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UNITED STATES DEPARTMENT OF AGRICULTURE  
FOREST SERVICE

THE FORTY-MAN CREW

A REPORT ON THE ACTIVITIES OF THE EXPERIMENTAL  
40-MAN FIRE SUPPRESSION CREW

By

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Region 6

And

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December 19, 1939

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of an article to appear in the April 1940 issue  
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UNITED STATES DEPARTMENT OF AGRICULTURE  
Forest Service

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STUDIES  
Suppression  
40-Man Crew

Washington  
January 25, 1940.

FOREWORD

Region Six conducted, throughout the past summer season, an experiment in organizing and operating a special 40-man suppression crew. With regard to this venture in an important field, Regional Forester Lyle F. Watts in his letter of January 9 states:

"The past season's experience has been valuable. All Forests are enthusiastic about well organized, trained, and properly equipped mobile crews. Special instructions have been prepared for Forests, so they can organize such crews from their own resources. The Region is going to spend several thousand dollars for light beds and special equipment. Special overhead training is going to be handled as a project. New ideas in organizing and managing crews on the fire line are being developed and tried out. Reducing overhead costs, particularly behind the line, is almost daily talk on many Forests. Costs on walking men to and from camps have been analyzed and discussed. The impetus to these and many other matters has, it is believed, been brought about in part, at least, by the use of the 40-man crew.

"If total expenditure for the 40-man crew, exclusive of the road and bridge construction, is prorated to each mile of fire line constructed, it cost \$871 per mile. Long distance transportation, camp construction, etc., are all included. If only fire equipment, training, transportation, and suppression costs are included, the crew constructed each mile of fire line for \$325. By comparison, it cost an average of \$1,991 to construct and work each mile of 229 miles of fire line on six of our largest fires. If one-third of this was expended for mop-up and thus eliminated, the 40-man crew constructed line 35% cheaper, if all its costs are included; or over four times as cheap if only its fire costs are included, as compared to ordinary crews. Such a rough comparison does not tell the whole story as the 40-man crew in every case worked on the most inaccessible and difficult sections on fires, and time and expense of transportation were unusually high because of long distances traveled."

By this letter was transmitted the comprehensive illustrated and charted report on the project. In addition to this detailed report Messrs. Cliff and Anderson have prepared for publication in Fire Control Notes a more condensed version. This version will be run in the April issue of Fire Control Notes, but for advance study and use has been mimeographed and is attached.

Very truly yours,



ROY HEADLEY  
Chief, Division of Fire Control

December 19, 1939.

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By

Edward P. Cliff,  
Supervisor of the Siskiyou National Forest-R6

And

Rolf E. Anderson,  
Leader of the 40-Man Crew

Fire control men have realized for several years that the practice of recruiting untrained fire fighters for the suppression of large fires has proved inefficient and expensive. The 40-Man Fire Suppression Crew was organized in an effort to overcome such apparent weaknesses in this important phase of forest management. Plans originating in Region Six and the Washington Office called for the organization, on an experimental basis, of a carefully selected, highly trained 40-man fire suppression crew equipped to sustain themselves for periods of at least three days in inaccessible back country where the work of ordinary crews is inefficient. Each member of this crew was to be selected for his physical prowess and woodsmanship, hardened by work, and trained to use the correct technique in handling each foot of fire line without detailed supervision.

The Redwood Ranger Station on the Siskiyou National Forest was selected as the best location for the crew. This station was on the Redwood Highway, facilitating fast travel by paved routes to forest areas along the Coast and Pacific Highways, and forests east of the Cascade Range. In addition, this headquarters site was in the immediate proximity of needed project work, which would help finance the crew, and was located on a forest with large inaccessible areas and difficult fire problems.

Recruiting

A junior forester with ten seasons' experience in supervisory work on fires was chosen as leader. In an effort to choose qualified men for the crew in a limited time, the Regional Office requested each forest to submit the names of several qualified candidates. The crew members were selected from these candidates by the leader immediately after his assignment to the job. Most of the crew members reported for duty between June 16 and July 1, and the crew reached full strength by July 9. Eight additional men were recruited throughout the ensuing season to replace men found to be unqualified due to poor health, poor workmanship, and other deficiencies.

Four squad bosses were selected who were well qualified in the instruction and management of small crews on fires, in camp, and on work projects. In picking other members of the crew, men were selected who were not only capable fire fighters, but who had specialties in other lines of work. The crew included two qualified first-aid men, two "cat skimmers", one graderman, ten fallers, and three men capable of doing fire line cooking. A professional cook and two flunkies were hired to prepare all meals for the crew while in camp. The leader and squad bosses were included as part of the total crew of 40 men. The kitchen force was in addition to the regular 40 men of the crew. Since the work of this crew was largely experimental in nature, a special recorder was added to insure obtaining necessary detailed records of the activities and accomplishments of the crew.

#### Salaries and Civil Service Status

Members of the crew were hired as guards (CU-4) pending certification of eligibles, at a monthly entrance salary of \$110 per month. The squad bosses were given a CU-5 rating, with a salary of \$125 per month. When away from Grants Pass, the crew members were supplied board and lodging by the Government.

#### Camp Site and Quarters

A camp site was selected one-fourth of a mile from Redwood Ranger Station on the bank of the Illinois River. Eleven tents set up on tent frames provided comfortable living quarters for the crew. Two portable, wooden buildings were constructed for use as a mess hall and bath house. A third portable building, loaned by the Siskiyou National Forest, was erected for use as a study hall, conference room, and office quarters.

Water was distributed to all parts of the camp by a pipeline tapping the Ranger Station water system. Electricity for camp lighting was purchased from a commercial power distributor. A grounded telephone line, 800 feet of road, and a 20-foot bridge were constructed by the crew to provide communication and access to the camp.

A number of recreational facilities were provided to occupy the leisure time of the men closely confined to camp. A gravel dam was thrown up across the river to form a small lake for swimming. A softball diamond and volley ball and horseshoe courts were cleared and leveled for the enjoyment and conditioning of the men.

The cost of constructing and maintaining the camp and supplying fuel amounted to \$6,345.00, which includes the value of the time devoted by the 40-man crew to these activities.

## Equipment and Supplies

The objective in equipping the 40-man crew was the selection of tools, bedding, and rations which would convert the crew into an effective fire fighting unit, self-sustained for a minimum period of 72 hours, and which at the same time could be carried over trails and rough country at a creditable speed without unduly tiring the men. This objective was met by building up packs which included essential fire tools, concentrated rations consisting mainly of dehydrated food, and lightweight, goosedown sleeping bags which rolled into bundles 13 inches long and 7 inches in diameter. These compact bags, well tailored, with zipper on both inner bag and cover, proved sufficiently warm for summer use.

Table 1 shows the content and weight of an average pack with essential equipment. The complete list of fire tools carried to and used on all fires upon which the 40-man crew took action is shown in Table 2.

Table 1 - Contents of an Average 40-Man Crew Pack

<u>Number</u>	<u>Item</u>	<u>Weight in Pounds</u>
1	Packboard, Trapper Nelson	5 $\frac{1}{2}$
1	Headlight w/3 extra batteries	1 $\frac{1}{2}$
1	Canteen w/water (to hang on belt)	2 $\frac{1}{2}$
1	Sleeping bag, lightweight	5 $\frac{1}{2}$
2	Lunches in cloth sack (to hang on belt)	1 $\frac{1}{2}$
1	Rations, 3 days'	11
	Cook and mess outfit or extra equipment	2
	Personal effects	2
	Tool, fire (average weight)	4
	Average weight per man - Total	35 $\frac{1}{2}$ pounds

Table 2 - Fire Tools Carried To and Used on Fires by the 40-Man Crew

<u>Number</u>	<u>Item</u>	<u>Weight in Pounds (Each)</u>
4	Axes, cruiser's	2 $\frac{1}{2}$
6	Axes, swamping	3 $\frac{1}{2}$
10	Pulaskis	3 $\frac{1}{2}$
10	Hoes, hazel	3 $\frac{1}{2}$
10	Shovels, baby (6 carried by last 6 hoemen)	2
12	Fusees (for burning out)	1 $\frac{1}{2}$
2	Saws, falling w/handles	10
1	Backpack bag w/pump	6 $\frac{1}{2}$
4	Axes, falling	4
2	Oil cans, 1 pt.	1
4	Wedges, wooden	1 $\frac{1}{2}$
10	Axestones, carborundum	1 $\frac{1}{2}$
10	Files, 10"	1 $\frac{1}{2}$
4	Bags, water, 2 $\frac{1}{2}$ gal.	1 $\frac{1}{2}$
1	Bag, water, 5 gal.	1

Surplus saws, axes, steel wedges, sledges, hoes, and shovels were always carried on the fire truck for use in case the regular tools were not sufficient. During the season no use was made of this extra equipment except in the exchange of dull tools for sharp ones.

Equipment used by this crew and found to be especially adaptable included hardwood wedges which can be driven with the side of an axe, and fusees for backfiring. Fusees were particularly adaptable for this crew due to their light weight, which made it possible to carry sufficient numbers to enable several men to backfire at one time.

Special equipment such as radio, compasses, and first-aid kits was used by the crew on all fires.

Various kinds of concentrated food were tried by the 40-man crew on the fire line. The following table lists items of food by weight and calorie content which proved to be the most satisfactory combination. It is felt that through further study, however, it might be possible to arrive at a lighter ration with equal nutritive value.

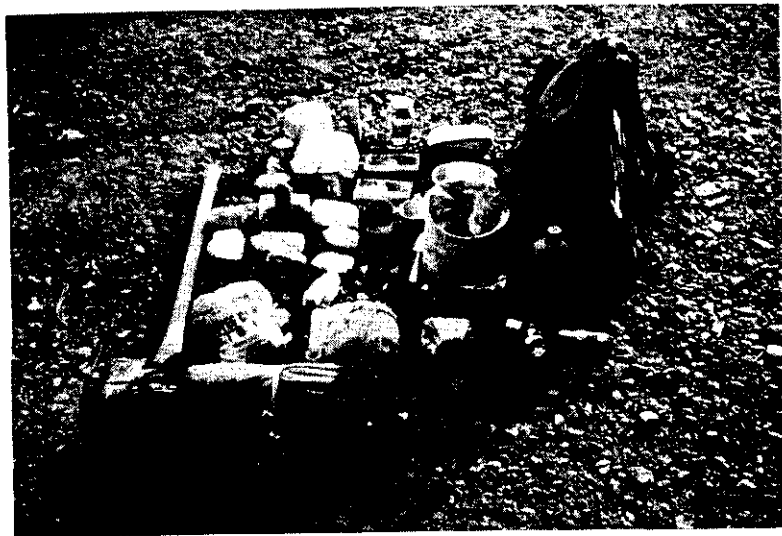
On going to a fire each man carried two lunches on his belt so that no time would be lost in preparing meals during the first shift on the fire line.

Table 3 - Ration List - 1 Man - 3 Days

	<u>Item</u>	<u>Weight</u>	<u>Calorie Content</u>	<u>Where to Obtain</u>
1.	Eggs, powdered	$\frac{1}{2}$ lb.	1,330	Eddie Bauer, 2nd & Seneca St., Seattle, Wash., or Sports Craft Inc., 512 SE Yamhill St., Portland, Ore.
2.	Cervelot	1 lb.	1,800	Nearly all grocers
3.	Bacon, canned	1 lb.	2,600	Nearly all grocers
4.	Soup concentrate	$\frac{1}{2}$ lb.	2,500	Eddie Bauer, 2nd & Seneca St., Seattle, Wash.
5.	Potatoes, dehydrated	$\frac{1}{2}$ lb.	1,800	Same
6.	Rice, white	1 lb.	1,600	Any grocer
7.	Apple concentrate	$\frac{1}{2}$ lb.	1,500	Columbia Fruit Processors, Inc., Pateros, Wash.
8.	Sugar	$\frac{1}{2}$ lb.	900	Any grocer
9.	Tomato juice	$\frac{1}{2}$ lb.	100	Any grocer
10.	Hardtack	1 lb.	1,600	Any grocer
11.	Coffee	$\frac{1}{4}$ lb.	..	Any grocer
12.	Lemon drops	$\frac{1}{2}$ lb.	850	Any confectionery
13.	Anchovy paste	1/8 lb.	600	Any grocer
14.	Dates	1 lb.	1,600	Any grocer
15.	Figs	1 lb.	1,400	Any grocer
16.	Salt	1/8 lb.	..	Any grocer
17.	Butter, canned	$\frac{1}{2}$ lb.	3,500	Order through grocer
18.	Milk, powdered	$\frac{1}{2}$ lb.	2,300	Any grocer
	Total	11 lbs.	25,980	



Cooking on the Fire Line



Contents of 40-Man Pack

PLATE I

According to dietitians, hard manual labor requires 3 calories per pound per hour. A 180-pound man working and/or hiking 16 hours per day for three days requires 25,920 calories. Therefore, the ration listed in Table 3 is ample, and the two lunches carried by the men on the first shift offers a large margin of safety.

Based on the experience of 1939, it is advisable for the leader of the crew to make out a basic menu with a choice of substitutes of about equal weight and calorie content. The men may be allowed to choose any substitute listed in Table 4. This will assure a balanced food ration. It was found that a free individual choice usually does not result in a balanced menu.

Table 4 - Desirable Substitutes for 40-Man Crew Ration

<u>Item</u>	<u>Weight</u>	<u>Substitute for</u>	<u>Where to Obtain</u>
1. Dried beef		Cervelat	Any meat market
2. Lemon juice	12 oz.	Tomato juice	Any grocer
3. Grapefruit juice	12 oz.	Tomato juice	Any grocer
4. Raisins	12 oz.	Dates	Any grocer
5. Cheese, dried	8 oz.	Anchovy paste	Any grocer
6. Peaches, dried	1 lb.	Figs	Any grocer
7. Apricots, dried	1 lb.	Figs	Any grocer
8. Spaghetti	2 lb.	Rice	Any grocer
9. Oatmeal	2 lb.	Rice	Any grocer

#### Transportation

Three 1939 model, 1½-ton Chevrolet trucks were used for transportation of crew, supplies, and equipment to and from most of the fires and on work projects. Two of these trucks were equipped with comfortable, upholstered seats for hauling the men, and one was used for supplies and fire packs.

On the longer and more tiring trips such as the 360-mile trip to the Big Cow Creek Fire on the Malheur and Whitman National Forest, commercial busses were used. These busses added greatly to the comfort of the men and made it possible for them to rest enroute, which resulted in their arrival on the fire in better condition than if they had traveled by truck.

#### Personnel Management

Some restrictions were required in order to keep the men constantly within fire call. Camp rules were established, outlining the responsibilities of the crew members as to fire duty, fire calls, camp police duties, and personal conduct and appearance. Only a few instances of infringement of these rules were experienced during the season. Tension of standby duty was lessened considerably by frequent fire suppression jobs.



Opportunity was given each member of the crew to leave camp periodically to purchase tobacco and other personal effects and to attend the local theater once or twice weekly, provided they signed out and agreed to stay in a group going to and returning from the theater. Excursion trips were made under the same arrangement.

Soft ball and volley ball teams were organized, and weekly games with Cave Junction and the Oregon Caves C.C.C. Camp were played through the early part of the summer. Swimming, horseshoe pitching, and punching bag workouts also absorbed no small amount of surplus energy. Some leisure time was devoted to study of the handbooks, bulletins, and periodicals contained in the 40-man crew library. Leisure time classes in first-aid, life saving, and safety were conducted by qualified crew members.

Because of the seriousness of the fire season, and due to the shortage of manpower caused by sickness and injury, only a small amount of annual leave was given during the main part of the fire season. Two more men were added to the crew during the latter part of the season so that accumulated leave could be granted and still maintain the crew strength at 40 men.

#### Fire Training

Fire training was started June 20, immediately after the first large influx of recruits. Frequent training sessions continued up to July 21, when the crew was called on the first fire. An occasional training period was given subsequently for the benefit of new recruits.

In the first training periods emphasis was placed on fire line organization and construction so that the crew would be in readiness for immediate call. Training continued with practice hikes and drills in unloading fire packs from trucks and reloading them again so that a certain speed and precision was acquired in performing these routine jobs. Conferences were held on methods of line construction, fire behavior, and fire strategy in various fuel types, in conjunction with the field training sessions.

Special training was given selected crew members in radio operation, fuel type mapping, and first-aid by qualified instructors.

#### Work Projects

Two work projects, located nine miles from camp, were selected to utilize the time and energy of the crew members when they were not occupied with training or fire fighting or engaged in camp construction activities. The purpose was threefold--namely, to keep the men in good physical condition, to help finance the crew, and to accomplish useful and needed work. The construction of the Illinois River Bridge and the Eight Dollar Mountain Road were the two projects selected. The bridge was a creosoted wood, Howe truss structure, with a main span of  $137\frac{1}{2}$  feet and an approach on one end of 52 feet. This bridge was completed by the crew in the fall of 1939. A total of 815 man-days was spent on the project.

The crew spent a total of 672 man days on the Eight Dollar Mountain Road and brought a two-mile section to about 75 per cent of completion.

#### ACTION ON FIRES

The 40-man crew worked on eight Class "C" or larger fires located on five National Forests in Region Six between July 21 and September 2, 1939. The two periods worked by this crew on the Saddle Mountain Fire were counted as two fires since they were analyzed separately and were widely divergent in location and time. The fires on which the 40-man crew worked and the time and travel chargeable to these fires, are listed in Table 5.

Table 5- Fires Worked upon by the 40-Man Crew in 1939

<u>Name of Fire</u>	<u>Forest</u>	<u>Dates</u>	<u>Days on Fire (Inc. Travel)</u>	<u>Miles Traveled (Truck or Bus)</u>
1. Horseshoe Bend	Siskiyou	7/21 - 7/26	5½	80
2. Elue River	Willamette	7/27 - 7/28	2	421
3. Wheeler Creek	Siskiyou	8/ 7 - 8/ 8	2	150
4. Saddle Mountain (East Side)	Siuslaw	8/10 - 8/13	4	300
5. Willard	Columbia	8/14 - 8/17	4	543
6. Eagle Creek	Siskiyou	8/18 - 8/21	4	127
7. Saddle Mountain (West Side)	Siuslaw	8/22 - 8/26	6	663
8. Big Cow Creek	Whitman	8/28 - 9/2	6	725
		Totals	<u>33½</u>	<u>3,009</u>

#### Get-Away Action

Get-away time on fires varied from 31 to 75 minutes, according to circumstances at the time of the call. The crew was dispatched from their headquarters camp on four occasions. Three of these calls came in the late afternoon before supper and the fourth immediately after breakfast. On two occasions the crew was working on the road project nine miles away, and it was necessary to assemble them at camp before leaving.

If the call came near mealtime and the meal was practically prepared, the men were usually fed before leaving. Assembling and feeding the men resulted in rather slow get-away time on several occasions. However, it is believed that the practice of feeding the men before leaving is justified, particularly if a long trip of several hundred miles is involved, because it avoids making a meal stop enroute and the men arrive in better condition than if they travel on an empty stomach.

Experience in 1939 brought out that the following considerations should govern action looking toward faster get-away time:

1. Keep all members of crew in direct telephone communication at all times. Use large extension bells, sirens, and other signals where necessary.

2. Order lunches or prepared meals ahead on route of travel if time can be saved in this way.

3. If dinner is prepared at camp at the time of the call, the crew should be allowed to eat before leaving in order to avoid losing time enroute.

#### Meals and Stops Enroute

One or more meals were usually eaten enroute to the more distant fires. In all but a few cases, a dependable restaurant was notified by phone in advance and no time was lost in the preparation of the meals.

#### Time Distribution on Fires

Table 6 shows the distribution of fire time for the 40-man crew, based on data recorded on the eight fires upon which the crew worked. These computations include time from start of work to completion of control line on all fires or sectors of fires handled by the crew.

Table 6 - Time Distribution of 40-Man Crew on Fires

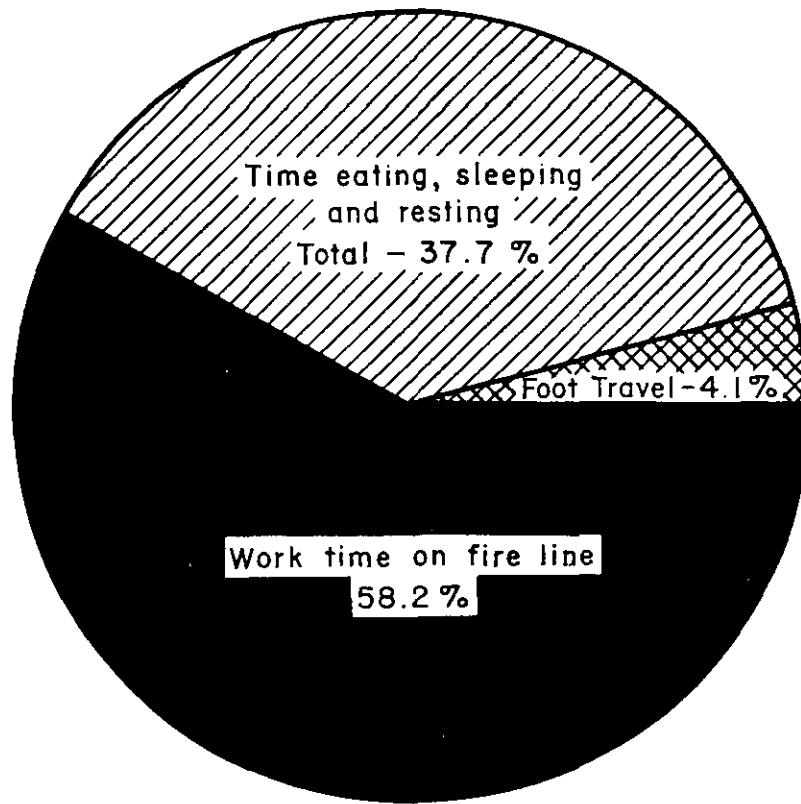
<u>Time Element</u>	<u>Total Hours</u>	<u>Per Cent of Time</u>
Foot travel	12.31	4.1
Work time on fire line	176.58	58.2
Time eating, sleeping, and resting	<u>114.36</u>	<u>37.7</u>
	303.25	100.0

Distribution of time as recorded above is shown graphically in Figure 1.

No comparable figures are available for other crews, but it is believed that this table shows plainly the advantages of using self-sustaining crews on inaccessible sectors of fires. Foot travel to and from such sectors by ordinary crews serviced in established base or line camps usually consumes a great deal more than 4% of the time of fire fighters and saps a tremendous amount of energy of men who are unaccustomed to hiking in rough country. The usual practice of camping on or near the fire line wherever night overtook the crew enabled the effective use of a large proportion of the day with a minimum of lost motion. Truck and foot travel time to the fires from the time the crew was dispatched up to the point control action was started, is not included in these figures. However, when determining the distance practicable to dispatch such a crew, it should be considered that more than one-quarter of the total time charged to fires was consumed in travel by truck and on foot to the fires.

FIGURE I

TIME DISTRIBUTION CHART



## Organization and Method Used in Line Construction

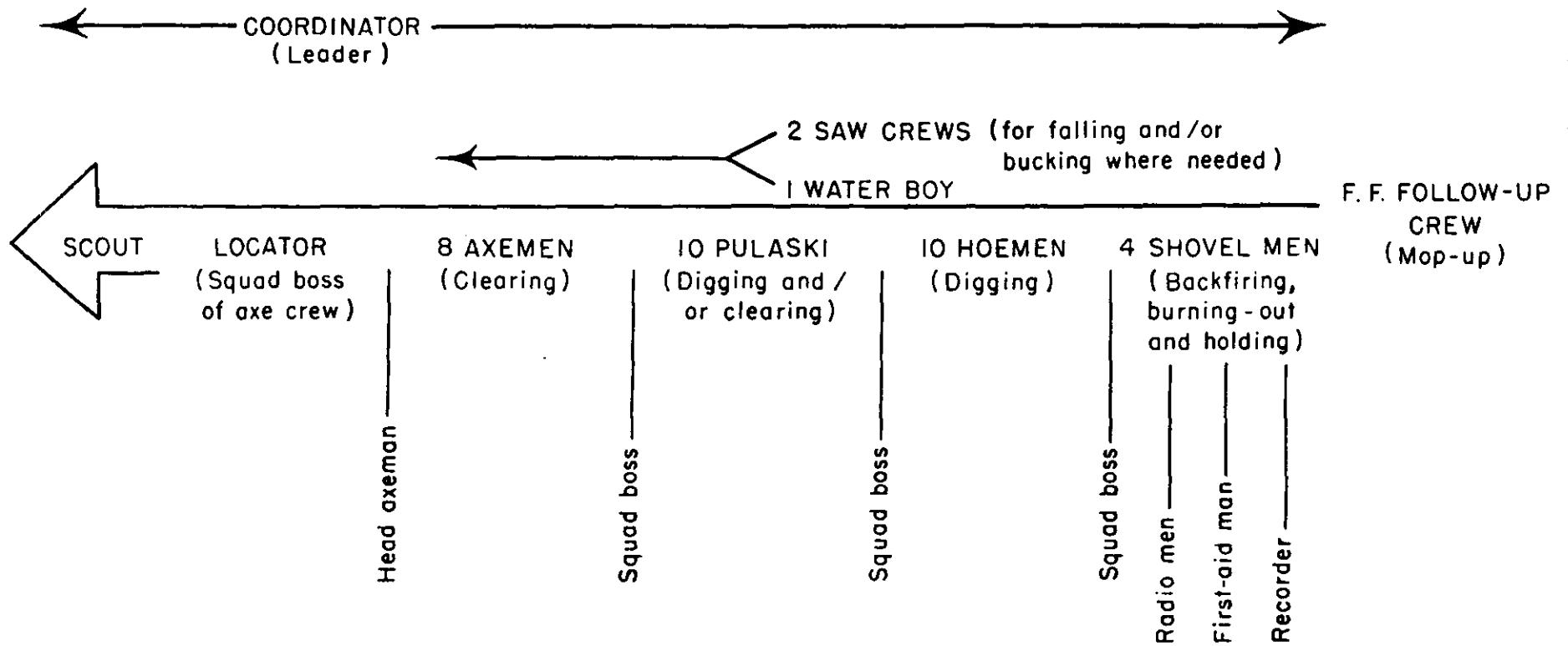
A progressive method of line construction, which in reality is a variation of the one-lick method, was used successfully by the 40-man crew on all fire suppression work.

The progressive method used has the advantages of the one-lick method--namely, the elimination of lost time occasioned by men passing each other in the line and the enthusiasm and unity of effort generated by rapid and continuous progress. It is superior to the one-lick method in that men can do more effective work by taking a stance and completing a unit of work and each man can be held accountable for a given segment of line. The form of organization is illustrated in Figure 2.

A description of the organization of the men on the line and their duties under the progressive system follows:

1. A scout from the crew was used when no outside scout was provided. When not scouting, this man worked as an axeman.
2. The line locator selected the location and blazed the way. He was directed from time to time by the crew leader as information was received from the scout or direct observations of the fire were made.
3. Nine axemen, using three cruiser's axes and six  $3\frac{1}{2}$ -pound swamping axes, followed the locator. Ordinarily the axe crew did from 50 to 100 percent of the clearing, depending on the relative amount of clearing to be done as compared with digging and holding.
4. Ten pulaski men worked behind the axemen and cleared or dug line as the needs justified. The pulaski men hold a unique and vital position on the line. By using the cutting edge of the tool for clearing they may speed the clearing and slow the hoe work, and by turning over the same tool the opposite effect can be accomplished. The versatility of the pulaski men enabled the crew to adapt itself to a great variety of cover types without changing the line-up of tools.
5. Ten hoemen followed the pulaski men and completed the line digging. In favorable types one or more Kortich tools were substituted for hoes. Six of the hoe men carried extra shovels to the point of attack so as to have them when needed to assist in holding and mopping up the line. These extra shovels were called into action on almost every fire in order to take care of the emergency "breakovers" and spot fires which the usual shovel crew could not handle. After arrival on the fire, the spare shovels were carried by the shovel men in an extra pack sack with the fuscous and other miscellaneous items. By following this practice, the hoe men were not burdened with an extra tool while working.

FIGURE 2  
 DIAGRAM OF PROGRESSIVE METHOD OF LINE CONSTRUCTION  
 USED BY THE 40-MAN CREW



6. Four regular shovel men were on hand at all times to do the burning-out and holding the line behind the line construction men.

7. Two sets of fallers equipped with falling tools worked as and where needed for falling or bucking. They were usually directed by the coordinator.

8. One man was always used to carry water, and two were so employed when needed.

The crew leader controlled the movement of the squads in such a way as to effect the highest rate of held line production. A qualified squad boss was used as a line locator. When not engaged in locating he was in charge of the axe crew. Where considered of vital importance the leader did his own locating. The second squad boss was in charge of the pulaski crew. It was his responsibility to keep a balance of work between clearing and digging by shifting his men from one operation to the other as the needs arose. The third squad boss was in charge of the hoe crew. It was his function to complete the line and cooperate with the burning-out and holding crew, dropping men from his crew to the holding crew when needed. The fourth squad boss supervised the burning-out and holding of the completed line until it was taken over by the follow-up crew.

#### Numbering of Men and Packs

Each man of the crew was given a number, according to his place in the line and, except for a few changes, each man kept this number throughout the summer. Each fire pack was also numbered from one to forty, corresponding to the number of the man carrying the pack.

Unloading from the trucks and hiking to the fire front was done in sequence of numbers. Upon returning from the fire the packs were placed in the truck in reverse order from which they were taken out-- that is, number 40 pack was the first to be loaded. This system of unloading and loading made for speed and precision. A quick deployment of men in working positions was facilitated by arriving at the point of attack in regular formation.

#### Foot Travel

Upon reaching the end of motor transportation, each man received his pack and the crew was led over trail or rough country in single file formation to the point of attack. Rest stops were made during hikes as needed. Average rate of foot travel was computed at 2.5 miles per hour, including rest stops of less than 30 minutes.

#### Deployment of the Crew on Fire

Upon arrival on the fire, a quick size-up was made and, if necessary, the 40-man crew scout was sent out to look over the country immediately ahead. Scouting was usually done by scouts not attached to

the 40-man crew. If the entire crew worked as one unit, they fell to work in line in the regular unloading and hiking order. If the crew was split into two units, as was occasionally done, the even-numbered men went one way and the odds another. This resulted in the even division of both men and tools. Unless the direct method was used, the burning-out crew followed and kept apace, but at a short distance behind the hoe crew. If a follow-up crew was worked immediately behind, the burning-out crew was usually able to keep up without additional help. If adequate follow-up was not provided, however, it became necessary to drop more and more men from line construction work to burning-out and holding.

The practice of splitting the crew into two or three work units worked out very satisfactorily on spot fires and in cover having low to medium resistance-to-control factors. The gain in splitting of crews, of course, is brought about by a saving in total time devoted to walking. In high resistance-to-control types, however, the relative saving in walking time is much reduced, and it is believed the advantage is negligible in an extreme resistance-to-control type. Another advantage of a split crew is that work can often begin at the head of a fire, and one unit can work each way to effect a faster control.

The greatest disadvantage in the division of the unit was the difficulty of giving adequate supervision. This disadvantage can be overcome by careful training of overhead. In the heavy resistance-to-control types found on three fires in 1939 the crew worked to greatest advantage as one unit.

#### Packing on the Fire Line

An ever-existing problem was that of keeping the fire packs up with the men. This problem was solved by using a variety of methods, as follows:

1. By intersecting the fire at a central point so that the crew can work both ways from the starting point. Upon arrival at a fire it was often possible to predict where the crew would stop work at the end of the shift and drop the packs there.
2. By leaving packs at the point work began and returning after them when an opportunity permitted.
3. By delegating the burning-out crew to take charge of moving the packs forward as the line progressed.
4. By delegating an FF or CCC crew to carry packs ahead from time to time. Horse-packing was not feasible on account of the inaccessibility of the country in which the 40-man crew worked. Horses were utilized but once during the season.





Building Fire Line



40-Man Crew Hiking to a Fire

### Follow-Up

One of the biggest problems which confronted the 40-man crew was securing adequate follow-up action. Almost every forest on which the crew worked showed a readiness to cooperate by sending ample follow-up behind the 40-man crew. The failures usually arose by not making certain that the men arrived when and where they were needed. For example, on one fire a night crew was sent out, but they were poorly guided and did not arrive. On another fire they worked on a "cold" line to the neglect of a mile of "hot" line. In each instance it was necessary for the 40-man crew to put in a double shift in order to prevent the loss of line they had constructed. It is recognized that the ordinary follow-up crew hiking in from a central camp each day, is under a tremendous handicap. After the second or third day behind the 40-man crew, the follow-up crew spends more and more time walking to and from work, which progressively reduces the amount of time and energy available for effective action on the line. The solution to this problem apparently lies in equipping the follow-up crew with light sleeping bags and condensed rations so that they too can stay out on the line.

### Cover Types

Several cover types were encountered by the 40-man crew, including high and low brush, Douglas fir timber, lodgepole deadenings, and ponderosa pine types and snag areas. The progressive method of line construction, with slight variations, worked well in all these types, and the crew proved to be a versatile unit and readily adapted itself to the various conditions encountered. The tools carried by the crew adequately met the needs in all types encountered. The pulaski tools are the "balance wheels" which made it possible to work efficiently in the various types with the same equipment. Experience during 1939 indicates that a trained crew of 40 men is about the proper size for work in moderate and high resistance-to-control types such as are encountered over most of the Douglas fir region, and that smaller units of about 20 men will work more efficiently in the low resistance-to-control cover which is characteristic of ponderosa pine forests.

### ACCOMPLISHMENTS

A careful record was made of the action of the crew and rate of line construction on each fire. At the completion of the fire season a detailed review was made of each fire by the leader of the crew. Space will not allow these records or reviews to be presented here. By way of summary, however, two measurements of the efficiency of the crew are given by comparing its rate of held line production with the Region Six standards and with average production of other crews on large fires in this Region.

The comparison of rate of line construction by the 40-man crew with the Region Six standard was made by computing the length of time that it would take to build under Regional standards the same line as was constructed by the 40-man crew on the various fires. In making these computations due weight was given to the proportion or length of line on each fire in the different resistance-to-control classes. Complete data for this comparison were taken on six fires and are summarized in Table 7.

Table 7 - Held Line Production, 40-Man Crew 1939, Compared to Region Six Standard

*Name of Fire	:Resistance To :			:Total	:40-Man Prod.:	:R. 6 Standard	
	:Control Rating:					:Held Line	:Same Held Line
	:Chains			:Line Worked	:Per Man-Hour:	:Per Man-Hour	
	:Low:	:Med.:	:High :	**Chains:	:Hours:	Chains	: Chains
1. Horseshoe Bend	: 51:	: 42:	: 19 :	: 112	: 67.4:	1.66	: .53
2. Wheeler Creek	: 15:	: 25:	: 22 :	: 62	: 46.5:	1.33	: .45
3. Saddle Mtn. (E. Side)	: 55:	: 30:	: 9 :	: 94	: 87.1:	1.08	: .62
4. Willard	: 32:	: 20:	: 7 :	: 59	: 42.5:	1.39	: .56
5. Eagle Creek	: 40:	: 124:	: 63 :	: 227	: 319.8:	0.72	: .42
6. Big Cow Creek	: 97:	: 39:	: 4 :	: 140	: 100.5:	1.39	: .73
Total or Aver.	: 290:	: 280:	: 124 :	: 694	: 663.8:	1.04	: .51

\* Accurate data were available only on six fires.

\*\* This figure includes only length of recorded held line. About 1/3 of held line built was recorded and given resistance-to-control ratings. A total of 28 miles of control line was worked in 1939 in addition to a large amount of unmeasured work on spot fires.

The comparison of the accomplishments of the 40-man crew with other crews shows that throughout the season it attained an average rate of held line production of .34 chains per man hour as compared with .07 chains per man hour for large crews working in Region Six on fires 300 acres or larger from 1936 to 1938, inclusive. The data for these large crews were taken from the July 1939 issue of Fire Control Notes. It may be noted that the rate of line production in this second comparison is less than that shown in Table 7. This is accounted for by the fact that burning-out, holding, and mop-up as well as travel time while on a fire or sector of a fire was included when computing this average in order to make the 40-man crew rates comparable to those listed in Fire Control Notes.

These figures show that the 40-man crew produced line at twice the speed set up by Region Six standards and about five times the rate produced by other crews on all large fires in Region Six over the past three years. Even so, these figures do not give a true picture of the efficiency of the 40-man crew in comparison with other crews because of the following factors:

1. In the first comparison the Regional standards are based on small as well as large fires, and accomplishments on small fires are usually greater than on fires of the size acted upon by the 40-man crew.
2. The 40-man unit was in most cases dispatched to the most rugged and remote sectors of the fires in which the fatigue factor of travel is more pronounced than for crews working near the road.
3. The 40-man unit was sometimes used as "pinch hitters" on sectors difficult for other crews to hold. On these sectors the 40-man crew was valuable chiefly as a holding crew and line production was a secondary factor. After hours of difficult holding under heavy smoke conditions, the crew was in a poor condition for high production on the line.

#### Weak Points

The 40-man crew was organized and trained as a line-building crew. Plans were made for the 40-man crew to burn out and hold their own line for about two hours after construction, after which time the line would be taken over by an FF or CCC crew. The men were told that they would be expected to work at a fast rate of speed for a definite shift of eight to ten hours and that mop-up and holding would be taken over by another crew. To work a longer shift would definitely call for a slower pace.

As it actually worked on many of the fires, the men walked long distances, then worked on line construction at a fast pace for eight to ten hours; but instead of being relieved it was necessary for the crew to do their own mop-up and patrol for long periods after the line was constructed. This worked the men excessively long hours. In one case the crew was engaged more than 20 hours in continuous work and travel with only short intervals of rest. It is not physically possible, however, to continue at a fast pace for such long periods and the men will consciously slow their pace to avoid complete fatigue.

The ultimate results of this practice, if continued, will be to slow down the rate of line production. The men will expect to stay out on the line for excessive hours and will work at a speed commensurate with those hours in order to sustain themselves throughout the day. In working excessive hours day after day, we have lost sight of that part of our objective of maintaining a fire fighting crew capable of working at unprecedented speed to stop the first run of fire, burn out the line, and turn the mop-up over to a relief crew.

## COSTS

A total allotment of \$35,090.00 was set up to the Forest to finance the 40-man crew from the time of recruiting to the end of the fiscal year 1940. This allotment was planned to cover all costs of camp construction, subsistence, transportation, and wages throughout the work season, including fire suppression and project work. It was planned that a contingent of \$7,000 should be carried over to finance the crew in the spring of 1940.

Actual expenditures for the crew through the season of 1939 totaled \$30,914.00. Of this amount \$2,642.00 was spent on overhead and \$5,491.00 was used for the subsistence of the crew. The entire cost of camp construction and maintenance totaled \$6,245.00, and fire training was recorded at \$1,082.00. The contribution to fire suppression work by the 40-man crew amounted to \$6,742.00. All other cost, including labor, cost of transportation to and from work on the bridge and road projects, and other miscellaneous items of cost, totaled \$8,712.00. The work of the crew on these two projects was appraised at \$5,000.00 at the close of the season.

The balance in the available allotment, plus the unexpended F.R.D. earnings, amounts to \$9,176.00, which will be available to pay the salary of the leader during the balance of the present fiscal year and finance the crew for approximately two months next spring.

## CONCLUSIONS

It is felt that the 40-man crew experiment was successful in achieving the purpose for which it was conceived. The careful selection and methodical training of personnel and the choice of lightweight equipment, including concentrated rations, featherweight beds and up to date fire tools, combined to make a sturdy fire fighting unit of great mobility, which was able to sustain itself in inaccessible country for periods of 72 hours or more and take effective independent action on the most remote sectors of a fire. The merits of this form of organization are obviously shown in the records of rate of line construction contained herein.

It is believed that this system can be applied to other crews organized from picked C.C.C. enrollees and the personnel of construction crews. Units so organized will probably not measure up to the 40-man crew in physical development but would have all of the advantages of mobility and self-reliance made possible by the use of lightweight beds, concentrated rations, and a judicious balance of tools.

It is also believed that the special equipment can be used to advantage by crews of untrained pick-up laborers by enabling them to stay out on the fire line, thus reducing the usual large expenditure of time and energy used in walking to and from established camps and curtailing the expense of servicing fire fighters in inaccessible country.