Fuel Treatment for Patch Clear Cuts

on the Sloan-Kennally Timber Sale

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EXECUTIVE SUMMARY

The goal of this project is to ensure that post harvest 0-3 inch fuel loading, on the patch clear cuts within the Sloan-Kennally timber sale, will be in compliance with Forest Service Manual – 5100, Payette National Forest Supplement 5100-93-1, standards.

In order to meet this goal the existing 0-3 inch fuel loading on the patch clear cuts was determined. This was added to the predicted amount of 0-3 inch fuel that would be created during harvest activity. The total 0-3 inch fuel loading was compared to the Payette Supplement standards for the given slope.

The total 0-3 inch fuel loading would exceed the Payette Supplement standards and would require treatment. Viable treatment alternatives were compared. The least cost alternative was chosen as the preferred alternative.

Fire behavior was also analyzed. This was to determine the predicted flame length that would occur should a wildfire ignite after harvest but before fuel treatment took place. A flame length of 4 feet at the head of a fire is considered the maximum that can be directly attacked by ground personnel.

BACKGROUND

The Sloan-Kennally Timber Sale will harvest timber on approximately 571 acres of the estimated 5100 acre Sloan-Kennally planning area. The Sloan-Kennally planning area lies within the Sloans and Kennally Creek drainages of the Gold Fork Watershed within Management Area 20, Fall Creek/Paddy Flat, on the Payette National Forest. The planning area includes approximately 2100 acres of the multiple use portion of the Needles Roadless Area. The Needles Roadless Area contains an estimated 132,340 acres of which 25,383 acres were allocated for multiple use, including timber management, in the Payette National Forest Land and Resource Management Plan (Forest Plan) approved in 1988. The planning area was analyzed in the Final Environmental Impact Statement (FEIS) for the Forest Plan. The analysis was programmatic and allowed but did not mandate development. The analysis concluded that the timber stands in the area were biologically capable, administratively available, tentatively suitable, and economically viable for management. The Sloan-Kennally sale will harvest timber in and near the Needles Roadless Area.

The original Draft Environmental Impact Statement (DEIS) for the Sloan-Kennally Timber Sale was released to the public in September 1994. However, due to changes and delays caused by a record wildfire season in 1994, the post fire salvage efforts in 1995, amendment of the Payette National Forest Land and Resource Management Plan (Forest Plan) by INFISH (Inland Native Fish Strategy) in 1995, major flooding on the Forest in 1997 and other changes since the release of the 1994 DEIS, the Forest was delayed in completing the Final Environmental Impact Statement (FEIS). In 1998, a new Interdisciplinary (ID) Team was assigned to reanalyze the Sloan-Kennally Timber Sale in light of the changes that had occurred since the 1994 DEIS. The ID Team produced a new DEIS that was responsive to the many changes and released it to the public in September 1999. One of the changes the 1999 DEIS responded to was the Payette National Forest's adoption of *Management Recommendations for the Northern Goshawk in the Southwestern United States* (Reynolds, et al. 1992) as policy.

The Northern Goshawk is a sensitive species and there are two known goshawk nests within the project area. The home range for the goshawk covers about 6000 acres and is divided into three components, one of which is the post fledgling/family area. There are 11, 3-acre, patch clear cut, sale units within the Needles Roadless Area. These patch clear cuts, in response to issues raised during scooping, were designed to enhance post fledgling/family area habitat.

PROBLEM STATEMENT

Harvest activity on the patch clear cuts will increase the loading of 0-3 inch fuels. No determination has been made as to whether this increase will cause the total loading of 0-3 inch fuels to exceed the standards in FSM – 5100 Payette National Forest Supplement 5100-93-1 and therefore require treatment of the fuels.

GOAL

Ensure the post harvest 0-3 inch fuel loading on the patch clear cuts meets the FSM – 5100 Payette National Forest Supplement 5100-93-1 standards.

OBJECTIVES

Determine whether the post harvest 0-3 inch fuel loading on the patch clear cuts will meet or exceed the Payette Supplement standards.

Develop fuel treatment alternatives including no treatment.

If the post harvest loading will exceed the Payette Supplement standards, determine the lowest cost viable treatment method that will bring the 0-3 inch fuel loading back into compliance with the standards.

DIRECTION

Direction for fuels management on the Payette National Forest is found in several places.

1. Forest Service Manual 5100 – Fire Management
    a. Chapter 5150 Fuel Management
    b. WO Amendments
    c. Payette National Forest Supplements
2. Payette National Forest Land and Resource Management Plan
    a. Chapter IV Forest Management Direction
    b. Management Area 20 - Fall Creek/Paddy Flat - Management Direction
3. Payette National Forest Fire Management Action Plan
    a. Chapter 50 – Fuel/Residue Management

Forest Service Manual 5100 – Fire Management

<u>Chapter 5150 – Fuel Management</u>

Chapter 5150 of the Forest Service Manual 5100 – Fire Management, addresses fuel management directly.

WO Amendment 5100-91-8

Washington Office Amendment 5100-91-8 pertains to Chapter 5150 directly. In the amendment under 5150.3 – Policy, item 1.a. states among other things: Consider a full range of fuel management alternatives, including no treatment. Item 2 states: Manage fuel in accordance with fire management direction in the Forest Land and Resource Management Plan. Part 5151 – Fuel Treatment, states: Initiate fuel treatment in accordance with the Forest Land and Resource Management Plan and the Fire Management Action Plan. Part 5151.1 – Methods of Fuel Treatment, states: Consider the following treatment options, in the priority listed, when developing fuel management direction and plans.

1. Utilization. Use methods that reduce unwanted fuel through improved harvest techniques or through higher utilization standards. Favor utilization when the cost of onsite treatment equals the cost of removal for utilization.
2. Rearrangement. Redistribute fuel onsite to a condition that is less hazardous, or that enables more rapid deterioration or more effective disposal.
3. Removal. Remove unwanted fuel offsite for further utilization, storage or disposal.
4. Disposal. Reduce or eliminate unwanted fuel onsite. Methods include manual, mechanical, chemical, biological, and prescribed fire treatments and their necessary associated activities.
5. Conversion. Replace hazardous fuel with less flammable fuel or fuel that offers less resistance to suppression.
6. Nontreatment. Where appropriate, identify if and when fire program costs plus anticipated net value changes do not justify fuel treatment.
7. Interim Protection. Provide protection on an interim basis only when the hazard of newly created fuel cannot be abated in a timely manner and where:
    a. An analysis of hazard and risks fully supports the cost-effectiveness of interim protection.
    b. Treatment takes place as soon as practical following creation of the hazard.
8. Supplemental Protection. Use supplemental protection only if the economic analysis indicates that this is the most cost-efficient means of mitigating the fire hazard until deterioration of fuel makes such protection unnecessary. Supplemental protection may be justifiable in limited situations as part of an overall land management strategy. When justified, the responsible line officer must annually review and approve its continued use.

Part 5152 – Economic Analysis, states: Include economic criteria in the decision process for evaluating proposed fuel treatment programs and activities, and for selecting the practices used to perform fuel treatment. Use conventional economic evaluation procedures to determine the most cost-efficient alternative.

Payette National Forest Supplement 5100-93-1

Payette National Forest Supplement 5100-93-1 also pertains to FSM 5100 – Fire Management, Chapter 5150 – Fuel Management. It states "FSM 5150 requires an analysis to determine the level of activity fuel treatment that is appropriate. This supplement provides the standards to be followed on the Payette National Forest to meet that requirement." The subheading "Standards for Planning Timber Sale Slash Treatment" states: "These standards provide only for acceptable fire hazard; additional treatment may be required to meet other land management objectives." It goes on to state: "To determine if treatment is needed start with the slope class of the unit or stand in question, then select the appropriate fuel loading." Fuel loading in this case includes the existing and activity generated fuels, under 3-inches in diameter.

For the Payette Supplement, slope is divided into three ranges: 0 – 40%, 41 – 60% and over 60%. The fuel loadings associated with these slope ranges are ≥ 15 t/ac, ≥12 t/ac, and ≥ 7 t/ac, respectively. If the total 0-3 inch fuel loading on a unit, after harvest activity takes place, is less than the amount listed for the given slope range, no treatment for fire hazard abatement is required. If total fuel loading meets or exceeds the loading constraint, treatment for fire hazard abatement is required.

Payette National Forest Land and Resource Management Plan

Chapter IV Forest Management Direction

"Forestwide Standards and Guidelines" are found in Chapter IV. Under this heading are found the subheadings "Standards And Guidelines For Fire And Fuels", "Fuel Treatments", and then "Activity Fuels Improvements", respectively. Direction here states "Slash to be treated to minimize chances of large wildfire, but will not be cleared to the point that the forest floor is void of all slash, logs, and organic material." Further, "Emphasize utilization of unmerchantable material to reduce total fuel loads."

Management Area 20 Fall Creek/Paddy Flat

"Proposed and Probable Management Practices for Management Area 20" are found in this chapter. Under this heading is more specific direction. It states: "In Addition To The Forestwide Standards And Guidelines, The Following Management Practices Will Apply:" this is followed by several subheadings. Under the subheading "Protection" is "Activity Fuel Improvements" which states: "Utilize prescribed fire to treat fuels associated with timber harvest activities. Emphasis will be the reduction of fire hazard associated with activity fuels and improvement of sites for regeneration."

Payette National Forest Fire Management Action Plan

Chapter 50 – Fuel/Residue Management

The contents of Chapter 50 discuss objectives and management direction.

Part 51 – Fuel Treatment Objectives, states: "Levels and methods of fuel treatment will be guided by the resource objectives within the management area." In this case the management area is Management Area 20 Fall Creek/Paddy Flat.

Part 51.1 – Fuel Residue Management Direction, states: "Prescribed fire may be used to treat natural and activity related fuels as specified by management area direction." Again, the pertinent area is Management Area 20 Fall Creek/Paddy Flat. It goes on to state: "The following provides general guidance for the use of fire to treat fuels throughout the forest." The subheading General Forest Area pertains to timber harvest activity. It states: "Residue loadings from activity fuels will be treated to minimize the chances of large wildfires but should not be cleared to the point that the forest floor is devoid of all slash and logs. Some slash and larger dead material should be left for ground cover, soil protection, microclimates for establishment of trees, and small mammal habitat."

ALTERNATIVES

In determining alternatives, including the no treatment alternative, the most specific criteria for whether treatment is required or not is found in the Forest Service Manual 5100 – Fire Management, Payette National Forest Supplement 5100-93-1. This supplement gives specific fuel loading/slope combination standards that govern treatment requirements.

The most restrictive direction for methods of treatment is found in the Payette National Forest Land and Resource Management Plan in the chapter Management Area 20 Fall Creek/Paddy Flat. Under the heading "Proposed and Probable Management Practices for Management Area 20" it states "In Addition To The Forestwide Standards And Guidelines, The Following Management Practices Will Apply". The pertinent subheadings, relating to this statement, concerning timber harvest activity fuels are Protection and Activity Fuel Improvements respectively. The specific direction states: "Utilize prescribed fire to treat fuels associated with timber harvest activities. Emphasis will be the reduction of fire hazard associated with activity fuels and improvement of sites for regeneration."

After reviewing the specific direction from the various sources, the following alternatives have been developed:

Alternatives

Alternative 1 - No Treatment
Alternative 2 - Whole Tree Yarding by Helicopter, Machine Pile and Burn At Landing
Alternative 3 - Hand Pile and Burn
Alternative 4 - Broadcast Burn

In analyzing the alternatives several assumptions are being made due to the way in which the timber cruise data was obtained and reported for the actual sale. (The cruise printout is provided in the appendix.) The cruise data was compiled by strata rather than by individual unit. For the Sloan-Kennally Sale there were two strata; strata 1 outside the roadless area and strata 2 within the roadless area. The eleven, 3-acre, patch clear cuts comprise strata 2. Helicopter logging is necessary for these units due to their location within the roadless area. All of the patch clear cuts are on slopes less than 40%.

In reality the units are similar but not exactly the same regarding the number, species and diameter breast height (DBH) of the trees to be harvested. For this paper I am going to use a simple per acre average based on all the trees listed in strata 2 in determining the tons/acre of activity fuels generated. Further, I am making the assumption that the existing fuel loading is the same for all the patch clear cuts. The sum total will determine whether treatment is required or not.

To determine the existing fuel loading on the patch clear cuts I used the *Photo Guide For Appraising Downed Woody Fuels In Montana Forests:* Interior Ponderosa Pine, Ponderosa Pine-Larch-Douglas-Fir, Larch-Douglas-Fir, and Interior Douglas-Fir Cover Types. The Photo and Data Sheet on page 107, Interior Douglas-fir, Douglas-fir/pinegrass-pinegrass phase (PSME/CARU-CARU) represent the existing condition. (Copy in the appendix.) The listed weight for existing downed 0-3 inch material is 5.1 tons/acre.

To calculate the tons/acre of 0-3 inch activity fuel generated from the harvest activity, I used the *Handbook for Predicting Slash Weight of Western Conifers*, USDA Forest Service, General Technical Report INT-37 and the species and DBH data from the Sloan-Kennally Timber Sale, Cruise Number: 12383. The Handbook provides tables, which give the weight of slash produced, expressed on an oven-dried basis (page 24). The print out from Cruise 12383 is provided in the appendix. An excel spreadsheet I built which uses information from these documents is found on the next two pages. It determines the tons/acre of 0-3 inch fuel that will be produced by the harvest activity.

When the existing **5.1 tons/acre** of 0-3 inch fuel is added to the **13.5 tons/acre** of 0-3 inch activity fuels generated, the resulting total is **18.6 tons/acre** of 0-3 inch fuels. This is over the standard of 15.0 tons/acre of 0-3 inch fuel for 0-40% slopes listed in the Payette National Forest Supplement 5100-93-1. **This means that treatment of 0-3 inch fuels is required and that Alternative 1 – No Treatment will be no longer considered.**

Sloan Kennally Slash Weight Summary for Strata 2

Estimated Number Of Trees By 2" Diameter Class (For Cut Trees Only)
(12-inch class = 11.0 - 12.9 inches; 14-inch class = 13.0 - 14.9 inches, and so on.)
PY is immature Ponderosa Pine

Number of Trees By Species and DBH
From Cruise Number 12383

Species / DBH	DF	LP	GF	PY	PP	Totals
1-4	0	0	0	0	0	0
6	0	0	0	0	0	0
8	0	0	0	0	0	0
10	368	1364	313	0	0	2045
12	134	116	0	0	0	250
14	225	95	0	0	0	320
16	139	0	0	0	0	139
18	154	0	163	0	0	317
20	54	0	61	22	16	153
22	98	0	50	12	0	160
24	65	0	27	7	0	99
26	26	0	17	0	0	43
28	0	0	0	0	9	9
30	0	0	0	0	5	5
32	0	0	0	0	0	0
34	0	0	0	0	0	0
36	0	0	0	0	0	0
38	0	0	0	0	0	0
40	0	0	0	0	2	2
Totals	1263	1575	631	41	32	3542

Weight Per Tree--Crown And Tip Under 3-inches (Pounds)
From Table 4 General Technical Report INT-37
Handbook for Predicting Slash Weight of Western Conifers

DBH	DF	LP	GF	PY	PP
1-4	40	29	45	35	35
6	64	46	77	66	66
8	97	74	120	111	111
10	137	112	175	170	170
12	184	155	242	243	243
14	239	205	324	328	328
16	299	262	422	426	426
18	377	325	538	536	536
20	476	396	637	658	658
22	588	473	741	790	790
24	713	556	852	933	933
26	852	645	968	1090	1090
28	1000	741	1090	1250	1250
30	1170	844	1220	1420	1420
32	1350		1350	1600	1600
34	1550		1490	1780	1780
36	1760		1630	1980	1980
38	1990		1780	2180	2180
40	2240		1930	2380	2380

Sloan Kennally Slash Weight Summary for Strata 2

Slash Weight By Species and DBH
In Pounds

Species DBH	DF	LP	GF	PY	PP	
1-4	0	0	0	0	0	
6	0	0	0	0	0	
8	0	0	0	0	0	
10	50416	152768	54775	0	0	
12	24656	17980	0	0	0	
14	53775	19475	0	0	0	
16	41561	0	0	0	0	
18	58058	0	87694	0	0	
20	25704	0	38857	14476	10528	
22	57624	0	37050	9480	0	
24	46345	0	23004	6531	0	
26	22152	0	16456	0	0	
28	0	0	0	0	11250	
30	0	0	0	0	7100	
32	0	0	0	0	0	
34	0	0	0	0	0	
36	0	0	0	0	0	
38	0	0	0	0	0	
40	0	0	0	0	4760	
Totals	380291	190223	257836	30487	33638	892475 lbs.

Strata 2 covers 33 acres.
Total pounds/2000/33=T/AC.

892475 lbs / 2000 / 33 acres = 13.5 T/AC

Alternative 2 - Whole Tree Yarding by Helicopter, Machine Pile and Burn At Landing, will also be no longer considered. This is due to the timber sale itself. As noted in the cruise the minimum top DIB is 6 inches. In order for this alternative to have been viable the sale contract itself would have to have been changed.

This leaves **Alternative 3** – Hand Pile and Burn, and **Alternative 4** – Broadcast Burn, as viable alternatives to be analyzed further.

FIRE BEHAVIOR

For fire suppression purposes, the Patch Clear Cuts are within the Southern Idaho Timber Protection Association's (SITPA) initial response area, rather than the McCall Ranger District's. These types of areas are considered offset lands, in that they offset state and private lands that the McCall District has initial suppression responsibility for, elsewhere.

An assessment of the potential fire behavior within the Patch Clear Cuts will help SITPA plan suppression actions, should a fire ignite after harvest activity takes place, but before fuel treatment occurs.

In terms of fire behavior, the existing condition is represented by NFFL Fuel Model 8 (FM-8), closed canopy stands of short needled conifers. The post harvest condition would be represented by NFFL Fuel Model 11 (FM-11), light logging slash. To determine the expected fire behavior under these conditions I used the Behave: Fire Behavior Prediction and Fuel Modeling System (Behave). I ran the program using variables predicted under both average and 90th percentile weather conditions for the period July 1 to September 15. (Data descriptions for FM-8 and FM-11 are provided in the appendix.)

The variables that are entered into the Behave model to predict fire behavior for FM-8 and FM-11 are the dead 1,10 and 100 hour fuel moistures, midflame windspeed and slope. For this comparison I held slope constant at 30%.

To determine values for the 1, 10 and 100 hour fuel moistures and midflame windspeed I used Fire Family Plus, a software system that summarizes and analyzes daily weather observations. In general, the weather observations come from Remote Automated Weather Stations (RAWS) that download the data to an archive in Kansas City. Since each RAWS has a unique identifier the archive can be queried for data from a single or multiple RAWS. This data can then be downloaded, as a database, into the Fire Family Plus system. In this particular case the weather observation data came from RAWS 101223 – SKIHIL, which represents Management Area 20, Fall Creek/Paddy Flat.

The output from Fire Family Plus is in the form of graphs. (The graphs are in the appendix.) The predicted 1, 10 and 100 hour fuel moistures for both average and 90th percentile weather are easily determined and can be used as direct inputs to Behave. The windspeeds recorded by the RAWS and provided through Fire Family Plus are 20-foot windspeeds. These need to be converted to midflame windspeeds before they can be

input to Behave. The "Wind Adjustment Table" found in section III of the *Fire Behavior Field Reference Guide* (NFES 2224) provides adjustment factors to convert 20-foot windspeeds to midflame windspeeds. In this case the conversion factor is ".4", which pertains to unsheltered fuels and both FM-8 and FM-11.

The outputs provided by Behave show that for a FM-8, under 90th percentile weather conditions, the flame lengths from the head of a surface fire are predicted to be 1.1 feet. For a FM-11, under 90th percentile weather, the flame lengths from the head of a surface fire are predicted to be 3.6 feet. This is significant because the maximum flame length that is considered to be attackable by ground personnel is 4.0 feet. In this case, according to the Behave predictions, if a fire were to start in one of the patch clear cuts after harvest activity took place (FM-11), ground personnel should be able to attack the head of the fire. Further, if the fire reached the surrounding standing timber (FM-8), the flame lengths should diminish.

Alternative 3 – Hand Pile and Burn, would treat the activity fuels in such a manner that they would change the patch clear cuts from a Fuel Model 11 back to a Fuel Model 8. **Alternative 4** – Broadcast Burn would change the patch clear cuts from a Fuel Model 11 to a potential Fuel Model 8, given anticipated regrowth.

COSTS

The cost/acre of the treatment activities hand piling and burning, broadcast burning, and thinning, was determined through discussions with the forest fuels specialist and district fuels personnel. These costs were determined to be:

Broadcast Burning	$140.00/acre
Thinning	$180.00/acre
Hand Piling and Burning	$300.00/acre

The cost calculation for **Alternative 3** – Hand Pile and Burn, is relatively easy. 11 patch clear cuts of 3-acres each times the cost of $300.00/acre. The cost of Alternative 3 is:

11x3=33x$300.00= $9,900.00 Total Cost

The cost calculation for **Alternative 4** – Broadcast Burn, is slightly more complex. The patch clear cuts are being logged by helicopter, therefore, there will be no mechanical trampling of saplings or other residual vegetation. In order to effectively broadcast burn the units the residual fuels will have to be cut down to provide a uniform fuelbed. After consulting with other fuels personnel it was felt that thinning costs would best approximate the cost of doing this. The costs of Alternative 4 are:

11x3=33x$180.00= $ 5,940.00 Thinning Cost
11x3=33x$140.00= $ 4,620.00 Burning Cost
11x3=33x$320.00= $10,560.00 Total Cost

Alternative 3 – Hand Pile and Burn is the least costly alternative.

SUMMARY

The original goal was to ensure that the post harvest 0-3 inch fuel loading on the patch clear cuts would meet the Payette Supplement standards. This goal was met through accomplishing the three objectives.

Objective 1, to determine whether the post harvest 0-3 inch fuel loading would meet or exceed the Payette Supplement standards was accomplished by measuring the existing and activity generated fuels. The loading was found to exceed the Supplement standards and therefore, treatment was required.

Objective 2, to develop fuel treatment alternatives including no treatment, was accomplished by developing the four treatment alternatives:
Alternative 1 – No Treatment
Alternative 2 – Whole Tree Yarding by Helicopter, Machine Pile and Burn At Landing
Alternative 3 – Hand Pile and Burn
Alternative 4 – Broadcast Burn

Alternative 1, No Treatment was dropped from consideration when treatment was found to be required.

Alternatives 2,3, and **4** were all viable alternatives according to specific direction found in Management Area 20 Fall Creek/Paddy Flat, which stated that prescribed fire would be the treatment method used in this management area. However, while considered viable, **Alternative 2**, Whole Tree Yarding by Helicopter, Machine Pile and Burn At Landing, was found to be not in compliance with the timber contract specifications and was therefore dropped from further consideration.

Objective 3, to determine the lowest cost viable treatment method that will bring the 0-3 inch fuel loading back into compliance with the Payette Supplement standards, was accomplished by comparing the costs of the two remaining viable alternatives, **Alternative 3**, Hand Pile and Burn and **Alternative 4**, Broadcast Burn.

Alternative 3, **Hand Pile and Burn, was determined to be the least costly viable alternative, and therefore chosen as the preferred alternative.**

REFERENCES

Brown, James K., Snell, J.A. Kendall, and Bunnell, David L., 1977. *Handbook For Predicting Slash Weight Of Western Conifers.* USDA Forest Service General Technical Report INT-37. Intermountain Forest and Range Experiment Station, Ogden Utah.

Fisher, William C.,1981. *Photo Guide For Appraising Downed Woody Fuels In Montana Forests:* Interior Ponderosa Pine, Ponderosa Pine-Larch-Douglas-Fir, Larch-Douglas-Fir, and Interior Douglas-Fir Cover Types. National Wildfire Coordinating Group, NFES 2293.

National Wildfire Coordinating Group, 1992. *Fire Behavior Field Reference Guide*. National Interagency Fire Center. Boise, Idaho.

USDA Forest Service, 1988. *Payette National Forest Land and Resource Management Plan.* Payette N.F., McCall Idaho.

USDA Forest Service, 1999. *Payette National Forest. Sloan-Kennally Timber Sale. Final Environmental Impact Statement.* McCall Ranger District. Valley County, Idaho.

USDA Forest Service, 2000. *Payette National Forest. Sloan-Kennally Timber Sale Record of Decision.* McCall Ranger District. Valley County, Idaho.

USDA Forest Service. *Fire Management Action Plan*. Payette National Forest. McCall, Idaho.

USDA Forest Service. *Forest Service Manual 5100 – Fire Management*. Washington D.C.

APPENDIX

Sloan-Kennally Timber Cruise Number 12383 **17**

Data sheet from *Photo Guide For Appraising Downed Woody Fuels In Montana Forests* **27**

Fire Family Plus Graphs **28**

Fuel Model 8 **30**

Fuel Model 11 **31**

Behave Printouts **32**

USDA FOREST SERVICE

NATIONAL TIMBER CRUISING PROGRAM (NATCRS)

VERSION 7.13:A|7.13:B

RELEASE DATE: A: 06/16/98 B: 06/16/98

RUN DATE: 01-14-02 RUN TIME: 15:06:26

WASHINGTON OFFICE - TIMBER MANAGEMENT
FORT COLLINS, COLORADO
(970)498-1808

CRUISE HEADER

CRUISE NUMBER: 12383

SALE NUMBER: 12383

REGION: 4

SALE NAME: Sloan Kennally

FOREST: 12

YEAR: 1998

DISTRICT: 03

REPORTS REQUESTED

A1,A1,TC18,TC24

RUN DATE: 01-14-02
PAGE 2
CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383
INPUT FILE NAME: 12383.JOB
REGION: 4

VOLUME EQUATION TABLE

SECONDARY ****** PRODUCT ******						PRIMARY ******* PRODUCT ********				
SPECIES	PROD	VOLUME EQUATION	STUMP HEIGHT	TOTAL CUBIC VOLUME	MIN TOP DIB	BDFT	CUFT	CORDS	MIN TOP DIB	CUFT	CORDS
DF	01	401MATW202	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
DF	02	401MATW202	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
WL	01	400MATW073	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
WL	02	400MATW073	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
LP	01	400MATW108	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
LP	02	400MATW108	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
AF	01	400MATW019	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
DAF	02	400MATW019	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
ES	01	400MATW093	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
ES	02	400MATW093	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
GF	01	400MATW015	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
GF	02	400MATW015	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
PP	01	400MATW122	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
PP	02	400MATW122	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
PY	01	400MATW122	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
PY	02	400MATW122	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
gf	01	400MATW015	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO
gf	02	400MATW015	1.0	NO	6.0	YES	YES	NO	0.0	NO	NO

CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383

REPORT A1
VERSION 7.13:B
STRATA AND UNIT REPORT
2A RECORDS

RECORD TYPE	CRUISE NO.	CUTTING UNIT NO.	CUTTING UNIT ACRES	CUTTING UNIT DESCRIPTION	LOG METHOD	PAYMENT UNIT NO.
2A	12383	102	0.00		TRA	
2A	12383	114	0.00		TRA	
2A	12383	115	0.00		TRA	
2A	12383	117	0.00		TRA	
2A	12383	118	0.00		TRA	
2A	12383	119	0.00		TRA	
2A	12383	124	0.00		TRA	
2A	12383	125	0.00		TRA	
2A	12383	144	0.00		TRA	
2A	12383	240	0.00		TRA	
2A	12383	243	0.00		TRA	
2A	12383	244	0.00		TRA	
2A	12383	245	0.00		TRA	
2A	12383	247	0.00		TRA	
2A	12383	250	0.00		TRA	
2A	12383	253	0.00		TRA	
2A	12383	333	0.00		TRA	
2A	12383	339	0.00		TRA	
2A	12383	425	0.00		TRA	
2A	12383	426	0.00		TRA	
2A	12383	427	0.00		TRA	
2A	12383	428	0.00		TRA	
2A	12383	432	0.00		TRA	
2A	12383	433	0.00		TRA	
2A	12383	435	0.00		TRA	
2A	12383	712	0.00		TRA	
2A	12383	715	0.00		HEL	
2A	12383	717	0.00		TRA	
2A	12383	718	0.00		TRA	
2A	12383	826	0.00		TRA	
2A	12383	827	0.00		TRA	
2A	12383	828	0.00		TRA	
2A	12383	999	0.00		TRA	
2A	12383	320	0.00		HEL	
2A	12383	321	0.00		HEL	
2A	12383	322	0.00		HEL	
2A	12383	323	0.00		HEL	
2A	12383	324	0.00		HEL	
2A	12383	325	0.00		HEL	
2A	12383	326	0.00		HEL	

RUN DATE: 01-14-02
PAGE 4
CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383

REPORT A1
VERSION 7.13:B
STRATA AND UNIT REPORT
2A RECORDS

RECORD TYPE	CRUISE NO.	CUTTING UNIT NO.	CUTTING UNIT ACRES	CUTTING UNIT DESCRIPTION	LOG METHOD	PAYMENT UNIT NO.
2A	12383	327	0.00		HEL	
2A	12383	328	0.00		HEL	
2A	12383	329	0.00		HEL	
2A	12383	330	0.00		HEL	

TOTAL SALE ACRES: 0.00

RUN DATE: 01-14-02
PAGE 5
CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383

REPORT A1
VERSION 7.13:B
STRATA AND UNIT REPORT
3A RECORDS

RECORD TYPE	CRUISE NO.	STRATA NO.	CRUISE METHOD	STRATA ACRES	BAF	PLOT SIZE	NO. OF PLOTS	STRATA DESCRIPTION	DATE MMYYYY
3A	12383	1	3P	521.00	0.00	0.	0		081998
3A	12383	2	3P	33.00	0.00	0.	0		19

RUN DATE: 01-14-02
PAGE 6
CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383

REPORT A1
VERSION 7.13:B
STRATA AND UNIT REPORT
4A RECORDS

RECORD TYPE	CRUISE NO.	STRATA NO.	CUTTING UNIT NO.	STRATA/UNIT ACRES
4A	12383	1	102	12.00
4A	12383	1	114	6.00
4A	12383	1	115	17.00
4A	12383	1	117	17.00
4A	12383	1	118	29.00
4A	12383	1	119	24.00
4A	12383	1	124	13.00
4A	12383	1	125	14.00
4A	12383	1	144	39.00
4A	12383	1	240	10.00
4A	12383	1	243	6.00
4A	12383	1	244	28.00
4A	12383	1	245	7.00
4A	12383	1	247	40.00
4A	12383	1	250	2.00
4A	12383	1	253	6.00
4A	12383	1	333	33.00
4A	12383	1	339	19.00
4A	12383	1	425	16.00
4A	12383	1	426	3.00
4A	12383	1	427	37.00
4A	12383	1	428	3.00
4A	12383	1	432	11.00
4A	12383	1	433	16.00
4A	12383	1	435	24.00
4A	12383	1	712	3.00
4A	12383	1	715	37.00
4A	12383	1	717	3.00
4A	12383	1	718	3.00
4A	12383	1	826	16.00
4A	12383	1	827	15.00
4A	12383	1	828	11.00
4A	12383	1	999	1.00
4A	12383	2	320	3.00
4A	12383	2	321	3.00
4A	12383	2	322	3.00
4A	12383	2	323	3.00
4A	12383	2	324	3.00
4A	12383	2	325	3.00
4A	12383	2	326	3.00
4A	12383	2	327	3.00

RUN DATE: 01-14-02
PAGE 7
CRUISE #: 12383
SALENAME: Sloan Kennally
SALE #: 12383

REPORT A1
VERSION 7.13:B
STRATA AND UNIT REPORT
4A RECORDS

RECORD TYPE	CRUISE NO.	STRATA NO.	CUTTING UNIT NO.	STRATA/UNIT ACRES
4A	12383	2	328	3.00
4A	12383	2	329	3.00
4A	12383	2	330	3.00

RUN DATE: 01-14-02 REPORT TC18 - STAND TABLE FOR STRATA 1
PAGE 8
CRUISE #: 12383 VERSION 7.13:B
SALENAME: Sloan Kennally ESTIMATED NUMBER OF TREES
SALE #: 12383 BY 2" DIAMETER CLASS (FOR CUT TREES ONLY)

(12-inch class = 11.0 - 12.9 inches; 14-inch class = 13.0 - 14.9 inches, and so on.)

SPEC / PROD / U OF M	DF / ALL / ALL	GF / ALL / ALL	PP / ALL / ALL	LP / ALL / ALL	PY / ALL / ALL	ES / ALL / ALL	WL / ALL / ALL	AF / ALL / ALL	TOTALS
1-4	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
8	970	1	0	5788	0	0	0	0	6759
10	1176	1162	0	2794	431	634	0	634	6831
12	1595	1991	0	1817	0	490	0	0	5894
14	470	1807	0	1200	58	307	0	0	3843
16	279	797	0	0	0	173	167	0	1416
18	229	345	0	146	0	124	0	0	843
20	136	326	0	0	0	0	112	0	575
22	261	106	31	0	0	70	0	0	468
24	89	37	14	0	0	54	0	0	195
26	92	74	10	0	0	0	0	0	176
28	0	60	31	0	0	0	0	0	91
30	26	0	0	0	0	0	0	0	26
32	0	21	0	0	0	0	0	0	21
34	0	0	0	0	0	0	0	0	0
36	0	0	7	0	0	0	0	0	7
38	24	0	2	0	0	0	0	0	26
40	7	0	3	0	0	0	0	0	10
42	0	0	2	0	0	0	0	0	2
44	1	0	4	0	0	0	0	0	5
TOTALS	5356	6729	104	11745	489	1853	279	634	27189

RUN DATE: 01-14-02 REPORT TC18 - STAND TABLE FOR STRATA 2
PAGE 9
CRUISE #: 12383 VERSION 7.13:B
SALENAME: Sloan Kennally ESTIMATED NUMBER OF TREES
SALE #: 12383 BY 2" DIAMETER CLASS (FOR CUT TREES ONLY)

(12-inch class = 11.0 - 12.9 inches; 14-inch class = 13.0 - 14.9 inches, and so on.)

SPEC / PROD / U OF M	DF / ALL / ALL	LP / ALL / ALL	GF / ALL / ALL	PY / ALL / ALL	PP / ALL / ALL	TOTALS
1-4	0	0	0	0	0	0
6	0	0	0	0	0	0
8	0	0	0	0	0	0
10	368	1364	313	0	0	2045
12	134	116	0	0	0	250
14	225	95	0	0	0	320
16	139	0	0	0	0	139
18	154	0	163	0	0	317
20	54	0	61	22	16	153
22	98	0	50	12	0	160
24	65	0	27	7	0	99
26	26	0	17	0	0	44
28	0	0	0	0	9	9
30	0	0	0	0	5	5
32	0	0	0	0	0	0
34	0	0	0	0	0	0
36	0	0	0	0	0	0
38	0	0	0	0	0	0
40	0	0	0	0	2	2
TOTALS	1263	1575	631	41	32	3542

RUN DATE: 01-14-02 REPORT TC24 - STAND TABLE FOR SALE 12383
PAGE 10
CRUISE #: 12383 VERSION 7.13:B
SALENAME: Sloan Kennally ESTIMATED NUMBER OF TREES
SALE #: 12383 BY 2" DIAMETER CLASS (FOR CUT TREES ONLY)

(12-inch class = 11.0 - 12.9 inches; 14-inch class = 13.0 - 14.9 inches, and so on.)

SPEC / PROD / U OF M	DF / ALL / ALL	GF / ALL / ALL	PP / ALL / ALL	LP / ALL / ALL	PY / ALL / ALL	ES / ALL / ALL	WL / ALL / ALL	AF / ALL / ALL	TOTALS
1-4	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
8	970	1	0	5788	0	0	0	0	6759
10	1544	1476	0	4158	431	634	0	634	8877
12	1730	1991	0	1933	0	490	0	0	6144
14	695	1807	0	1295	58	307	0	0	4163
16	418	797	0	0	0	173	167	0	1555
18	383	508	0	146	0	124	0	0	1160
20	190	387	16	0	22	0	112	0	729
22	359	157	31	0	12	70	0	0	628
24	154	64	14	0	7	54	0	0	293
26	118	91	10	0	0	0	0	0	220
28	0	60	40	0	0	0	0	0	100
30	26	0	5	0	0	0	0	0	32
32	0	21	0	0	0	0	0	0	21
34	0	0	0	0	0	0	0	0	0
36	0	0	7	0	0	0	0	0	7
38	24	0	2	0	0	0	0	0	26
40	7	0	5	0	0	0	0	0	12
42	0	0	2	0	0	0	0	0	2
44	1	0	4	0	0	0	0	0	5
TOTALS	6620	7361	136	13320	531	1853	279	634	30733

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DATA SHEET

Stand No. 28A

FOREST COVER TYPE: SAF NO. 210, Interior Douglas-fir

MONTANA HABITAT TYPE: NO. 323, Douglas-fir/pinegrass-pinegrass phase (PSME/CARU-CARU)

DOWN & DEAD WOODY FUEL LOADINGS

Size Class (Inches)	Weight T/ac	Weight Kg/m²
0-0.25	0.4	0.09
0.25-1	1.1	0.25
1-3	3.6	0.81
Subtotal 0-3	5.1	1.15
3-6	2.0	0.45
6-10	0.8	0.18
10-20	0.4	0.09
20+	0	0
SUBTOTAL 3+	3.2	0.72
TOTAL	8.3	1.87

NFDRS FUEL MODEL	STYLIZED FUEL MODEL
H/G	8/10

OTHER FUEL DATA

Average duff depth: 2.4 in / 6.10 cm

Average diameter, 3+ fuels: 3.9 in / 9.91 cm

Percent rotten, 3+ fuels: 41 %

Volume of **sound** 3+ fuels: 151 ft³/ac / 10.6 m³/ha

STAND AND SITE DATA

Age of overstory dominants:
PICO 77 yrs
PSME 70 yrs

Average slope: 14 %
Aspect: northeast
Elevation: 5250 ft 1600 m

Remarks: Fire Ecology Group Six

FIRE POTENTIAL RATING

Based on an average bad day: 85-90° temp., 15-20% R.H., 10-15 mi/h wind, 4 weeks since rain

Rate of Spread: high
Intensity: medium
Torching: low
Crowning: medium
Resistance to control: medium

Overall Fire Potential MEDIUM

STAND LOCATION

National Forest: Helena
Ranger District: Lincoln
Drainage: Keep Cool Cr.

Photo taken: 7/28/78
By: W. C. Fischer

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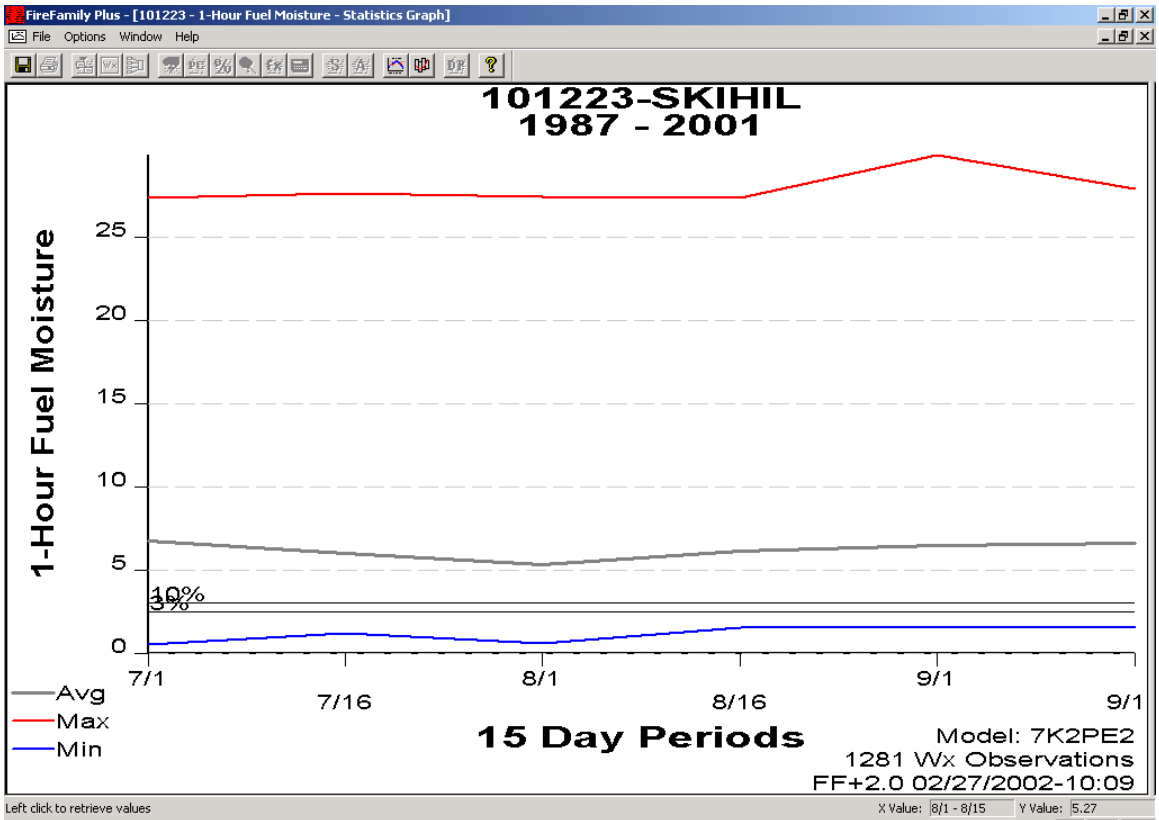
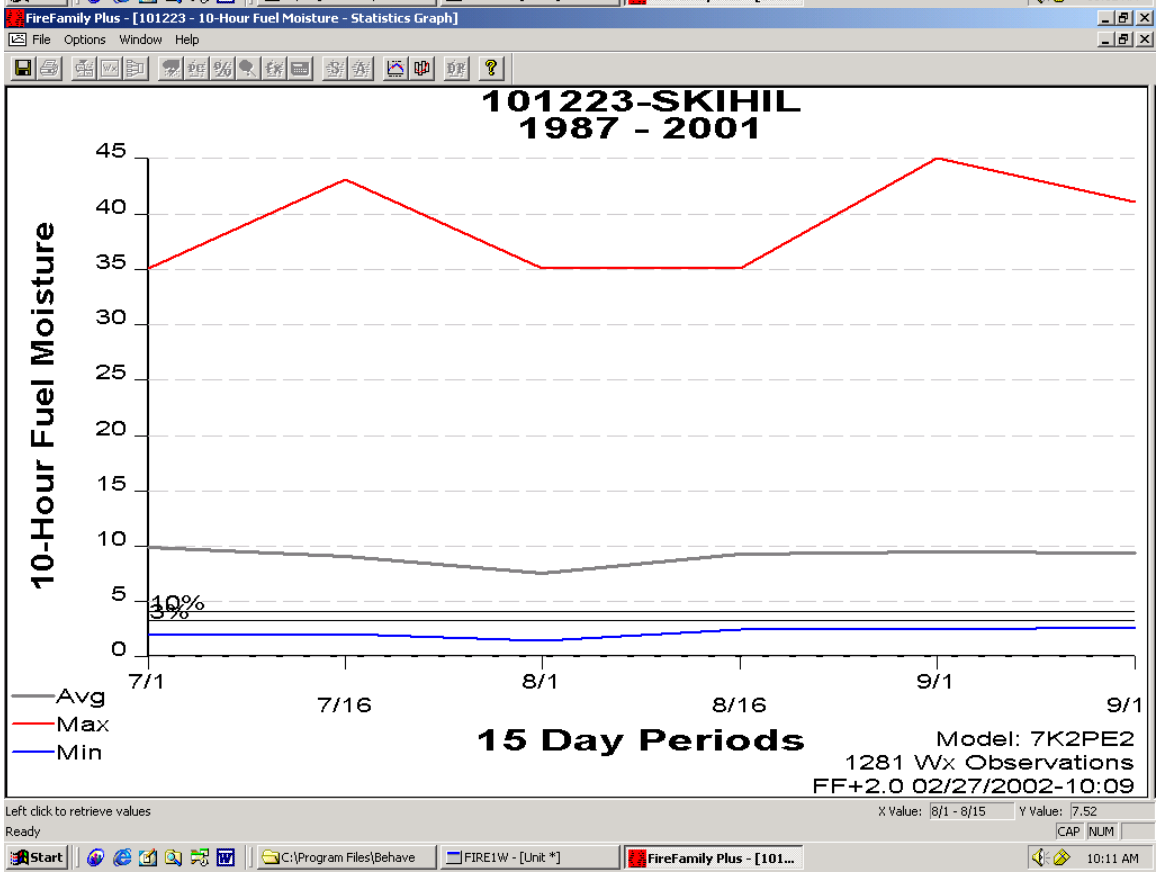
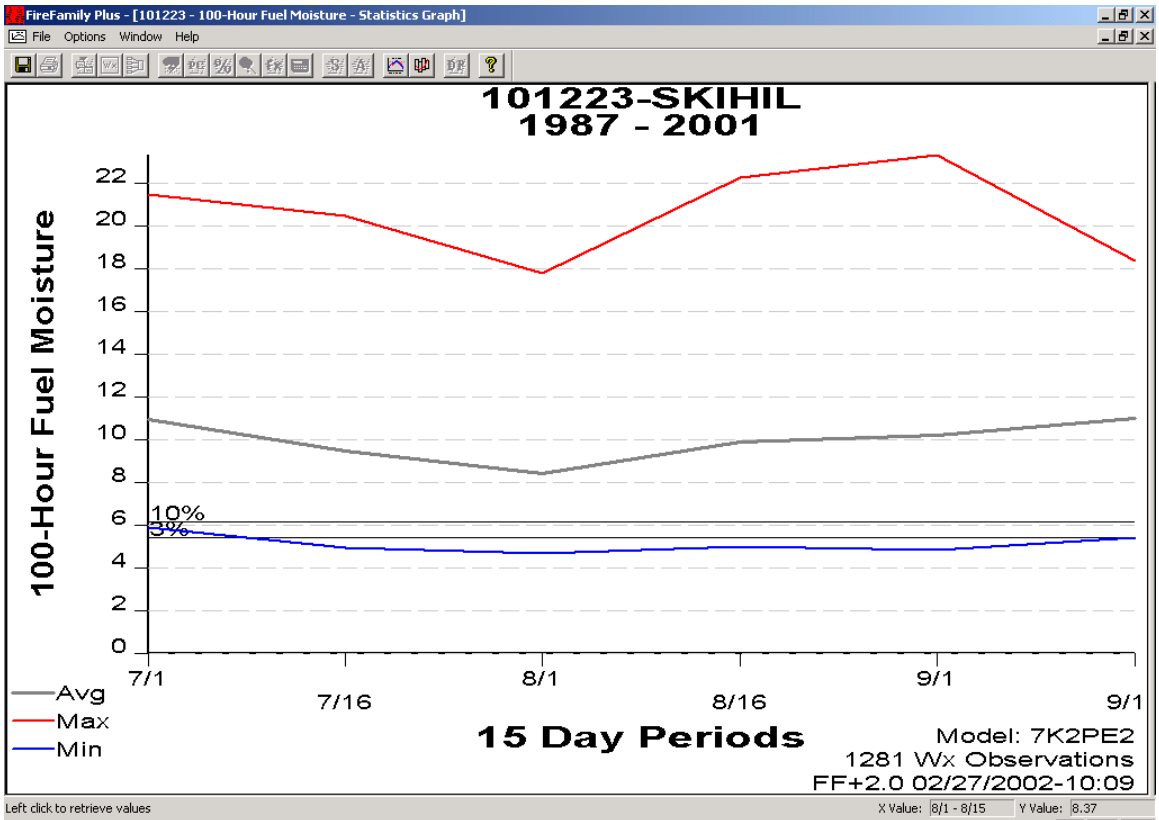
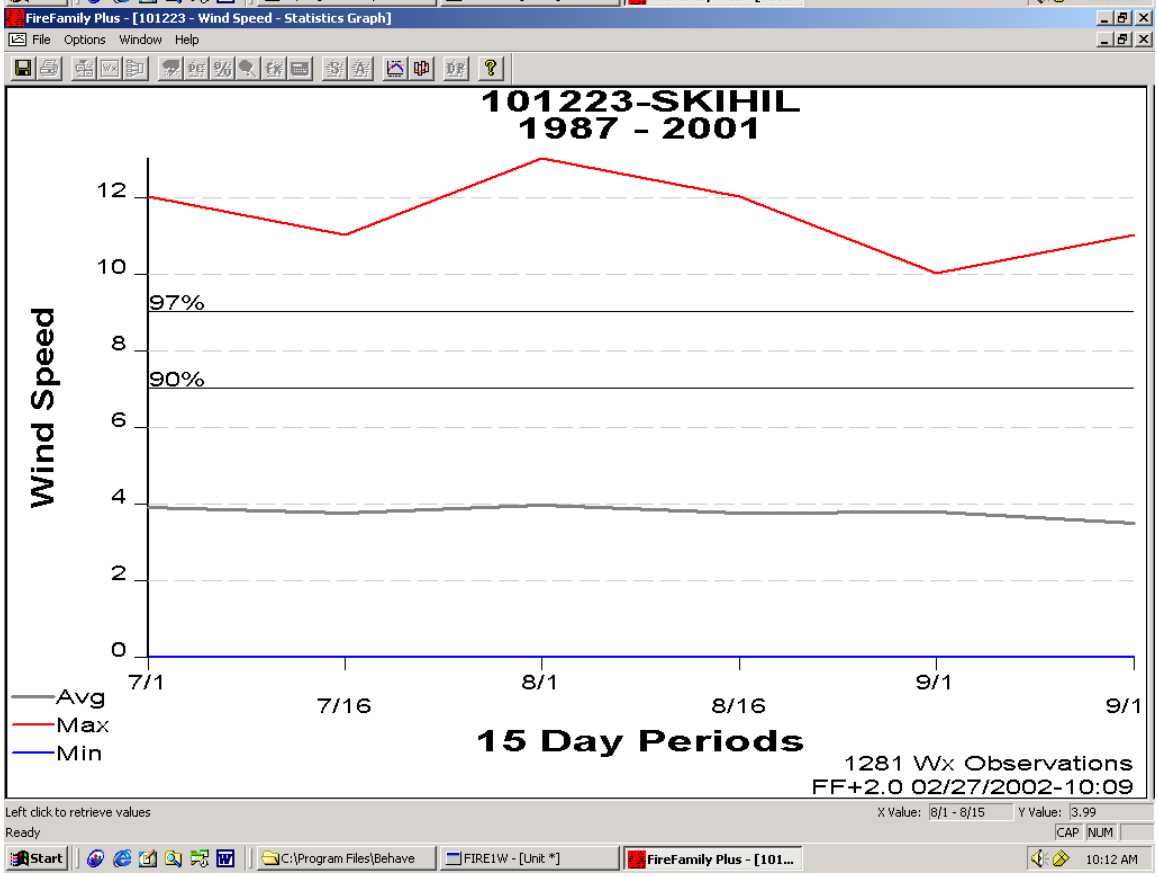

FireFamily Plus - [101223 - 1-Hour Fuel Moisture - Statistics Graph]
File Options Window Help
101223-SKIHIL
1987 - 2001
1-Hour Fuel Moisture
25
20
15
10
5
0
10%
3%
7/1
7/16
8/1
8/16
9/1
9/1
Avg
Max
Min
15 Day Periods
Model: 7K2PE2
1281 Wx Observations
FF+2.0 02/27/2002-10:09
Left click to retrieve values
X Value: 8/1 - 8/15
Y Value: 5.27
Ready
CAP NUM
Start
C:\Program Files\Behave
FIRE1W - [Unit *]
FireFamily Plus - [101...
10:12 AM


FireFamily Plus - [101223 - 10-Hour Fuel Moisture - Statistics Graph]
File Options Window Help
101223-SKIHIL
1987 - 2001
10-Hour Fuel Moisture
45
40
35
30
25
20
15
10
5
0
10%
3%
7/1
7/16
8/1
8/16
9/1
9/1
Avg
Max
Min
15 Day Periods
Model: 7K2PE2
1281 Wx Observations
FF+2.0 02/27/2002-10:09
Left click to retrieve values
X Value: 8/1 - 8/15
Y Value: 7.52
Ready
CAP NUM
Start
C:\Program Files\Behave
FIRE1W - [Unit *]
FireFamily Plus - [101...
10:11 AM


FireFamily Plus - [101223 - 100-Hour Fuel Moisture - Statistics Graph]
File Options Window Help
101223-SKIHIL
1987 - 2001
100-Hour Fuel Moisture
22
20
18
16
14
12
10
8
6
4
2
0
10%
3%
7/1
7/16
8/1
8/16
9/1
9/1
Avg
Max
Min
15 Day Periods
Model: 7K2PE2
1281 Wx Observations
FF+2.0 02/27/2002-10:09
Left click to retrieve values
X Value: 8/1 - 8/15
Y Value: 8.37
Ready
CAP NUM
Start
C:\Program Files\Behave
FIRE1W - [Unit *]
FireFamily Plus - [101...
10:10 AM


FireFamily Plus - [101223 - Wind Speed - Statistics Graph]
File Options Window Help
101223-SKIHIL
1987 - 2001
Wind Speed
12
10
8
6
4
2
0
97%
90%
7/1
7/16
8/1
8/16
9/1
9/1
Avg
Max
Min
15 Day Periods
1281 Wx Observations
FF+2.0 02/27/2002-10:09
Left click to retrieve values
X Value: 8/1 - 8/15
Y Value: 3.99
Ready
CAP NUM
Start
C:\Program Files\Behave
FIRE1W - [Unit *]
FireFamily Plus - [101...
10:12 AM

Timber Group

Fire Behavior Fuel Model 8

Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Representative conifer types are white pine, and lodgepole pine, spruce, fir, and larch.

This model can be used for 1978 NFDRS fuel models H and R. Photographs 22, 23, and 24 illustrate the situations representative of this fuel.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch, dead and live, tons/acre	5.0
Dead fuel load, ¼-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	0.2

Photo 22. Surface litter fuels in western hemlock stands of Oregon and Washington.

Photo 23. Understory of inland Douglas-fir has little fuel here to add to dead-down litter load.

Photo 24. Closed stand of birch-aspen with leaf litter compacted.

Logging Slash Group

Fire Behavior Fuel Model 11

Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential. Light partial cuts or thinning operations in mixed conifer stands, hardwood stands, and southern pine harvests are considered. Clearcut operations generally produce more slash than represented here. The less-than-3-inch (7.6-cm) material load is less than 12 tons per acre (5.4 t/ha). The greater-than-3-inch (7.6-cm) is represented by not more than 10 pieces, 4 inches (10.2 cm) in diameter, along a 50-foot (15-m) transect.

The 1978 NFDRS fuel model K is represented by this model and field examples are shown in photographs 31, 32, and 33.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	11.5
Dead fuel load, ¼-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	1.0

Photo 31. Slash residues left after skyline logging in western Montana.

Photo 32. Mixed conifer partial cut slash residues may be similar to closed timber with down woody fuels.

Photo 33. Light logging residues with patchy distribution seldom can develop high intensities.

Fuel Model 8 – Average Weather

```
WELCOME TO THE BEHAVE SYSTEM
  BURN SUBSYSTEM
    FIRE1 PROGRAM: VERSION 4.4 -- FEBRUARY 1997

DEVELOPED BY:  THE FIRE BEHAVIOR RESEARCH WORK UNIT
               INTERMOUNTAIN FIRE SCIENCES LABORATORY
               MISSOULA, MONTANA

YOU ARE RESPONSIBLE FOR SUPPLYING VALID INPUT AND FOR
  CORRECTLY INTERPRETING THE FIRE BEHAVIOR PREDICTIONS.

ASSUMPTIONS, LIMITATIONS, AND APPLICATION OF MATHEMATICAL
  MODELS USED IN THIS PROGRAM ARE IN:
  Andrews, Patricia L. "BEHAVE: Fire behavior prediction and
    fuel modeling system--BURN subsystem, Part 1", INT-GTR-194, 1986
  Andrews, Patricia L., and Chase, Carolyn H. "BEHAVE: Fire
    behavior prediction and fuel modeling system--BURN
    subsystem, Part 2", INT-GTR-260, 1989


DIRECT
 1--FUEL MODEL -------------     8 -- CLOSED TIMBER LITTER
 2--1-HR FUEL MOISTURE, % --    5.3
 3--10-HR FUEL MOISTURE, % -    7.5
 4--100-HR FUEL MOISTURE, %     8.4
 7--MIDFLAME WINDSPEED, MI/H    1.6
 8--TERRAIN SLOPE, % -------   30.0
 9--DIRECTION OF WIND VECTOR     .0
     DEGREES CLOCKWISE
      FROM UPHILL
10--DIRECTION OF SPREAD ----     .0  (DIRECTION OF MAX SPREAD)
    CALCULATIONS
     DEGREES CLOCKWISE
      FROM UPHILL


    (VERSION 4.4)

     RATE OF SPREAD, CH/H ----------     1.
     HEAT PER UNIT AREA, BTU/SQFT --   195.
     FIRELINE INTENSITY, BTU/FT/S---     3.
     FLAME LENGTH, FT---------------      .8
     REACTION INTENSITY, BTU/SQFT/M    957.
     EFFECTIVE WINDSPEED, MI/H------     2.5
```

Fuel Model 8 – 90th Percentile Weather

```
WELCOME TO THE BEHAVE SYSTEM
  BURN SUBSYSTEM
    FIRE1 PROGRAM: VERSION 4.4 -- FEBRUARY 1997

DEVELOPED BY:  THE FIRE BEHAVIOR RESEARCH WORK UNIT
               INTERMOUNTAIN FIRE SCIENCES LABORATORY
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  Andrews, Patricia L., and Chase, Carolyn H. "BEHAVE: Fire
    behavior prediction and fuel modeling system--BURN
    subsystem, Part 2", INT-GTR-260, 1989


DIRECT
 1--FUEL MODEL -------------     8 -- CLOSED TIMBER LITTER
 2--1-HR FUEL MOISTURE, % --    2.9
 3--10-HR FUEL MOISTURE, % -    3.9
 4--100-HR FUEL MOISTURE, %     6.2
 7--MIDFLAME WINDSPEED, MI/H    2.8
 8--TERRAIN SLOPE, % -------   30.0
 9--DIRECTION OF WIND VECTOR     .0
     DEGREES CLOCKWISE
      FROM UPHILL
10--DIRECTION OF SPREAD ----     .0  (DIRECTION OF MAX SPREAD)
    CALCULATIONS
     DEGREES CLOCKWISE
      FROM UPHILL


    (VERSION 4.4)

     RATE OF SPREAD, CH/H ----------     2.
     HEAT PER UNIT AREA, BTU/SQFT --   227.
     FIRELINE INTENSITY, BTU/FT/S---     7.
     FLAME LENGTH, FT---------------     1.1
     REACTION INTENSITY, BTU/SQFT/M   1114.
     EFFECTIVE WINDSPEED, MI/H------     3.5
```

Fuel Model 11 – Average Weather

```
WELCOME TO THE BEHAVE SYSTEM
  BURN SUBSYSTEM
    FIRE1 PROGRAM: VERSION 4.4 -- FEBRUARY 1997

DEVELOPED BY:  THE FIRE BEHAVIOR RESEARCH WORK UNIT
               INTERMOUNTAIN FIRE SCIENCES LABORATORY
               MISSOULA, MONTANA

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    fuel modeling system--BURN subsystem, Part 1", INT-GTR-194, 1986
  Andrews, Patricia L., and Chase, Carolyn H. "BEHAVE: Fire
    behavior prediction and fuel modeling system--BURN
    subsystem, Part 2", INT-GTR-260, 1989


DIRECT
 1--FUEL MODEL -------------    11 -- LIGHT LOGGING SLASH
 2--1-HR FUEL MOISTURE, % --    5.3
 3--10-HR FUEL MOISTURE, % -    7.5
 4--100-HR FUEL MOISTURE, %     8.4
 7--MIDFLAME WINDSPEED, MI/H    1.6
 8--TERRAIN SLOPE, % -------   30.0
 9--DIRECTION OF WIND VECTOR     .0
     DEGREES CLOCKWISE
      FROM UPHILL
10--DIRECTION OF SPREAD ----     .0  (DIRECTION OF MAX SPREAD)
    CALCULATIONS
     DEGREES CLOCKWISE
      FROM UPHILL


    (VERSION 4.4)

     RATE OF SPREAD, CH/H ----------     3.
     HEAT PER UNIT AREA, BTU/SQFT --   767.
     FIRELINE INTENSITY, BTU/FT/S---    43.
     FLAME LENGTH, FT---------------     2.5
     REACTION INTENSITY, BTU/SQFT/M   2362.
     EFFECTIVE WINDSPEED, MI/H------     2.4
```

Fuel Model 11 – 90th Percentile Weather

```
WELCOME TO THE BEHAVE SYSTEM
  BURN SUBSYSTEM
    FIRE1 PROGRAM: VERSION 4.4 -- FEBRUARY 1997

DEVELOPED BY:  THE FIRE BEHAVIOR RESEARCH WORK UNIT
               INTERMOUNTAIN FIRE SCIENCES LABORATORY
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  Andrews, Patricia L., and Chase, Carolyn H. "BEHAVE: Fire
    behavior prediction and fuel modeling system--BURN
    subsystem, Part 2", INT-GTR-260, 1989


DIRECT
 1--FUEL MODEL -------------    11 -- LIGHT LOGGING SLASH
 2--1-HR FUEL MOISTURE, % --    2.9
 3--10-HR FUEL MOISTURE, % -    3.9
 4--100-HR FUEL MOISTURE, %     6.2
 7--MIDFLAME WINDSPEED, MI/H    2.8
 8--TERRAIN SLOPE, % -------   30.0
 9--DIRECTION OF WIND VECTOR     .0
     DEGREES CLOCKWISE
      FROM UPHILL
10--DIRECTION OF SPREAD ----     .0  (DIRECTION OF MAX SPREAD)
    CALCULATIONS
     DEGREES CLOCKWISE
      FROM UPHILL


    (VERSION 4.4)

     RATE OF SPREAD, CH/H ----------     6.
     HEAT PER UNIT AREA, BTU/SQFT --   883.
     FIRELINE INTENSITY, BTU/FT/S---    91.
     FLAME LENGTH, FT---------------     3.6
     REACTION INTENSITY, BTU/SQFT/M   2718.
     EFFECTIVE WINDSPEED, MI/H------     3.6
```