the second cohorts has made these stands more susceptible to stand replacing fires.

Conclusions

Recognizing two cohorts in these stands led to many useful insights. Employing distinct cohort distributions instead of indistinct age-diameter relationships simplified stand analysis. The wide ranges of diameters at older ages in Figures l(a) to 1(e) are consistent with findings by other researchers that diameter distributions can mask age distributions in multicohort forests. Examination of stand development using two objectively identified cohorts, differentiated by easily measured tree characteristics, helped to reveal the actual developmental processes.

It is our observation that multicohort stands are common in southwest Oregon. Future management of these and similar stands should recognize the dynamic changes occurring, and develop multicohort silvicultural strategies for retaining and replacing large trees, an important component of current forest structure. Without management it appears that these stands will lose their large tree component over the next few decades. Further understanding of multicohort stand dynamics should also be useful in predicting future growth and development of stands subject to "permanent shelterwood" and "green tree retention" silviculture.

A greater understanding of forest conditions prior to 1800 will help in preparation of effective management strategies for these forests. More backdating of existing multicohort stands is necessary to accomplish this goal, and the sooner such efforts begin, the more the evidence of past conditions will be obtainable. Continued decline and mortality of the first cohort, through timber harvest, fire, or simply competition from the second cohort, may lead to loss of such evidence.

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