Testimony of Dr. Peter Kolb
Extension Forestry Specialist and Associate Professor of Forest Ecology
Montana State University

Before the
House Resources Committee, Subcommittee on Forests and Forest Health
Oversight Hearing - Medford, Oregon,
February 24, 2006

Good Afternoon,

For the past 21 years I have studied and worked in the forests of Idaho and Montana specializing in forest regeneration, restoration, and the roles of disturbance processes on forest ecosystem health. Over the past 9 years I have worked specifically on applied research and restoration practices following wildfires and insect and disease outbreaks with private landowners, industry foresters, and public land managers. I would like to present the results of post-fire vegetation research conducted following the Bitterroot fires of 2000.

First, I'd like to point to a few general observations that can be made about post-fire recovery, based on my experience, the scientific literature, and the experience of other forestry professionals:

- Harvesting fire killed trees before natural revegetation takes place would have the least impact on plant recolonization. There is a wealth of research examining natural post-fire plant recovery, the effects of prescribed fire on forest plant communities and impacts of various harvesting practices on natural tree regeneration. This literature provides significant information that is needed to make good decisions about post-fire management practices.
- Furthermore, research examining the conditions that favor tree seedling regeneration and survival indicates that some disturbance of the of soil surface organic layers, including ash, that exposes mineral soil might favor natural tree regeneration.
- A comprehensive literature review of post-fire mitigation impacts was published in 2000 that indicated contour felling, often part of salvage operations, had been shown to have the greatest impact on soil stabilization, often a major concern after wildfires.
- Although scientific experimentation is a critical component, and requires adequate funding, it is important to recognize the experiential expertise and knowledge that exists in the current forestry workforce.

To demonstrate these points and other information about the forest recovery and reforestation following wildfires, I'll share with you findings from a study conducted following the Bitterroot fires in Montana. In 2000, approximately 356,000 acres burned across the Bitterroot National Forest (307,000 ac), the Sula State Forest, and private ownerships in Montana. The southern Bitterroot Valley provided a remarkable opportunity as a post- fire study area because of the large area affected by the 2000

wildfires that burned in diverse topography at various levels of fire severity. Approximately 101,000 acres of this area burned with high severity, 71,500 acres with moderate severity, and 183,500 with low severity effects (USDA Forest Service 2000).

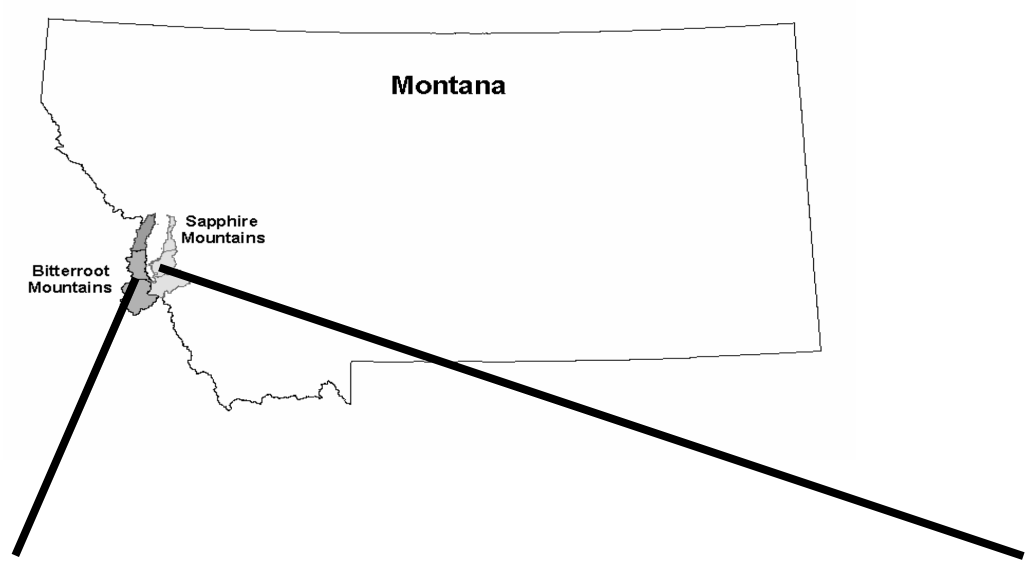
Following the fires, a team of professional foresters consulting with scientists and logging practitioners developed a salvage plan for post-fire management in Douglas-Fir forest types in western Montana. We conducted a study after the management plan was implemented. Our findings include:

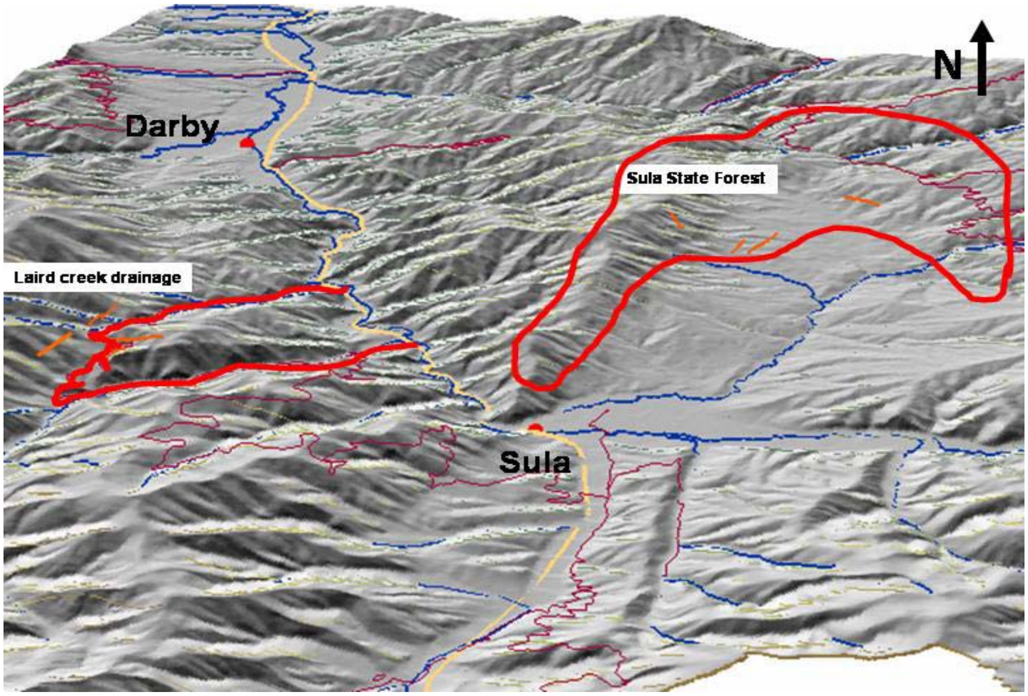
- There are many variables that affect post-fire recovery.
- Salvage logging implemented under the specific conditions specified by the post-fire recovery management plan, did achieve a desirable outcome with respect to vegetative recovery and soil stabilization.
- That the forest ecosystem we sampled appears to have a natural resilience to disturbance, whether it is natural or human related. Although without human intervention a significant portion of the study area will convert from forest to grass and shrubland, from an ecological perspective this is not destructive. From a human perspective it may, however, be undesirable.

.

Study Background and Design

The Bitterroot Valley is located in western Montana nestled between the Bitterroot Mountains to the west and the Sapphire Mountains to the east (see below). The Bitterroot National Forest (BNF) surrounds the valley like a large horseshoe, encompassing both mountain ranges above the wildland/urban interface. The Sula State Forest (SSF) is located in the southeastern portion of the valley between the privately owned French Basin and Rye Creek to the north.





In the spring of 2001, eight post-fire study blocks were established within the 2000 Bitterroot fires perimeter, where each block consisted of a 0.5 – 0.75 mile transect with three 1/10 acre plots and twelve 50-ft subtransects. Four of the eight blocks were located in the Bitterroot Mountains within Sula Ranger District of the Bitterroot National Forest (BNF) in the Laird and Warm Springs drainages (Picture 1). The remaining four blocks in the Sapphire Mountains were above French Basin in the Cameron Creek drainage, with one block on the BNF and three blocks on Sula State Forest (Picture 2). Since the Valley complex fire burned in a mosaic of severities, each block was located to cross all three fire severities along one contour (Picture 3). The study area encompasses approximately 20,000 acres of fire affected landscape. Fire severity and vegetation recovery were sampled within these blocks in 2001 and again in 2003 (Pictures 4-12).

All blocks were located within the Douglas-fir habitat type series. The five study blocks located on the Bitterroot National Forest (BNF) had a broad spectrum of past management activities including no past management, thinning treatments, shelterwood, seed tree, and overstory removal harvests. None of the study areas on the Bitterroot National Forest experienced immediate post-fire salvage harvesting prior to the 2001 sampling. Several of the study plots were salvage logged during 2002 and 2003 prior to their remeasurement in the summer of 2003. These treatments were not statistically comparable since they occurred on only a few plots. A non-statistical comparison of these later salvage logging impacts did not show any differences from comparable non-salvage logged plots. Three study blocks within the Sula State Forest crossed severely burned sites that had been salvage logged during the winter of 2000 to 2001 on snow-covered ground with a ground based mechanical harvesting system, rubber tired skidders, and cable yarding on steeper slopes.

The purpose of this study was to investigate post-fire vegetation recovery in western Montana by exploring the influence of fire severity, topography, and management. The specific research objectives included:

1. Compare post-fire vegetation recovery on severely scorched soils based on the influence of independent variables such as topographic position, forest structure, habitat type, tree fire impacts, etc.
2. Compare individual plant species ability to colonize across severe, moderate and mildly fire impacted soils.
3. **Compare the vegetation recovery of salvaged with unsalvaged sites to determine if there are any differences in plant species occurrence, distribution, overall plant cover, and natural conifer regeneration**.
4. Model plant recovery to determine which independent variables (fire severity, topographic position, plant community type, etc.) best predict understory vegetation cover by the third year post-fire.

Summary of Results

Fire severity and forest plant community type affected plant recolonization. The plant colonization results varied significantly for each species and across fire induced variables such as overstory severity, understory severity, and by existing plant community type. Numerous species showed affinities for certain environmental factors and fire effects as demonstrated by successful colonization.

There is much variability in the initial recovery and subsequent rate of recovery of vegetation due to naturally occurring gradients across the landscape. Overall plant resprouting and colonization can be summarized by the amount of total vegetative cover present on sampled sites. Table 1 shows a summary of vegetative cover as stratified by some of the variables encountered in a post-fire landscape.

Much of the initial post-fire vegetation recovery occurs within the first growing season following a fire event for the sites we studied, and then increases at a much slower rate. This point is demonstrated in Table 2. In general, the 40% average plant cover occurred on patches of soil that had not been severely scorched within the first year. By year three, moderately scorched soil surfaces had been colonized. Severely scorched soils had a very slow rate of vegetative recovery on them with many of the more severe patches showing minimal recovery even 3 years post-fire.

Colonizing plants originate from a variety of sources. Table 3 shows sources of plants that sprouted in the sites, including on-site and off-site sources. Three survival strategies describe the immediate response following a disturbance. On-site species are represented by two forms: survivor and residual colonizer. Survivor plants have fire avoidance mechanisms that enable species to resprout from the root crown, stolons, or rhizomes. Residual colonizers include germinating seeds and fruits that survived the fire through heat resistant properties or by being located in fire avoidant sites. Off-site sources include seeds and fruits that are transported by wind, animals, or water, and is often the means by which exotic weedy species invade. On-site sources dominated the post-fire

community in 2001 and 2003. This leads us to conclude that a healthy pre-fire understory plant community can ensure a faster plant recovery following a fire.

Salvaged logged sites showed similar vegetation recovery as unsalvaged logged sites, indicating that salvage does not necessarily damage vegetation recovery (see Table 4). It is critical to point out that for this analysis to be meaningful, sites that had similar burn severities must be compared. Therefore, only sites that had experienced similar fire impacts and no post-fire manipulation were used for comparison. Salvage logging occurred on sites within the Sula State Forest that had experienced severe overstory fire effects where more than 80% of the trees had been killed. Salvage logging encompassed approximately 10,000 acres with an average of 5,000 board-feet per acre removed (DNRC harvest statistics). Although logging occurred during the winter using a combination of mechanical harvesting and skidding along with cable yarding on steeper slopes, mild conditions often resulted in minimal snowpack and unfrozen ground, thus some soil disturbance occurred. This was actually favorable for our study since we had speculated that disruption of the thick organic ash layer by equipment travel would actually enhance vegetative recovery. Although there is some evidence of higher plant cover on salvage logged sites the differences are not statistically different. Similarly several of the plots on the Bitterroot National Forest experienced selective salvage harvesting two and three years after the fire. We did not have enough of these plots to make statistically valid comparisons; however, the limited data did not show any observable differences on these plots with associated plots on similar fire severities without salvage logging. Considering the number of variables that affect post-fire recovery more study plots would have been needed to make meaningful statistical comparisons among all variables.

Natural conifer regeneration was closely correlated to the occurrence of seed producing mature trees, and the prevalence of shade from either surviving trees or northern aspects. A record was kept of residual tree cover survival for both 2001 and 2003 sample periods, natural conifer tree seedling abundance, insect and disease activity, and presence of invasive exotic weeds (Table 5). Only 19% of our sample area had abundant conifer natural regeneration (more than 49 seedlings per 1/10 acre plot), 24% of our sample area had moderate natural regeneration (between 21 and 49 seedlings per 1/10 acre plot), and 57% of our sample area had scarce natural regeneration (1 – 20 seedlings per 1/10 acre plot). There was no correlation between salvage logging and seedling abundance, nor was there any correlation between the presence of invasive weeds and salvage logging.

Bark beetle activity on residual surviving trees was present on 76% of the plots.

Corroborating data

In 2002 the Montana Department of Natural Resources and Conservation conducted an independent survey of the 12,000 acres of fire affected lands within the Sula State Forest. A survey sample grid of 2,910 plots that were 1/300 acre in size was measured. The results showed that only 13.3% of the area had naturally establishing seedlings and that 18.9 % of the area was within 200ft of trees capable of producing seed. This survey indicated a need to plant tree seedlings across 86.7% of the fire affected forest to ensure

adequate tree regeneration.

An additional study conducted by the Montana DNRC monitored soil erosion on burned sites across the Sula State forest in the year following the fires. Although there were areas that exhibited severe post-fire erosion, salvage logged sites did not show any greater propensity for erosion than sites that were not salvaged. In a second study of salvage logged areas following the 2003 Moose fire in northern Montana, soil impacts from salvage logging were found to be "less than 15% of detrimental affect considered to acceptable.......Levels of soil erosion and disturbance observed on logged sites are not expected to affect long-term soil productivity compared to unlogged sites."

Conclusions

The study of trends within nature is very difficult because of the many variables that influence a single event. Wildfires across a forested landscape add another dimension of variability by burning in a mosaic that is influenced by topography, wind, fuel, fuel characteristics, and past human management activities. Once these fires have stopped burning, the vegetation response is equally variable, and depends on seed availability, microclimate, animal influences, weather trends, and continued disturbance processes. The ash left by a wildfire may be a good seedbed for some tree species, and a poor seedbed for others. On some sites the burn severity has affected the soil surface to such a degree that it presents an inhospitable seedbed. In other instances the desired tree species may no longer be in the vicinity to provide seed or even capable of producing viable seed. For forested sites that are water limited and prone to high summer temperatures, even adequate seed may not ensure a desired survival rate. Alternatively, cooler moist sites with a good seed source may regenerate with an over abundance. Considering that we have been experiencing a warm dry climatic trend, which is partially responsible for the wildfires in the first place, it should come as no surprise that natural regeneration is severely inadequate on many sites that formerly supported trees within our study area.

It is important to note that this study is based on one forest type in one ecological region. However, its findings combined with other scientific analysis and practical experience demonstrates:

- A need for localized management prescriptions based on local experiential knowledge of site conditions and vegetation responses, professional forestry expertise, and scientific data.
- A need for additional research that is conducted cooperatively with applied land managers to help refine management prescriptions.
- Timely salvage, using the appropriate equipment and management prescriptions can produce desired outcomes while limiting the negative consequences of wildfires.
- Natural regeneration, while desirable, does not always occur following wildfires in forests. Tree planting may be needed to return an ecosystem into a forested condition.

This study was initiated to add basic knowledge of how vegetation recovers following wildfires across a mosaic of severities on the Douglas-fir habitat type of western

Montana. It was also designed to measure if salvage logging, combined with logging debris manipulation to stabilize soil would impact natural vegetation recovery. Although the desire was to establish more study plots, the data we gathered was adequate. Although not yet published in a peer reviewed journal, the study was the basis for the Master's Thesis of LaWen Hollingsworth and was reviewed by three other well respected and prominent scientists with expertise in statistics, fire behavior and fire ecology.

Table 1. Mean understory cover stratified by independent variables

			Understory cover (%)		
Independent variable	**Category**	**N**	**2001**	**2003**	**Δ**
Overstory severity	Low	32	39	41	2
	Mixed	28	31	46	15
	High	40	26	41	15
Understory severity	Low	44	39	45	6
	Mixed	32	25	44	19
	High	24	26	36	10
Habitat type group	Warm/dry	68	28	38	10
	Cool/dry	32	40	52	12
Aspect	North	16	36	51	15
	Northeast	28	36	45	9
	East	12	38	51	13
	Southeast	16	25	30	5
	South	4	32	39	7
	Southwest	4	40	26	-14
	West	8	14	35	21
	Northwest	12	29	47	18
Slope (%)	0 - 20	24	34	40	6
	21 - 40	44	34	42	8
	41 - 60	32	26	45	19
Position on slope	Bottom	20	45	41	-4
	Mid-slope	44	34	48	14
	Top	36	22	37	15
Vertical slope shape	Linear	64	31	42	11
	Convex	24	24	36	12
	Undulating	12	53	56	3
Horizontal slope shape	Linear	16	27	39	12
	Concave	44	35	45	10
	Convex	40	29	41	12
Firegroup	4	20	34	50	16
	6	80	31	41	10
Pre-fire tree cover (%)	1 - 30%	32	35	49	14
	31 - 45%	32	31	44	13
	>45%	36	29	35	6
Post-fire tree cover (%)	0	48	25	41	16
	1 - 25%	28	36	43	7
	>25%	24	40	45	5

[1]n = number of transects

Table 2. Change of vegetation cover from 2001 to 2003

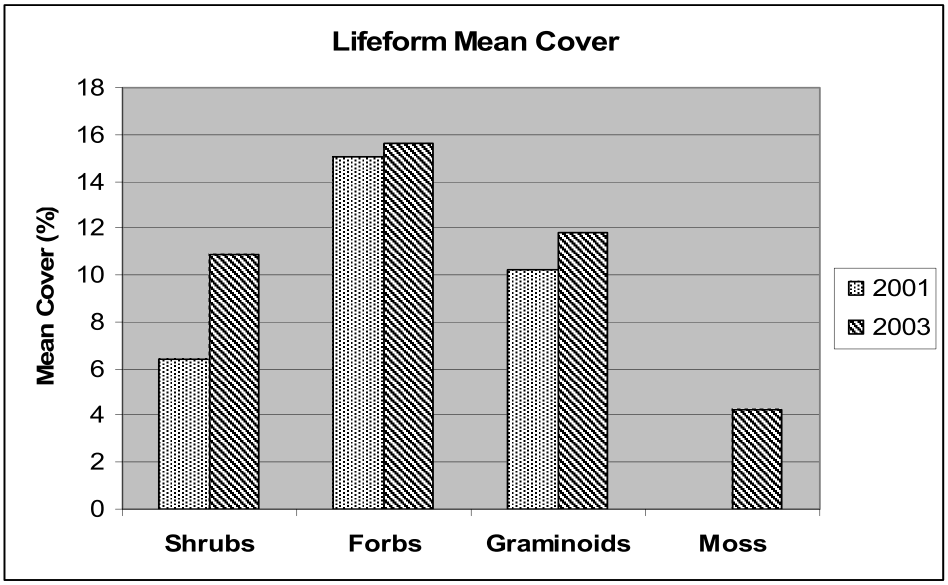


Table 3. Colonizing plant sources

Seral origin	2001	2003
Survivors	**24**	**42**
Root crown	5	9
Rhizomes	15	29
Stolons	1	1
Caudex	3	3
Residual colonizers	**2**	**5**
Buried seed	1	3
Fruit	1	2
Off-site colonizers	**5**	**15**
Light seed	3	12
Fruit	2	2
Other	-	1
Total	**31**	**62**

Table 4. Post-fire Vegetation response following salvage logging

Description	Test variable	No salvage 2001	No salvage 2003	Salvage 2001	Salvage 2003
Dep. variable	Mean patch size (m)	8.2	1.5	7.9	2.1
	Black patch mean size (m)	7.0	1.2	7.0	1.5
	Understory cover (%)	26	45	32	39
Richness	ICE	19.68	28.82	20.63	31.76
	Chao 2	23.88	32.68	23.04	37.12
Diversity	Shannon index	1.82	2.31	1.72	2.2
	Simpson index	5.82	8.32	4.17	6.78
Evenness	Shannon	0.655	0.71	0.621	0.674
	Simpson	0.364	0.32	0.261	0.261

Table 5. Stand characteristics, pests, pathogens, regeneration and weed summary.

Block no., Plot no.	Pre-fire tree cover (%)	Post-fire tree cover 2001 (%)	Post-fire tree cover 2003 (%)	Harvest activity	Insect activity	Disease activity	Conifer regeneration	Mean understory cover 2003 (4 transects)	Noxious weeds[3]
3,1	40	35	30	-	BB	-	abundant	34%	CEMA
5,1	50	25	20	-	-	-	-	21%	CEMA
2,1	50	35	35	-	BB	-	moderate	25%	CEMA
9,1	60	50	45	-	-	-	abundant	64%	scarce
7,1	50	30	30	2003	BB	-	scarce	29%	-
1,2	30	25	25	-	BB	-	scarce	39%	CEMA
6,3	35	35	30	2000	BB	-	abundant	58%	CEMA
4,1	50	50	50	-	BB	-	scarce	58%	CEMA
1,3	20	0	0	-	BB	-	-	40%	CEMA
3,2	45	0	0	-	BB	root/stem	scarce	41%	CEMA
5,2	55	25	10	-	-	-	scarce	26%	-
2,2	25	15	15	-	-	-	abundant	53%	scarce
7,2	30	10	10	-	BB	-	moderate	62%	-
4,2	45	25	25	2003	BB	root/stem	scarce	57%	CEMA
1,1	35	25	20	-	BB	root/stem	moderate	46%	CEMA
6,2	25	0	0	2000	BB	root/stem	moderate	39%	CEMA
9,3	35	0	0	2000	-	-	scarce	34%	-
3,3	70	0	0	-	BB	-	scarce	25%	scarce
4,3	60	0	0	2003	BB	-	scarce	33%	scarce
5,3	50	0	0	-	BB	-	-	38%	CEMA
6,1	20	0	0	2000	BB	-	scarce	38%	-
9,2	40	0	0	2000	BB	-	scarce	43%	-
7,3	30	0	0	-	-	-	scarce	67%	-
2,4	40	0	0	-	BB	-	moderate	42%	CIAR
1,4	30	0	0	-	BB	-	-	53%	CIAR

[1]Insect activity BB = bark beetle

[2]Noxious weed species where CEMA = *Centaurea maculosa* (spotted knapweed)
and CIAR = *Cirsium arvense (Canada thistle)*

Picture 1. An overview of the Bitterroot National Forest study area

Picture 2. An overview of the Sula State Forest study area

Picture 3. Sample transect with plots in 3 fire severities

Picture 4. Sula state forest immediately after fire 2000

Picture 5. Sula state forest summer 2001 following salvage harvest

Picture 6. Salvage harvest debris placed to minimize soil erosion

Picture 7. Non-harvested study plot 2001

Picture 8. Same plot 3 years following fire, 2003

Picture 9. Salvage harvested study plot in 2001

Picture 10. Same plot three years following fire, 2003

Picture 11. High soil severity salvage plot, 2001

Picture 12. Same plot three years following fire, 2003