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:

- Alaska, pages 205 - 218
- Northwest and Northern Rocky Mountains, pages 219 - 236
- Southern and Central California, pages 237 - 256
- Great Basin and Southern Rocky Mountains, pages 257 - 282
- Southwest, pages 283 - 296
- Northeast, pages 297 - 312
- Southeast, pages 313 - 332

SOUTHWEST

I. FACTORS INFLUENCING FIRE BEHAVIOR IN THE SOUTHWEST

A. Topography

Topography is the greatest single factor influencing fuel types in the Southwest. Elevations range from near 1,000 to over 13,000 feet. Like the Peak fire, steep mountain ranges in southern Arizona and New Mexico have many fires which burn from bottom to top and go through many fuel types.

In addition, aspect plays a bigger role in fuel types and in fire behavior in the Southwest than any other area in the United States. Fuel types frequently change on ridge tops and in drainage bottoms.

At lower elevations, south and west slopes are frequently grass or desert shrub while north and east facing slopes can be pinyon-juniper or pinyon-juniper mixed with various types of brush. Canyons may have a mixture of deciduous trees, conifers and brush in the bottoms.

Mid elevations may have pinyon-juniper on south and west slopes with ponderosa pine and oak on north and east slopes. Canyons may be a mixture of ponderosa pine, pinyon-juniper, oak and brush.

Upper elevations often have ponderosa pine and oak on south and west facing slopes and mixed conifer and aspen on north and east slopes. Canyons may have ponderosa pine on drier sites with mixed conifer across the drainage.

Fire behavior can be drastically different from one side of a Ridge/drainage to another due to the differences in fuel types and moisture levels.

Land form is also an important factor as fires can move long distances without wind. Slope driven fires are quite common especially in lighter fuel types.

The Mogollon Rim is the most dominant geological/topographic feature in the Southwest Region. It extends from Ashfork, Arizona to Luna, New Mexico. It is a continuous uplift which rises 2,000-4,000 feet above the lower elevations.

The base of the rim is 6,000-7,000 feet while the top ranges from 8,000-10,500 feet. Fuel types range from pinyon-juniper-oak and brush to mixed conifer and aspen.

The land north of the Mogollon Rim is referred to as the "Colorado Plateau." The Colorado Plateau loses elevation from the Mogollon Rim as it spreads to the north. Fuel types go from spruce-fir to ponderosa pine to pinyon-juniper to grasslands. Land forms are generally gentle sloping with steep drainages. However, there are also large volcanic derived mountains which rise above the existing plateau. These have their own fuel types based upon elevation and aspect.

The southern part of both Arizona and New Mexico includes steep rocky terrain. Southern Arizona has unique "sky islands" which include all of the Coronado National Forest. These mountain ranges all begin with desert fuels at the base and end with mixed conifer, and/or spruce-fir at elevations over 9,000 feet.

Southern New Mexico is similar except the mountain ranges are generally much larger in size.

Fire behavior predictions using any computer modeling are difficult because of the ever changing topography and fuel types. Again - it's a good idea to have a local fire behavior specialist.

B. Weather

1. Precipitation:

Weather is another obvious factor influencing fire behavior, with topography or elevation being tied to precipitation kinds and amounts. Elevations of 7,000 feet and above generally receive in excess of 100 inches of snow annually. Elevations above 8,000 feet generally have a snowpack of two feet. Snowpack of six to seven feet may be found above 9,000 feet. Total annual precipitation ranges from 4 inches in the lower deserts to 20 inches at 7,000 feet to 35 inches at 11,000 feet.

2. Winds

Spring begins in late March at the lower elevations and in April at the higher elevations. Weather is generally dry and windy.

Daily winds above the Mogollon Rim can average a steady 20-30 mph for many days at a time reducing snow pack and exposing fuels to sun and wind. High elevations in the southern part of both Arizona and New Mexico receive similar winds.

Winds can reach 50-70 mph as spring storms move across from the west. Although some moisture is received, the effects are short-lived due to continued winds. By the end of May most snow has melted except at elevations above 10,000 feet. Fire during these periods can move significant distances in short time frames especially in ponderosa pine above the Mogollon Rim.

May and June are the two driest months and those in which most large fires occur. Winds continue through May but generally subside in June. Temperatures range from 110 degrees or more with 5% humidity in the desert to 90 degrees and 10 % humidity at 7,000 feet. Fire behavior is obviously extreme during these conditions which makes suppression efforts difficult.

In late June or early July the Bermuda High sets up off Florida and affects much of the nation's weather. This high creates a flow of moisture aloft from the Gulf of Mexico and into the Southwest. This moisture mixed with the daily high temperatures creates the summer thunderstorm and monsoon season. The Southwest has the highest incidence of lightning caused fires in the United States.

The lightning season starts out as dry lightning storms in late June in southern New Mexico and Arizona and continues northwest across the Southwest area during the next two to three weeks. The storms become wetter as the Bermuda High sets up. Showers are scattered then become more widespread.

This rainy season continues through July and August. Daily temperatures are still over 100 degrees in the desert and near 90 degrees above 7,000 feet. Fires in low elevations are a problem because of lack of moisture in fuels even though RH is higher.

September and October can be dry aria windy. During this time there is an increase in human-caused fires due to hunters. Night time temperatures and RH keep these fires to one or two burning periods.

C. Fuel Types

The Southwest has twelve fuel types. One fire can involve many of these types. The six problem fuel types for firefighters are:

1. Grass Fuels

Grass fuels are widespread in the Southwest and consist of annual grasses in the lower elevations and perennial grasses mainly in the higher, more humid, elevations. Although grasses are mixed throughout all the fuel types, desert fuels are part of this fuel type and rates of spread are significant due to typically low RH.

It takes surprisingly little grass cover for ignition or fire spread. These fuels are very flashy and combined with a wind (especially from a thunderstorm) can result in a fast moving erratic spread.

Some grass types like sacaton and bear grass produce high intensity fires. These fuels react quickly to changes in RH. Spread is obviously achieved by wind and also by slope. Fire can run up slopes then stop. There is little spotting.

Sotols, a succulent found within the desert plant community, are a problem and spread desert fires quickly. When sotol are on a slope and the roots bum through, the plant breaks loose and rolls downslope.

These fuels react quickly to changes in RH. Early in the afternoon fire can move rapidly, then clouds buildup, humidity increases, and burnouts cannot be accomplished. Because of this a fire can look extremely placid but just a couple of hours later as temperatures rise and RH changes the fire may take on a significantly different behavior.

2. Shrub/Brush

The fuels include various desert and brush species dominated by manzanita, several species of oak and mountain mahogany. Grasses are important for ignition and spread in this fuel type. However, absence of grass has little effect on steep slopes or during windy conditions.

Fires are intense and can have rapid rates of spread. Percent of dead material plays a large role in fire spread.

Green fuel moisture also plays a major role in spread. Local fire management officers should track the moisture content and give you criteria on critical thresholds by species.

Live fuel moisture is a very good indicator of burning conditions in the chaparral fuels. Where fuel moisture reaches 70 percent or less, extreme burning conditions can be expected.

The location of this fuel in relation to any commercial timber land is important. Lack of control of a fire in this type can result in a large fire in ponderosa pine.

Spotting is not much of a problem but fire intensity creates a rapid spread. Fires typically slow or even stop at sharp ridge tops.

3. Pinyon-Juniper

This type generally falls between the ponderosa pine and shrub/brush types. However transition areas can have a mixture of brush species and/or ponderosa pine.

In pure stands, fire is not much of a problem as there is typically little ground fuel due to grazing and soil conditions. In areas where stands are dense, fires can spread with a good strong wind. Spotting in Utah or one-seed juniper stands is common but fire spread is slow.

Stands with an understory of brush, grass, or down fuels can bum intensively and move rapidly. Typically a wind is needed to spread the fire unless the fire is on a steep slope.

Again the location in relation to the commercial timber land is important as fire can spread into the pine stands easily.

4. Ponderosa Pine

Ponderosa pine is found at elevations ranging from 6,000 to 9,000 feet and occurs in all geographic areas.

Most large fires needing incident management teams occur in this fuel type. Most of the ponderosa pine stands have been commercially harvested sometime within the last century. Fire behavior depends on previous logging activity, resultant residual slash, stand density, quantity of stories, and ground fuels including associated shrub species.

Fire spread can be extremely fast especially with wind. Crown fires are common but generally are dependent on ground or ladder fuels to sustain.

Spotting is a large contribution to spread and is very common up to 114 to 1/2 mile ahead of the fire.

As a guide, whenever 1000 hour fuels (dead fuel over 3 inches in diameter) reach 13% or lower, we can expect critical burning conditions in this fuel type.

Across an evenly flat plateau, fires can become very large if wind driven and spotting is active. Ponderosa pine is a valuable resource as it is a highly valued commercial timber species and a significant portion of recreation activity occurs within this type.

5. Mixed Conifer

This type includes various mixtures of ponderosa pine, southwestern white pine, Douglas-fir, white fir, and Engelman and blue spruce. Generally these fuel types occur above 8,000 feet. A large percentage of mixed conifer occurs on steep slopes.

Some of these stands have been logged but others have not. Fuel loading is significant at 70 to 150 tons per acre. Access is limited due to steep slopes and lack of roads. Fires are intense and spotting can easily occur up to 1/2 mile.

Although historically significant fires have not occurred here (in relation to ponderosa pine), as stands are being logged and sites are dried out more fires will occur. Also, recreation use of the mixed conifer type is increasing which will increase human-caused fires.

Many large fires can occur because of fires escaping from the ponderosa pine zone.

Where dogged, most stands are very dense with total canopy closure. Mixed conifer fires are difficult to control due to lack of good topographic features.

6. Spruce-fir

This fuel type, in the Southwest, occurs only in locations above 9,500 feet. Fires are rare but mentioned here because they are extremely difficult to control. They typically are at the top of a mountain range and therefore above all the other fuels.

Access is extremely limited. Fuel loading is heavy and spotting is severe. On large fires, because of the steep topography, fuel loading and access problems, control lines will generally be outside this fuel type.

II. STRATEGY AND TACTICS

A. Direct attack as a strategy works well in the Southwest especially when fires are small. If a fire is large, a number of items need to be considered before deciding on strategy; topography, fire behavior and intensity, rate of spread, availability of needed resources, logistics in moving and supplying firefighters and of course, probability of success.

B. Indirect attack is also used, especially in lower elevation fuel types. Acreage is often sacrificed .for lower suppression costs and higher probabilities of success. Direct attack on a fast moving desert or brush fire is seldom successful. Using natural barriers and roads when burning out is very common below the Mogollon Rim. Dozer use below the Rim is limited for environmental reasons. Dozer tracks stay forever in the desert. Disturbing the soil creates erosion problems during intense thunderstorm activities.

C. Parallel attack with burnout is also used with success on wind driven ponderosa pine fires. Nanking until wind quits then cutting off the head is frequently used.

On most large fires a combination of direct, indirect, and parallel may be used. Again much is dependent on line officer direction, EFSA, available resources and team philosophy.

Safety as the first standard fire order is above all else. No strategy or tactics should be considered if it sacrifices safety. Safety should be included in all planning.

D. Developing Tactics

First, topographic features are of great importance in determining line location. Remember, that fuel type changes at ridge tops and drainage bottoms. Because of this, especially below the Mogollon Rim, these fires typically have a tendency to run to ridges and quit or slow down. This is extremely important to remember in indirect attack situation. Midslope lines seldom work in the Southwest.

Natural barriers can be used to a great extent and can save many hours/days of line building. Natural barriers have been used as control lines, burnouts accomplished from the air, and the next day a small task group assigned to pick up slop-overs.

Burnouts are a must in the Southwest. A line not burned out is almost worthless. In parallel and indirect attack bring fire with you even without lines being tied in. Unless indirect line is quite distant, the line can easily be out-flanked by a fast moving fire. Don't wait for "perfect" burning conditions. However, burning in the middle of the afternoon can be disastrous. Burnouts are very successful at night as long as RH stays low (although not to where spotting occurs). But again, if that's the best condition you have, then do it! Early morning burnouts before the heat of the day are not very successful. All night operations are generally successful and should be utilized.

Burnouts can be accomplished by hand (drip torch, very pistol, fusee or pen flare), Terra-torch or similar home-built equipment, and by air with ping-pong machine or flying drip torch.

Length of line constructed is much more important than the width or quality of line. When burning out, especially with crews on the scene, holding is fairly easy. Fires typically move too fast for any slow line construction techniques.

Because of lack of ground fuels some chaparral brush country is difficult to ignite especially from the air. If unsuccessful, burning out may need to be done under windier, lower RH or higher temperature conditions.

Burning periods in the Southwest occur between 10 a.m. and 4 p.m. Depending on wind, temperature, RH and live fuel moistures, fires can bum actively 24 hours a day. Shift changes can and should be adjusted to insure crew movement is not taking place during critical burning periods.

Since these conditions prevail, especially in the desert country, many years ago "coyote" tactics were developed.

The coyote tactics consist of a progressive line construction technique involving self-sufficient crews who build fireline until the end of an operational period, remain overnight at/near that point, and then begin again on the next operational period.

Crews should be properly equipped and be prepared to spend several operational periods on the line with minimal support from the incident base.

Camps are standard and should be used. They can be supplied by air and crews moved by air to camps. Crew movement should be kept to a minimum to reduce exposure to air and road travel.

Mopup is critical in ponderosa pine and mixed conifer stands. Desert fires require little, but cold trailing is effective. Where cold trailing is used it must be watched or patrolled.

Immediate rehabilitation of control lines is necessary. Most moisture occurs as intensive thundershowers and soil movement is rapid and immediate. Unless otherwise directed, most Southwest type I and II crews place water bars as firelines are constructed.

Archeological sites, both prehistoric and historic, are everywhere across the Southwest. Special precautions or changes in tactics may be needed to protect them.

Threatened and endangered species include birds (Mexican spotted owl, Goshawk), animals (Mt. Graham squirrel), fish (Apache Trout, Gila Trout, spinedace, loach minnow), and plants (Arizona willow, Mogollon paintbrush, various cactus). Almost any drainage with permanent water has some threatened or endangered species associated with it. Make sure you get this information and receive direction on guidelines and protection.

With few exceptions (National Park Service) all lands within the Southwest are grazed by either cattle or sheep. Tactics using overgrazed areas as anchor points or locations for control are successful.

Be aware of livestock location when locating camps and when burning out. Fence locations are also important to know. If a fence is cut, notify local authorities.

Make agreements with local land owners, agency representatives, and/or permittees before using stock water for firefighting operations.

Location and amount of slash is important in determining tactics. Protection of reforestation areas will be needed.

III. Suppression resources within the Southwest and their effectiveness.

A. Engines

Numbers of engines are limited. ***All*** units have a few which range from Model 20s to Model 70s, 71s and 46s. There are few four-wheel drive models. You will find that most units want their engines returned to the home unit for initial attack. You will not receive a large number of engines from within region if requested. Then again you may not need many. Time should be allowed to receive engines from other geographic areas.

Engines are very effective on large fires for holding line and mopup situations.

B. Dozers

These are even more limited. Most units have one or two small (JD 3501450) dozers. However, again, pressure will be applied to return these to home units for initial attack. Dozers and log skidders are extremely useful in ponderosa pine and mixed conifer fuel types.

Dozers can be used in lower elevations but are restricted by rock, steep slopes, and environmental concerns.

C. Helicopters

Helicopters are effective for crew movement, spike camp and line supply, bucket work, and aerial ignition for burnouts.

Bucket work is restricted by lack of water. Effectiveness is affected by turnaround time.

The biggest restriction in the Southwest when utilizing helicopters is density altitude, with high temperatures and high elevations, payloads are extremely limited. When ordering helicopters be sure and describe the type of performance you require based on the altitudes you are working in or you will receive something which can't be used.

D. Airtankers

There are 11 airtankers assigned to the Southwest. As with helicopters, turnaround times are important in -their effectiveness.

They can be used in light fuels (desert) as initial attack without crew support and are effective.

In ponderosa pine and mixed conifer they are also effective if wind conditions are low. Airtankers are not useful in stopping crown fire at their heads but are typically used in flanking action. They are effective in reducing behavior for hand crew action and holding a fire until crews can arrive.

Airtanker drops without retardant (water only) have been used in cases where aesthetics are important.

Late afternoon airtanker or helicopter work can be successful in suppressing fires without ground support in light fuels.

E. Type 1 Crews

There are 18 Type 1 crews within the Southwest area. Depending upon the regional fire situation crews will arrive from a couple of hours to 12 hours after ordering.

F. Type 2 Crews

Through an agreement with SWIFF (Southwest Indian Fire Fighters) 78 crews are available for dispatch. Typically, they can be on the scene a few hours to 12 to 18 hours after ordering. Most are extremely good and can be used on hot line. Others cannot. You must judge.

G. Saws/Saw Teams

Saws and saw teams should be ordered with Type 2 crews. Few Type 2 crews include individuals who are qualified. Saws are a must for brush as well as for timberland.

Regular crews will carry their own saws but since you probably will be in the Southwest during a multiple fire situation most employees will have already been assigned to other fires.

Contract sawyers are limited.

IV. SPECIAL CONSIDERATIONS

A. Safety

Southwestern fires can be suffocatingly hot, have steep rocky slopes, cactus, snakes, tarantulas and scorpions. Everything either bites, stings, pokes or scratches.

All of these can result in medical emergencies and medivacs. The lack of roads and long distances to medical facilities requires special attention to medivac plans. We try to have line qualified EMTs on each division.

Temperatures in the desert frequently are above 110 degrees. Dehydration is a problem. Each crew member needs a minimum of two gallons of water daily.

Differences in daytime and nighttime temperatures can be dramatic and can cause various medical afflictions. Working all day in heat and moving to higher elevations where it is cooler can affect a person's health. Getting wet with a brief afternoon shower can also be a problem. Nighttime temperatures in the desert can be very cool.

Situations can occur where you can have cases of heat stroke and hypothermia during the same day and on the same piece of line.

Open water should not be used for drinking as giardia is common in all Southwestern streams and lakes. Plan on supplying all potable water.

Density altitude was discussed earlier. It is important not just in crew and cargo movement but also in medivac helicopters. Be sure your selected medivac helicopter has sufficient payload.

Air attack is the eyes and ears of ground forces. It is extremely helpful in monitoring quickly changing fire behavior situations. It is good to keep an aircraft over the fire from daylight to dark if possible. However, do not depend on them for total information. They are just another "tool" and do not replace on-the-ground lookouts. If you depend upon aerial observations alone and the aircraft must return to base due to mechanical problems or sickness then you would be out of luck.

B. Functional Considerations

1. Fire Behavior

Fire activity may not decrease at night due to lack of RH recovery.

Fire behavior during daytime hours, especially at lower elevations, is extreme and intense. Expect very large fires.

2. Sotols

   A Sotol is a yucca which, when burned, develops the shape of a basketball. It will roll downslope spreading fire. "Rock the Sotols." They are dangerous to firefighters. Mid-slope lines are ineffective.

3. Logistics

   Roads are few and those that exist are bad. Reduce exposure to road travel. Use camps but also keep helicopter flights at a minimum.

   Overall travel for suppression and support activities is slow. Understand this in developing strategy and tactics.

4. Urban Interface

   Communities are being built in wildland fuels all over in the West. Access in and out of these communities is almost always limited. In addition to these communities, the Southwest has hundreds, if not thousands, of isolated homes, summer cabins, mining cabins, ranch houses and other structures scattered about.

   Coordination with local agencies, homeowner groups, and others knowing roads and structure locations is extremely important.