S-390

FIRE BEHAVIOR

UNIT II
FUELS CLASSIFICATION

STUDENT WORKBOOK for Individual Study

1981

The NATIONAL WILDFIRE COORDINATING GROUP consists of representatives from: United States Department of Agriculture Forest Service; United States Department of Interior Bureau of Indian Affairs; Bureau of Land Management, Fish and Wildlife Service, and National Park Service; and National Association of State Foresters.

ACKNOWLEDGEMENTS

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US Forest Service, Region 1, Missoula, MT.

Northern Forest Fire Laboratory, Missoula, MT.

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Bureau of Land Management, BIFC, Boise, ID.

Produced By

Boise Interagency Fire Center
3905 Vista Avenue
Boise, Idaho 83705

COURSE SCHEDULE

SELF-STUDY UNITS		APPROXIMATE HOURS *
0	Student Guide**	1/2
I	The Fire Environment**	2 1/2
II	**Fuels Classification**	**3**
III	Topography and Fire Behavior	2 1/2
IV	Temperature-Moisture Relationship	2 1/2
V	Fuel Moisture	3
VI	Local and General Winds	2 1/2
VII	Atmospheric Stability and Instability	3
VIII	Keeping Current with the Weather	2 1/2
IX	Extreme Fire Behavior	3
X	Fire Behavior Affects Fireline Tactics	3
XI	Fire Behavior Predictions	4
	Total Review Period for all Units	3
CONTROLLED ACTIVITY		
	Final Examination	2 1/2

* Includes time for unit tests or evaluations but not for break periods.

** Prerequisite units to this unit.

INSTRUCTIONS TO STUDENTS

This unit has been designed for self-instruction. In addition to the workbook, you will need the fire behavior field guide, an audio cassette tape player and the cassette tape for the unit, or you may use the reference text. A small calculator would be desirable.

The workbook section contains a series of questions, exercises and note-taking items which help you interact with the materials. Much technical information will be provided in the workbook and by the narrator on tape. If the tape proceeds too fast, manually pause it. An audible 'beep' will signal when you are to stop the tape and perform an assignment. When you complete an assignment, restart the tape as instructed in the workbook. Follow the workbook sequence. Do not go ahead until instructed.

FOR UNFAMILIAR TERMS USE THE GLOSSARY IN THE STUDENT GUIDE.

START THE TAPE, OR TURN TO THIS UNIT IN THE REFERENCE TEXT

UNIT OBJECTIVES

UPON COMPLETION OF THIS UNIT YOU WILL BE EXPECTED TO:

1. List and describe seven characteristics of fuels which affect fire behavior.

2. Give the four fuel timelag categories used to classify fuels and the range of fuel sizes for each.

3. Discuss why analysing fuels availability is essential to predicting fire behavior.

4. Discuss the fuel model concept and its utility for predicting fire behavior.

*5. Given fuel complex descriptions, determine the appropriate fire behavior fuel models using a key and descriptors.

*6. Given a fuel complex description and photo, identify those fuels characteristics which will most affect the spread and intensity of a wildfire.

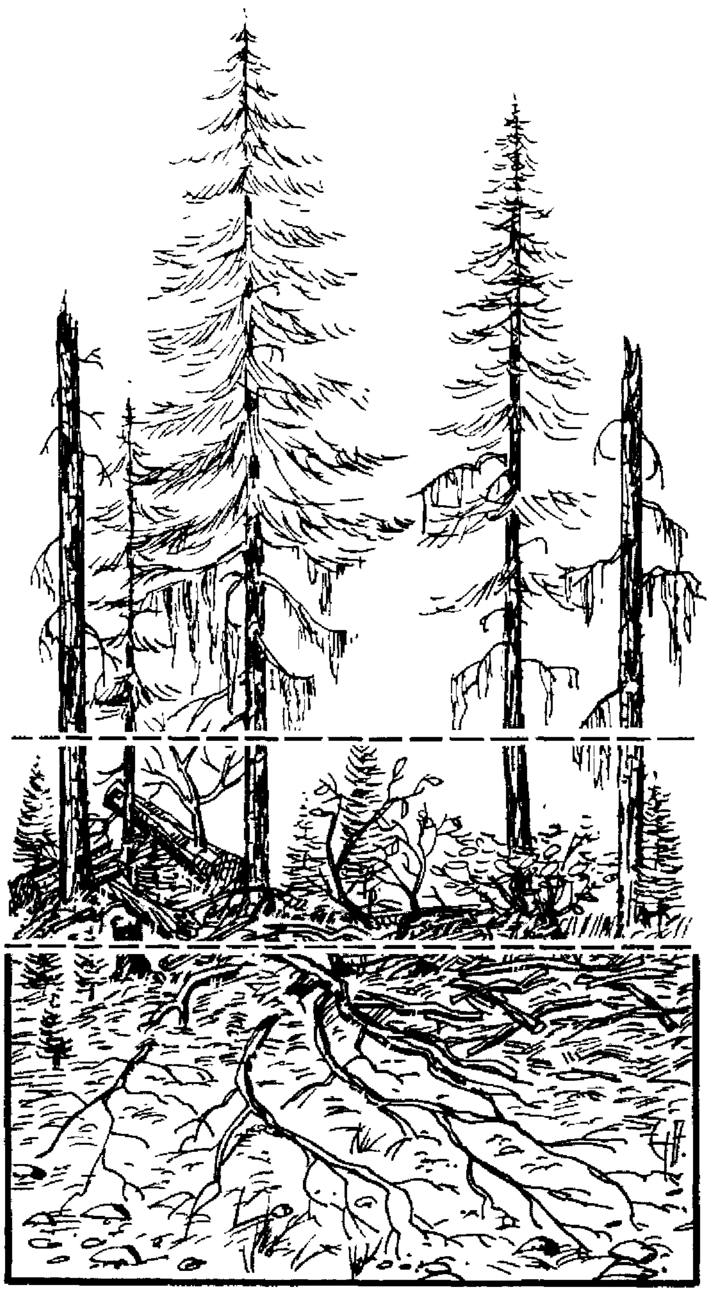
7. Given a fuel model and specific fuel complex characteristics, describe probable fire behavior.

* Key skill objectives

RESTART THE TAPE

FUELS DISTRIBUTION AND FIRE BEHAVIOR

FIGURE 1 — FUEL COMPONENTS AND LEVELS

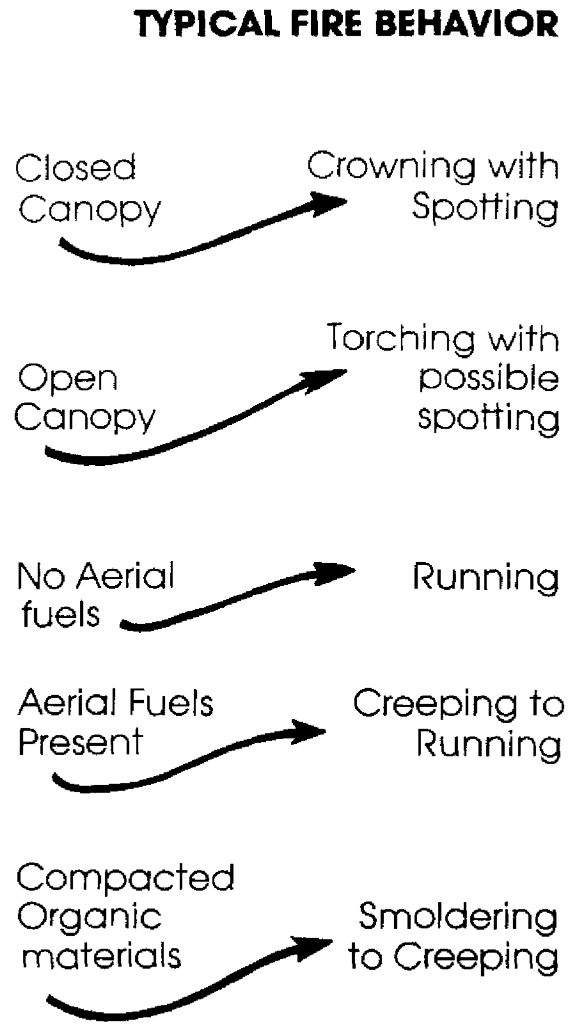


AERIAL FUELS: All green and dead materials located in the upper forest canopy including tree branches and crowns, snags, moss, and high brush.

SURFACE FUELS: All materials lying on or immediately above the ground including needles or leaves, duff, grass, small dead wood, downed logs, stumps, large limbs, low brush, and reproduction.

GROUND FUELS: All combustible materials lying beneath the surface including deep duff, roots, rotten buried logs, and other woody fuels.

FIGURE 2 — TYPICAL FIRE BEHAVIOR IN FUELS



QUESTION 1

The rate of spread in surface fuels with an overstory of aerial fuels is typically less because:

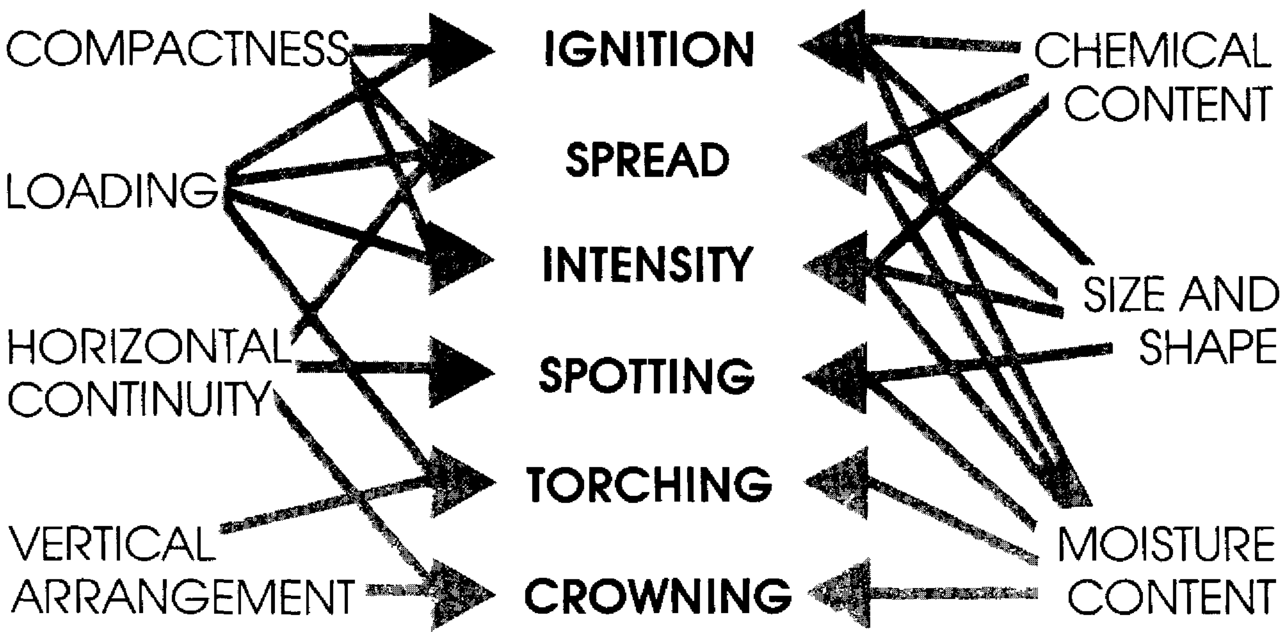
1. Shaded fuels normally have a higher fuel moisture.
2. General winds over terrain would have less effect on the surface fuels.
3. The sizes of surface fuels under a canopy of aerial fuels are likely to be larger.
4. Drying of fine fuels is generally slower in areas less exposed to the wind.

FUELS CHARACTERISTICS

A. THE PRINCIPAL FUEL CHARACTERISTICS WHICH AFFECT FIRE BEHAVIOR ARE:

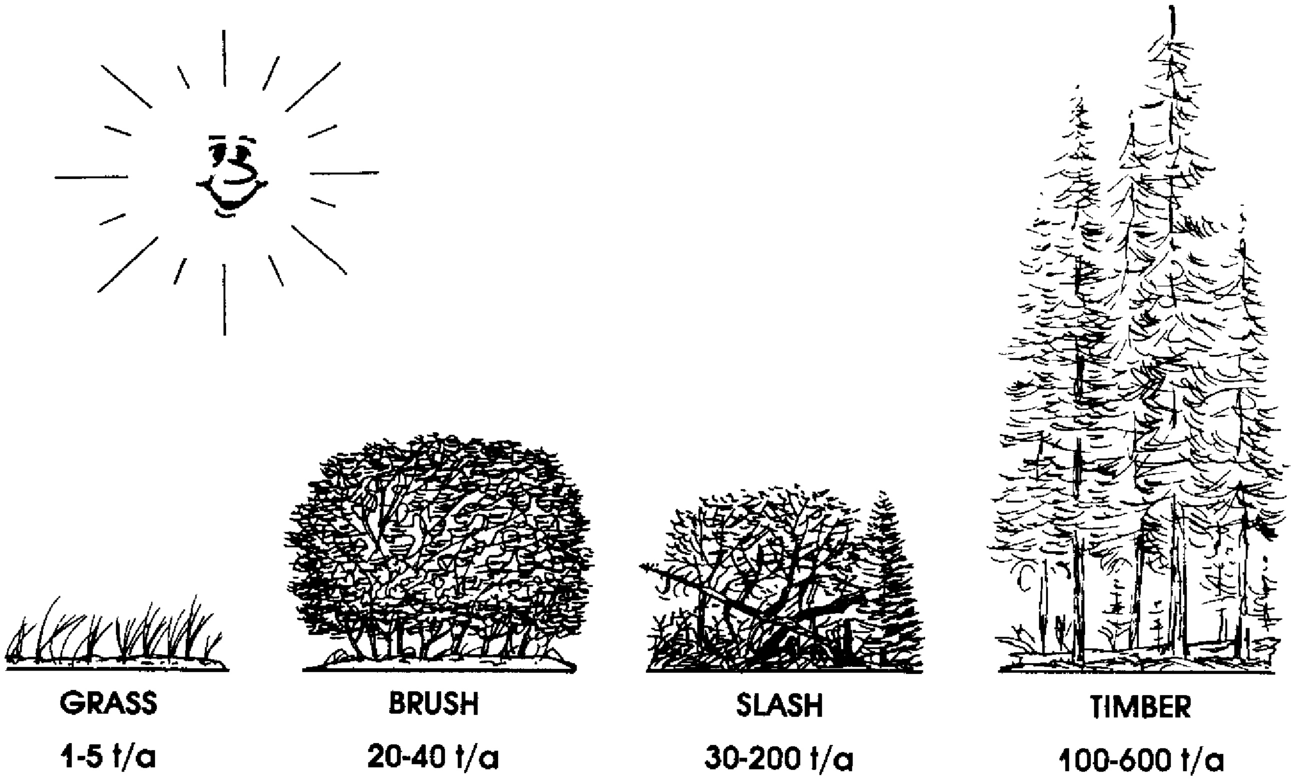
1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________

FIGURE 3 — VARIOUS FUEL CHARACTERISTICS AFFECT FIRE BEHAVIOR



FUEL LOADING: THE OVEN DRY WIGHT OF FUELS IN A GIVEN AREA, USUALLY EXPRESSED IN TONS/ACRE

FIGURE 4 — EXAMPLES OF TOTAL FUEL LOADINGS



QUESTION 2

Which of the following statements about fuel loading are true?

1. Fuel loading and volume of fuels are essentially the same.

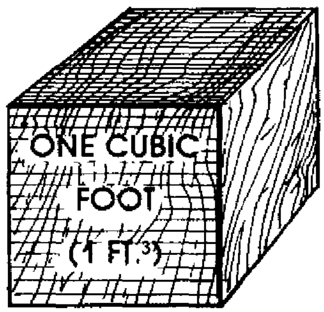
2. Fuel loading involves only those fuels that are available for combustion.

3. Fuel loading in a grass type can vary considerably from year to year.

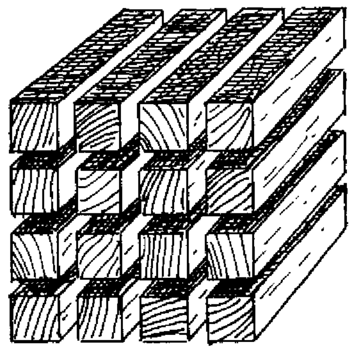
4. Fuel loading in a timber type can vary considerably by time of year.

SIZE AND SHAPE AFFECTS THE SURFACE AREA TO VOLUME RATIO OF FUELS. SMALL FUELS AND FLAT FUELS HAVE A GREATER SURFACE AREA TO VOLUME RATIO THAN LARGER FUELS.

FIGURE 5 — FUEL SIZE AND SURFACE AREA RELATIONSHIPS



SURFACE AREA
6 SQ. FT.



SURFACE AREA
18 SQ. FT.

QUESTION 3

Which of the following statements are true when comparing small fuels to large fuels?

1. The burnout time required for small fuels is longer.
2. The heat required to reach sustained ignition in small fuels is less.
3. Fuel moisture content changes more rapidly in small fuels.
4. Small fuels spot easier than large fuels.

FIGURE 6 — SHAPE OF FUELS INFLUENCES SPOTTING

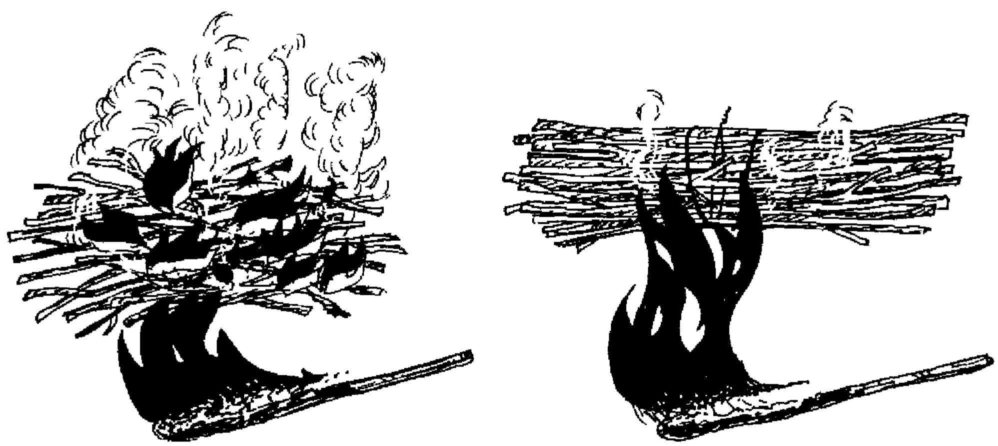
CONES **CEDAR FRONDS** **BARK PLATES** **PINE NEEDLES**

B. THE MAJOR SIZE CLASSES OF FUELS ARE:

1. Grass, litter, duff ____________________
2. Twigs and small stems ____________________
3. Branches ____________________
4. Large stems and branches ____________________

COMPACTNESS IS THE SPACING BETWEEN FUEL PARTICLES AND AFFECTS THE RATE OF COMBUSTION.

FIGURE 7 — COMPACTNESS AFFECTS RATE OF COMBUSTION.



LOOSELY COMPACTED **TIGHTLY COMPACTED**

QUESTION 4

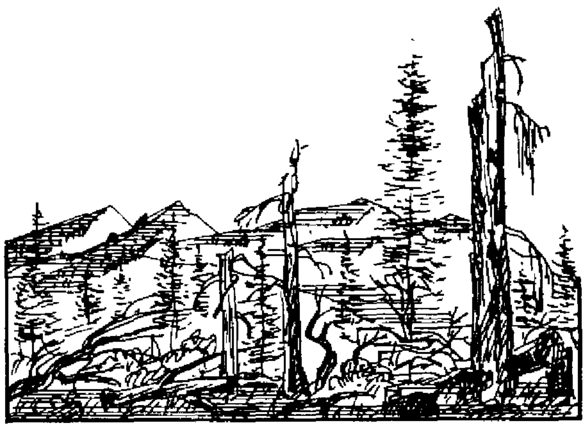
Which of the following statements are true about loosely compacted fuels as compared to tightly compacted fuels?

1. More oxygen is available for combustion.
2. The rate of spread is usually greater.
3. Fuel moisture is usually lower.
4. The burnout time is usually less.

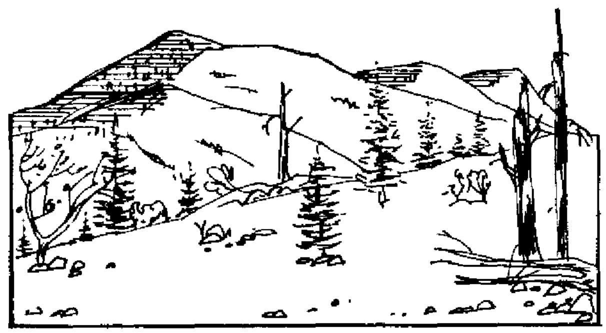
HORIZONTAL CONTINUITY IS THE EXTENT OF HORIZONTAL DISTRIBUTION OF FUELS AT VARIOUS LEVELS OR PLANES.

FIGURE 8 — HORIZONTAL CONTINUITY

CONTINUOUS FUELS



PATCHY FUELS

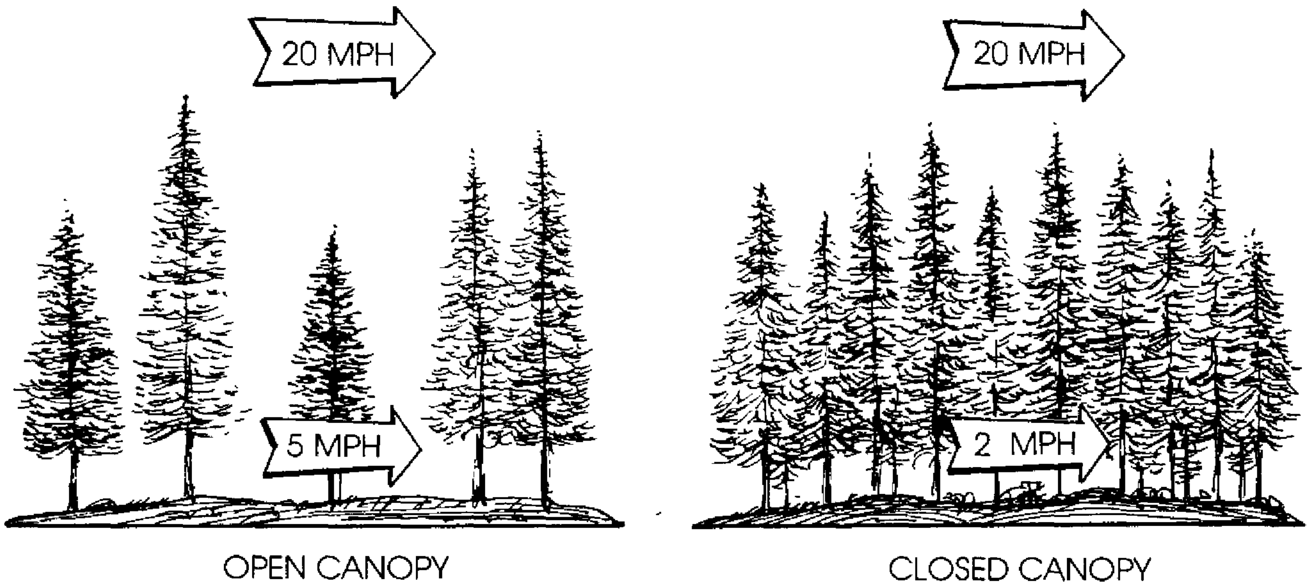


QUESTION 5

Which of the following statements about horizontal continuity of fuels are true?

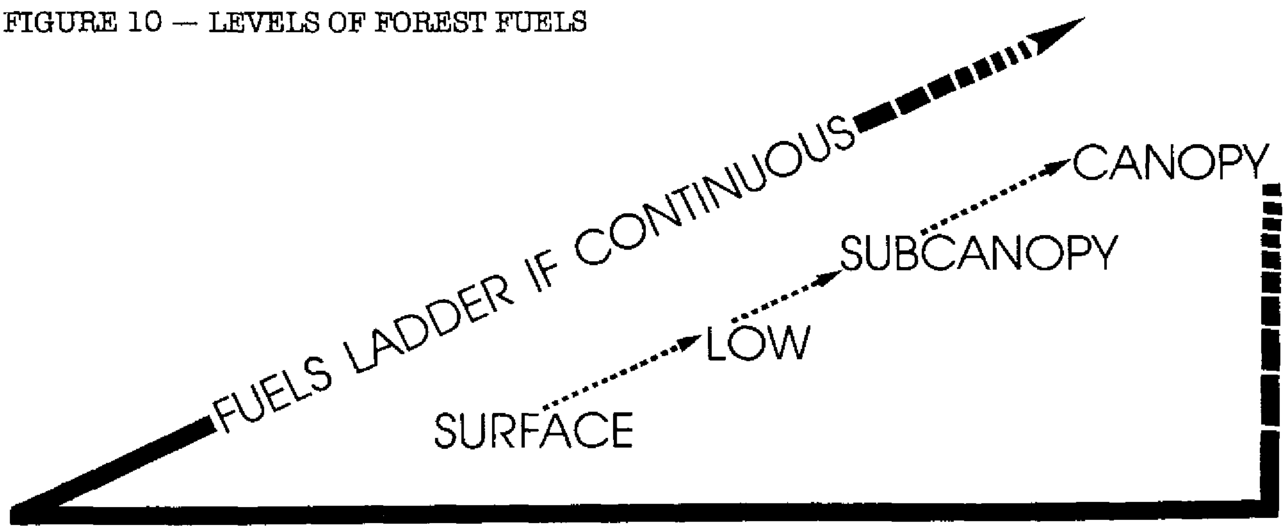
1. Horizontal continuity applies only to the surface fuels.
2. Continuous fuels provide a continuous path for the spread of fire.
3. The direction a fire spreads can be influenced by horizontal continuity.
4. The continuity of fine fuels is less important for surface fires than crown fires.

FIGURE 9 — AERIAL FUELS REDUCE SURFACE WIND SPEEDS



VERTICAL ARRANGEMENT: THE RELATIVE HEIGHTS OF FUELS ABOVE THE GROUND AND TEIR VERTICAL CINTINUITY. THIS INFLUENCES FIRE REACHING VARIOUS FUEL LEVELS OR STRATA.

FIGURE 10 — LEVELS OF FOREST FUELS



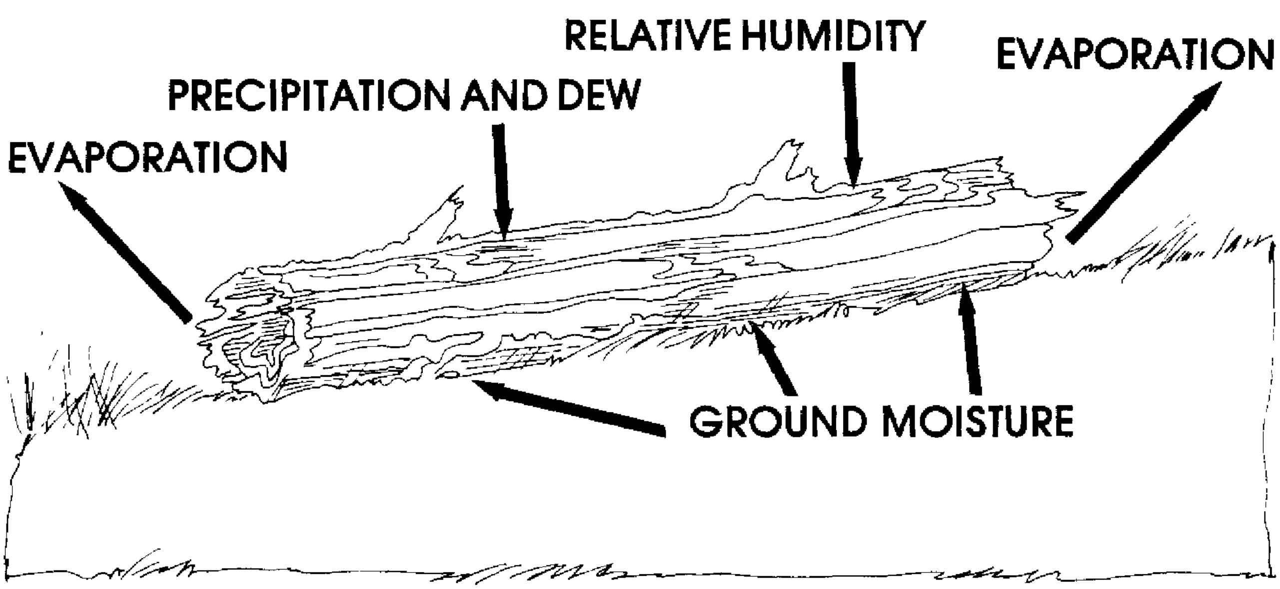
QUESTION 6

Which of the following statements about vertical arrangement of fuels are true?

1. Fire may consume surface fuels only, aerial fuels only, or both.
2. Any of the levels in Figure 10 can be missing.
3. Continuous fuels from the surface to the canopy can be called ladder fuels.
4. The intensity of surface fire usually determines whether fire will travel up through green ladder fuels.

FUEL MOISTURE CONTENT IS THE AMOUNT OF WATER IN FUELS EXPRESSED AS A PERCENT OF THE OVEN DRY WEIGHT OF THAT FUEL.

FIGURE 11 — MOISTURE EXCHANGE IN WILDLAND FUELS



QUESTION 7

Which of the following statements about fuel moisture are true?

1. Fuel moisture affects the rate at which fire will spread both vertically and horizontally.

2. Live fuels can not burn as the moisture content is too high.

3. Fuel moisture influences the heat required for combustion.

4. The fuel moisture of the fine fuels is usually most important to the spread of the fire.

C. TIMELAG IS A MEASURE OF THE RATE AT WHICH A GIVEN DEAD FUEL GAINS OR LOSES MOISTURE. THE TIMELAG CATEGORIES ARE:

1. 1 hour timelag fuels ______________________
2. 10 hour timelag fuels ______________________
3. 100 hour timelag fuels ______________________
4. 1000 hour timelag fuels ______________________

D. THREE GENERAL STAGES IN THE LIFE CYCLE OF HERBACEOUS VEGETATION ARE:

1. ______________________
2. ______________________
3. ______________________

CHEMICAL PROPERTIES INCLUDE THE PRESENCE OF VOLATILE SUBSTANCES SUCH AS OILS, RESINS, WAX. AND PITCH IN THE FUELS, WHICH AFFECTS RATE OF COMBUSTION.

E. SOME WELL KNOWN FUELS IN WHICH VOLATILE SUBSTANCES CONTRIBUTE GREATLY TO FIRE INTENSITY AND FIRE SPREAD ARE:

1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________
5. ________________________________

QUESTION 8

Which of the following statements about volatile substances are true?

1. They increase rates of combustion.
2. They speed up the burnout time.
3. They increase the resistance to mop-up.
4. They increase fire intensity.

FUELS AVAILABILITY

AVAILABLE FUELS ARE THOSE THAT WILL IGNITE AND SUPPORT COMBUSTION AT THE FLAMING FRONT UNDER SPECIFIC BURNING CONDITIONS AT A GIVEN TIME.

FIGURE 12 — CONSUMPTION OF VARIOUS FUELS BY FIRE

GRASS UP TO 100% BRUSH 5 - 95% SLASH 10 - 70% TIMBER 5 - 25%

QUESTION 9

Which fuel components are usually most available for combustion in a conifer forest type? (Check two)

1. Live branches	4. Tree trunks
2. Live foliage	5. Downed logs
3. Needles & litter on ground	6. Cured grasses

F. FUELS THAT IGNITE MOST READILY FROM EMBERS (SPOTTING) ARE:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

QUESTION 10

Rank order the following fuel conditions according to the percent availability during typical mid-summer conditions. Indicate the most available with 1, etc., through 4, the least available.

1. _____ Logging slash, 1 year old
2. _____ Mature timber, spruce
3. _____ Uniform grass cover, cured
4. _____ Heavy brush, scrub oak

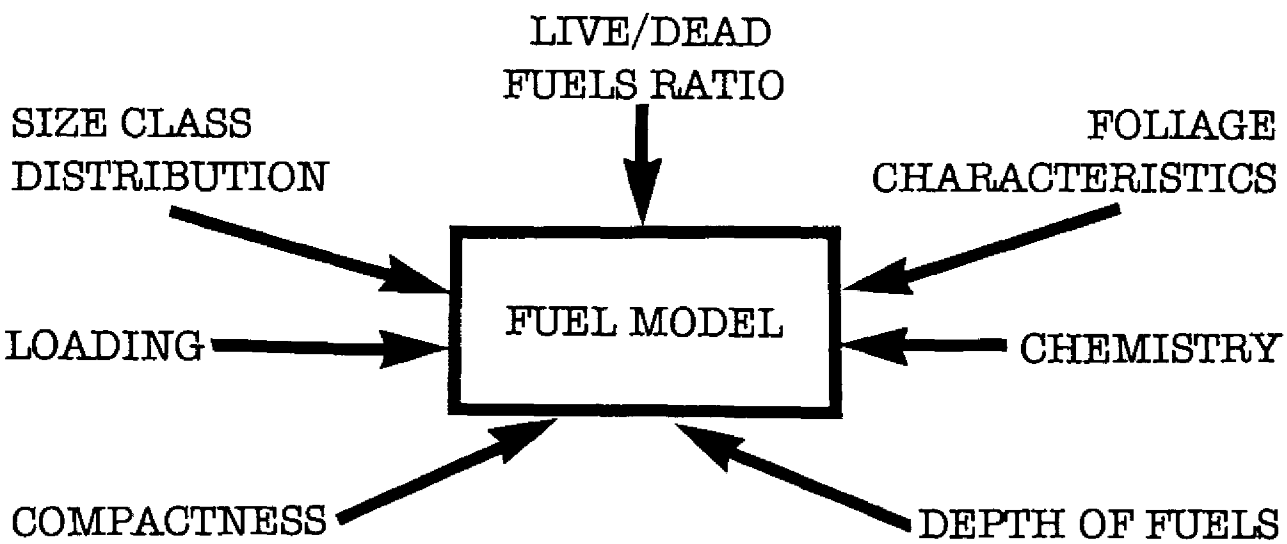
G. FUEL CONDITIONS WHICH INFLUENCE THE PROBABILITY AND CHARACTER OF CROWN FIRES ARE:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

FUEL MODELS

FUEL MODEL IS A SIMULATED FUEL COMPLEX FOR WHICH ALL THE FUEL DESCRIPTORS REQUIRED FOR THE SOLUTION OF A MATHE MATICAL FIRE SPREAS MODEL HAVE BEEN SPECIFIED.

FIGURE 13 — FUEL MODEL CONSIDERATIONS



FOUR MAJOR FUEL COMMUNITY GROUPS ARE:

1. ______________________
2. ______________________
3. ______________________
4. ______________________

FIGURE 14 — FUEL MODEL DESCRIPTIONS - GRASS GROUP

FUEL MODELS	DESCRIPTION	COMMON TYPES/SPECIES	FIRE BEHAVIOR
#1 SHORT GRASS (1 FOOT)	Fire spread governed by the fine herbaceous fuels that have cured or are nearly cured. Very little, if any, shrubs or timber is present, generally less than one-third of the area.	Best fits grasslands that are not grazed. Also consider savanna types, stubble, grass with scattered shrubs, and grass-tundra or low tussock with grasses, lichens, and mosses.	Surface fires that can burn very rapidly.
#2 TIMBER (GRASS AND UNDERSTORY)	Fire spread is primarily through fine herbaceous fuels, either curing or dead. In addition litter and dead-down stemwood from open shrub or timber overstory contributes to fire intensity. Shrub or tree cover is approximately one-third to two-thirds of the area.	Best fits open pine/grassy understory, wiregrass/scrub oak associations, but can be used for timber/sage-brush/grass associations, some pinyon-juniper stands, and southern pine clearcut slash.	Surface fires can spread easily. Clumps of fuels that generate higher intensities may produce firebrands.
#3 TALL GRASS (2 1/2 FEET)	Fire spread is in tall stands of grass averaging about 3 feet where one-third or more of stand is considered dead or cured. Fire may be carried by wind through the upper heights of grasses standing in water.	Best fits tall sawgrasses, fountain grass (Hawaii), eastern marsh vegetation, and other grasses such as bluebunch wheatgrass, blue-stem, broomsedge, and panic-grass. Also consider wild or cultivated grains that haven't been har-vested, and tall tussock/ tundra/grass situations.	Fires in this fuel are the most intense of the grass group and display high rates of spread under the influence of wind.

FIGURE 15 — FUEL MODEL DESCRIPTIONS - SHRUB GROUP

FUEL MODELS	DESCRIPTION	COMMON TYPES/SPECIES	FIRE BEHAVIOR
#4 CHAPARRAL (6 FEET)	Fire intensity and fast spreading fire involve the foliage and live and dead fine woody material in the crowns of the nearly continuous secondary overstory. Dead woody material in the stand significantly contributes to fire intensity. There may also be a deep litter layer that confounds suppression efforts.	Stands of mature shrubs, 6 or more feet tall, such as California mixed chaparral, the high pocosins along the east coast, the pine barren of New Jersey or the closed jack pine stands of the north-central states are typical candidates. Red slash sites with 40 tons per acre or more of less than 3-inch material can also be considered.	Very high to extreme rates of spread can be experienced in this model. Very high intensities make control efforts difficult.
#5 BRUSH (2 FEET)	Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. Shrubs are generally not tall but have nearly total coverage of the area.	Best fits the generally non-flammable shrubs such as laurel, salal, vine maple, alder, or mountain mahogany. Young, green stands of chaparrel, manzanita, and chamise qualify until deadwood is generated.	Fires are generally of low intensity as surface fuel loads are light, shrubs are young with little dead, and the foliage contains little volatile materials.
#6 INTERMEDIATE BRUSH-HARDWOOD SLASH	Brush is taller than in #5, but less height and fuel than #4. Foliage is generally flammable although moderate to strong winds may be required to carry fire in the crowns.	A broad range of shrub conditions are covered, such as intermediate stands of chamise, chaparral, oak brush, low pocosin, and palmetto-gallberry. Pinyon-juniper shrublands may be represented with winds of 20 mph or greater. Fresh but cured hardwood slash can be represented.	Fire carries through the shrub layer with moderate winds, but drops to the ground at low windspeeds or openings in the stand.

FIGURE 15 (CONTINUED)

FUEL MODELS	DESCRIPTION	COMMON TYPES/SPECIES	FIRE BEHAVIOR
#7 SOUTHERN ROUGH	Fires burn through the surface and shrub strata with equal ease, and can occur at higher dead fuel moisture contents because of flammable nature of live foliage and other live materials. Stands are generally between 2 and 6 feet high.	Best fits the southern rough communities of the palmetto-gallberry understory/pine overstory association of the southeast coastal plains. Can be used for low pocosins when moisture content is high in the foliage.	Rate of spread and fire intensity are both moderately high.

FIGURE 16 — FUEL MODEL DESCRIPTIONS - TIMBER GROUP

FULL MODELS	DESCRIPTION	COMMON TYPES/SPECIES	FIRE BEHAVIOR
#8 CLOSED TIMBER LITTER	Closed canopy stands of healthy, short-needled conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and some twigs since little undergrowth is present.	Representative conifer types are white pine, lodgepole pine, spruces, firs, and larch.	Slow burning surface fires with low flame heights are typical, although an occasional "jackpot" or heavy fuel concentration can cause flareups.
#9 HARDWOOD LITTER	Fire spread is primarily in surface litter such as concentrations of dead, dry leaves in fall or spring. Stands can be hardwoods, mixed hardwood/conifers, or long needle conifers.	The oak/hickory types are best represented, but also covers other hardwoods and loosely compacted litter under long-needled conifers, such as ponderosa, Jeffrey and red pines or southern pine plantations. Also includes mixed hardwoods/white spruce type in Alaska when conditions are very dry.	Fires run through the surface litter and possibly torch out trees, spot, and crown where concentrations of dead-down woody materials are encountered.
#10 TIMBER (LITTER AND UNDERSTORY)	Fire spreads through high loadings of dead, down woody fuels beneath over-mature timber stands. Shrub understory or tree reproduction may be present. Much of the woody material is over 3 inches in diameter.	Any forest type may be considered if heavy down materials are present; examples are insect or disease-ridden stands, wind thrown stands, over-mature situations with deadfall, and aged light thinning or partial cut slash. Also used for settled thinning or partial cut conifer slash with needles fallen.	Torching of individual trees and spotting is more frequent, and fire intensity is higher in this model than model 8 or 9, thereby leading to potential fire control difficulties.

FIGURE 17 — FUEL MODEL DESCRIPTIONS - SLASH GROUP

FUEL MODELS	DESCRIPTION	COMMON TYPES/SPECIES	FIRE BEHAVIOR
#11 LIGHT LOGGING SLASH	Slash and herbaceous material intermixed carry an active fire. The spacing of the rather light fuel loading, shading from overstory, or aging of fine fuels can contribute to lowering fire potential. The less than 3-inch material load is less than 12 tons/acre. The greater than 3-inch material is represented by not more than 10 pieces, 4-inches in diameter along a 50-foot transect.	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.	Surface fires of moderate rates of spread and moderate to high intensities can be expected where fuels are continuous.
#12 MEDIUM LOGGING SLASH	Slash loadings where the less than 3-inch material is less than 35 tons per acre. Most needles have fallen and the slash is somewhat compact. The greater than 3-inch material is represented by 11 or more pieces, 6 inches in diameter along a 50-foot transect.	Heavily thinned conifer stands, clear-cuts and medium or heavy partial cuts are represented. Typical of logging operations in northwestern forests.	Rapidly spreading fire with high intensities capable of generating firebrands. When fire starts, it generally sustains itself until a fuelbreak or change in fuels occurs.
#13 HEAVY LOGGING SLASH	Fire generally carries across an area by a continuous lay of slash. Loading is dominated by greater than 3-inch diameter material. The total load may exceed 200 tons/acre but less than 3-inch fuel is generally only 30 percent or less of total load.	Best fits conifer clearcuts and partial cuts in old growth stands west of the Cascade and Sierra Nevada mountains. Areas where "red" needles are attached, but loadings are lighter can also be considered.	Fire spreads quickly through the fine fuels, but intensity builds up more slowly as the larger fuels start. Active flaming is sustained for longer periods. Spotting can occur.

FIRE BEHAVIOR FUEL MODEL KEY

ALWAYS CHECK THE SELECTED MODEL WITH FUEL MODEL DESCRIPTION.

I. Primary carrier of fire is grass. Expected rate of spread is moderate to high, with low to moderate intensity.

A. Grass has a relatively fine strucure, is generally below knee level and is easy to walk through . . . . . . .Model 1

B. Grass has thick, coarse stems, is above knee level and is difficult to walk through . . . . .Model 3

C. Mixture of grass and litter beneath open timber or brush overstory that does not burn . . . . .Model 2

II. Primary carrier of fire is brush. Expected rate of spread and intensity are both moderate.

A. Vegetation type is southern rough or low pocosin. . . . . .Model 7

B. Live fuels absent or sparse with no capability to reduce fire spread rate. . . . . .Model 6

C. Live fuel moisture can have a significant damping effect on the fire behavior.

1. Brush is about knee deep with a light loading of 1-hour timelag fuels . . . . .Model 5

2. Brush is close to head high with a heavy loading of 1-hour timelag fuels . . . . .Model 4

III. Primary carrier of fire is debris beneath a timber stand.

A. Live fuels are present in sufficient quanity to influence fire behavior. The load of 100-H TL fuels is heavy . . . . Model 10

B. Surface fuels are mostly foliage litter, with little or no live fuel.

1. 1-H TL load strongly predominates; 10-H and 100-H TL fuels are sparse. Foliage litter is long needle pine or hardwood leaves, loosely compacted . . . . .Model 9

2. 1-H and 10-H TL fuel load combined is about equal to 100-H TL load. Foliage litter is short needle coniferous or small hardwood leaves, tightly compacted . . . . .Model 8

IV. Primary carrier of fire is slash.

A. Slash is not continuous. Other ground fuels must be present to help carry the fire. Average slash depth is about 1 foot . . . . Model 11

B. Slash is continuous or nearly so. Other surface fuels need not be present to carry the fire. Average slash depth is about 3 feet . . . . Model 13

C. Slash generally covers the ground, though there may be bare spots or areas of light coverage. Average slash depth is about 2 feet . . . . Model 12

EXERCISE 1: USING THE FUEL MODEL KEY

IDENTIFY THE APPROPRIATE FUEL MODEL FOR EACH FUEL COMPLEX DESCRIPTION BELOW USING THE FUEL MODEL KEY ON PAGES 23 AND 24. YOU SHOULD THEN CHECK YOUR SELECTIONS WITH THE FUEL MODEL DESCRIPTIONS ON PAGES 18-22.

FUEL MODEL

1. An area in the Sierra Nevadas consists of an open park-like stand of Jeffrey pine of approximately 1/4 canopy cover with grassy understory, scattered low shrubs, and scattered litter. ________

2. An Alaskan fuel type of aspen and birch mixed with white spruce has a sparse understory of shrubs and litter. Conditions are very dry. ________

3. A dense stand of southern yellow pine has a dense understory of palmetto-gallberry brush 2 - 3 feet tall. The "rough" understory vegetation carries fire very well. ________

4. A partial cut of ponderosa pine in the southwest produces scattered and somewhat discontinuous slash up to 2 feet deep. A moderate amount of grasses, shrubs, and tree regeneration are present to carry fire. ________

CHECK YOUR ANSWERS WITH THOSE ON PAGE 29, THEN RESTART THE TAPE.

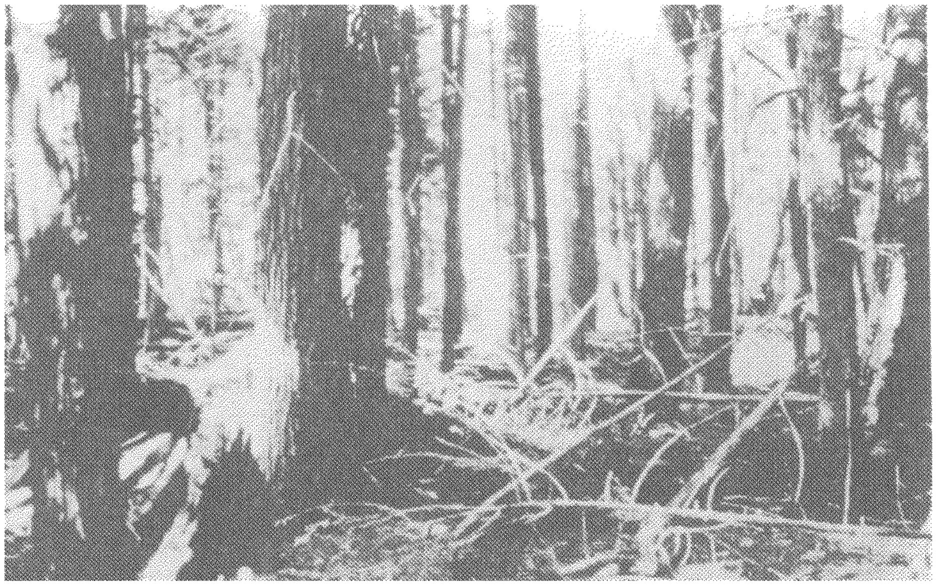
FIGURE 18 — FUEL MODEL SIZE CLASSES

Fuel Model	Fuel Loading				Approx. Fuel Bed Depth (Feet)
	1Hr.	10 Hr.	100 Hr.	Live	
	GRASS GROUP				
1	X	X	X	X	1.0
2	X	X	X	X	1.0
3	X				2.5
	BRUSH GROUP				
4	X	X	X	X	6.0
5	X	X		X	2.0
6	X	X	X		2.5
7	X	X	X	X	2.5
	TIMBER GROUP				
8	X	X	X		0.2
9	X	X	X		0.2
10	X	X	X	X	1.0
	SLASH GROUP				
11	X	X	X		1.0
12	X	X	X		2.3
13	X	X	X		3.0

NOTE: The X's indicate the presence of fuels within each fuel group that are considered in predicting fire behavior. Fuel bed depth considers only the surface fuels.

EXERCISE 2: ANALYSING FUEL SITUATIONS

COMPLETE THE ITEMS BELOW USING THE FOLLOWING FUELS PHOTO AND ANY FUELS CHARACTERISTICS AND FUEL MODEL MATERIALS PRESENTED IN THIS UNIT.



1. What is the general vegetation or fuel--grass, brush, timber, or slash? (Circle one)

2. What category fuel classes are present--1 hour, timelag, 10 hour, 100 hour, 1000 hour, Live? (Circle one or more)

3. Which two of the fuel classes in 2. above do you expect to influence fire behavior the most? ______________________

4. What is the primary carrier of a fire here? ______________

____

5. Do you think the overstory fuels would be involved in the flaming front? __________ Explain. ______________________

____

6. What fuel model would you assign to this fuel situation?

____

CHECK YOUR ANSWERS WITH THOSE ON PAGE 29.