SECTION 7 - FUELS, FIRE BEHAVIOR, AND TACTICS BY GEOGRAPHIC AREAS OF THE UNITED STATES

The purpose of this section is to identify by geographic areas of the United States:

- important fuel, topographic, and fire weather conditions that produce critical fire behavior situations.
- appropriate safety, strategies, and tactics for fire suppression.

The following geographic areas are covered:

NORTHEAST

I. THE NORTHEAST AREA

A. Forest Types - There are 11 major forest types in the area. The most common is oak-hickory (Fire Behavior Fuel Models 8 and 9) which is found in all 20 states. This discussion will include spruce/fir (Fire Behavior Fuel Models 4 and 10) of New England and Northern Minnesota, the pine barrens of New Jersey, (Fire Behavior Fuel Model 4) the jack pine/red pine (Fire Behavior Fuel Model 6) areas of the Lake States, and the peat/muck fuels found in the northeast and elsewhere in the US. Some of the others which play a major role in a normal fire season are common to the Southeast area and will be discussed there.

B. Topography - The Northeast Area is the same as the USFS's Eastern Region. It is a 20 state rectangle with the "4M" comers – Minnesota to Maine to Maryland to Missouri. It is relatively flat with elevations ranging from sea level to 6,288 feet above sea level. While local topography may cause some concern, the overall impact is not significant except in the mountainous areas in the New England and Mid-Atlantic States.

C. Weather - The fire weather season in the Northeast usually lasts from March through November. It is characterized by a spring fire season that starts in the southem part of the area and moves northward. By mid-June the major period has passed and there will usually be a lull until early or mid-September when the fall fire season begins. How soon this area gets frost and the maturing of the fine fuels and hardwood leaves will determine when the major fire activity begins. The season moves slowly southward and will usually end in mid-November in most of the area. Although extreme fire behavior and severe fires are experienced in the fall, the chances are lessened by the shorter, cooler days, nightly frost, and limited drying periods. Unless it has been an unusually dry summer and fall the only serious problems will occur with the weather system known as "Indian summer." This is a period of two to five days when a stagnant, dry high pressure system is in the area. Temperatures in the 80's are not uncommon; relative humidities will drop to the middle or low teens, and the winds will usually blow from a southerly direction. Speeds may vary from 3 to 13 miles per hour with gusts up to 18 - 25 being common.

Some other characteristics of this pattern are limited relative humidity recovery at night; minor nighttime temperature changes; continuous winds, even after dark; and very hazy conditions which reduce visibility to two miles or less.

Four of the six synoptic weather types, all associated with high pressure systems and periods of critical forest fire weather in the United States, are found in the Northeast Area. They are:

1. *Pacific High*

    a. Loses moisture crossing the Rocky Mountains; arrives in the Northeast as a dry continental air mass. Usually about three days from the time it crosses into the Continental U.S. before it arrives.

    b. More numerous than any other type of system.

    c. Often tracks southeast across the bottom of the region. Can give the Southeast more problems than the Northeast.

    d. If the preceding cold front is *dry,* high fire danger occurs in the postfrontal area.

    e. The western or northwestern side is usually the most dangerous side of the system.

2. *Northwestern Canadian High*

    a. Is dry to begin with because it originates over land.

    b. All sides can be dangerous, but the north and northwest sides are the most critical.

3. *Hudson Bay High*

    a. Tends to stagnate in the Hudson Bay area.

    b. Moves south into the United States so it passes right over the Lake States on its way.

    c. The greatest danger usually occurs on the Northwest side of the high.

    d. The longer the system is with you, the more the visibility deteriorates. Can get as low as two miles or less.

    e. Most frequent in the spring and fall.

f. This is the system that will tear you apart before you know what has happened. It begins as a cool Canadian High which forms over Hudson Bay ice and moves south. It picks up very little moisture over Canada and warms through subsidence. The humidities will drop (10 percent or less in extreme cases), temperatures go up and winds become gusty. Nighttime temperatures may vary as much as 40 degrees. Humidity might not recover. Tendency to stagnate for days. Visibility goes to pieces. At height may be one mile. Is a haze. When it begins to move, winds will shift from E to S-SW-W. Tendency to fishtail. Sign that system is moving! Lake States' forecasters are experienced with this weather pattern and will advise you of it.

4. *Bermuda High*

a. Long lasting and stagnant type of system.

b. Frequent in spring, early summer and fall.

c. Quite often extends into Texas to block the flow of moisture from the Gulf of Mexico. Type of system said to cause a lot of the drought type conditions that existed in the NE in the spring and early summer of 1988.

d. Low humidities and high temperatures common with this type.

e. The worst winds for fires occur when low pressure troughs pass by a stagnant Bermuda High on its north side.

Add the Alberta Low to this list as a catalyst, especially when it follows on the heels of the one of the highs just listed. This type of system can prompt a dry lightning situation along with high winds. It was this combination which moved across a very narrow band of northern Minnesota, Wisconsin, and Upper Michigan on May 6, 1986, with surface winds of 50 - 60 mph. During its passage a USFS prescribed bum escaped mopup for 1,000 acres, a major forest fire of 8,000 acres threatened an air force base on Michigan’s Upper Peninsula, and 80 power line fires were started in a three county area of northern Wisconsin.

In addition to the systems mentioned, the Atlantic Coast can have occasional high fire danger associated with tropical storms when the windy area reaches beyond the wind and cloud shield.

D. Strategy.

A full control strategy using direct or flanking attack is the most common. These strategies are driven by two major factors:

1. Federal land ownership is a very minor part of the total landscape and, in some instances may even be a minor part of the holdings within the boundary of the property. At the same time the number of qualified fire personnel and the fire equipment on the federal properties is limited to non-existent. Several of the states protect the federal property under contract to the agency.

2. Time is the second major factor. Almost all project fires will complete their run during the first day of the bum. They may burn through the night, but by morning of the second day they will have ended because of a change in fuel type, successful control by the local agency, or a combination of the two. The exceptions may be found in the national parks, such as Voyagers and Isle Royal, and in the USFS's Boundary Water Canoe Area in northern Minnesota where indirect attack or a confinement strategy may be used in areas of large federal ownership to meet agency specific land management objectives.

E. Tactics.

1. Tactics will usually involve the use of mechanized line construction by tractor and plow or dozer units reinforced by hand tool crews.

2. In some parts of the Northeast water lines or variations involving the use of foam and water will be the primary tactic for suppression. Handtools such as the backpack pumps, fire rake, shovel, McLeod tool and fire swats are standard equipment for fire agencies of all types.

3. Volunteer Fire departments are a major resource used by many of the states and some federal agencies. Depending upon the particular area, their wildland capabilities will vary from a few structural engines that will not leave a hard surfaced road to those that have highly specialized wildfire equipment.

4. Limited use is made of aerial suppression equipment. Helicopters with foam injection buckets, agency owned or contracted aerial tankers and single engine air tankers (S.E.A.T.) are used in Maine, Michigan, Minnesota, New Jersey, Pennsylvania, and Wisconsin. Federal and state agencies may share equipment under "Call When Needed" contracts. In Minnesota, the state and USPS use a small fleet of float equipped Beaver aircraft for suppression, detection, and transportation. Extensive use is made of state owned aircraft for detection and direction of ground forces on going incidents. Density altitude is not usually a problem for aircraft operations in the northeast.

F. Special Considerations.

1. Safety

Check with your local resource advisor for specifics, but some special safety problems you may encounter are:

a. Black Bears - Most likely to encounter them in northern Minnesota, northern Wisconsin, and northern Michigan. Usually will leave you alone, but in a drought year when there is an absence of natural food, such as berries, they will raid camps in search of food. Proper storage of open food, fresh meats, vegetables, and garbage will usually prevent a visit by this critter.

b. Snakes - Cottonmouth water moccasins, copperheads, and rattlesnakes are the three varieties of poisonous snakes found in the Northeast. The moccasins are usually found in southern Illinois, Indiana, Ohio, Missouri, and West Virginia. Copperheads are found in the same states as well as Pennsylvania. Rattlesnakes are Minnesota, Iowa, Illinois, Indiana, Ohio, Pennsylvania, New York, West Virginia, and Missouri.

c. Diseases - Lyme disease is not fatal, but is a serious concern because of the delayed appearance and the side effects. It is tick borne. Rabies can be a local problem in some areas. Giardia, or beaver fever is present in many of the waters of the northeast.

d. Miscellaneous Hazards - Poison ivy and poison sumac are common. In some areas they can be a major problem. Abandoned mine shafts, tunnels, caves, quarries, open pit mines, and exploration holes are present in some areas. Many of these also serve as dens for poisonous snakes.

II. SPECIFIC FUELS

Unique Fire Situations.

Maine - Maine is the most forested state, on a per acre basis, of any state in the United States. It also has the least public land ownership of any state - less than 2 percent. It has a state fire control organization which is directly or indirectly responsible for all forest fire protection in the state. Over 50 percent of its forest lands are spruce-fir type. Fire Behavior Models 4 & 10 best represent this fuel type. Maine has the most lightning fires of any state in the northeast.

New Jersey - Within 35 miles of New York City and Philadelphia rests 1.2 million acres of forest area known as the New Jersey Pine Barrens. It is composed of highly flammable pine types that have a long history of fire. Fire Behavior Model 4 is used for this fuel. Fires in this area occur with regular frequency and cause major damage, loss of property and, in some instances, loss of life. An aggressive, direct attack with the occasional use of backfires is the tactic recommended here.

Pennsylvania - Primary forest type for the Keystone State is Oak-Hickory. Use Fire Behavior Models 8 and 9. Over one million acres of Pennsylvania wild land suffered mortality from the oak leaf roller. In addition, it has been severely damaged by the gypsy moth. The topography of Pennsylvania is some of the more rugged in the Northeast area. The encroachment of second homes into this area has added problems to their suppression efforts. Tactics in this fuel are aggressive, direct attack, use topography and natural barriers and burn out lines once they are constructed.

A. Lake States Area.

1. Lake States area consists of Minnesota, Wisconsin, and Michigan.

2. Approximately 70 million acres of potential wildfire land.

3. Influenced by four of the Great Lakes - Superior, Michigan, Huron, and Erie.

4. Topography.

    a. From flat to somewhat hilly.

    b. Elevation from 500 to 2,300 feet.

    c. Slope - generally not a problem in fire control.

5. Climate and Weather.

    a. Four seasons.

    b. Precipitation - 28 to 32 inches.

    c. Winds - prevailing southwest to west.

6. Fire Season and Fire Conditions.

    a. Normal fire season is April through June, with a second season from mid-September to late October or early November. The crown fire season will usually begin in mid-April and end in late May or early June. Jack pine seems to be most susceptible to crowning when it is pollinating. Drought conditions will extend the crown fire season into late summer and early fall.

    b. Critical weather preceding a crown fire will usually be:

        (1) Winds from SW to W at 8 - 12 gusting to 25;

        (2) Temperatures of 65 degrees or more. Above 75 degrees in spring or fall indicate potential problems;

        (3) Humidity of 30 percent or less. Below 30 percent expect erratic fire behavior and below 20 percent look for things to explode;

        (4) Fuel moisture of 8 percent or less in the 10-hour sticks and 5 percent or less in the 1-hour readings;

        (5) Usually occurs during or on the back side of a high pressure area.

B. Problem Fuels.

1. Pine fuels.

2. Muck and peat fuels (spruce-bog).

C. Jack Pine.

1. Predominate fuel.

2. Medium to heavy density.

3. Contiguous arrangement of live and slash fuel.

4. One thing to remember about surface or grass fuels is that they are perennials and do not automatically brown off each summer. They will recover from drought with some rain, and can reduce fire spread in many instances. On the other hand, they will tend to stay green during dry weather and burn quite readily if ignited.

D. Pine Fire Problem.

The major fire problem is a crown fire in a jack pine or red pine area. These are fast burning fires that can run in excess of a mile per hour and be all done in one day's duration. It may bum up to 15 miles during this period of time with spotting 1/4 mile or more in advance of the head. Normal fire run will be until dark or change of fuel type, but fires have been known to run through the night.

E. Crown Fire Strategy.

Plan for a large fire. Under crown fire conditions a fire can easily reach 1,000 acres in the first hour. The Mack Lake Fire of May 5, 1980, had a sustained rate of spread of 2 mph the first three hours. (176 feet per minute). The next 2 1/2 hours it dropped to 1.2 mph or 100 feet per minute. It burned 24,790 acres in one afternoon. Individual runs of 6 mph or 528 feet per minute have been reported.

1. Work the flanks. Try to pinch or narrow the fire at every opportunity.

2. If you are planning back fires, allow an hour to two hours to carry them out, otherwise spotting will negate your efforts.

3. Plan to control or reduce the head when:

   a. You get a change in fuel types.

   b. You get a change in weather conditions.

   c. Usually nightfall will help you.

4. Control confusion.

5. Maintain awareness of weather conditions.

    a. Prepare for turning action of fire as front passes.

    b. Expect spotting to be up to 1/2 mile ahead of the main fire.

    c. There are experienced fire weather forecasters in each of the three states. They are familiar with the vagaries of the Hudson Bay high, as well as the influence the Great Lakes have on your fires. USE THEM.

6. Remember, land ownership patterns here do not allow the luxury of writing off large acres of government land for back fires or indirect attack. Private land patterns require an effort to protect every acre of land.

7. Resource Deployment.

    Most fires are divided into divisions, and if structures are involved, zones, early on to facilitate control of the suppression effort.

    a. As you stand at the origin of the fire and look toward the head, the usual deployment of equipment and personnel is 1/4 to the left flank, 1/2 to the right flank, and 1/4 floating with the head to take advantage of any changes in fuel type, natural barriers, or other events which will help narrow the head. This tactic is used because in almost all cases the fire will be moving from southwest to northeast and will be driven by a wind that will be changing to the northwest as the frontal system passes.

    b. Many of the local agencies will have designated preplanned zones to handle interface activities. These will be assigned to the structural force under the control of an experienced structural fire person. A guideline for planning and assignment is one structural engine for each structure to be protected for one hour.

Needless to say there will have to be a hard decision made on what is going to be defended and what will be written off because there usually will not be enough equipment available to go around!

10. Fire control tactics are based on a highly mechanized fire control force backed up by personnel, especially in mopup. Air tankers and helicopters are usually not available for the first day. In some instances they might not be available at all.

11. Use equipment effectively, do not waste tractor-plow effort. Do not underestimate the capability.

12. If fire runs into the night:

    a. Increase aggressiveness - attempt to control as soon as possible.

    b. Complete line to secure.

    c. Do not wait for next day. (Equipment should be equipped for night use.)

    d. Begin mopup.

F. Equipment Assignment - Fireline Tactics.

1. Tractor-plow Unit.

    a. Will construct line at various rates, depending on cover and fire behavior. Blade is not for line construction but to clear slash and debris for lime building.

    b. Tractor-plows should be assigned in tandem if available and should build line as close as safety will allow. Burn out line behind tractor-plow. Use caution - be prepared to yield to fire.

    No UNBROKEN LINE behind tractor-plows, PATROL must be maintained. Aircraft surveillance can be utilized but hand tool crews are best. Maintain constant availability of communications.

    Fire is moving at a relatively fast rate - do not lose control of equipment.

    c. Line placement should utilize all natural openings, skidways, hardwood ridges, or other breaks. Do not depend on roads to stop a crown fire.

d. Line placement into plantations requires extreme caution and operators must have a planned escape route. Demands highly skilled operators knowledgeable of crown fire behavior.

e. Line placement approaching the head of fire on the right flank must be done with extreme caution. Tractor-plow operator may become involved with spot fires and developing head of fire.

Explosive fire conditions - rapid swings of the fire flank are to be expected. Tractor-plow line construction rates for 450 and 350 class tractors allow tractors to overtake fire head.

Actively develop and improve tractor-plow line of right flank. BE PREPARED to yield if frontal action turns fire. All equipment must begin working fire in new direction.

2. Volunteer Fire Departments.

Maintain contact with their equipment. Do not allow the resources to be wasted. Structural fire protection is their key responsibility; however, if a favorable condition is reached, allowing for a stand on a road, hardwood area, etc., the fire department tanker capability can be utilized for pre-wetting and line holding. Many will have extensive wildfire experience - but make certain of levels of experience.

G. Modification in Crown Fire Strategy and Tactics.

Michigan - Use same basic strategies and techniques. Some equipment is the same, such as the JD-450 unit, but also use rubber tired skidders with plowers, armored 6x6 tankers with a plow and armored 6x6 tankers to build and hold line. Engines follow tractorplow units, they do not lead it.

Minnesota - Aircraft used in control of fires. Retardant is used on flanks, primarily to slow the fire spread in order to allow line construction equipment to control fire flank. Retardant drops are not used at the head of a running jack pine crown fire. (May be rare exceptions). Basic fire control strategy and tactics are similar to Michigan and Wisconsin.

III. MUCK AND PEAT FIRE PROBLEM

A. Definition and General Description.

Peat is raw and partially decomposed plant remains accumulated under conditions of excessive moisture. For practical purposes, peat soils typically contain a great deal of woody and rooted material and are brownish in color. Muck soils are fine, fully decomposed with a characteristically dark black color.

B. Moisture Retention.

Organic or muck soils hold several times more moisture than mineral soils. The amount of water held is dependent on the type of organic soils and degree of decomposition.

C. Time Period to Produce.

It takes 100 to 500 years to produce a foot-layer of residue. The rate depends upon plant cover and environmental conditions. Depth may be 40 feet or more.

IV. STRATEGY

A. Planning for the control and suppression of a fire involving muck or peat lands will often require planning for two distinct fire problems.

1. Control and mopup of a surface fire.

2. Control and mopup of a ground fire. The control and mopup may require different equipment and personnel to meet the needs of each problem.

3. If a Fire Team is requested to assist in the control and suppression of a muck or peat fire in the Lake States, it should be assumed a severe drought condition exists.

B. Strategy Planning.

1. Control and mopup of surface fire - fuels.

a. Surface fuels involved.

(1) Spruce - bog (patchy).

(2) Grass meadow.

(3) Spruce, balsam, tamarack swamps.

(4) Dense brush.

(5) Leather leaf bog.

(6) Farm lands, drained.

(7) Aspen - scrub oak.

b. Size of area involved.

c. Depth and condition of muck or peat (affects surface fire control).

(1) Accessibility.

(2) Water table.

(3) Ability to support equipment (flotation).

(4) Availability of water source.

(5) Amount and condition of ground fire.

d. Values threatened.

(1) Farmland.

(2) Highways.

(3) Homes, subdivision.

(4) Other.

2. Attack Plan.

a. Indirect.

b. Direct.

c. Combination of both.

In most cases the attack plan will consist of both direct and indirect attack on portions of the line.

3. Plan to control fire spread as quickly as possible.

a. Do not intentionally allow seemingly safe areas to burn when peat or muck is involved with a surface fire. To do so may require expensive mopup.

b. Plan to suppress surface fire as quickly as possible and mop up completely.

c. Determine how line construction is to be accomplished and equipment and personnel needs.

d. Determine if fire may spread into adjacent fuels; e.g., Jack pine, spruce or other problem fuels (drought condition -- will affect personnel and equipment needs and strategy to control).

e. Determine if fire may become involved with high value farm lands.

4. Do not underestimate problems.

   a. Fire involving muck and peat require a great deal of initiative and adapting of equipment to meet needs.

   b. Set up equipment maintenance program. Muck and peat fires raise havoc with equipment.

5. Set up and monitor safety program.

   a. Injuries to firefighters.

      Safety -- It is extremely important that proper training and clothing be provided to crews assigned to control and mop up of muck and peat fires.

      (1) Wearing apparel.

         (a) Helmets.

         (b) Gloves.

         (c) Goggles.

         (d) Face masks (dust).

         (e) Snug fitting coveralls.

      (2) Foot gear.

         (a) Laced 10" boots.

         (b) Rubber boots.

         (c) "Bean" boots.

      (3) Do not allow other types of boots. Stepping into hot burning peat or muck could result in severe burns.

      (4) Common injuries.

         (a) Eyes - dust and blowing ash.

         (b) Falling material - trees burned off at the roots. No warning.

         (c) Tripping.

         (d) Burns.

         (e) Typical injury prone area.

   b. Involvement with highways (smoke).

C. Construction of Firelines.

1. Lines must be constructed to mineral soil or below water table.

2. Care must be used in constructing lines with tractor-plows or bulldozers when working over peat or muck. You will probably be only able to make one pass. After vegetation and material supporting the tractor has been disturbed, any further action may result in getting the unit stuck. Wide tracks (36+ pads) are available from private sources for hire.

3. Lines constructed through peat or muck that do not reach mineral soil or the water table should not be depended on to hold the fire. They will normally restrict the fire for 24 hours. After that, either new lines must be constructed or plow lines wet down.

4. When constructing lines through peat or muck, do not push material onto the fire side. To do so will result in a difficult and costly suppression problem.

5. Equipment used in line construction.

   a. Plowing.

   b. Bulldozing.

   c. Hand crews.

   d. Line to mineral soil - shallow peat.

   e. Trenching, backhoes, etc.

   f. Blasting.

   g. Drag line, etc.

D. Suppression of Muck and Peat Fires.

1. Suppression of muck and peat fires using water. Water -- The use of water is effective, when available in an unlimited supply, or at least sufficient to meet suppression needs.

   a. Effective on large fires or where dense surface fuels are present.

      May be necessary to pump long distance.

   b. Requires manpower and equipment to set up and operate.

c. Pumping equipment, irrigation pipe and specialized hose lays are required.

d. Difficult to deploy through downed material.

e. Require continuous operation to be effective.

(1) May require pumping for weeks or even months.

(2) Equipment must be moved every 6 -10 hours.

(3) Sprinkler system must overlap.

(4) Becomes a mess.

(5) Care must be used to not lay hose over burning peat or muck.

(6) When pumping from sources near fire, beware of water table and influence on fire.

(7) If water source is moving, will probably support pumping.

f. Water source may be several miles from fire. Do not let this restrict you.

The use of water in suppressing muck and peat fires is usually an expensive and time consuming task. On large fires or where dense surface fuels are present, water is the only practical means of suppression.

It may be necessary to pump water for weeks or even months. Large quantities of water must then be available.

2. Suppression of muck and peat fires using dry methods or combination of water and dry.

The dry method of suppressing a muck or peat fire is usually less costly and will require less time and personnel to suppress.

a. Blading - to mix and cool material - effective on areas where surface will allow. Mixing of burning material with cool, damp peat will suppress the burning material.

b. Discing - breaking up surface material and mixing unburned, cool, damp peat. Discing is effective where fire has not burned down into peat or muck. Particularly effective on drained farm land. Begin immediately.