The Forest Steward's Journal

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The MISSION of the Forest Stewardship Foundation is to "educate and inform landowners, natural resource professionals and the general public about the science and ecology of forest lands, the many values derived from forested lands and the principles of sustainable forest land development." DISCLAIMER: As in the past, we again advise that this information is submitted for your interest only. The Foundation's mission, as indicated above, is to "educate and inform", not to advocate or persuade. The Foundation takes no position either endorsing or opposing, approving or disapproving, any of the assertions or arguments in the contributed information.

Montana Climate Change

Climatic Influences on Forests Across Montana – Strategies for Conservation and Functional Retention

Peter F. Kolb (PhD) MSU Extension Forestry Specialist

Part 2

(Ed. Note: Part 1 of Dr. Kolb's two-part series was published in the Fall 2012 edition of the Montana Forest Stewardship Journal.)

Current Forest Conditions

The climatic changes that have been occurring across the northwestern United States have put Montana forests into a state of transition. Although all forested lands are subjected to these climatic influences, most often manifested as wildfires, bark beetle, and defoliator outbreaks (Figure 6), the most severely impacted areas are usually found on federally managed lands. National Forests experienced the least stand-replacing disturbance of any ownership over the past century with some records indicating only 20% of this land base had an active timber harvesting program (U.S. Forest Service records) and all lands active fire suppression.

Alternatively, harvesting on private lands was extensive and most likely more than 75% of all private lands across Montana have been logged at some level. Railroad and timber industry lands, accounting for less than 10% of Montana forests, produced more than 50% of the state harvest over the more recent several decades and much of this land is currently in a forest regeneration phase (young trees). Family owned tracts of private land account

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When is Winter Really Winter? How Can We React?

Special to the Montana Forest Stewardship Foundation Journal By Floyd Quiram, Whitefish, Montana

"The new winter" or just another wet season? How the traditional winter timber harvest might need a makeover.

If you are a timberland owner in Montana how often have you heard or even said yourself that a "winter harvest in my woodlot will be the best time to cut some trees as there will be very little impact to my forest and it will look like nothing happened in the spring." Is this still a true statement? Will weather changes demand a different strategy? Should we not worry about weather changes? Maybe last year was just a blip. But what if it wasn't? Let's discuss some of these questions.

A most common conversation starter in Montana is probably the weather. And if you are a "dirt under the finger nails gal or guy" in Montana, i.e. working outside in a natural resources industry, it's almost a sure bet that weather is a major player in determining your successes and failures.

The four distinct seasons we experience in Montana are wonderful and mostly welcomed by everyone. Almost. But

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From The Chair

By Ed Levert, Chair, Montana Forest Stewardship Foundation

2013 has been an exciting year for the Forest Stewardship Foundation. First of all we signed a Memorandum Of Understanding with the Montana Forest Stewardship Steering Committee (MFSSC) to work cooperatively to use our ability as a nonprofit organization to help bring needed educational programs to forest landowners. In the past this has consisted primarily in fundraising for the forest stewardship workshop program along with a host of other related educational efforts that were not being covered by agency, university or other groups.

What this really means is that through our involvement with the MFSSC we will closely coordinate in determining forestry educational needs and then decide who is responsible for the delivery of that information. The Foundation will in particular look at where we might be able to team up with other organizations. In the past we have been able to partner with organizations like the Montana Association of Land Trusts to help bring numerous conservation easement workshops across the state. If an educational need is identified by the MFSSC that the Foundation feels has sufficient appeal we will attempt to raise funds through grants. Currently MSU Extension Forestry does some grant writing, but their time is limited.

In April we co-sponsored the fourth annual Montana Forest Landowner Conference in Helena with Northwest Management, Inc. and the Society of American Foresters. Impressively, our attendance more than doubled to over 200. Although we were initially a little hesitant about combining the landowners and foresters, we found that both groups benefited from the experience. We hope that we can continue this relationship into the future.

We continue to deliver the Forest Stewards Journal twice a year, which we hope provides valuable and helpful information to the over 1,400 that receive it.

Our most recent endeavor has been involvement in the Foys Lake Community Forest in Kalispell (see the Fall 2012 edition of The Journal for more details). Although we are just getting started with this community project, we hope to play a constructive role in the effort to provide forestry education to the citizens of the area.

In summary, the Foundation is doing very well. Our membership has reached an all time high, we have a great board and we all remain enthusiastic about our future role with forest landowner education.

We hope you enjoy this edition of the Journal. Please feel free to pass along any thoughts or suggestions for future Journal articles.

2013 Montana Forest Landowner/SAF Conference a Success

by Ed Levert, Montana Forest Stewardship Foundation

This year's conference was titled Managing Montana Forests for Resiliency. Over 200 of you attended, but if you didn't, you missed out on a great opportunity. The conference started out with our keynote speaker, Governor Steve Bullock, addressing the current status of the forest products industry and forest management in Montana.

Many of the conference presentations are available on Northwest Management, Inc.'s website: www.consulting-foresters.com. Click on the "Events" tab at the top of the page (near center) and then scroll down the left column of the next page until you find *Helena Montana Landowner SAF Joint Conference Presentations 2013*. Click on the link to get to the presentations provided by speakers who were able to share their information.

The morning session included:

<u>Conservation Easements</u>:

Glenn Marx, executive director of the Montana Association of Land Trusts, gave a summary on conservation easements, which was followed by speakers from two conservation easement organizations, Mark Schiltz of the Montana Land Reliance and Brad Bauer of The Nature Conservancy, who spoke about their programs. These presentations were followed by two forest landowners with conservation easements with conservation easements on their properties: Tom Jones from the wet, productive Troy area in northwest Montana and Bette Lowery from the arid forestlands of eastern Montana near Roundup. They spoke about forest management options within conservation easements and the cooperation between the landowner and the land trust.

<u>Managing for Resilient Soils:</u>

Jay Brooker, a resource soil scientist for the Natural Resource Conservation Service

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(NRCS), gave a presentation on using the vast resources available on their new website called the Web Soil Survey. Soil productivity information, resource limitations, soil maps and an abundance of additional information helpful to forest landowners are all available on the website.

MSU Extension Forestry forester Peter Kolb covered the complex issue of how to keep forest soils productive. Peter's presentation included discussions on nutrient availability and requirements of trees, soil texture, mycorrhizae development on tree roots, slash decomposition, fire effects, and much more. As always Peter went far and above in presenting state of the art information, that is both scientific and practical for landowners.

Silvicultural Approaches to Ecological Resiliency

Retired University of Montana (UM) professor Carl Fiedler and John Goodburn, Associate Professor at the UM, both presented silvicultural strategies for dealing with drought and other adverse environmental conditions. Carl provided information about the extensive research project results from Lubrecht Experimental Forest. John explained some of the details related to a more landscape approach to forest management.

Luncheon speaker

Jamie Jonkel, Wildlife Conflict Specialist, Montana Fish, Wildlife & Parks, discussed grizzly bear management and monitoring, including a spellbinding series of bear photos, anecdotes, GPS tracking information and personal experiences.

Resilient Landscapes for Wildlife

Rick Northrup, Wildlife Habitat Bureau Chief, with Montana Fish, Wildlife & Parks, described recently completed and planned forest management activities on Montana's Wildlife Management Areas. These projects are designed to improve wildlife habitat and reduce wildfire hazards for neighboring properties.

Carly Lewis, Wildlife Technician with the U.S. Forest Service, described what monitoring efforts are telling biologists about the current population status of wolverine, lynx and fisher populations in the Seeley/Swan area of western Montana. She also described the habitat requirements of these species to help landowners better understand how forests can be managed to provide habitat required by each species.

Managing Forests for Social Resiliency

Jim Burchfield, Dean of the U of M College of Forestry & Conservation, gave an entertaining presentation on the need for community diversity in predominantly timber communities in the Northwest. Jim stressed that communities that have been devastated by the loss of the timber industry may rise again, but there is no going back to the good old days.

All Smiles

Presenters at the Montana Forest Landowner/SAF Conference included (left to right) Brad Bauer, Bette Lowery, Tom Jones and Mark Schiltz. These presenters were part of the morning panel on conservation easements and forest management. The conference was very well attended and drew an excellent diversity of speakers and presenters. COURTESY PHOTO

Vincent Corrao, President of Northwest Management, Inc. shared his experiences in dealing with multiple ownerships in north Idaho and northeast Washington. The "Anchor Forest" concept has been used predominantly on tribal lands, but the concept of a joint management plan, including manufacturing facilities, promises economic and social sustainability to smaller diverse ownerships.

Economic Resilience of Forests

Todd Morgan, Bureau of Business & Economic Research (UM), gave an update on the status of Montana forest products, markets and infrastructure. The good news is that the economy is improving and so is the timber industry.

Arnie Didier of the Forest Business Network (FBN) emphasized the significance of Montana's wood products industry. He used the recent Small Wood Conference sponsored by FBN as an example of the markets that are interested in the Inland Empire wood supply and specifically the tour of Montana forests by Asian business interests following the conference.

Conference sponsors the Montana Forest Stewardship Foundation, Society of American Foresters and Northwest Management extend a sincere thank you to all the conference presenters for their excellent presentations.

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not quite. The weather deals us quite a different hand of cards to play with each season as forest owners or logging contractors. It’s too hot, it’s too cold, it’s too dry and dusty, or it’s too wet and muddy, on and on, depending on where and what your project might be and when you plan to do it.

So without getting into why the weather seems to be different let us just acknowledge that we are seeing some weather changes in our little “eye blink of time” here and that this should cause us to consider how we might adjust our actions (methods) so that we can carry on with business as usual? Well there is oxymoron if there ever was one. Business as usual?

Let’s back up a bit to October-November-December of 2012 (really the changes started well before that but those months will serve the purpose of this writing quite well). I will need to acknowledge here that all weather is not the same in every locale at the same time so this story may not have been your experience. Lucky you.

Floyd (right) with landowner and Forest Stewardship graduate Charles Zook. Photo was taken at a logging job on Glen Lake near Eureka. PHOTO COURTESY OF ED LEVERT

The early fall of 2012 was typical in the North Fork of the Flathead. September and the first half of October were wow “Indian Summer Days.” But then it was not. The first snow was about ten inches in mid October followed by cold days – we were disgusted it was winter – but our haul road was hard and frozen and conditions in harvest unit were excellent also. Was there to be no mud season this fall? Three days later it rained nearly all the snow away and we had water everywhere. This snow and rain event happened three times in varying amounts and by Nov. 5 we were in total shutdown. The soils were wet! More snow – more rain – no cold. There were no consistent freezing temperatures to allow the ground to freeze.

My past experience almost always guaranteed a Thanksgiving freeze up. Almost always. But not now. Not this year. Maybe not next year. There wasn’t much snow now to protect the soil and vegetation from disturbance. Adequate deep snow conditions – which allowed us to start up again – didn’t materialize until the third of January 2013. Yet even then the soil couldn’t or wouldn’t freeze. Water was running under the snow in low spots. We continued to hunt for drier spots to work. We focused on working in the deepest snow depths that finally did accumulate to 30 inches. For the remainder of our logging season – which ended on Feb. 26 with traditional “spring break up conditions” – we had been able to work with the thought that “every day might be our last.”

So, if this sounds like conditions you encountered you know the havoc it can cause to your “winter timber harvest.” Poor operating conditions can produce adverse effects to on the ground results: rutting, compaction, soil displacement, changes to normal skid trail pattern and use, building or using more or less roads than you wanted and on and on. Adapting to poor conditions and the mitigation of those conditions can also change the economics of the harvest for both the landowner and logging contractor.

So what might be some operating options that could allow your “less than winter” harvest to proceed. Let’s explore three options.

Option One: If you are lucky enough to have some freezing conditions and some snow cover, pretrailing, (meaning establishing trails ahead and then letting them freeze down) before the final cut of trees between trails can be an option. This initial light “trail only harvest” will pack the snow down, allow some cold to penetrate and with luck you can “freeze up” the trail. This is similar to what happens when you continually drive on your driveway and the depth of the frost increases over time.

Option Two: Or can you get some slash (top limbs and non commercial wood) back out on the skid trail from the landing? A grapple skidder works well here. Or maybe you can saw limbs and tops off the whole trees in strategic spots on the

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trail? This brush-slash option on a trail can be very effective but does have at least two negatives. One being that it has a dollar cost. Second may be the thought of some landowners that those skid trails may appear messy with that trashy biomass in plain sight when bare ground conditions arrive. These trails could be piled and burned or masticated later to reduce that visual impact. But “down and woody” isn’t all bad and substantial moisture will be retained well into the summer on those trail “slash mats.” I am a big fan of using slash even before anticipated negative conditions can develop during wet conditions.

Option Three: Wider skid trail spacing. This can be helpful as it simply reduces the amount of area exposed to the skidding process. Under certain conditions, however, these wider spaced trails may not be the answer as they are going to have more fiber (trees) as we go further away to “pack” the trees to the trail with a feller buncher. There can be negative effects as more or bigger skid payloads are taken to the landing or roadside. This will almost dictate hauling slash back from the landing to form a slash mat immediately.

These three options just tweak the traditional whole skidding harvest. What else is out there that might get the job done?

Two other options to assist timber harvest are available. How about cut-to-length? This might be an option if a contractor is available. This operational method can be very useful as it hauls processed and measured logs out of the woods versus the whole tree skidding options where one end of the tree or log drags on the ground. Cut to length is likely to cost more, but it may prove a good wet weather option.

Cable or line skidding could be a solution also. It is probably more expensive, but certainly would allow the work to go forward if terrain, topography and roads are available to complement this solution. This operation entails moving trees or logs by cable to a corridor (trail) where they are then winched up to a roadside landing. This method may be difficult to schedule contractors, as they typically are not as numerous as ground skidding operations.

Will any or all of the aforementioned remedies solve those unanticipated…“I’ve never seen this condition before?” Maybe. Maybe not. All operational methods bring positive and negative attributes.

It is possible that any single option will work for you, but using several together may improve your odds of a successful timber harvest with minimal impacts.

And don’t forget… keep those BMPs (Best Management Practices) in good working condition both in the woods and on the haul roads!

Should you join the Forest Stewardship Foundation?

By joining us you become a part of a small but energetic organization that gets things done. For nearly twenty years we have been involved as a non-profit organization in promoting our mission of providing resource education to forest landowners, natural resource professionals and the general public.

We have not raised our $25 membership fee for the last twenty years and our membership is now at 110. You can do the math and recognize that your membership and contributions mean a great deal to our continuing success. Please note the membership application envelope attached and join our organization.

Thank you very much for your support.

"Climate" Continued From Page 1

for 19% of all forested land and provided 30% of total annual timber harvest across the past decades. Family forest harvesting practices have been highly variable as determined by individual management goals, leaving a mosaic of forest species and age classes, including groves of ancient trees that landowners valued and wished to protect. Thus some private lands still support original forest and other lands have been harvested at varying levels including conversion of forest to pasture. During more recent decades "thinning" has been the most prevalent practice on family forestlands as a promoted practice to reduce wildfire risk and increase forest vigor against insect attack.

Another example is Tribal forestry, which is also considered "private land". Because of their unique status, tribal forestry has consisted of a more traditional forestry approach where a sustained yield mosaic of different harvesting techniques ranging among clearcut, seedtree, shelterwood cuts, and thinning practices was implemented. Although originally administered by Bureau of Indian Affairs foresters who were utilizing classic forestry practices in concert with tribal needs and wishes at varying levels, most tribal lands these days are actively managed by tribal councils and foresters. Using a historic reference to forests provided by tribal elders, these forests remain very actively managed and harvested to provide for the many habitats, plants and wildlife that elders recall from times prior to forests reaching their current day densities. Both Tribal and family forestlands across Montana are being managed with some of the most progressive forest management philosophies and techniques available. These include quick responses to salvage recently killed trees as well as preventative harvesting to reduce densities of select tree species determined to be at high risk to insect attack of severe wildfire impacts.

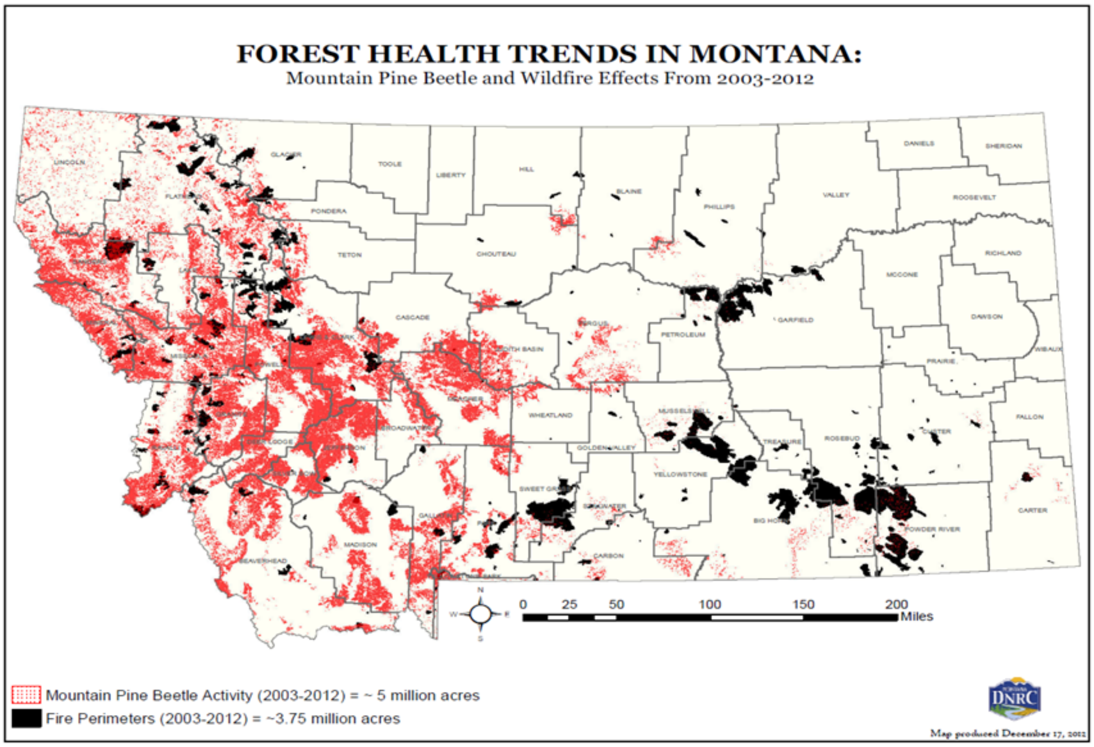

Figure 6 – statewide impact of wildfires and mountain pine beetle over past decade – does not include the 1.4 million acres that burned or the 700,000 acres of bark beetle impacted lands from 2000-2002.

To put the current forest condition into perspective with past forest management practices, an examination of A) research conducted on bark beetle biology, B)) climatic changes and other historical influences, and C) the bark beetle outbreaks Montana and other states are experiencing across the entire western portion of North America, can be considered a result of multiple ecological factors converging at the same time, most notably warmer winters, summer drought and expansive landscapes with tree species and age classes that are most susceptible to beetle attack. Beetle outbreaks, similar to wildfires, can be considered a natural phenomenon, perhaps having been exacerbated in certain situations by past human activities.

Alternatively, other human activities such as forest thinning and regeneration harvesting have also acted to reduce the expansiveness and severity of both wildfire and beetle activity. The former might be expansion of even-aged lodgepole pine forests enhanced by logging for mining timbers in the Helena and Butte regions at the turn of the century, or in the later case the extensive salvage logging that increased the age class mosaic within extensive lodgepole pine forests of the Kootenai National Forest during the mountain pine beetle outbreak in the late 1970s and 1980s. Management activities that were heavily criticized because of the often square clearcuts, large harvest volumes and extensive access networks, in part because they were perceived by emerging environmentalism as landscape degrading, today have proven to be among the most resilient to landscape level disturbances brought by recent severe wildfires and epidemic bark beetle activity. Although the original intent was to remove timber volume before it degraded and to maximize tree growth potential as outlined by classic forestry texts from Europe, chasing tree mortality also inadvertently caused human management to mimic to some extent the mosaic that insect and wildfires might naturally have created during milder fire seasons consistent with the climate of the mini-ice age. The biggest difference one might find between human caused management and the natural mosaic that historic disturbance processes created would be the

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geometric shapes of human surveying and thus harvest units versus the more irregular patterns created by wildfires acting on topographic and weather constraints. The end result has been the same, however, where mosaics of tree species and age classes, either natural or human created have proven to be much more resilient to the severe disturbances of today that are largely driven by milder winters, longer summers and the associated drought (Figure 7). It might also be noteworthy to point out that management practices that fell outside of what might be considered "natural ranges of variability" such as treating harvest units for excessive woody debris and reforesting with seral (pioneer) tree species that may have been lost from the landscape due to the longer term absence of stand replacing disturbances, also has helped prepare these landscapes for greater stresses associated with climatic variability. In some cases this added species diversity to the landscape and fuel reduction has caused both wildfire behavior and bark beetle infestations to vary more in severity and intensity thereby leaving behind a more functional forest ecosystem.

Figure 7. The difference between wildfire that burned through a homogeneous landscape of even aged lodgepole pine and subalpine fir on left, and wildfire that burned during similar circumstances but through a mosaic of different species and age classes created through management by previously harvests.

To be fair, a significant number of forest harvesting operations did not leave behind a more functional or resilient forest. The science of forest management and harvesting was in many cases focused only on harvesting the greatest volume and regrowing the fastest volume, sometimes resulting in overharvesting certain areas and reforesting with trees that were perceived to grow the fastest, and not with the best resilience. Much has been learned and it is important to utilize that knowledge to help moderate the natural "boom and bust" cycles that is more typical of natural processes than the "steady state" modern human society desires and in many cases needs. Thus past harvesting, where it occurred in the right combination of harvest unit sizes, timimg and mosaics, also promoted greater species diversity and forest resilience whereas many unmanaged areas converged into a similar density, species composition and age class distribution. An apt analogy is if the population of a city ages uniformly to the point where most people are over 65 years of age and of similar genetic background. It is much more susceptible to catastrophic failures.

Forest Conservation and Resilience

Active forest management practices can help forests of the Northern Rockies increase their resilience to large scale disturbances and adapt to the current and predicted climatic trends by using silivicultural practices specifically targeted to lessen the magnitude of drought, insect outbreaks and wildfires. Of these, managing for soil water retention is a key component (Figure 8). It is well established with numerous studies and empirical observations spanning the last century that trees with adequate water availability are less likely to die from fire related injuries, be attacked by insect pests, or even contribute to severe fire behavior because a high leaf moisture is more resistant to combustion.

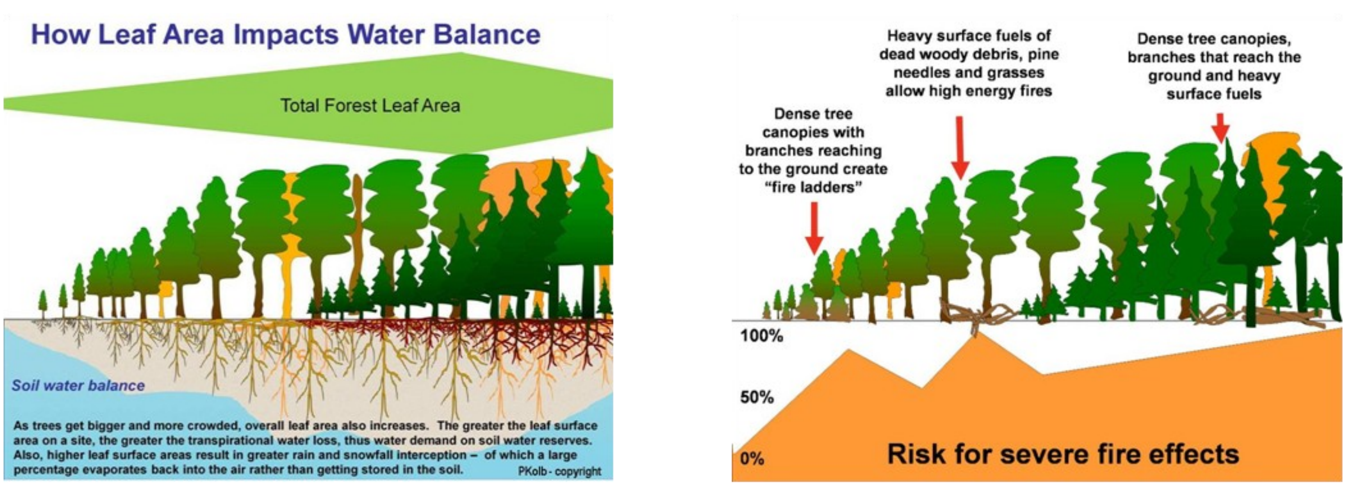

Figure 8. As a forest develops from establishing deep rooted pioneer (seral) species that are designed to reflect light and thereby shed heat, and changes to one of more shade tolerant (climax), shallow rooted and water consumptive species who's strategy is to acquire light, water and nutrients before it reaches seral species, a forests dynamics change dramatically. Denser trees result in more leaf area, which in turn loses more water through transpiration but also intercepts more rain and snow, allowing it to directly evaporate back into the air. This transition results in cumulative drought stress because dense forest requires more water, but by their very nature cause even less water to penetrate to the soil surface. The very nature of this process also promotes stand-replacing wildfires that in turn can recycle this entire process, that may occur over a century to a millennia based on the forest type. However, a very severe wildfire can also cause a forested ecosystem to cycle back past the pioneer tree phase to the moss and grass stage where tree seed sources and regeneration may be excluded for centuries.

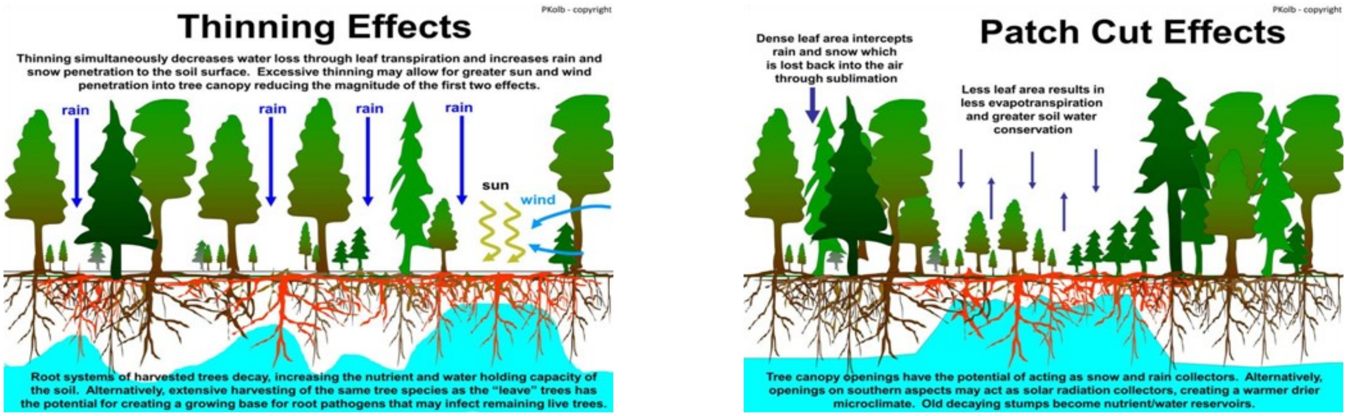

Figure 9. Diagram of the impacts of thinning (left) and patch cuts (right) on overall forest water balance and function. Thinning and patch cutting achieve the same objective of reducing overall leaf area and promoting greater hydrologic recharge from rain and snow. The only difference is how the trees are distributed where thinning promotes individual trees with an emphasis on existing or shade tolerant species and patch cutting promotes groups of trees and regenerates sun-tolerant pioneer species. Fine root turnover is the greatest source of soil organic matter and soil development as opposed to woody debris deposited on the soil surface, thus harvesting also adds to overall soil functionality by providing a dense source of decomposing roots that in turn allow for better soil water infiltration and soil water retention.

Drought stress is a function of water deposits through rain and snow, soil water holding capacity, and water loss through direct surface water evaporation, leaf transpiration and snow sublimation. Manipulating forest leaf area (tree density) is the only cultural practice though which the overall water deposit and utilization of a stand of trees can be influenced. In addition, the decomposing root system of harvested trees provides for better soil water infiltration and retention (Figure 9). Managing the density of trees, specifically reducing the total leaf area, can be very effective in mitigating the effect of drought by decreasing total leaf transpiration, reducing direct evaporation of water and snow that has been intercepted by tree canopies, increasing snowpack within trees and reducing sublimation and spring snowmelt by retaining adequate shade through residual tree spacing. Ultimately this requires that thinning/harvesting guidelines be established for each tree species and crown condition class along aspect and elevation gradients. To affect soil water balance tree stands need to be thinned to optimize precipitation through-fall, soil surface shading for snow retention, suppression of competing understory vegetation, and evapotranspirational needs of foliage. Not only does forest manipulation for water retention benefit trees, but as primary watershed forests also provide for regional stream flows and all of the ecosystem services those water sources provide. Climatic influences have been shown to have had a rather dramatic impact on major watersheds as examined by Leppi et al (2011), especially for pristine watershed that have been relatively unaffected by landscape management actions or water conservation such as contributing reservoirs (Table 1).

Table 1 Comparison of gauging site groupings in the Central Rockies. The analysis indicates that the largest decreases in discharge are occurring in the pristine and un-regulated sites over the 1950–2008 period

Site classification	Number of sites	Number of significant trends		Change per record	
		Decreasing	Increasing	Mean	Median
Pristine	16	8	0	−22.87%	−22.15%
Un-regulated	49	13	2	−18.73%	−21.58%
Regulated	88	14	11	−9.44%	−11.84%

From Leppi et al 2011

Each tree species with its unique canopy architecture and physiological requirements as well as each forested landscape may need to be treated differently. Tree species with thick bark and deep root systems and thus adapted to survive fires, should have wider spacing recommendations to keep wildfires on the surface and avoid conditions for crown fires. An example would be ponderosa pine, which has high survival probabilities from grass and forb fires. Species adapted to reseed after disturbances such as fire, including lodgepole pine, larch and to a lesser degree Douglas-fir, should have narrower spacing guidelines for thinning that suppresses understory growth but still increases soil water balance for growth and bark beetle resistance. The rationale is that surface fires can still lead to significant tree mortality with these species (with the exception of larch). Denser stands of trees on wetter and more productive sites can act as "shaded fuel breaks" when they are maintained with high crowns and no ladder fuels as a moderately dense crown area is needed to suppress understory vegetation and thus fine fuel production. Some thinning decreases crown fire potential by decreasing the ability of a torching tree to ignite neighboring tree crowns, and by providing individual trees with greater soil water reserves and thereby potentially increasing live foliage moisture, which in turn decreases ignitability. Strategies other than thinning are, however, needed on these sites for creating maximum resilience.

The higher plant productivity of wetter ecotypes means that fuel loading will increase quickly following fuel reduction practices. This means that even frequent fires have a higher probability of having severe effects on these forests. A management strategy that only relies on tree thinning to reduce severe wildfire effects will not work as well in these forests. Since these forests often burn as stand replacing events, it is necessary to manage on a landscape level, and create zones that will not carry crown fires. This involves using patch cuts to break up continuous tree canopies in a way that presents wildfire suppression teams with the opportunity to contain crown fires versus trying to suppress them. A mosaic of fuels and structural characteristics presents more places where heat transfer through radiation or convection dissipates, thus interrupting the energy transfer required for crown fires to spread. For example, a crown fire that burns into a clearcut or seedtree where surface fuels have been adequately treated will usually drop to a smoldering ground fire, which is both containable and suppressible. This same mosaic also creates a landscape that is less capable of supporting and contributing to a bark beetle epidemic. Across the wetter Douglas-fir and grand fir ecotypes, as well as the subalpine fir and cedar/hemlock types, younger stands of trees such as those found on regenerated clearcuts do not support as high a leaf area, and thus do not use or intercept as much water, maintaining higher leaf water content longer into the summer and are less flammable. They are also not good reproductive sites for bark beetles as most beetles require larger trees with thicker inner bark. There are many examples from the past decade of wildfires across Montana where extreme wildfire behavior in dense stands of mature trees converted to smoldering surface fires when they burned into clearcuts where post harvest fuel reduction treatments such as prescribed burning had taken place. Although there is much research that remains to be conducted before the exact mechanisms are fully understood and modeled, it is a common practice for fire suppression teams to link old clearcuts together into a fuel break when trying to contain a wildfire.

The biggest challenge for landowners on any particular landscape will be to determine where and what size management units will need to be employed. Each landscape is unique with different topographic features, geologic substrates, soils, species and natural histories. Intact landscapes can offer clues to past disturbances and well trained forestry specialists can also assess any landscape using understory plants (habitat types) and soils analysis to help determine potential species and their growth rates. In the end, this type of analysis offers evidence that can temper the management plan for any forested setting, that ultimately will require a subjective but educated picture to be painted based on both scientific and experiential knowledge, and the recognition that any forest is a dynamic and complex interaction of millions of organisms and processes that can change at any time (Figure 11). Forests are therefore never completely predictable and landowners and managers should not expect management plans to be the ultimate solution, but a working tool to provide thought continuity for an ecosystem that is defined as one that constantly changes.

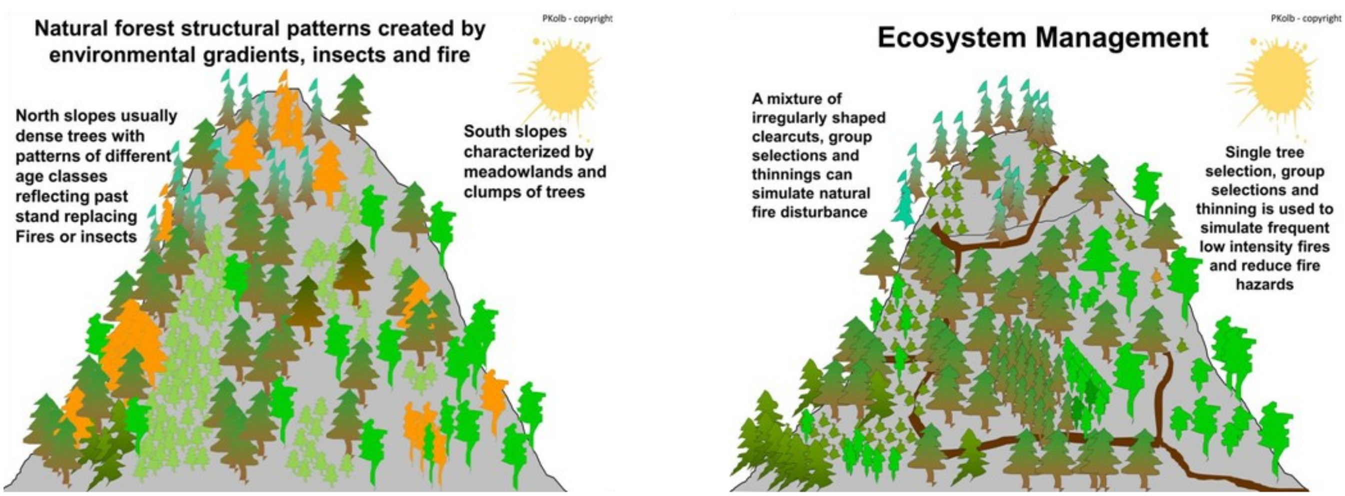

Figure 11. A natural landscape as illustrated on the left typically has tree species and age class variability that reflects both the potential of different species to grow there but also the impacts of the past natural disturbance history. Although evidence of past disturbances might indicate one reality, it should not be considered the "perfect" mosaic to be recreated as the environmental factors that created it are also dynamic and can radically change over time. Blindly emulating past processes may lead to completely novel or unwanted outcomes. The design of a management plan should foremost allow for rapid responses to unwanted outcomes and flexibility to reanalyze the landscape and alter objectives in a timely manner. Climatic fluctuations can be rapid and create new circumstances within very short time periods.

Action Recommendations

The compounding effects of climatic change, fire suppression, and natural forest succession all point towards the need for a landscape level forest management strategy for the next century. Global research on climatic trends strongly indicates that we are in a significant warming trend with more turbulent and unpredictable weather patterns in the forecast. Glacial melting indicates a tendency for reduced snow packs and a longer growing season which results in a forest predisposed to drought conditions. Forest research on the patterns and distributions of tree species of the northwestern U.S. indicates that conifer species have dramatically expanded outside their historical ranges. We now have landscapes covered with conifer species that are not the best adapted to deal with drought stress and climatic turbulence. Wildfire suppression together with a series of wet decades has compounded the problem by allowing forests to reach high stem densities, often with shade tolerant/drought intolerant climax species crowding the more drought and fire adapted species. When the resilience to disturbance of the current forest composition is analyzed based upon projected climates, the result is a landscape of mal-adapted, drought stressed forests predisposed to wildfires of uncharacteristic proportion. Landscape level restoration of forest mosaics through active management may be the only way to conserve the dynamics and complexity of northwest forests.

Specific recommendations for mitigating the effects of a changing climate on Montana forests and aid in carbon sequestration are:

1. Increase drought resilience of forests by thinning groups of trees that are at risk of extreme water stress due to a) shallow soils, b) overcrowding, c) drought intolerant species combinations, d) at risk age distributions. Montana forests survive droughty summers by relying on water stored in the soil. Milder winters can result in less snowpack and earlier spring runoff, with the potential of depositing less water within soil profiles. Longer summers will result in greater water needs for trees. The combination of events will result in prolonged drought stress, which can directly kill trees and/or weaken them to the point of becoming highly susceptible to bark beetle attack. If individual trees are provided greater soil volume from which to draw water, they will better be able to survive extended summers and less soil water availability. Greater soil volume per tree can be achieved by reducing the number of trees per given soil volume. In addition, selecting tree species, and age classes that have a greater tolerance for drought conditions will maximize the soil water conservation strategy. Tree water loss is a function of total leaf area, thus younger trees that have less total needle area require less water. Alternatively, older trees may have deeper and more extensive root systems. In addition there is some evidence that older trees have slower growth rates and thus utilize less water. Given that a tree changes in its water needs and water use as it ages, and each stage has advantages and disadvantages, a landscape with an extensive distribution of tree ages would offer a greater probability of some tree survival during unpredictable climatic fluctuations yet probable drought.

2. Promote a greater tree species and age class distribution across landscapes using a combination of tree thinning and patch cuts that emulate wildfire patterns. This distribution should include the full complement of species and tree ages, where management actions are used to maintain a mosaic ranging from seedlings to very old trees and partial wilderness designation.

3. Promote wildfire/bark beetle resilient forests. Wildfire occurrence and magnitude is controlled by fuels and climate. Climate, however, is the larger controlling factor. Under the projected future climatic scenario for Montana wildfires will be more prevalent. On the other hand, how wildfires burn, and how difficult it is to contain them can be substantially mitigated by fuel treatments. A forest's fire resiliency (the ability of trees to minimize wildfire intensity and for the trees to survive) can be increased using several tools. As indicated earlier, tree spacing affects their water balance. Trees with abundant water are less likely to have highly combustible foliage, and more likely to tolerate intense heat. Thinning of trees (and treating logging debris) also creates a lower overall fuel load, making it more difficult for a fire to be carried through the crowns. Some tree species are more resistant to heat than others, and some species also have less flammable foliage. Discriminating against a landscape with a majority of fire intolerant and/or combustible tree species would also reduce the probability of a wildfire using trees as fuel. Finally, uniform fuels lead to uniform fire behavior. This is a problem if wildfire behavior is extreme. Promoting a landscape with diverse forest structures in the form of groups of different age classes, tree spacing, and tree species would increase the probability of a wildfire burning in a mosaic rather than a uniform flame front. Strategically placed thinned areas and harvest units where harvesting residual debris has been treated could be linked to help fire suppression crews contain wildfires. Examples of this were evident in the 2007 Mile Marker 126 and Blackcat fires. These same strategies also reduce the probability of a bark beetle outbreak.

4. Treat fire and insect impacted forests. Fire and beetle killed trees, when excessively abundant will fall over in 3-15 years and create high surface fuel levels. As the past decade had shown, extended drought dries even large diameter surface fuels, which can impart extreme heat to soil surfaces and adjacent trees. This type of fire has a high probability of killing trees that survived insect outbreaks and may potentially have genetic resilience to future outbreaks, as well as fire resistant trees that act as a seed source following fires. The result may be vegetation shift away from forest and to brush and grassland as no natural tree seed source would remain. Fuels treatment of strategic areas, perhaps in a mosaic pattern would minimize future fire risk for some areas while maintaining down woody debris habitat for other forest organisms (wildlife, fungus, arthropods, etc.) favored by such woody debris.

Figure 12. A lodgepole pine stand (left) following a mountain pine beetle outbreak and the high risk surface fuel matrix that can develop. A forest (right) following a severe surface fire that killed 80% of trees and the 4-ft deep surface fuel matrix that developed 7 years later. If the later burns the remaining trees will be killed.

5. Promote local utilization of forest materials and support locally utilized wood products. Research has shown that carbon dioxide emissions may be contributing to climatic warming. To stabilize or reverse atmospheric carbon dioxide accumulations one would ideally need a device that converts gaseous carbon dioxide into solid and stable form of carbon dioxide. In nature there exist two such mechanisms. The first are water born organisms that extract dissolved carbon out of the water and combine it with calcium to form calcium carbonate. These organisms, most of which range in size from microscopic to pint sized form exoskeletons better known as shells and coral that are responsible for the considerable limestone deposits around the world. The second are plants that extract carbon dioxide directly from the air and store it as either organic matter below ground as is the case with grasses and forbs, or above ground as woody tissue in the case of shrubs and trees. The carbon that plants store, particularly above-ground as is the case with trees can, however, be quite short lived. Upon a trees death woody tissue decays or is consumed by fire and almost all stored carbon is once again released into the atmosphere. Alternatively wood that milled for human utilization can be put into long term storage as a primary construction material for structures that have an extended utility. Although the lifespan of buildings varies, there are a considerable number that are over 100 years old, which is consistently longer than most dead wood survives in a natural setting (with some exceptions such as cold subalpine regions that do not support wildfires). Wood extracted from a forest and placed in such long term storage then acts as a carbon storage mechanism that can increase the carbon absorption capacity of a forest. There are, however, two caveats that should be adhered to maximize this form of atmospheric carbon cleansing and storage. First, harvesting and manufacturing of wood is a carbon fixing process as long as the fossil fuels consumed during the process do not exceed the carbon being stored in the wood. A carbon balance study that examined the energy requirements of wood harvesting, manufacturing and structural utilization found that transportation accounted for approximately 90% of the fossil fuel use. By utilizing local forests as the source of wood, and locally milling and building with this material the process of wood harvesting can lend itself as a significant carbon sequestration mechanism. Second, utilizing wood waste material for energy production decreases the amount of positive carbon emission from wood manufacturing and associated worker energy needs. Third, wooden structures that are built to last offer a much longer carbon sequestration mechanism than structures that have a short effective lifespan. For example, the wooden beams and framing in many European castles, churches and in some instances houses have been in place for many centuries and in some cases a thousand years.

6. Support an integrated forest workforce. Forestry workers, ranging from pre-commercial thinning contractors to high efficiency loggers have advanced experience and skills of working in forested terrain. Recruiting and providing this workforce with wildfire suppression and rehabilitation training would allow for a "reserve" workforce to be on hand when catastrophic events such as a bad wildfire season occur. This limits the financial commitment for the state and federal government of maintaining an extensive wildfire response team when wildfires are not an issue. It also limits the training expenses and risk assumed with retraining a young workforce every season. The state and federal agencies should retain a core and skilled response team that act as leaders, trainers and workforce during minimal or "normal" wildfire years.

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