Soil Report for Project Record

Flagtail Fire Recovery Project

Blue Mountain Ranger District,
Malheur National Forest

Robert (Hersh) McNeil, Soil Specialist 2-11-04

Soil analysis is found in the Flagtail FEIS. This report contains documentation to support the analysis in the Flagtail FEIS.

Alternative 1 upland sediment production, from high and moderate burn severity tractor ground

R.C. McNeil, 1-28-04

Methods

I described use of Disturbed WEPP in "Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP" and the reader should be familiar with that report.

I selected ten sample "flow lines," dispersed about the high and moderate severity burn areas that were proposed for logging under Alternative 2 (April 2003 map).

Erosion was modeled from ridge line to draw bottom, edge of the unit, or where the erosion left high or moderate burn severity. As it happens, for the ten sample flow lines used, in no case did a flow line pass from low burn severity to high or moderate. Erosion was modeled as if there were no roads.

Disturbed WEPP Variables

All Runs

Climate: "Flagtail1"
loam (soil type 33)

Sideslope Soil Segments

35% Rock
Moderate and High Severity Burn: "treatment" = Short Grass . Ground Cover = 45%

Results

Sample	Sediment delivered to draw, unit boundary, or low burn severity area (ton/ac)
70	0.09
71	0.31
72	0.25
73	0.24
74	0.07
75	0.25
76	0.30
77	0.21
78	0.14
79	0.31
Mean	0.22 (=0.26 yd^3/ac)

Alternative 1 upland sediment production, Snow Creek catchment

R.C. McNeil, 10-7-03

Methods

I described use of Disturbed WEPP in "Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP" and the reader should be familiar with that report.

I selected ten sample "flow lines," dispersed about the catchment.

Erosion was modeled as if there were no roads.

Some steep draws were counted as parts of flow lines, because deposition was not expected in these draws.

Where multiple segments were needed because the flow line went into a different burn intensity, "equivalent segments" were used, as described in "Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP," "Skidtrails cross flow lines" section.

Disturbed WEPP Variables

All Runs

Climate: "Flagtail1"
loam (soil type 33)

Sideslope Soil Segments

35% Rock
Moderate and High Severity Burn: "treatment" = Short Grass . Ground Cover = 45%
Low Severity Burn: "treatment" = Tall Grass. Ground Cover = 71%

Alluvial Soil Segments

(The lowest 50 or 20 feet of a flow line was counted as "alluvial soil." Also, flow lines that went down steep draws were counted as alluvial. Observation in September 2003 indicated ground cover on alluvial soil had recovered more than sideslopes.)
10% or less slope (except draws, where slope was measured)
10% Rock
Moderate and High Severity Burn: "treatment" = Short Grass. Ground Cover = 80%
Low Severity Burn: "treatment" = Tall Grass. Ground Cover = 90%

Results

Sample	Sediment delivered to stream or draw (yd^3/ac)	Low Severity Burn (% of flow line)	Average Slope (%)	Alluvial Soil (feet)	Slope Length (feet)	Road Crossing	Stream Category at End
50	0.01	100	14	50	550	yes	"5"
51	0.10	0	29	50	170	no	1
52	0.24	0	19	50	590	no	4*
53	0.02	100	18	50	820	no	"5"
54	0.08	56	25	50	1180	yes	1
55	0.18	60	37	20	650	no	2
56	0.05	84	15	130	1340	yes	4
57	0.25	0	20	50	585	yes	4
58	0.19	0	25	20	260	no	1
59	0.11	58	25	50	725	yes	1
Mean	0.12	46	23	52	687	0.5	--

* 150’ buffer, not 50' buffer

The average amount of upland erosion was 0.15 yd^3/ac; about 20% of the erosion was deposited in the "alluvial segment" before it reached a stream or draw bottom.

Effect of slash on erosion

R.C. McNeil, 11-26-03

Introduction

I described use of Disturbed WEPP in "Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP" and the reader should be familiar with that report. The calculations in that report are based on the assumption that ground cover off of skidtrails is 45% whether or not the area was logged. However, the DEIS discloses "Harvest could add a little additional ground cover from slash. This addition would be negligible in most units .... Even in units where tops stay on the ground , the increase in ground cover due to slash would be small." (p. 182). The purpose of this investigation is to see what Disturbed WEPP indicates about the effect of the slash on erosion.

Methods

I assumed the slash would increase ground cover from 45% to 47%. I ran Disturbed WEPP with the same variables as the Alternative 1 runs, except I used 47%. Then I subtracted the erosion with slash from Alternative 1 runs, to find the decrease in erosion due to increased ground cover.

Results

Unit	Flow Line	Decrease in erosion due to increased ground cover tons/acre
4	0	0.02
4	3	0.04
4	5	0.01
4	6	0.01
4	7	0.02
4	9	0.02
4	mean	0.02
40	31	0.01
40	32	0.00
40	33	0.02
40	34	0.01
40	35	0.01
40	36	0.02
40	mean	0.01

Perhaps the reasons the slash would reduce erosion more on unit 4 than on unit 40 are 1) unit 4 has more erosion and 2) unit 4 has more skidtrails that cross flow lines, instead of being parallel to them.

The effects of harvest should be reduced by these amounts. Thus, harvest would increase sediment delivery to the edge of the unit 4 by about 0.05 m^3/ac, and of unit 40 by about 0.06 m^3/ac.

Effect on erosion of scattering slash on skidtrails

R.C. McNeil, 11-26-03

Introduction

I described use of Disturbed WEPP in "Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP" and in "Effect of Slash on Erosion." The reader should be familiar with those reports. The calculations in those reports are based on the assumption that ground cover on skid trails is 10%. One proposal for reducing erosion is to scatter slash on skidtrails in areas with high severity fire. The purpose of this investigation is to see what Disturbed WEPP indicates about the effect of scattering slash on skidtrails on erosion.

Methods

I assumed that scattering slash would increase ground cover from 10% to 18%. This small increase is due to the fact that the fire burned most of the needles in severely burned areas. I selected the skidtrail segments closest to the bottom of the slope to model, because these segments produce more of the sediment that leave the unit, than other segments.

Results

unit	flow line	flow line crosses or lies parallel to skidtrails	% decrease in erosion due to scattering slash
4	0	crosses	20
4	3	crosses	12
4	5	crosses	19
4	6	parallel	26
4	7	parallel	36
4	9	crosses	17
4	mean	-	22
40	31	parallel	35
40	32	parallel	33
40	33	parallel	37
40	34	parallel	33
40	35	parallel	37
40	36	parallel	35
40	mean	-	35
Both	mean	-	28

These results indicate that the net increase in average erosion due to skidding and then scattering slash on the skidtrails would be about 0.04 yd^3/ac on both unit 4 and unit 40.

Possibly, scattering slash would reduce erosion more than this, because slash placed on the contour acts as more than simple ground cover. Each piece of slash could accumulate a small amount of sediment uphill from it, in addition to its action as ground cover.

If skidtrails have 2-5 inch deep ruts, scattering slash possibly would not be as effective as the model suggests, because contact between the slash and the ground would be reduced. Perhaps the reason that scattering slash would be less effective at reducing erosion where a flow line crosses a skidtrail, is that in these situations, water from above the skidtrail runs onto it, whereas this doesn't happen where flow lines and skidtrails are parallel.

Erodibility of Soil Type 33
R.C. McNeil
1-13-04

The erodibility rating currently attached to the SRI lists the erodibility of soil type 33, as "high." This rating appears to be incorrect based on evidence from both the SRI and field experience, as described below. The District Soil Scientist believes the erodibility of Soil 33 is M-H.

1. First, according to the SRI, soil 33 is similar to other non-ash soils that are steep, well-forested, and have an erodibility rating of "Moderate to High" (M-H).

Soil 33 was compared to other non-ash soils that are steep and well-forested, that occur on the Malheur NF (43, 68, 88, 123, 133, 143, 163, 8, 97, 188), and have an erodibility rating greater than L-M. These soils fall into 4 classes of erodibility (L-H, M-H, H, or VH).

Properties of soil 33 were compared against soils of this group which have M-H erodibility (43, 68, 88, 123, 133, 143, 163). Properties of Soil 33 are similar to several of these soils. The table on the next page compares soil 33 to soils 43 and 123, which are among the soils that are most similar to soil 33. Properties shown include those used to calculate the California Erosion Hazard Rating, a standard erodibility rating.

Soil 33 was also compared against the non-ash soils that are steep and well-forested that have erodibility ratings higher than M-H. These two soils are highly erodible because of certain unusual soil properties which Soil 33 lacks. Soil type 97 (VH) formed from serpentine parent material, and so grows ground cover slowly, and tends to be intermixed with non-forest. Soil type 188 (H) has surface soil with clay loam texture, has very sticky and very plastic consistence, and has very slow permeability.

2. Second, field observations indicate soil type 33 is not particularly erodible. The district soil scientist has observed soil type 33 several times, and has observed erosion only on a few skid trails with severely displaced soil. Observations included areas in the following potential timber sales: Camp (1995), Dry Gulch (1995), Guard (1993), Hanscock (1993), Hem (1996,1997), Laycock (1997), Lime (1997,2000), Pete (1996), Riley (1994), SF Deer (1995), Starr (1994), Silvies NW (1991), Sweet (1992), Tex (2000), Van Aspen (1994), Vance (1994), White (1990), Wickiup (1991,1994). However, generally these soils had abundant ground cover, so erosion would not be expected on them.

See back of this page for table

Soil property	Soil 33	Soil 43	Soil 123
Slope %	30-70	30-70	30-70
surface texture*	gravelly loam	gravelly loam	loam to gravelly loam
surface permeability*	moderate	moderate	moderate
surface thickness	6-10 inches	6-10 inches	6-12 inches
subsoil texture	gravelly or cobbly loam	gravelly or cobbly clay loam	gravelly and cobbly loam
subsoil permeability*	moderate	moderate	moderate
subsoil thickness	6-14 inches	6-18 inches	6-24 inches
total soil depth*	12-24 inches	12-30 inches	12-30 inches
coarse fragment content	30-50 %	20-60 %	25-50 %
1974 erodibility rating**	High	High	High
litter ground cover*	30-50 %	30-50 %	30-50 %
vegetative ground cover*	30-60 %	30-60 %	30-60 %
annual herbage production potential	300-400 lb./ac.	300-400 lb./ac.	300-400 lb./ac.
available water holding capacity	2.2 inches	2.3 inches	2.2 inches
Runoff from adjacent and intermingled areas*	moderate	moderate	moderate
Uniform slope length*	>50 feet	>50 feet	>50 feet
parent material	sedimentary	basalt & andesite, with some tuffaceous material	argillite & other metasedimentary

* Factors considered in computation of California Erosion Hazard Rating.
** current erodibility rating dates from about 1989

Existing Detrimental Impacts in Old Units
R.C. McNeil, 1-13-04

Unit	Total %	in unit %	roads %	YEAR	LSU	ACTIVITY	ACRES
SNOW33	18	13	5	9-89	T	HFR	54
SNOW37	17	13	4	10-8	T	HFR	39
JACK27	16	11	5	F-91	T	HFR	23
29605	14	11	3	W-93	T	HOR	31
DIPPINGVAT02A HU14	14	9	5	1974		HPR	179
COLD54	12	7	5	M-91	T	HFR	26
JACK01A	12	8	4	F-91	T	HFR	72
JACK01B	12	9	3	F-91	T	HFR	64
SNOW32B	12	12	0	9-89	T	HFR	20
VAT201B	12	9	3	12-9	T	HTH	48
VAT347	12	7	5	6-96	T	HTH	16
29604	11	9	2	W-93	T	HOR	38
9614A	11	8	3	1985	T	HOR	122
COLD52	11	8	3	M-91	T	HFR	71
SNOW28	11	8	3	10-8	T	HFR	18
SNOW29	11	8	3	10-8	T	HFR	25
SNOW34	11	6	5	9-89	T	HFR	69
SNOW35	11	9	2	9-89	T	HCC	21
29606	10	8	2	W-93	T	HOR	32
9606B	10	7	3	1985	T	HPR	58
9607S02C	10	7	3	1985	T	HPR	93
9614D	10	6	4	1985	T	HOR	59
SNOW30	10	7	3	9-89	T	HCR	14
VAT295	10	8	2	12-9	T	HTH	48
29623	9	6	3	W-93	T	HOR	65
9602	9	6	3	1985	T	HCC	23
9610	9	6	3	1985	T	HPR	58
COLD85	9	5	4	F-91	T	HFR	28
JACK08	9	6	3	F-91	T	HFR	72
POISONLP	9	7	2	1986	T	HSV	29
SNOW26	9	6	3	10-8	T	HCR	32
SNOW27	9	8	1	10-8	T	HFR	26
29602	8	5	3	W-93	T	HOR	48
9606A	8	6	2	1985	T	HPR	66
9607S02A	8	5	3	1985	T	HPR	67
9612	8	3	5	1985	T	HPR	47
SILVIESNW03	8	4	4	9-97	T	HPR	35
SNOW25	8	5	3	11-8	T	HCR	20
SNOW32A	8	6	2	9-89	T	HFR	50
VAT201A	8	7	1	12-9	T	HTH	22
9603SUB02	7	4	3	F-85	T	HOR	10
9607S02B	7	4	3	1985	T	HPR	79
9611A	7	3	4	1985	T	HPR	81
29603	6	3	3	W-93	T	HTH	60

29615	6	5	1	1992	T	HOR	30
Unit	Total %	in unit %	roads %	YEAR	LSU	ACTIVITY	ACRES
29617	6	5	1	1992	T	HOR	35
9614B	6	3	3	1985	T	HOR	122
9603SUB01	5	3	2	F-85	T	HOR	94
9607S01	5	4	1	1985	T	HPR	12
9611B	5	2	3	1985	T	HPR	45
9614C	5	2	3	1985	T	HOR	51
JACK01C	5	2	3	F-91	T	HFR	39
SNOW24	5	2	3	11-8	T	HFR	32
SWAMPSSTS46	5	4	1	1995	T	HTH	17
29618	4	1	3	1992	T	HOR	39
29601	3	1	2	W-93	T	HPR	53
29611	3	1	2	W-93	T	HOR	76
HOG10	0			1991		HCR	13

Mycorrhiza and Forest Management on Bear Valley District

April, 1992

R.C. McNeil, Soil Scientist

Introduction

A concern has arisen that clearcutting and severe fuels reduction burns may decrease tree establishment and growth by reducing formation of mycorrhiza. This effect may be most important on low productivity sites and on sites where trees do not rapidly restock (Amaranthus et al. 1989). There are many dry and/or cold sites on Malheur National Forest and if there is a reduction of productivity, it would be a concern on the Malheur.

Mitigations to avoid loss of mycorrhiza include (1) insuring seedlings have mycorrhiza when planted; (2) minimizing disturbance severity; (3) retaining organic matter on site; (4) restocking the site as rapidly as possible; (5) mitigating more carefully than normal on dry and cold sites (Amaranthus et al. 1989). Another mitigation would be (6) retaining trees on the site to retain innoculum.

However, some evidence suggests that lack of mycorrhizae formation may not be a problem on Malheur National Forest: (1) If a problem exists, it will only be during the establishment phase. (2) Probably aerial dispersed spores can innoculate roots with mycorrhizal fungi. (3) Most of the mitigations listed above are applied to some extent already. (4) Increased mycorrhiza formation does not always increase survival and growth. (5) Clearcuts where restocking difficulty has been attributed to lack of mycorrhizal formation are in southwestern Oregon, which differs from the Malheur in climate, soils, and biota. (6) The suggested mitigations have not been shown to promote tree establishment and growth, except possibly mitigation (1).

Evidence & Arguments

(1) If a problem exists, it will only be during the establishment phase.

As the stand supplys nutrients to mycorrhizal fungi, the fungi will grow and produce innoculum. This is apparently what happens at Bend Pine Nursery.

(2) Probably aerial dispersed spores can innoculate roots with mycorrhizal fungi.

Many mycorrhizal fungi produce mushrooms (Molina & Amaranthus 1991). However, in the clearcuts in the Klamath Mountains discussed below, aerial innocualtion did not appear to be effective.

(3) Most of the mitigations listed above are applied to some extent already.

Mahlon Hale, Cultural Assistant at the Bend Pine Nursery, has observed that seedling shipped from that nursery have good mycorrhizal development, even though there is no artificial innoculation.
By observing Regional soil protection guidelines, management on the Malheur minimizes disturbance severity and retains organic matter.
By law, sites that cannot be restocked within five years are classified as unsuitable for timber production.
On the Malheur, clearcuts are the exception, mainly limited to mixed conifer sites.

(4) Increased mycorrhiza formation does not always increase survival and growth.

Some of the papers reviewed by Harvey and coworkers (1991) showed increased survival and growth, whereas other papers did not.

(5) Clearcuts where restocking difficulty has been attributed to lack of mycorrhizal formation are in southwestern Oregon, which differs from the Malheur in climate, soils, and biota.

Perry and coworkers (1989) claim that there is a "consistent failure of regeneration after clear-cutting" on high elevation granitic soil in the Klamath Mountains. These authors present no data showing consistent failure of regeneration. There are some clearcuts that have not been successfully reforested despite "numerous attempts." In soil from these clearcuts, only 4-5 % of seedling root tips were mycorrhizal (Amaranthus & Perry 1989, Amaranthus et al. 1987). This reduction in mycorrhiza may have resulted from management and this reduction may have contributed to regeneration failures. The hypothesized connection between reduction in mycorrhizae and regeneration failures is supported by the finding that survival, growth, and mycorrhizae formation is enhanced by planting seedlings with small amounts of soil from other plantations (Amaranthus & Perry 1987, Amaranthus & Perry 1989). However, additional evidence is needed to draw firm conclusions about the chain (or web) of cause and effect. For instance, there is little evidence of why or when reduction of mycorrhizae formation took place. Possibly there was sufficient mycorrhizal formation for the first two or three plantings. Why did pasteurized soil enhance survival, growth, and mycorrhizae formation as well as or better than soil containing living innoculum (Amaranthus & Perry 1987)? Perhaps fungi and plants were inhibited by growth of actinomycetes (Friedman et al. 1989) and destruction of soil structure (Perry et al. 1989); would similar causes be operating elsewhere? Are clearcutting, buring, herbicide, dryness, cold, sandy soil, certain strains of actinomycetes, and the passage of time all necessary to reduce mycorrhizae this much? In summary, it is unknown what caused the reduction in mycorrhizae formation, and it is unclear that the results can be extrapolated to the Malheur.

The difficulty of extrapolating between areas is illustrated by Schoenberger & Perry (1982), who found no reduction of mycorrhizae on Douglas-fir grown in soil from clearcuts.

The conflicting results do suggest that when there is high seedling mortality due to drought, competition, or unknown causes, root tips should be checked for mycorrhizae, if possible. Recurring failures of plantings should also be investigated.

(6) The suggested mitigations have not been shown to promote tree establishment and growth, except mitigation (1).

The most convincing evidence for the effectiveness of the mitigations would be designed experimental comparisons replicated in varying localities in the inland Northwest, preferably in the Blue Mountains. Such a program is unlikely to be funded. A few designed experimental comparisons would be moderately convincing. I found no such comparisons except as follows:

Harvey & coworkers (1991) found that scalping 5 cm of soil from planting microsites or mounding topsoil onto planting microsites did not significantly affect tree growth during the first three years. On a 'harsh' site, Douglas fir trees on the scalped microsite had more mycorrhizal root tips than tress on the mounded microsite. These finding contradict mitigations (2), (3), and (5). Harvey & coworkers (1988) did find that scalping 10 cm of soil decreased growth 6 %, though they did not report effects on mycorhizae.

Reports of widespread repeated regeneration failure, as in the Klamath Mountains, also would be convincing. I found no such reports. Much of the cutting on Bear Valley District has been partial cutting, so most of the planting has been recent. According to James Soupir, Regeneration Forester, there have been some problems with soil-related mortality in plantations in the Vance Creek and Hanscombe Mt. areas. There has been little chance to replant. The replanting that has taken place indicates that plantings survive under favorable weather conditions, so mortality is probably not due to deficient mycorrhizal fungi.

Arguments based on well supported, widely applicable conceptual models of environment/fungi/plant interactions would also be convincing. Amaranthus and coworkers' (1989) arguments are based on conceptual models (1) of effects of disturbance and climate on mycorrhizae formation; (2) of the longivity of mycorrhizal fungi in the absence of hosts; and (3) of the effects of mycorrhizal formation on tree growth. Though I am not well qualified to judge, it seems the models are supported by only a few observations, and those observations must be extrapolated a long way to conclude increased mitigations are beneficial on the Malheur. Similarly, Harvey & coworkers (1986) found more mycorrhizal root tips in association with surface soil, especially organic matter, than with deeper soil. They conclude that management should minimize disruption of surface soil and loss of organic matter. However, it seems to me that the results are not sufficient to support the conclusions; many other factors affect production and productivity. The arguments of both Amaranthus and coworkers (1989) and Harvey & coworkers (1986) support hypotheses, not conclusions.

Conclusions

At present, there is insufficient evidence that the Malheur needs to implement additional mitigation to encourage mycorrhizae formation. Additional monitoring may show a need.

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Recommended Guide for Cross Drain Spacing on Skidtrails

R.C. McNeil
1-13-04

From DEIS. Adopted from Fremont N.F.

Slope (%)	Cross Drain Spacing (feet)
0-5	200-160
6-10	160-120
11-15	120-100
16-20	100-60
21-30	60-40
31-45	40-25

Response to comment 11-32, excerpts from "Decaying Wood in Pacific Northwest Forests: Concepts and Tools for Habitat Management (by C.L. Rose, B.G. Marcot, T. K. Mellen, J.L. Ohman, K.L. Waddell, D.L. Lindley, & B. Schreiber. Chapter 24 (pp. 580-623)in *Wildlife-Habitat Relationships in Oregon and Washington*, D.H. Johnson & T.A. O'Neil (managing directors). Oregon State University Press, Corvallis. 2001)

R.C. McNeil

1-26-04

a. "In this region, the abundance of large decaying wood is a defining feature of forest ecosystems, and a key factor in ecosystem diversity and productivity.[127] … Large accumulations of decaying wood provide wildlife habitat and influence basic ecosystem processes such as soil development and productivity, nutrient immobilization and mineralization, and nitrogen fixation." This statement applies to moister forests than those in Flagtail. Before fire suppression became effective, down and decaying wood in the Flagtail area burned frequently, so there were few or no large accumulations of decaying wood.

c. The soils specialist agrees with most of the statements in this comment. However, before fire suppression became effective, down and decaying wood in the Flagtail area burned frequently, so large down wood was not an ample source of nutrients throughout secondary succession. As disclosed in Chapter 3, Soil, Environmental Consequences, Alternatives 2, 3, and 5, Nutrients section, removal of logs may decrease productivity a small amount.

Although losses in soil productivity are linked to losses in soil organic matter, the removal of logs (future woody debris) during harvest on Flagtail is unlikely to cause loss of significant soil organic matter. Soil organic matter is naturally very stable, turning over (mineralizing and replenishing) very slowly, due to the stable chemicals that constitute soil organic matter. Only a small proportion of soil organic matter would come from the dead wood, even under Alternative 1, even if no fire occurs. Most soil organic matter comes from roots or fine above ground organic matter, not coarse aboveground organic matter, especially under historic conditions when the above ground organic matter periodically burned. Coarse above ground organic matter does make a small contribution to soil organic matter (through leaching and the action of burrowing animals such as ants), but the contribution from dead wood from the Flagtail fire would be negligible under any alternative.

Summary: As disclosed in Chapter 3, Soil, Environmental Consequences, Alternatives 2, 3, and 5, Nutrients section, removal of logs may decrease productivity a small amount. As discussed in the Analysis File, effects on soil organic matter would be negligible under any alternative.

d. As disclosed in Chapter 3, Soil, Environmental Consequences introduction, effects on mass movement (slope stability) would be negligible.

Large wood on hillslopes of Flagtail fire would have negligible effects on ground cover. As disclosed in Chapter 3, Soils, Environmental Consequences, Cumulative Effects, Changes Under All Alternatives section, ground cover will recover in five years or less, before much of the large wood would fall. In addition, after most of the large wood falls (after 10 years), the amount of ground cover provided by logs would be small (probably less than 8%) because much of the wood would be suspended above the ground on limbs.

Large wood on hillslopes of Flagtail fire would have negligible effects on forming a barrier to creeping and raveling soils, or creating favorable substrates for plants, under all alternatives. Even under Alternatives 1 and 4, only a small number of snags would fall parallel to the contour and come into contact with the ground, especially on steep ground.

Large wood was not a major ground cover for reducing erosion historically; ground cover was mostly supplied by ground vegetation, by forest floor that the low intensity fires missed, and by needles cast from trees within a few years after a fire.

Summary: As discussed in the Analysis File, effects of removing future woody debris on ground cover or creeping or raveling soil would be negligible under any alternative.

e. Decreases in nitrogen fixation by *Ceanothus* due to removal of logs is likely to be quantitatively small, due to the limited amount of ground cover that would be provided by logs under all alternatives.

g. No scientific data was found on loss (due to removal of logs) of dead wood-associated, digging wildlife, and resulting effects on soil quality, as described in Chapter 3, Other Disclosures, Unavailable and Unknown Information section.

j. As noted in the response to Letter #11, comment 11-32d, the removal of logs would not significantly decrease water percolation into soil or accelerate soil erosion. As disclosed in Chapter 3, Soil, Environmental Consequences introduction, effects on mass movement (slope stability) would be negligible. See response to Letter #11, comment 11-44 about nutrient loss from litter. See Chapter 3, Soil, Environmental Consequences, Alternatives 2, 3, and 5, Nutrients section about loss of nutrients in logs.

As for removal of logs contributing to a decline in productivity, the only reference that appears directly applicable to the Flagtail area is 137. (Gast, W., D. Scatt, C. Schmitt, D. Clemens, S. Howes, C.G. Johnson Jr., R. Mason, F. Mofr, & R.A. Clapp. 1991. Blue Mountains Forest Health Report: New Perspectives in Forest Health. U.S. Forest Service, Pacific Northwest Region, Malheur, Umatilla, and Wallowa-Whitman Nat. For.) Page V-5 of this reference says "In managed systems, woody debris has often been removed. As a result of that removal, productivity, and diversity have been diminished." However, there is no data or citation to support or quantify this statement. It is probably the opinion of one person.

. *Summary:* As discussed in the Analysis File, effects of removing future wood debris on soil erosion would be negligible under any alternative. As disclosed in Chapter 3, Soil, Environmental Consequences, Alternatives 2, 3, and 5, Nutrients section, removal of logs may decrease productivity a small amount.

General response

Effects of nutrient removal on nutrient cycling and soil fertility are disclosed in Chapter 3, Soil, Environmental Consequences, Alternatives 2, 3, and 5, Nutrients section,. As stated there, removal of nutrients and organic matter "may decrease site productivity a few percent on some sites. .... Woody fuel loads would be similar to historical conditions," ("Historical conditions" refers to conditions before Euro-Americans arrived).

Comment 11-32 implies other soil functions, other than nutrient supply, would be impaired by removal of dead wood during logging. These functions include stabilizing pools of organic matter, providing ground cover, forming a barrier to creeping and raveling soil, elevating nitrogen fixation, increasing water percolation into soil, stabilizing slopes, and decreasing nutrient losses. Most of these functions of logs (including providing ground cover, forming a barrier to creeping and raveling soil, elevating nitrogen fixation, increasing water percolation into soil, stabilizing slopes, and decreasing nutrient losses) have at most minor effects on soil quality. So removal of logs under the action alternatives would have negligible detrimental effects on soil quality, except for the small effects described in the "Nutrients" section. See the responses to the specific sections above for more explanation.

Also, under historical conditions, dead wood in the Flagtail Fire performed these functions only to a negligible extent, because the dead wood tended to burn up.

Rough Calculation of N Fixation by *Ceanothus*

Hersh McNeil, 10-7-03

Calculation

The calculation is multiplicative for a given year since the fire:

N fixed in a given year = (Max fixation) * (Age factor) * (Tree factor)

where
Max fixation = the maximum rate of fixation (lb/ac), at the age of maximum fixation
Age Factor = a proportion between 1 and 0, that represents the decreased fixation due to age.
Tree Factor = a proportion between 1 and 0, that represents the decreased fixation due to presence of a tree canopy.

The N fixed in a given year is then summed for ages 1 to 50.

Max Fixation was set at an average of 10 lb/ac/year. Jurgensen et al. (1991) (p. 104) reported McNabb and others (1979) reported a fixation rate of 32 kg/ha/yr in a stand with 64% *Ceanothus* cover in northeastern Oregon. Presumably, this was an open grown brush field. This is the most similar site available. But, since *Ceanothus* is not expected to severely suppress tree regeneration in the Flagtail area (DEIS p. 84), *Ceanothus* probably would not form a brush field; average coverage under Alternative 1 probably would be only one third of 64%, so Max Fixation was set at 10 lb/ac/yr.

Age Factor: Busse (2000) (p. 29) reported that Youngberg & Wollum (1976) found that maximum N accretion started in year 7. For years 1-6, I assumed a sigmoid growth curve. I assumed maximum fixation (Age Factor =1) from ages 7 to 15. Busse (2000) (Fig. 2) believed 25 year old stands have 0.6 of the fixation of 15 year old stands, and 35 year old stands have 0.4 of the fixation of 15 year old stands. Between these ages, I assumed linear declines. Beyond 35 years, I assumed constant Age Factor 0.4.

Tree Factor: Busse (2000) (Tab. 3) reported his understory stands fixed 10 kg/ha/yr, whereas Youngberg & Wollum's (1976) open grown brush field fixed 72 kg/ha/yr. On this basis, I assumed the Tree Factor for a fully developed canopy of 0.15. I assumed that after tree stand regeneration, the trees were shorter than the shrubs for five years (Tree Factor = 1), and that the Tree Factor decrease linearly to 0.15 between 5 and 20 years after tree regeneration. For Alternative 1, for the 4300 acres with a tree seed source (DEIS p. 82), I assumed tree regeneration at 35 years. For the 1250 acres without a tree seed source, I assumed tree regeneration beyond 50 years. For the action alternatives, I assumed tree regeneration at year 5.

Results

	lb/ac N fixed through 50 years
Alt. 1 with tree seed source	290
Alt. 1 without tree seed source	300
Action Alternatives	160

Literature Cited

Jurgensen, M.F., Tonn, J.R., Graham, R.T., Harvey, A.E., & Geier-Hayes, K. 1991. Nitrogen fixation in forest soils of the inland northwest. pp. 101-109 in Harvey, A.E. & Neuenschwander, L.F. (compilers); Proceedings - management and productivity of western-montane forest soils, April 10-12 1990. Gen. Tech. Rep. INT-280. USDA For. Serv. Intermountain Res. Sta., Ogden, UT

Busse, M.D. 2000. Ecological significance of nitrogen fixation by actinorhizal shrubs in interior forests of California and Oregon. pp. 23-41 in Powers, R.F., Hauxwell, D.L., & Nakamura, G.M. (coordinators); Proceedings of the California Forest Soils Council conference on forest soils biology and forest management, February 23-24 1996. Gen. Tech. Rep. PSW-GTR-178. USDA For. Serv. Pacific Southwest Res. Sta., Albany, CA

Soil Erosion from Skidding on Flagtail Fire, Modeled by Disturbed WEPP

R.C. McNeil, Soils Specialist, 11-21-03

Use of Disturbed WEPP

Disturbed WEPP is a soil erosion model described at:
http://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/wd/weppdist.pl

I selected two units for modeling erosion. Both units had tractor yarding on high percentage of moderate and high burn severity. I selected Unit 004 as "worst case" because of its relatively high percentage of steep slopes. Unit 040 is more typical in that it has a low percentage of steep slopes.

I selected several sample "flow lines", dispersed about the units. A "flow line" is the line that shows where water placed on the flow line would flow. It extends from a ridge crest to a draw bottom (or to the edge of the unit). It is the basic "profile" for which Disturbed WEPP models erosion.

In order to keep the modeling tractable, and to show only the effects of skidding, I did not deal with flow lines that crossed roads. Depending on the situation, roads can either increase or decrease transport of eroded soil. They can decrease it by providing benches where eroded soil would be deposited. They can increase it by providing more concentrated water flow. In addition, roads produce sediment (usually small amounts in the Flagtail landscape), and sediment production probably would temporarily increase during log transport. The net effect of ignoring roads is probably a small underestimate of sediment production from logging.

I modeled skidtrail interactions with the sample flow lines, based on information from Mike Burgett, who designed the units and logging systems. I assumed about 120 feet between skid trails. In unit 040, most skidtrails would go down hill, parallel to flow lines. In unit 004, most of the major skidtrails would go down the ridge crest, and so do not intersect flow lines. In this unit, most of the skidtrails that do intersect the flow lines are on the sidehill, more or less perpendicular to the flow line. I assumed skidding would not go either uphill or sidehill on slopes steeper than 25%. I assumed that winching could be done up to 150' from skidtrails (50 ft. tall tree + 100 ft. line).

Disturbed WEPP models only two segments ("elements") of the flow line. I needed to model more segments than two. I used two different "work-around" methods - one where skidtrails cross flow lines, and a second where skidtrails lie parallel to flow lines. (For the following calculations, the "t/ac" erosion rate was used, not the "kg/m" rate.)

Skidtrails cross flow lines

I wanted a segment for each skid trail and a segment for each area between skidtrails. In order to model more than two segments, I followed this procedure:

1. Model the top two segments.
2. By adjusting the ground cover, model a single segment (an "equivalent segment") that has runoff and erosion as close as possible to the runoff and erosion from the two segments.

3. Add the effect of the next lower segment, using the "equivalent segment" as the upper segment.
4. Repeat steps 2 and 3 until the bottom segment is reached.

Skidtrails lie parallel to flow lines

Sediment from the skidtrail was modeled as follows:

1. Model erosion without skidtrail.
2. Divide the skidtrail into portions, based on waterbar placement.
3. For each skidtrail portion:
    a. Model erosion, with skidtrail portion as upper segment and undisturbed land as the lower segment.
    b. Model erosion, with skidtrail portion as undisturbed.
    c. Subtract erosion to find effect of skidtrail portion.
4. Sum effects of all skidtrail portions.
5. Adjust skidtrail effects for the fact that skidtrails occupy 10% of the land.

Disturbed WEPP Variables

All Runs

Climate: "Flagtail1" - Start with Austin. Adjust temperatures with the lapse rate to 5300 feet. Increase precipitation 25% to 25 inches and increase number of days with precipitation by 25% to 137.
loam (soil type 33)
35% Rock

Off Skidtrail

Short Grass prairie (see Disturbed WEPP Documentation)
45% Ground Cover.

Skidtrail

The Disturbed WEPP "Skidtrail Treatment" doesn't seem to work, relative to "Short Grass." For instance, 40% slope, 40' long, 30% entered Cover, 30% Rock, skidtrail erodes 0.20 t/ac, but short grass erodes 0.28 t/ac. Possibly, this apparent reduction in erosion results from reduced detachability resulting from compaction. However, reduced erosion is not expected on skidtrails. For this reason, skid trails are modeled as:
Short Grass
10% Ground Cover

Results

Erosion varies with weather; years with relatively high intensity thunderstorms have more erosion than years that lack these storms. Disturbed WEPP handles this variability by randomly selecting a year's weather (for a given climate), calculating erosion, and then repeating this process for a number of years. I present the results of Disturbed WEPP as an "average" soil erosion, averaged for the different years.

Table 1. Effect of skidding on average soil erosion in 2004 for two units (assuming 1 g/cm^3 (1.19 yd^3/ton)).

Sample	Erosion with No Skidding (yd^3/ac)	Erosion with Skidding (yd^3/ac)	Increase due to Skidding (yd^3/ac)
------------	-- Unit 4 --	---------------	---------------
0	0.42	0.48	0.06
3	0.40	0.48	0.07
5	0.19	0.26	0.07
6	0.19	0.24	0.05
7	0.33	0.43	0.10
9	0.38	0.45	0.07
mean	0.32	0.39	0.07
------------	- Unit 40 --	---------------	---------------
31	0.18	0.24	0.06
32	0.24	0.30	0.06
33	0.26	0.32	0.06
34	0.21	0.29	0.07
35	0.20	0.26	0.06
36	0.32	0.40	0.08
mean	0.24	0.30	0.07

On average, less than 0.003 inches of soil would erode in 2004. This amount is negligible. In about two years out of three, no overland runoff or erosion would occur. (The average includes the years when there is no erosion. So if we look at just the years with erosion, we expect more than the average erosion rate of erosion.) A "5-year" rainfall would produce about the average erosion. A "15-year" rainfall would produce about 7 times as much erosion as average. The effect of skidtrails appears fairly constant on both units, about 0.07 yd^3/ac. This is because on the flatter ground, waterbars would be spaced further apart.

Soil Type by Unit
R.C. McNeil, 2-24-04

UNIT	acres	logging system	soils	>30% Slope (% of unit)	most abundant mapped soil	% of unit	2nd most abundant mapped soil	% of unit	3rd most abundant mapped soil	% of unit	> 35% slope (% of unit)
001	43	T	31,32,33	18	31C32C33	100		0		0	9
002	29	S	31,32,33	69	31C32C33	100		0		0	43
003	36	T	31,32,33	24	31C32C33	100		0		0	8
004	162	T	31,32,33	23	31C32C33	94		0		0	10
005	13	T	31,32,33	14	31C32C33	78	32C33	22		0	7
006	58	T	31,32,33	27	31C32C33	90	32C33	9		0	16
007	35	T	31	2	31C32C33	100		0		0	0
008	166	S	31,32,33	73	32C33	92	31C32C33	6		0	55
009	22	H	32,33	88	32C33	96		0		0	81
010	35	H	31,33	78	31C33	62	36	38		0	65
011	19	T	31	7	31C32C33	100		0		0	2
012	18	T	31,33	24	31C33	99		0		0	5
013	6	H	31,33	66	33	100		0		0	57
014	56	H	31,33	70	33	76	31C32	13	34C35	6	53
015	7	H	31,32	58	31C32	97		0		0	27
016	2	H	31,33	73	31C33	90	34C35	6		0	60
017	8	S	31,33	18	31C33	100		0		0	6
018	31	S	31,32,33	65	32C33	56	31C33	44			45
019	36	H	31,36	80	36	64	31C33	21	33C34	11	67
020	7	H	31,32,33	58	32C33	100		0		0	45
022	85	S	31,32,33	78	32C33	100		0		0	67
024	43	H	32,33	90	32C33	100		0		0	78
025	26	H	31,32,33	57	32C33	100		0		0	42
026	29	T	31,32,33	14	31	71	32C33	27		0	6
028	24	T	31	8	31	92	32C33	7		0	2
030	131	S	32,33	82	32C33	65	31C33	33		0	65
032	55	T	31	9	31C33	95		0		0	3
034	97	T	31	12	31	76	31C33	18		0	5
036	5	H	31	1	31	100		0		0	0
038	93	T	31	1	31	100		0		0	0
040	70	T	31	12	31	84	31C32	16			6
042	10	T	31	9	31	100		0		0	2
044	63	S	31,32,33	63	31C32	54	31C33	46		0	42
045	7	T	31	0	31C32C33	100		0		0	0
046	1	T	31	0	31C32C33	100		0		0	0
048	30	T	31,32,33	34	31C32	56	32C33	30	34C35	14	17
050	23	H	31,32,33	70	32C33	56	34C35	43		0	56
052	52	H	31,32,33	57	32C33	82	34C35	9	31C33	9	38
054	18	H	31,33	44	31C33	94		0		0	25
056	101	T	31	11	31C33	85	31C32C33	12		0	5
057	38	T	31	10	31C33	100		0		0	4
058	30	T	31	3	31C32C33	88	31C33	12		0	2
059	7	T	31	1	31C32C33	100		0		0	0

UNIT	acres	logging system	soils	>30% Slope (% of unit)	most abundant mapped soil	% of unit	2nd most abundant mapped soil	% of unit	3rd most abundant mapped soil	% of unit	> 35% slope (% of unit)
060	21	H	31,33	52	31C33	77	34C35	16			29
062	13	T	31,33	15	31C33	100		0		0	4
063	16	T	31,33	27	31C33	97		0		0	10
064	26	H	31,33	66	31C33	79	34C35	16		0	43
065	40	T	31	2	31C33	100		0		0	1
066	3	T	31	0	31C33	100		0		0	0
067	60	T	31	3	31	74	34C35	15	31C33	11	1
068	20	H	31	9	31	92		0		0	2
069	13	H	31,33	36	31C33	74	34C35	11	31	6	15
070	42	T	31	3	31	95		0		0	1
071	5	H	31	1	34C35	100		0		0	0
072	21	T	31,32,33	18	31	72	34C35	13	31C33	10	10
073	38	T	31	1	31C37	100		0		0	1
074	46	T	31	1	31C34	38	31C37	35	31	15	0
075	174	T	31	1	31	93		0		0	1
076	15	T	31	0	31C34	68	31	32		0	0
077	46	T	31	0	31C34	70	31	29		0	0
078	40	T	31	7	31	85	31C34	15		0	2
080	41	T	31	7	31	100		0		0	1
081	8	T	31	11	31	100		0		0	7
082	82	T	31	11	31C34	55	31	42			3
083	21	T	31	3	31	99		0		0	1
084	17	S	31,32	45	31C32	70	31C34	20	31	8	23
085	34	S	31,32	68	31C32	99		0		0	48
086	57	T	31	15	31	67	31C34	12	31C32	9	7
087	56	H	31,32,33	58	31C32	39	33C34	31	34C35	13	35
088	254	H	31,32,33	41	33C34	36	31C32	26	31C33	14	20
090	97	T	31	4	31	93		0		0	1
100	119	T	31	7	31C32C33	100		0		0	2
102	60	S	31,32	17	31C32	90	31C32C33	7		0	4
104	73	T	31	9	31C32	98		0		0	3
106	26	S	31,32	54	31C32	98		0		0	38
108	49	S	32,33	90	31C32	68	31C32C33	32		0	74
110	5	T	31,32,33	34	31C32C33	100		0		0	15
112	1	T	31,32,33	18	31C32C33	100		0		0	3
114	32	T	31,32,33	18	31C32C33	60	31C32	40			5
116	174	T	31	7	31C32C33	79	31C32	16		0	2
118	104	T	31	11	31C32C33	88	31C32	12		0	3
120	99	T	31	6	31C32C33	82	31C32	18		0	2
122	169	H	41,59	43	41C46	41	58C59	25	31C32	18	21
123	41	T	58,31	5	58C59	76	31C32	17	41C46	7	0
124	47	T	31,42	1	42	68	31C32	32		0	0
125	18	T	31,58,59	20	58C59	69	31C32	30		0	8
126	9	S	31,32	71	31C32	90	42	10		0	25
128	28	T	31	9	31C32	50	31C32C33	45		0	2

130	103	T	31	9	31C32C33	83	31C32	12	42	5	3
UNIT	acres	logging system	soils	>30% Slope (% of unit)	most abundant mapped soil	% of unit	2nd most abundant mapped soil	% of unit	3rd most abundant mapped soil	% of unit	> 35% slope (% of unit)
132	8	H	31,32,42	82	31C32	55	42	45		0	48
134	38	T	42	4	42	100		0		0	2
136	40	S	31,32,42	72	42	73	31C32	25		0	37
138	48	T	42,58	9	42	63	58C59	32		0	2
140	45	S	31,32,58,59	49	58C59	68	31C32	28		0	30
142	58	S	58,59	76	58C59	92	46C47	5		0	58
144	27	T	42,46	0	46C47	57	42	43		0	0
146	3	T	42,46	0	46C47	100		0		0	0
148	24	T	58,59	15	58C59	93	46C47	7		0	5
150	60	T	31	7	31C32	52	31C32C33	48		0	2
152	39	T	58,59	34	58C59	91	42	9		0	7
154	43	T	31,42	6	42	60	31C32C33	38		0	1
156	2	S	58,59	25	58C59	100		0		0	18
158	8	T	58,59	43	58C59	100		0		0	21
160	12	S	58,59	60	58C59	100		0		0	30
162	4	S	58	6	58C59	100		0		0	1
164	4	T	58,59	31	58C59	100		0		0	12
166	13	S	58,59	18	58C59	74	42	21		0	5
168	6	T	42,32	22	42	83	31C32	17		0	3
170	10	S	31,32,33	45	31C32	72	31C32C33	28		0	11
172	18	T	31	1	31C32C33	100		0		0	0
174	2	T	31	0	31C32C33	100		0		0	0
176	14	T	31	0	31C32C33	100		0		0	0
178	29	T	31	1	31C32C33	100		0		0	0
180	76	T	31	3	31C32C33	100		0		0	0
182	50	T	31	2	31C32C33	100		0		0	0
184	4	T	31	2	31C32C33	100		0		0	0
186	19	T	31	4	31C32C33	100		0		0	2

Subsoiling Units
R.C. McNeil, 12-19-04

UNIT	SubUnit	Alt 2 & 5 acres	Alt. 3 acres	
006	COLD54	11	11	
032	9614A	9	9	
034	9614A	91	91	
056	9607S02C		51	Alt. 3 only
056	VAT201B	15	15	
059	9607S02C	5	5	
073	VAT295		15	Alt. 3 only
074	VAT295		11	Alt. 3 only
075	H75A_UNK	34	34	
075	VAT347	13	13	
077	29606	6	6	
078	29605	26	26	
090	9614D	54	54	
090	H90_UNK	13	13	
118	SNOW34	35	35	
120	SNOW37	23	23	
120	SNOW33	25	25	
150	JACK08	8		not in Alt.3
180	JACK01B	19		not in Alt.3
180	JACK01A	58		not in Alt.3
182	JACK01B	41	41	
total		486	478	
subsoil		44	43	