For the past few years, since the abolition of the National Resources Planning Board, drainage basin investigations and reports have been coordinated to a significant extent through the Federal Inter-Agency River Basin Committee, operating under quadripartite agreement among the principle Federal agencies concerned—the Departments of War, Interior, Agriculture and the Federal Power Commission. (The Department of Commerce has recently been added.) Under the shield of the Federal Committee some regional or drainage basin committees have been formed. The Missouri Basin Inter-Agency Committee has been in operation for over a year, and the Columbia Basin Inter-Agency Committee for several months. The Columbia Committee is composed of regional representatives of the component Federal agencies of the Federal Committe plus the Bonneville Power Administrator. The governors of the Columbia Basin states or their representatives have been asked to participate in the Basin Committee.[9] These governors had previously, in 1943 as the Northwest States Development Association, adopted a unified post-war development program for the Columbia Basin and proposed governing principles for that development.[10]

More recently, the Department of the Interior has formed the Pacific Northwest Coordination Committee, composed of the ranking regional officers of its eight agencies, for the purpose of achieving successful coordination of the Department's own program in the Pacific Northwest and of facilitating cooperation with the appropriate Federal, state, and public agencies. The Agencies included are Bonneville Power Administration, Bureau of Reclamation, Office of Indian Affairs, Bureau of Land Management, Bureau of Mines, Fish and Wildlife Service, Geological Survey, and National Park Service. The Department of Agriculture has a Pacific Northwest regional advisory committee for similar purposes within that Department.

Both the Intra-Departmental and Inter-Departmental machinery are necessary and desirable and undoubtedly will prove to be effective. The effort is largely voluntary, however, and still needed, as previously stated, are certain definite responsibilities for planning, programming and financial management of the essentials of the basin development program.

[9] THE PACIFIC NORTHWEST, ITS RESOURCES, POTENTIALITIES, DEVELOPMENT, ... (in preparation), Columbia Basin Inter-Agency Committee, 1947.

[10] COLUMBIA RIVER BASIN POST-WAR DEVELOPMENT PROGRAM, Northwest States Development Association.

SMOKEJUMPING, AIRPLANE TRANSPORT AND HELICOPTERS IN FUTURE FOREST FIRE CONTROL

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The title of this article implies a prediction. Predictions or forecasts, to be correctly interpreted, should be specifically designed as probables, or as possibles, in order to establish a degree of certainty.

In forest fire control the realm of possibility extends far beyond the visible limits of probability. The former is limited only to development of knowledge and mechanics, while probabilities are circumscribed by economics, public attitudes, and that element of caution which must safeguard the progress of any activity involving the future of a vital resource. Hence, a plan for forest fire protection must take into account the financial aspects, the influence of public and national demand, and the professional facilities which will dominate the period under consideration. Then too, we must allow time for conversion of human attitudes and physical facilities, from the old to the new. The more radical or drastic changes require more time for professional and organizational readjustment and for liquidation of the old plant. History provides a guide for estimating the time element in major transitions in forest fire methodology.

In stating my expectancy of the influence which air transportation will have in forest protection, I shall restrict my estimate to probables of the next 10 years. I am assuming that the current trend of public and industrial interest in management of of natural resources will be accelerated by a growing scarcity of forest products and a greatly increased public use of forest lands. Economic need and popular demand for better forest protection is anticipated. Like the control of disease or enemy armies, successful fire control requires effective, adequate attack immediately following inception. Too late rather than too little has most often been the reason for devastation of our forests by fire. Thousands of fires have grown from a single spark into conflagrations while our attack forces trudged wearily through miles of rugged mountain country only to arrive too late.

During the decade of the twenties, in the era of pack trains and foot transportation, it was not uncommon for fires to spread 36 hours or more before being attacked by a lone fireman. Too often that fireman arrived worn and exhausted by a long grueling hike under heavy back pack. Reinforcements came days later—too late, and big costly fires resulted. Damage reached inestimable figures. A great decentralized organization of men, equipment and pack trains was essential to fire protection under a trail transportation scheme. Men were spotted throughout the forests on virtually every mountaintop and major trail intersection. Even so, sufficient strength could not be concentrated with sufficient rapidity on any one fire to assure success. Movement was too slow and the point of emergency could not be determined in advance. Hence, a big part of the organization could not be brought into action although many parts of the region were sorely in need of assistance.

The following decade, the nineteen thirties, brought us the age of the automobile and truck road. Attack was greatly improved. More men and equipment reached fires with less delay and less fatigue. Some reduction of force was effected because road travel made concentration of facilities more possi-

ble. Cost and damage decreased materially. Though thousands of miles of truck trail were built at heavy cost, the actual savings in total expense of fire fighting made this development economically sound.

However, like all things, there is a point of diminishing returns in building roads for forest protection alone. Distances become so great from the bases of supply that travel time requirements become intolerable. Millions of acres of our forest land, some in large blocks, are now outside reasonable travel time limits despite our network of roads.

Another saturation point is reached in road development strictly for fire protection when costs for opening up areas of low hazard country become greater than the fire control benefits to result from such accessibility. We have more millions of acres in that class—orphans in the world of ground transportation. These areas are costing the public heavily for fire protection, yet because of inaccessibility, the resources of these lands are not being utilized. There is dire need for opening these cold-storage areas in order to permit utilization of the products they offer. Such accessibility will have material value to fire protection, even though fire protection alone could not justify the road program.

Motor road accessibility is vital to successful fire protection, but because of the limitations previously stated, it is not within itself fully adequate to insure the degree of forest protection which appears essential to national economy.

The inadequacy of road development as a complete and final answer to the transportation needs of fire control were foreseen more than 10 years ago. At that time aeronautics offered little in the way of dependable service which could be adopted as a supplement to road transportation in forest fire work. Feeble experiments in detection work had proved valueless—that was the extent of air transportation background in forest fire control. However, it appeared to be the most likely solution to the problem.

With considerable doubt and a measure of genuine fear, we began experimenting in adaptation of air transport to fire uses. Equipment was inefficient and sources of information were lacking. There was no precedent. Progress came slowly until the drought period of the middle thirties brought on a fire situation which required many departures from the previously overcautious and ulta-conservative thinking and action. Pressure of necessity resulted in rapid development of techniques and mechanics. Now, after a decade of experiments and practical application the airplane has taken its place as a regular part of the fire machine. It has eliminated the word "inaccessible" from the vocabulary of fire men and those vast areas which were orphans in the era of ground transportation are now only an hour's travel from supply bases. Within an hour after a fire is discovered a trained fireman steps from a plane over a fire in the back country and floats to its very edge by parachute. He arrives at the point of attack free from the fatigue which handicapped the smokechaser of foot travel days.

More than 1,000 fireman jumps were made to the most remote and troublesome fires in Region One during the season of 1945. One hundred eighty-one fires were handled by jumpers. If reinforcements are needed, a radio call brings more jumpers within the hour. No waiting for equipment and camp facilities is suffered. Such facilities come by parachute to within a few feet of the specific point of use. Two hundred twenty-eight tons of supplies were delivered by air, most of it to trailless, wilderness area fires during the past season. Aerial photography and observation of large fires speedily provided intelligence essential to effective strategy and management.

Many lookouts and other ground personnel have been eliminated through use of aircraft. This new service not only stands on its own feet financially but by actual cost records it pays dividends. The saving in damage to timber resources is great.

The foregoing history is not only a report of progress to date but is essential to a clear understanding of those trends which shall influence the immediate future . It pictures the use of aircraft in forest fire control up to the end of the 1945 season.

Now to the future. According to present indications there will be three separate but definitely related functions for aircraft to perform in any sound fire plan involving large tracts of forest in which ground accessibility is inadequate. These are: detection or intelligence service, transportation of facilities, and lastly, the undeveloped job of applying chemical or mechanical retardants and extinguishing agents directly on fires.

As a detector of small incipient fires, the conventional airplane has but limited value. It can be used to supplement fixed ground lookouts but cannot substitute for them entirely. The airplane sees all the land surface, while the most intensive lookout system possible within reasonable costs sees but 60 percent of the ground on which fires may start. However, conventional planes move across the forest at 100 miles per hour and observation of any given spot is limited to a fraction of a minute. Should smoke or a fire be lying below the tree tops at that particular moment, it may go undetected and could spring to life at a later time.

Despite this limitation, fixed wing aircraft will continue to give valuable detection service in large areas where fire occurrence is low and where fuel conditions are not conducive to high rate of spread. Such service will further reduce the size of ground facilities and thereby effect additional savings in cost.

Current development of the helicopter promises to establish it as the most valuable of fire detectors. Those now in operation are capable of hovering motionless at elevations up to 3,500 feet above sea level. Thus this craft, within the limits of its ceiling, has already overcome the one major failure of the ordinary type airplane.

Manufacturers expect to increase the ceiling limits of helicopters to the extent that hovering may be possible at all elevations in which forest protection is important in this region. Availability of such performance will permit prolonged observation of any questionable spot by the air observer. It will allow more hours of effective flying for a given cost, since deadhead flying to and from airfields will become unnecessary. It will provide better intelligence in that the observer while suspended at treetop level may evaluate and study conditions intensively. This service may permit abandonment of a portion of the ground lookout system. In Region One that will involve the probable elimination of many lookout stations and those facilitating developments such as trails, roads, and telephone lines which are maintained solely for fire uses. This transition should be completed within the next 10 years. It is dependent upon development of the helicopter.

The second phase of air service in fire control, transportation of men and supplies, will result in benefits far greater than those of aerial detection. The future limits of this service are, with exception of the helicopter, dependent upon economies rather than mechanical and technical development. The point of diminishing returns must be determined. It has not yet been ascertained. However, it is not unreasonable to expect that this point will not fall short of a plan which provides adequate attack forces on any fire within ½ hour following its origin. Airborne reinforcements will be provided at a minimum rate of 100 men per hour—equipped and at the fire line.

Patrol planes carrying not only observers but also smokejumpers will follow in the wake of lightning storms. Discovery will be almost coincident with inception. Only minutes will elapse before the jumping fireman is at work on the embroyo fire. A radio call from the attacking smokejumper will bring reinforcing jumpers from the nearest base within a half hour's time. Such service

is already proved by actual test and found to be sound. Considerable expansion of this system will take place during the next 5 years, or, until parachute jumping is displaced by delivery from hovering-type aircraft. Such a transition from chutes to rope ladders will not be made overnight. It will be a gradual change-over, requiring several years.

One major reason for switching from fixed wing craft to helicopters in hauling personnel and freight in the forests is the latter's ability to pick up cargo in the wilderness without development of expensive airfields. Conventional planes can distribute cargo in the forests, but a vast system of trails, mules, roads, and trucks is required to retrieve men and equipment. Maintenance expense for these developments is large and will be eliminated through use of the helicopter. Those ground facilities essential to other purposes will of course be retained.

Despite the advantages of the helicopter, it will not completely eliminate the big cargo plane. Heavy transport planes will continue to ferry reinforcements from central bases to wilderness landing strips from which helicopters will make distribution to fires and other jobs. Likewise, helicopters will return men and equipment to fields where bigger, faster carriers will pick them up for long distance hauls. A combination of the two types of craft appears to offer greatest value. With such a transportation scheme a much smaller organization of fire fighters would be required. Best qualified technicians and managers could be quickly placed at the scene of action. The fatigue factor resulting from ground travel to the fire which has so greatly reduced effectiveness on fire lines of the past will be minimized. Costly field kitchens will be replaced by a scheme for delivering meals by air direct to the worker on the fire's edge. Water and chemicals for application through hand methods have been excluded from general use because of the difficulty involved in mule packing these items to the point of use It will become a simple delivery with the helicopter.

The third phase of aerial fire control concerns the application of retardants and extinguishing agents direct on fires from an aircraft.

Prewar experience in this field was discouraging. Best available equipment and planes were used in rather exhaustive experiments. Effective accuracy could not be accomplished. Anything short of a direct hit on the fire's edge is without desired effect, and with prewar equipment that degree of accuracy could not be attained.

However, with recent advancements made by our air forces in precision bombing, there appears reason to believe that bombing of forest fires may play an important part in future suppression work. Currently available military equipment offers much to cause optimism, and an experimental program is being negotiated.

It is expected that bombing of fires will become practical only under certain circumstances. It will be too costly for use in any but critically dangerous situations. It will most likely become the one means of stopping that occasional run-away fire which defies control by less drastic methods. Chemical bombing with conventional aircraft will have limited use.

Common use of chemical sprays or bombs in fire fighting to a large extent depends upon the helicopter. When it becomes possible to apply large quantities of retarding substances from carriers suspended motionless at treetop level, then forest fire control will have reached its climax in transportation. That day will come within the next 10 years—some believe it will be within 5 years. There are many mechanics, techniques, and perhaps some rather revolutionary changes in addition to those I have described, which constitute possibilities in aerial fire control. Most are outside the category of probables and therefore will not be mentioned in this paper.

The foregoing discussion has concerned the transition of fire control transportation of the present to that of the visible future. A summary of just what we can reasonably expect of air transportation during the next 10 years is offered in closing this subject. It follows:

1. Use of aircraft for observation-detection service will be greatly expanded. The fixed ground-detection plant will be reduced. Many lookout towers and observatories, and many miles of telephone line and trails which are now maintained solely for fire protection will be abandoned. Organization will be reduced. Fewer men will do a better job. The degree of transition from ground to air detection will be governed by the speed of helicopter development. Better detection will result and fire damage will be reduced.

2. Movement of personnel and supplies by air to fires will become normal practice. A reduction in size of suppression organization will be made possible through increased mobility of forces. Attack time will be shortened, thereby permitting fewer men to accomplish the suppression job. Effectiveness of manpower will be increased greatly through elimination of travel fatigue inherent in any transportation scheme requiring foot travel. More effective hours per man day will be spent on productive fire fighting, since air delivery of prepared meals and supplies directly to work crews on the fire line will eliminate the time lost where crews are subsisted and quartered at trail and road heads. There will be no "portal to portal" time loss. Fires will be more skillfully managed because through air travel it will be possible to provide adequate and timely technical supervision at the scene of action. Parachuting fire fighters will lead the parade of modern firemen until 1950 or perhaps longer. By 1955, parachutes will be discarded and attack forces will descend on ladders or elevators from helicopters to the point of attack. Employment of both conventional airplanes and helicopters will provide best service. Neither fill the requirements alone.

3. Aircraft will provide two effective methods for fighting fire with chemicals—the bomber and helicopter. Bombers will be used to curb the spread of especially dangerous fires under certain circumstances. Such use will be costly and will not become routine common practice. Helicopters, when capable of hovering with a worthwhile payload at forest elevations, will revolutionize the fighting of small fires. This will effect the greatest reduction of ground forces and will complete the currently foreseeable mechanization of fire control. Ten years should be ample time for this accomplishment.

4. Protection of our forests from fire has made great progress since the initiation of a comprehensive conservation program in 1905. This is evident in the records of area burned by decades in Region One of the United States Forest Service, as follows:

1908 to 1910	3,260,098 acres
1910 to 1920	1,957,850 "
1921 to 1930	1,075,656 "
1931 to 1940	750,968 "
1941 to 1945	62,212 "

That record is commendable, especially in view of the handicaps inherent in any new undertaking of such great proportions. Even so, it is not good enough and sound economics require further reduction of this devastation.

In conclusion, it may be said that the future of forest fire control is bright, and the air age has made it so.