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# Fighting Forest Fires in the Western United States: an Educational Filmstrip and Manual for Teaching Forest Conservation

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FIGHTING FOREST FIRES IN THE WESTERN UNITED STATES

AN EDUCATIONAL FILMSTRIP AND MANUAL FOR  
TEACHING FOREST CONSERVATION

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A Thesis

Presented to

the Graduate Faculty

Central Washington State College

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In Partial Fulfillment

of the Requirements for the Degree

Master of Education

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by

William Dale Moody

June 1964

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COLLECTION

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APPROVED FOR THE GRADUATE FACULTY

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## ACKNOWLEDGMENTS

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Filmstrip Manual: Fighting Forest Fires in the Western United States

## CHAPTER I

### THE PROBLEM

#### I. STATEMENT OF THE PROBLEM

The author's purpose in undertaking this project was to plan and produce a filmstrip and manual appropriate for informing people about the methods of forest fire control employed in the Western United States. The project was specifically intended to assist the teacher of forest conservation at the seventh grade level, but it should also prove useful in teaching at other levels.

#### II. IMPORTANCE OF THE STUDY

Of primary concern to the future well-being of our country is the conservation of our forests. It is imperative that we be informed about what is being done to conserve this natural resource.

Through the use of an up-to-date color filmstrip and manual depicting the causes, effects and behavior of fire and illustrating how forest fires are detected, manned and suppressed, the general public may become better informed about forest fire control in the United States.



The problem was selected because there is a deficiency of educational visual aids in this field. At present most of the films on forest fire control are outdated in that they do not show the latest methods and equipment used in fighting forest fires. Many of these films show only specific or technical phases of forest fire control and are used as training films for fire control personnel.

The project will provide the teacher with an up-to-date filmstrip particularly designed for the seventh grade level. The manual will explain the filmstrip captions and pictures in detail and will be of assistance in organizing a teaching unit on forest conservation.

### III. PROCEDURES

In planning and producing the filmstrip, FIGHTING FOREST FIRES IN THE WESTERN UNITED STATES, the author:

1. consulted film, filmstrip and slide catalogs in the Central Washington State College Audio-Visual Library to determine what visual aids were available on this subject.
2. consulted Washington State Curriculum Guides to determine on what grade levels forest conservation is taught.
3. prepared a filmstrip outline.
4. selected appropriate 35 mm. slides from the writer's slide collection.

5. secured additional 35 mm. slides from the U. S. Forest Service Regional Office, Portland, Oregon; Okanogan Smokejumper Unit, Winthrop, Washington; and from several members of fire suppression crews.
6. determined what additional pictures would be needed.
7. photographed additional pictures with the cooperation of the Ellensburg Ranger District, U. S. Forest Service, Ellensburg, Washington.
8. wrote captions to accompany the pictures. Consulted The Teacher's Word Book of 30,000 Words (Thorndike and Lorge) to determine appropriate seventh grade vocabulary.
9. arranged to have title art work done.
10. typed and edited captions on five by eight cards.
11. had captions and titles filmed on 35 mm. film and made into slides.
12. arranged pictures and captions in proper sequence. Because the maximum number of frames per roll of film was seventy-two, the filmstrip was made in two parts.
13. invited a fifth, seventh and ninth grade teacher to preview and criticize the pictures and captions.
14. secured permission to use the Production Laboratory facilities and equipment.
15. secured the services of a photographer, to convert the slide sequence into a filmstrip using a Honeywell Repronar.
16. sent filmstrip to Kodachrome Laboratory for processing.

17. prepared an outline for the manual.
18. wrote information to supplement each filmstrip caption, developed a teacher's reference bibliography, a student's reading list, list of fire control films and their sources, glossary of forest fire control terminology and a list of where free and inexpensive teaching aids may be obtained.
19. addressed Copyright Office, The Library of Congress, Washington 25, D. C. , for Application for Registration of a Claim to Copyright (form J).
20. completed Form L-M and returned to the Registrar of Copyright, Library of Congress, Washington 25, D. C.

## CHAPTER II

### FILMSTRIP SEQUENCE

#### I. PICTURES AND CAPTIONS

1. FIGHTING FOREST FIRES in the WESTERN UNITED STATES  
(Title)
2. Blazing forest fire
3. PART I  
Produced by William D. Moody
- \* 4. The tremendous losses due to forest fires cannot be measured in dollars alone. Why?
5. EFFECTS OF FOREST FIRE (Subtitle)
- \* 6. Under extreme fire weather conditions a fire may burn over a large area before it can be controlled.
7. Aerial view of large burn
- \* 8. Trees, logs, bushes and duff may be burned completely. What happens to the watershed?
9. Charred logs and barren soil
10. Stand of singed trees
11. Barren watershed and river
- \*12. Often wildlife are killed or forced to abandon their homes.
13. Calf elk lying in burned area

---

\* Caption

- \*14. Years later the snags are a grim reminder of the forest fire.
- 15. Snag covered hillside
- 16. CAUSES OF FOREST FIRES (Subtitle)
- \*17. Carelessness causes more than 90% of the 135,000 forest fires each year in the United States.
- 18. Cigarette in pine needles
- 19. Careless campfire
- \*20. In the Western United States lightning is a major cause of forest fires.
- 21. Lightning strike
- \*22. Lightning, spiraling down the tree, ignites the tree and the dry vegetation at its base.
- 23. Tree hit by lightning
- \*24. Most lightning-caused forest fires occurs in the mountainous West. It is difficult to reach and put out these fires.
- 25. Fire on mountain top
- 26. Fire in a steep rocky area
- 27. FIRE BEHAVIOR (Subtitle)
- \*28. The three basic parts of fire are known as the fire triangle.  
What are these parts?
- 29. Fire triangle labeled heat, air, fuel, fire triangle
- \*30. Most forest fires start and spread along the ground. Old logs and stumps burn furiously and are very hard to put out.

---

\* Caption

31. Ground fire
  32. Blazing logs
  - \*33. The fire soon spreads, finally reaching the tops of the trees.
  34. Fire in lower branches and trunk of tree
  - \*35. A crown fire is the most dangerous and difficult type of forest fire to control. Why?
  36. Crown fire
  - \*37. Dense choking smoke and excessive heat make fighting fire a dirty, tiring and dangerous job.
  38. Blazing, smokey fire
  39. DETECTING FOREST FIRES (Subtitle)
  - \*40. Forest fires are discovered primarily by people in lookout towers and patrol planes.
  41. Fire patrol plane before take off
  42. Lookout tower
  - \*43. Once detected, the forest fire's location is determined on an instrument called firefinder (center of next picture)
  44. Firefinder inside lookout
  - \*45. Sometimes sleeper fires produce little smoke. They may burn for days or even weeks before they are detected.
  46. Smoldering fire
  47. TRANSPORTING FIRE FIGHTERS (Subtitle)
- 

\* Caption

- \*48. Suppression crews often travel to the fire by vehicle, and hike in from the nearest road.
- 49. Fire fighters along side a truck
- \*50. The smokejumpers of the U. S. Forest Service use parachutes to reach the fire.
- 51. Smokejumpers standing next to plane
- \*52. Airplane travel saves precious time. Fires are attacked quickly before they can get out of control.
- 53. Along side the plane as a jumper jumps
- \*54. Jumps are made when the airplane is about 1,500 feet above the jump spot, traveling about 100 miles per hour.
- 55. Jumper falling before the chute opens
- 56. Jumper seen from above during his descent
- \*57. Tree landings are frequent. The jumpers reach the ground by ropes. Before leaving the fire their parachutes must be retrieved.
- 58. Parachute in top of a tree
- \*59. During the past few years, helicopters have become an important means of transporting fire fighters.
- 60. Helicopter ready to take off
- \*61. In many of the National forests of the West helispots have been built by the U. S. Forest Service.
- 62. Helispots seen from the air

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\* Caption

- \*63. Helispots are cleared, marked, and numbered. When a fire starts, men are flown to the closest helispot.
- 64. THE END -- PART I
- 65. FIGHTING FOREST FIRES in the WESTERN UNITED STATES  
(Title)
- 66. Blazing forest fire
- 67. PART II  
Produced by William D. Moody
- 68. FOREST FIRE SUPPRESSION (Subtitle)
- \*69. Fire fighters quickly organize and prepare for the initial attack.
- 70. Crew with tools
- \*71. In order to suppress a fire the men must break the fire triangle.  
How can this be done?
- 72. Broken fire triangle labeled
  1. Cut off fuel supply
  2. Reduce heat
  3. Take away air
- \*73. A fireline is built in order to cut off the fuel supply. Water and dirt cool and smother the fire.
- 74. Man cutting small trees
- \*75. Chainsaws can quickly cut through logs and trees
- 76. Man cutting through a log with a chainsaw
- 77. Crew digging a fireline

---

\* Caption



- \*78. In the forest of the West the pulaski and shovel are the two most commonly used fire fighting tools.
- 79. Close up of a pulaski and shovel
- \*80. The pulaski is used for digging and cutting wood. The shovel can be used for scraping and cutting roots.
- 81. Digging a fireline with a pulaski
- 82. Throwing dirt with a shovel
- 83. Scraping a fire line with a shovel.
- \*84. Recently mechanical tools have been used to build firelines.
- 85. Digging a fireline with a "hoffco" trencher.
- 86. One-man track-driven trencher
- 87. Two-man trencher
- \*88. Firelines must be dug down to mineral soil and roots must be cut. Why? What determines the width of the fireline?
- 89. Root being chopped in two
- 90. Completed fireline
- \*91. Logs and brances are placed so they won't roll. A cup trench is built to catch rolling material.
- 92. Cup trench
- \*93. If "cat" tractors are available and can be brought in, they are used for building wide firelines.
- 94. "Cat" next to the fire.

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\* Caption

- \*95. Dirt is the most widely used smothering agent. Water, a better agent, is sprayed on the fire when it is available.
- 96. Man spraying water with a hose.
- 97. Man using a backpack.
- \*98. During the mop-up stage burning embers are put out and heavy fuels are placed in a boneyard. The fire is out when it is cold.
- 99. Digging up embers with a shovel
- 100. Scraping coals off fuels in the boneyard
- 101. Burning snag
- \*102. Dangerous and burning trees are felled.
- 103. Falling snag
- \*104. Helicopters and airplanes often supply fire crews with food and equipment.
- 105. Cargo being pushed out the door
- 106. Cargo chute opening (ground view)
- \*107. Air tankers drop slurry on some forest fires. Slurry coats the forest with a mud-like covering. What does this do?
- 108. Plane dropping slurry
- 109. Close up of slurry drop
- \*110. Slurry laid down on the edge of the unburned forest acts as a fireline.
- 111. Large burn covered with slurry

---

\* Caption

112. Close up of slurried fuel
113. Fire prevention sign on a tree being burned up
- \*114. What will you do, "Make Your State Black" or "Keep It Green"?
115. Poster and scene saying "Yours to enjoy"
116. Poster and scene saying "Not to destroy"
117. Acknowledgments
118. THE END

## CHAPTER III

### SUMMARY AND CONCLUSIONS

#### I. SUMMARY

The writer planned and produced a filmstrip and manual to assist the teacher of forest conservation in informing people, specifically seventh graders, about the methods of forest fire control employed in the Western United States. This was done through the use of a color filmstrip and manual that depict the causes, effects and behavior of forest fires as well as how they are detected, manned and suppressed.

#### II. CONCLUSIONS

The manual and filmstrip, **FIGHTING FOREST FIRES IN THE WESTERN UNITED STATES** are tools for teaching forest conservation whether it be on the grade school, secondary or adult level. The filmstrip is up-to-date, showing the latest equipment and techniques used in forest fire control in the Western United States.

The manual provides current information that may assist the teacher in organizing a teaching unit on forest conservation.

The filmstrip may help to make its viewers more aware of the causes, effects and behavior of forest fires and will inform them as to

how forest fires are detected, manned and suppressed. It is hoped that the viewers will become more conscious of their part in preventing forest fires and in conserving our forests for the future.

### III. RECOMMENDATIONS

The project undertaken here deals briefly with forest fire control in the Western United States. The writer feels that it would be valuable to produce a series of filmstrips that deal with the subtopics mentioned in the filmstrip. Suggested filmstrip topics might be:

1. The Causes and Effects of Forest Fires
2. Aircraft in Forest Fire Control
3. Forest Fire Behavior
4. Forest Fire Suppression

It is further suggested that a series of filmstrips be made on other phases of forest conservation. Appropriate filmstrips might be:

1. Forest Insect and Disease Control
2. Harvesting Our Forests
3. Reforestation
4. Uses of Our Forests

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## APPENDIX

FILMSTRIP MANUAL  
for  
FIGHTING FOREST FIRES  
IN THE  
WESTERN UNITED STATES

by

WILLIAM D. MOODY

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## INTRODUCTION

This manual is intended to assist the teacher of forest conservation at the seventh grade, but should also prove useful in teaching at other levels. Included are supplementary caption information, a glossary, a teacher's reference bibliography, a student's reading list, a list of films, and a list of addresses where free and inexpensive materials may be obtained.

For each filmstrip caption the manual contains supplementary information. To provoke class discussion some captions are stated as questions. The answers to these questions as well as many other questions that may arise can be found in the supplementary information. If additional information is desired, see "Reference Material for Teachers," page 24.

Special terminology of forest fire control work is used. Definitions of these words appear on pages 20-23. The first time each term appears in the filmstrip and in the supplementary caption information it will be underlined.

Students interested in reading about forest fires may wish to read some of the books listed on page 25.

If time permits the teacher may want to show films on specific phases of forest fire control. An annotated list of such films and their source is listed on pages 26-28.

Free and inexpensive teaching aids may be obtained by writing to any of the agencies listed on page 29.

The filmstrip has 118 frames and is divided into two parts. Part One deals with the effects, causes, behavior and detection of forest fires as well as how fire fighters are transported to the fire. Part Two, beginning with frame sixty-five, deals primarily with the suppression of forest fires.

## SUPPLEMENTARY CAPTION INFORMATION

### PART I

#### FRAME 4. THE TREMENDOUS LOSSES DUE TO FOREST FIRES CANNOT BE MEASURED IN DOLLARS ALONE. WHY?

It is impossible to assess all the losses resulting from forest fires. In assessing the losses we must consider:

1. the monetary value of the damaged vegetation,
2. the consequences of soil destruction and erosion,
3. loss of the watershed,
4. the loss of grazing land for wild and domestic animals,
5. the loss of wildlife,
6. the loss of recreational land,
7. the loss of scenery and
8. the loss of human life and property.

In 1955, the United States Forest Service estimated the cost of fire control (fire planning, preparedness, prevention and suppression) alone to be \$91,500,500 in the United States (7:549). From 1948 to 1957, 188 persons were killed by forest fires in the United States (2:24-25).

#### FRAME 6. UNDER EXTREME FIRE WEATHER CONDITIONS A FIRE MAY BURN OVER A LARGE AREA BEFORE IT CAN BE CONTROLLED.

Weather conditions that cause a fire to spread quickly and make it difficult to control are:

1. low humidity,
2. high temperatures,
3. strong winds, and
4. a period of drought

These, combined with heavily timbered steep slopes, provide optimum burning circumstances, as in the past when great forest fires raged over two and three million acres in a matter of a few days.

FRAME 8. TREES, LOGS, BUSHES AND DUFF MAY BE BURNED COMPLETELY. WHAT HAPPENS TO THE WATERSHED?

Often grass, twigs, needles, duff and small vegetation are completely burned, but only rarely are logs and large trees totally consumed. Forest fire temperatures have been recorded as high as 1800°F (18:278) but only 130°F-160°F (14:19) conditions are needed to kill the cambium of a tree. Even though a tree is not killed by the fire, it may be weakened, later to be attacked by insects or disease. Once void of vegetation, the water-holding capacity of an area is lost. The melting snow pack and rains wash down the slope unretarded, carrying away valuable soil. Slopes are no longer water reservoirs but become eroded, barren, dry ground.

FRAME 12. OFTEN WILDLIFE ARE KILLED OR FORCED TO ABANDON THEIR HOMES.

Many animals, especially smaller ones, are killed by forest fires. As a result of lye from burned ashes being carried into streams, entire fish populations may be killed. If the wildlife do survive the fire, they



must search for a new area in which to find food and build homes.

Fleeing animals whose fur has been ignited can spread the fire.

FRAME 14. YEARS LATER THE SNAGS ARE A GRIM REMINDER OF THE FOREST FIRE.

Immediately following the fire, vegetation begins to re-establish itself, generally with different, inferior species. Depending on the specie, 50 to 150 years elapse before the new forest is mature.

FRAME 17. CARELESSNESS CAUSES MORE THAN 90 PER CENT OF THE 135,000 FOREST FIRES EACH YEAR IN THE UNITED STATES.

From 1950 to 1962, the United States averaged 135,000 forest fires each year. During this period the average area burned per year was about 7,500,000 acres (25:690). Man accidentally or intentionally causes 90 per cent or more of these blazes. This includes forest fires caused by railroads, campers, smokers, debris burners, "fire bugs" and lumbering. Normally, 97 per cent of the man-caused forest fires occur in state and private forests (14:54). These forests are predominantly in the Eastern United States.

FRAME 20. IN THE WESTERN UNITED STATES LIGHTNING IS A  
MAJOR CAUSE OF FOREST FIRES.

Although lightning normally accounts for only ten per cent of all forest fires, half of these occur in the Federal forests (14:54). Most of the Federal forests are in the Western United States. In some of the Rocky Mountain States approximately 70 to 80 per cent of the forest fires are caused by lightning (20:373). Lightning is such a predominant cause in the West because:

1. during the summer there are frequent lightning storms,
2. summer temperatures are very warm, and
3. the West is arid or relatively dry.

Most fire seasons are marked by two or three severe, often dry, lightning storms in which numerous fires are started. In the Montana-Idaho Region Forest on July 12, 1940, 335 lightning-caused forest fires were detected in a twenty-four hour period (21:14).

FRAME 22. LIGHTNING, SPIRALING DOWN THE TREE, IGNITES  
THE TREE AND THE DRY VEGETATION AT ITS BASE.

Trees hit by lightning are sometimes literally "blown to bits," but generally the lightning winds down the trunk into the ground, leaving a two or three inch barkless scar. Only a small percentage of lightning strikes hit and ignite trees. Dry snags are easily ignited by lightning but live trees are more difficult to ignite. Often the dry duff

and vegetation at the base of the tree are ignited. Showers accompanying lightning storms immediately extinguish many of the newly started fires.

FRAME 24. MOST LIGHTNING-CAUSED FOREST FIRES OCCUR IN THE MOUNTAINOUS WEST. IT IS DIFFICULT TO REACH AND PUT OUT THESE FIRES.

Here the major problems are travel and fire behavior. Fires in the remote regions may take days to reach. Slope provide the fire with easy pathways. Fighting fire on steep slopes is difficult, tiring and dangerous.

FRAME 28. THE THREE BASIC PARTS OF FIRE ARE KNOWN AS THE FIRE TRIANGLE. WHAT ARE THESE PARTS?

Fuel, air (oxygen) and heat. Without all three of these parts a fire cannot burn. Once the fuel is ignited the temperature must remain above the ignition point. The fire triangle is intensified when the fire has dry fuel, abundant air (as during a wind) and high temperatures accompanied by low humidity.

FRAME 30. MOST FOREST FIRES START AND SPREAD ALONG THE GROUND. OLD LOGS AND STUMPS BURN FURIOUSLY AND ARE VERY HARD TO PUT OUT.

Once started, the fire "feeds" on the light ground fuels, gradually strengthening the fire triangle. By means of radiation, conduction and

convection the fire dries out and ignites adjacent fuels. If enough heat is produced, logs, stumps and trees are ignited. These fuels create a fire triangle that is difficult to break.

FRAME 33. THE FIRE SOON SPREADS, FINALLY REACHING THE TOPS OF THE TREES.

This is common with larger fires. The fuel at each level acts as a step by which the fire spreads upward as convection currents produced by fire dry out and ignite the fuels above.

FRAME 35. A CROWN FIRE IS THE MOST DANGEROUS AND DIFFICULT TYPE OF FOREST FIRE TO CONTROL. WHY?

Under extreme fire conditions crown fires have traveled over sixty miles per hour, consuming thousands of acres in a very short period of time. It is almost impossible to construct a fireline in front of the fire when it travels at such high speeds. Even when wide firelines can be built the fire often leaps across or blows sparks across the line and continues on its way.

FRAME 37. DENSE CHOKING SMOKE AND EXCESSIVE HEAT MAKE FIGHTING FIRE A DIRTY, TIRING AND DANGEROUS JOB.

The smoke restricts visibility, makes the eyes water and hinders breathing while the flames increase fatigue and cause discomfort. A

large fire sucks air in toward itself from all directions, sometimes causing death due to suffocation. Burns and lung damage, due to breathing in extremely hot air, may occur. Great forest fires of the past took thousands of lives.

FRAME 40. FOREST FIRES ARE DISCOVERED PRIMARILY BY  
PEOPLE IN LOOKOUT TOWERS AND PATROL PLANES.

Men on foot, horseback or in vehicles also patrol forested areas. Most forests have a system of lookout stations (some built on stilts 100 feet in the air) to watch for fires. Where lookout coverage is inadequate patrol planes supplement the coverage. Patrol planes are advantageous because they can give a more accurate location and description of the fire than the lookout.

FRAME 43. ONCE DETECTED, THE FOREST FIRE'S LOCATION IS  
DETERMINED ON AN INSTRUMENT CALLED A  
FIREFINDER.

After spotting the fire, the lookout lines up the fire through a "peep sight" and records the azimuth reading. The azimuth reading and other pertinent information about the fire are telephoned or radioed to the forest ranger.

FRAME 45. SOMETIMES SLEEPER FIRES PRODUCE LITTLE SMOKE. THEY MAY BURN FOR DAYS OR EVEN WEEKS BEFORE THEY ARE DETECTED.

If fuel and weather conditions are not conducive to good burning, a fire may smolder and creep over a relatively large area before it becomes detectible. Fires smoldering in stumps and roots have endured through the winter.

FRAME 48. SUPPRESSION CREWS OFTEN TRAVEL TO THE FIRE BY VEHICLE, AND HIKE IN FROM THE NEAREST ROAD.

Each summer thousands of men (mostly college men) are hired to fight forest fires. These men are on twenty-four hour call. Within minutes after receiving a fire call, they are on their way, in either jeeps, trucks, buses or cars. After driving as close to the fire as possible, they hike the rest of the way.

FRAME 50. THE SMOKEJUMPERS OF THE UNITED STATES FOREST SERVICE USE PARACHUTES TO REACH THE FIRE.

Air-borne fire fighters are an important part of fire-fighting teams. In 1939, four men made the first experimental jumps at Winthrop, Washington. At present, there are nine smokejumper bases in the Western United States employing over 300 men. Recruits must be between 135 and 180 pounds, between five feet, three inches and six feet, three inches in height, and between eighteen and twenty-eight

years of age. Rookie jumpers undergo four weeks of intensive training before they are eligible for fire jumps. Training includes parachute jumping techniques, fire fighting (including power equipment), rigorous calisthenics, first aid, communications, map and compass training and tree climbing (using lineman's spurs). Seven actual practice jumps are made during the last two weeks of training.

FRAME 52. AIRPLANE TRAVEL SAVES PRECIOUS TIME. FIRES ARE ATTACKED QUICKLY BEFORE THEY CAN GET OUT OF CONTROL.

Smokejumping was "invented" for one important reason--to get men to the fire as soon as possible. Airplanes can fly to fires even in the most remote areas in a fraction of the time needed by ground transportation. Such savings in time rescue millions of dollars worth of timber each year. When smokejumpers reach the fire, they are not tired from long, rough drives and hikes. By seeing the fire from above, they can plan their fire fighting strategy.

FRAME 54. JUMPS ARE MADE WHEN THE AIRPLANE IS ABOUT 1,500 FEET ABOVE THE JUMP SPOT, TRAVELING ABOUT 100 MILES PER HOUR.

A "spotter" directs the jump. He checks the wind, selects the jump spot and tells the jumpers when to jump. After the jumpers

signal that they are unhurt, the spotter then drops tools and supplies to the men by parachute.

FRAME 57. TREE LANDINGS ARE FREQUENT. THE JUMPERS REACH THE GROUND BY ROPES. BEFORE LEAVING THE FIRE THEIR PARACHUTES MUST BE RETRIEVED.

Jump spots range from soft grassy meadows to rocky snag covered ridges. Where there are no clearings the jumpers land in trees, sometimes 200 feet above the ground. Tree landings are generally soft, but there is the danger that the branches will break and jumper will fall to the ground. Before leaving the fire the jumper must climb the tree and carefully remove his chute so it can be returned to the smokejumper base for necessary repairs and repacking. These nylon parachutes cost about \$150. Parachutes left in the trees might cause confusion or alarm to people flying over the area.

It takes one to two minutes to descend from 1,500 feet. A normal rate of descent is twelve to fifteen feet per second but under certain conditions descents are as fast as thirty feet per second. By manipulating the lines and material the jumper can steer his parachute. Gusty winds and rough jump spots make this a hazardous job.



FRAME 59. DURING THE PAST FEW YEARS, HELICOPTERS HAVE BECOME AN IMPORTANT MEANS OF TRANSPORTING FIRE FIGHTERS.

Helicopters suitable for work in the rugged mountains are somewhat limited in what they can do. They can only carry a few men; they are slower than an airplane; and they require an open and level landing spot.

FRAME 61. IN MANY OF THE NATIONAL FORESTS OF THE WEST, HELISPOTS HAVE BEEN BUILT BY THE UNITED STATES FOREST SERVICE.

A system of helispots throughout the forests would make the helicopter a more effective means of manning fires. Many helispots have already been built in the National Forests of the Southwest, but only a few of the planned helispots have been built elsewhere in the forests of the West.

FRAME 63. HELISPOTS ARE CLEARED, MARKED AND NUMBERED. WHEN A FIRE STARTS MEN ARE FLOWN TO THE NEAREST HELISPOT.

High brush and trees within 90 feet of the center of the circle must be cleared away. In the center of this area a fifty foot diameter touchdown pad is encircled with white painted rocks. The white circle and the identification numbers make the helispot easy to see from the air.

## PART II

### FRAME 69. FIRE FIGHTERS QUICKLY ORGANIZE AND PREPARE FOR INITIAL ATTACK.

The fire boss quickly scouts the fire, checking the fire's behavior, type of fuel and type of soil. His strategy and the kind and proportions of tools to be used are determined by these factors.

### FRAME 71. IN ORDER TO SUPPRESS THE FIRE THE MEN MUST BREAK THE FIRE TRIANGLE. HOW CAN THIS BE DONE?

See Frame 72.

### FRAME 73. A FIRELINE IS DUG IN ORDER TO CUT OFF THE FUEL SUPPLY. WATER AND DIRT COOL AND SMOTHER THE FIRE.

Deprived of its fuel supply the fire will eventually burn out. Cooling and smothering are achieved by applying water and dirt to the base of the flame. All three of these tactics weaken and finally break the fire triangle.

### FRAME 75. CHAINSAWS CAN QUICKLY CUT THROUGH LOGS AND TREES.

Crosscut saws (two-man hand saws) are still used on small fires but power driven chainsaws are necessary when fires are traveling fast in trees and logs. In a matter of seconds a chainsaw can cut through

small trees and logs. Chainsaws lead the way, cutting a swath through the woods, leaving the light work for the hand tools. If a fire is crowning, a swath up to 100 feet wide may have to be cleared.

FRAME 78. IN THE FORESTS OF THE WEST, THE PULASKI AND SHOVEL ARE THE TWO MOST COMMONLY USED FIRE FIGHTING TOOLS.

Due to the rooty and rocky nature of the soil in the forests of the West, the pulaski is widely used. In addition to the pulaski and shovel, a variety of hoes, mattocks and rakes are used.

FRAME 80. THE PULASKI IS USED FOR DIGGING AND CUTTING WOOD. THE SHOVEL CAN BE USED FOR SCRAPING AND CUTTING ROOTS.

The hoe edge of the pulaski is used as a pick in breaking the ground, for cutting roots, and for scraping coals off logs and trees. The shovel, smaller than a standard sized shovel, can be used for scraping fireline, for cutting small roots and for scraping hot coals off logs and trees. But the shovel is most commonly used for spreading or throwing dirt.

FRAME 85. RECENTLY MECHANICAL TOOLS HAVE BEEN USED TO BUILD FIRELINES.

Mechanical trenchers have proved to be labor saving devices. The heavy, bulky trenchers are difficult to handle on steep, rocky slopes.

FRAME 89. FIRELINES MUST BE DUG DOWN TO MINERAL SOIL, AND ROOTS MUST BE CUT. WHY? WHAT DETERMINES THE WIDTH OF THE FIRELINE?

Soil abundant with partially decomposed vegetation will burn, mineral soil will not. Fire can cross the fireline by way of uncut roots. The width of the fireline depends on the behavior of the fire, the slope and the type of fuel. Generally, the fireline is one and one-half to three feet wide. Bushes, small trees and overhanging branches near the fireline are cut away.

FRAME 91. LOGS AND BRANCHES ARE PLACED SO THEY WON'T ROLL. A CUP TRENCH IS BUILT TO CATCH ROLLING MATERIALS.

In order to keep rolling, burning materials from spreading the fire down the slope, cup trenches are built. The steeper the slope, the deeper and wider the cup trench must be. Logs are trenched and positioned on the slope to keep them from rolling.

FRAME 93. IF "CAT" TRACTORS ARE AVAILABLE AND CAN BE BROUGHT IN, THEY ARE USED FOR BUILDING A WIDE FIRELINE.

Steep terrain and inaccessibility limit the use of the "cat. "  
"Cats" can be used to build excellent wide firelines.

FRAME 95. DIRT IS THE MOST WIDELY USED SMOTHERING AGENT. WATER, A BETTER AGENT, IS SPRAYED ON THE FIRE WHEN IT IS AVAILABLE.

Contrary to popular belief, most forest fires are put out with dirt. Dirt does cool and cut off the fire's fuel supply, but its most outstanding feature is its smothering ability. In steep country where streams are nearby, a gravity power system can be employed to spray water, but power pumps and back pumps are used most often.

FRAME 98. DURING THE MOP-UP STAGE BURNING EMBERS ARE PUT OUT AND HEAVY FUELS ARE PLACED IN A BONEYARD.

The mop-up procedure varies with the size of the fire. All burning materials are extinguished if the fire is small. If the fire is large, only the burning in materials near the edge of the fire is completely extinguished. To determine if the fire is out, the fire fighter feels the burned materials. Only when the burned materials are cool are they out. The perimeters of large fires are patrolled for several weeks afterwards. If the fire is small, the large, burned materials are placed in a boneyard where they are separated, scraped, and allowed to cool.

FRAME 101. DANGEROUS AND BURNING TREES ARE FELLED.

This is part of the mop-up stage. If this were not done, hot sparks, carried by the wind, might start spot fires. Trees whose bases have been nearly burned through are safety hazards and must be cut down. Felled trees and logs on smaller fires are bucked up in order to make them easier to handle and put out.

FRAME 103. HELICOPTERS AND AIRPLANES OFTEN SUPPLY FIRE CREWS WITH FOOD AND EQUIPMENT.

Each year tons of cargo, including everything from eggs to 700 pound trenchers, are parachuted to fire fighters.

FRAME 106. AIR TANKERS DROP SLURRY ON SOME FOREST FIRES.  
SLURRY COATS THE FOREST WITH A MUD-LIKE COVERING, WHAT DOES THIS DO?

An assortment of World War II bombers has been converted for dropping slurry. The cost of borate, a kind of slurry made of sodium calcium borate, is about one dollar per gallon (raw material, mixing and deliver to the fire) (8:1). Newer liquid retardants are cheaper.

If slurry drops are accurate, they are effective in (1:19):

1. holding small fires until ground crews arrive,
2. knocking down spot fires,
3. cooling down hot spots,
4. laying a fire-retardant line in advance of a fire,

5. fireproofing unburned fuels, and
6. strengthening existing firelines.

Slurry cools, smothers, and cuts off the fuel supply.

FRAME 109. SLURRY LAID DOWN ON THE EDGE OF THE UNBURNED FOREST ACTS AS A FIRELINE.

By coating the forest with slurry the fuels become fireproofed (to a degree). The fire-retardant line is not used by itself. It merely retards the spread of the fire until a permanent fireline can be built.

FRAME 113. WHAT WILL YOU DO, "MAKE YOUR STATE BLACK"? OR "KEEP YOUR STATE GREEN"?

In the future, scientists hope to control lightning, the cause of ten per cent of our forest fires. What about the other ninety per cent? Your help is necessary if we are to save our forests.

## GLOSSARY

1. AIR TANKERS                      Airplanes that drop liquid fire retardants on forest fires
2. AZIMUTH                         Bearing or location expressed in degrees from North.
3. BACK-PUMP                      Consists of a four to five gallon tank carried on the back, a short hose and a sliding-action hand-operated pump.
4. BONEYARD                      Area cleared to mineral soil in which heavy fuels are placed and allowed to cool off
5. BUCK-UP                        To cut felled (downed) trees into lengths
6. CAMBIUM                        Soft layer of living cells between the bark and the wood
7. CONDUCTION                    Transfer of heat through materials, from particle to particle
8. CONTROLLED                    When the fireline is completed and there is no danger of the fire spreading
9. CONVECTION                    Transfer of heat by the movement of a gas (air) or liquid
10. CROWN                         Upper branches and stem of a tree, the treetop
11. CROWN FIRE                    Fire that advances from top to top of trees. The fastest spreading of all forest fires



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|-------------------------------------|---|
| 12. CUP TRENCH                      | A "U" shaped fireline built to catch rolling materials  |
| 13. DRY LIGHTNING                   | Lightning storm without rainfall  |
| 14. DUFF                            | Bed of decayed or decaying leaves, needles and limbs that lie beneath the ground surface and above the mineral soil   |
| 15. EXTREME FIRE WEATHER CONDITIONS | Weather conditions that allow fires to start easily, spread rapidly, thus making them difficult to control and put out. These conditions are low humidity, high temperatures and strong winds |
| 16. FIRE CONTROL                    | Fire planning, preparedness, suppression and prevention   |
| 17. FIREFINDER                      | A device consisting of a map and a sighting instrument for determining the location of a forest fire  |
| 18. FIRELINE                        | Strip of land cleared to mineral soil.  |
| 19. FIRE RETARDANT                  | Chemical that reduces the flammability of wood and other combustible materials  |
| 20. FIRE RETARDANT LINE             | Strip of land covered with fire retardant   |
| 21. FIRE TRIANGLE                   | Three parts of fire--fuel, air, (oxygen) and heat   |
| 22. HEAVY FUEL                      | Large branches, stumps, logs, snags and trees   |
| 23. HELISPOTS                       | Helicopter landing and take-off place   |

- |                    |   |
|--------------------|---|
| 24. IGNITES        | Sets on fire  |
| 25. INITIAL ATTACK | First attack on fire  |
| 26. JUMP SPOT      | Landing area for smokejumpers   |
| 27. LIGHT FUELS    | Duff, grass, leaves, needles, small branches, twigs, and small trees  |
| 28. LOOKOUT TOWER  | Building on a ridge or mountain top from which fires are detected   |
| 29. MINERAL SOIL   | Soil free of combustible, decayed vegetation  |
| 30. MOP-UP         | Making the fire safe after it is controlled. Includes putting out burning material, felling snags and trenching logs to prevent rolling, etc. |
| 31. PATROL PLANE   | Airplane used to detect forest fires  |
| 32. PULASKI        | Single-bit axe with a grub hoe extending from its back. Named after Edward Pulaski, twentieth century forest ranger                           |
| 33. RADIATION      | The transfer of heat by waves of energy   |
| 34. SLURRY         | Mixture of water and soluble materials, a thin mud-like fire retardant  |
| 35. SMOKEJUMPERS   | Fire fighters who parachute to forest fires   |
| 36. SPOT FIRE      | Small, separate fire started by sparks from the main fire   |

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|--------------------------------|---|
| 37. SNAG                       | Standing dead tree                        |
| 38. SUPPRESSION CREW<br>(fire) | Group of men that put out forest<br>fires |
| 39. TRENCHER                   | Mechanical fireline builder               |
| 40. WATERSHED                  | The area drained by a river system        |

## REFERENCE MATERIAL FOR TEACHERS

1. Air Attack on Forest Fires, Forest Service, United States Department of Agriculture, Information Bulletin 229, Washington: Government Printing Office, 1960.
2. Davis, Kenneth, Forest Fire: Control and Use, New York: McGraw-Hill Book Company Inc., 1959.
3. Hawley, Ralph and Paul Stickel, Forest Protection, New York: John Wiley and Sons Inc., 1959.
4. Teachers Guide: National Science and Conservation Education, Natural Science and Conservation Education Summer Curriculum Committee, Highline Public Schools, Seattle, 1963.
5. Fireman's Guide 5125.3, Forest Service Handbook, Forest Service, United States Department of Agriculture, Washington Government Printing Office, 1959. (Local Forest Service Ranger District)
6. Timber Resources for America's Future, Forest Service, United States Department of Agriculture, Resource Report 14, Washington: Government Printing Office, 1958.

Consult your local library or any of the agencies listed on page 29 for additional reference material on forest conservation.

## STUDENT READING LIST

The following books have selected chapters or complete stories about forest fires and the men who fight them. The reading level for each book is indicated. Consult your school and local library for additional books on this subject.

1. Blough, Glenn. Lookout For the Forest, New York: McGraw-Hill Company Inc., 1955. Grade 4.
2. Coombs, Charles. High Timber, New York: World Publishing Co., 1960. Grade 7.
3. Dietz, Lew. Jeff White: Forest Fire Fighter, Boston: Little and Brown Publishing Company, 1954. Grade 7.
4. Dowling, Ellen C. Gabby and the Forest Fire, Washington, D. C.: American Tree Association, 1947. Grade 4.
5. Floherty, J. J. Forest Ranger, Philadelphia: Lippincott Publishing Company, 1956. Grade 7.
6. Gilbert, Kenneth. Smoke Over Skygok, New York: Holt Publishing Company, 1951. Grade 6.
7. Hazard, Joseph. Our Living Forest, Seattle: Superior Publishing Company, 1948. Grade 7.
8. Holbrook, Steward. Burning An Empire, New York: Macmillian Company, 1943. Grade 9-Adult.
9. Hult, Ruby. Northwest Disaster, Portland, Oregon: Binfords and Mort Publishing Company, 1960. Grade 9-Adult.
10. Kjelgaard, James A. Forest Patrol, New York: Holiday House, 1941. Grade 6.
11. Kingsbury, Ruth F. Lookout Tower, Caldwell, Idaho: Caxton Printers, 1957. Grade 6.
12. Parker, Bertha M. Fire, Friend and Foe, Evanston, Illinois: Row Peterson and Company, 1952. Grade 4.
13. Spencer, Betty. The Big Blowup, Caldwell, Idaho: Caxton Printers, 1956. Grade 9-Adult.
14. Stewart, George R. Fire, New York: Random House, 1948. Grade 9-Adult.

## FOREST FIRE CONTROL FILMS

The films suggested below are films that may be useful in introducing a unit of study on forest conservation or forest fire control. Many of these films will show in detail specific phases of forest fire control.

Films may be obtained by writing to the following agencies:

1. Audio-Visual Library  
Central Washington State College  
Ellensburg, Washington
2. Audio-Visual Department  
Oregon State Superintendent of Higher Education  
1633 Southwest Park Avenue  
Portland 1, Oregon
3. United States Department of Agriculture  
Forest Service  
Post Office Box 4137  
Portland 8, Oregon
4. Audio-Visual Services  
University of Washington  
Seattle, Washington
5. Audio-Visual Center  
Washington State University  
Pullman, Washington

AIR TANKER ATTACK (color, 20 minutes, 1960) USDA

A training film for supervisory and other forest management and fire suppression personnel. Shows how the air tanker is used as an effective tool in control of forest fire. (U. S. Department of Agriculture)

**BUILDING THE FIRELINE** (color, 27 minutes, 1952) USDA

A training film showing typical forest fire problems and tactics used by the fire boss, foreman and crews. (U. S. Department of Agriculture)

**BURNING ISSUE** (color, 14 minutes, 1962) USDA

The provocative story of a magazine writer covering a major forest fire in the South. His approach -- to make the public understand just how important their forests are, and why they must be saved; many dramatic fires and fire fighting scenes. (Southern States Forestry Departments)

**CARGO DROPPING** (color, 20 minutes, 1950) USDA

How cargo is dropped to forest fire crews from a Ford Trimotor and DC-3 airplane. (U. S. Department of Agriculture)

**FIRE IN THE FOREST** (Color, 22 minutes, 1951) USDA

Fire, weather and slope are the main conditions that control fire behavior. This film shows the effect of these factors on fire behavior. (U. S. Department of Agriculture)

**FOREST SMOKECHASER** (color, 27 minutes, 1948) USDA

A training film for smokechasers and lookouts who have to handle one-man fires in the Western United States. The film shows correct action in putting out a small lightning fire. (U. S. Department of Agriculture)

**HELICOPTERS IN FIRE CONTROL** (color, 13 minutes, 1960) USDA

The film shows the various ways in which the helicopter has proved valuable in fire control and how it must be wisely managed by personnel and coordinated with other air and ground equipment. (U. S. Department of Agriculture)

**INTRODUCTION TO FIRE BEHAVIOR** (color, 16 3/4 minutes, 1960)  
USDA

A training film for fire fighters and initial attack foreman. By means of animation and table top photography interspersed with actual fire scenes, it shows the basic fundamentals for combustion and the influence of fuel, weather and topography on fire behavior. (U. S. Department of Agriculture)

LITTLE SMOKEY (color, 13 minutes, 1953) USDA, WSU

Story of Smokey, now a full-grown bear and living symbol of the need for applying fire prevention measures on all forests in the United States. (U.S. Department of Agriculture)

SMOKEY THE BEAR (black and white, 5 minutes, 1952) CWSC, USDA, WSU

Forest fire safety message for youngsters presented by singer Eddie Arnold, who sings ballad of Smokey the Bear while a cook cartoonist illustrates the song. (Co-op Forest Fire Prevention)

SMOKEJUMPERS (color and black and white, 10 minutes, 1949) CWSC, USDA, UW, WSU

Parachute fire fighters trained to combat forest fires in the remote and roadless areas of the North and Southwest. Glamorous and unglamorous aspects of smokejumping. Carries a forest fire prevention message. (U.S. Department of Agriculture)

SNUFFY-SMOKEY THE BEAR'S PAL (color, 4 minutes) CWSC, USDA

Snuffy assists Smokey the Bear by putting out a burning cigarette that was tossed into the grass by a camper. (U.S. Department of Agriculture)

THEN IT HAPPENED (color, 10 minutes) OSSHE

Destruction of natural beauty, farms, forest, homes, and towns by a forest fire in Maine that covered 200,000 acres in eleven days. A plea for care in preventing such fires. (U.S. Department of Agriculture)

VISION IN THE FOREST (color, 5 minutes, 1957) CWSC, OSSHE

Vaughn Monroe and his family show how we can all cooperate with Smokey to prevent forest fires from getting started in our forests. (U.S. Department of Agriculture)

WATERSHED WILDFIRE (color, 23 minutes, 1958) USDA, WSU

Story of the Santa Barbara watershed fire; methods of fighting the fire and subsequent reclamation efforts. (U.S. Department of Agriculture)



## FREE AND INEXPENSIVE TEACHING AIDS

Concepts of Conservation, Conservation Foundation, 30 East 40th Street, New York, free.

Conservation: You and Forest Fires, Department of Agriculture, Forest Service, Washington, D. C. , free.

Forest Fire, American Foresters Association, 919 Seventeenth Street, N. W. , Washington 6, D. C. , 10¢.

Materials to Help Teach Forest Conservation, (list of teaching aids) Department of Agriculture, Forest Service, Washington, D. C. , free.

Protecting the Forests From Fire, Department of Agriculture, Forest Service, Washington, D. C. , free.

In addition to the specific materials mentioned above, you may write to the following agencies and request forest conservation teaching aids.

American Forest Products Industries  
1816 "N" Street Northwest  
Washington 6, D. C.

Keep Washington Green  
University of Washington  
Seattle, Washington

State Conservationists  
301 Hutton Building  
South 9, Washington Street  
Spokane 4, Washington

United States Government Printing Office  
Superintendent of Documents  
Washington, D. C.

United States Forest Service  
Post Office Box 3623  
Portland 8, Oregon

Washington Forest Fire Association  
949 Henry Building  
Seattle 7, Washington

West Coast Lumberman's Association  
1410 Southwest Morrison  
Portland 5, Oregon           OR  
4444 White-Henry-Stuart  
Seattle, Washington

Western Forestry and Conservation Association  
712 United States National Bank Building  
Portland, Oregon

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2. Annual Fire Report for the National Forests Calendar Year 1962, Forest Service, United States Department of Agriculture, Washington: Government Printing Office, 1962.
3. Bacon, E. M., "Training in Forest Fire Behavior," American Forests, LXIV, (July, 1958), pp. 24-25.
4. Colman, E. A., Vegetation and Watershed Management, New York: Ronald Press, 1953.
5. Cooper, Charles, "Ecology of Fire," Scientific American, CCIV, (April, 1961), pp. 150-161.
6. C. W. C. E. Films 1963-1964, Audio-Visual Library, Central Washington State College, Ellensburg: October, 1963.
7. Davis, Kenneth, Forest Fire: Control and Use, New York: McGraw Hill Company, Inc., 1959.
8. Down, Eldon, "Statistics About Borate," (Correspondence, request for data), Blue Mountain Air Service, Inc., LaGrande, Oregon, October, 1959.
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15. How Can We Use Our Natural Resources Wisely? Curriculum Division, Portland Public Schools, Portland: 1957.
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17. Lutz, Harold and Robert Chandler, Forest Soils, New York: John Wiley and Sons Inc., 1961.
18. Motion Pictures of the U. S. Department of Agriculture, United States Department of Agriculture, Handbook 14, Washington, Government Printing Office, 1960.
19. "Project Skyfire Aimed at Stopping Lightning Fires," Science News Letter, LXXI, (June 15, 1957), pp. 373.
20. Quigg, Floyd, "Skyfire: How Science Fights It," American Forester, LXIX (October, 1963), pp. 12-15.
21. Recent Motion Pictures of the Department of Agriculture 1961-63, Cumulative Supplement to Agricultural Handbook 14, United States Department of Agriculture, Washington: Government Printing Office, 1960.
22. Sager, Daniel and Allen Davis (ed.), Audio-Visual Materials, 1964, Department of Public Printing, University of Washington, Seattle: 1964.
23. Saterstrom, Mary (3d.), Educator's Guide to Free Science Materials, 1962, Educators Progress Service, Randolph, Wisconsin: 1962.

24. Statistical Abstract of the United States-1962, Bureau of the Census, United States Department of Commerce, Washington: Government Printing Office, 1962, pp. 690.
25. Stewart, George R. , Fire, New York: Random House, 1948,
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