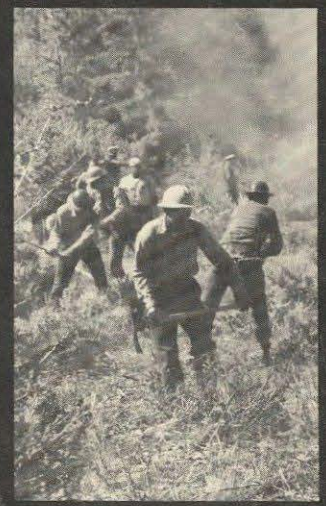
U.S. Office of Federal Coordinator for Meteorological Services and Supporting Research

FEDERAL PLAN FOR A

NATIONAL FIRE-WEATHER SERVICE



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FEDERAL PLAN FOR A

NATIONAL FIRE-WEATHER SERVICE

Prepared by
WEATHER BUREAU
in cooperation with
U.S. DEPARTMENT OF AGRICULTURE
and
U.S. DEPARTMENT OF INTERIOR

FOREWORD

This Federal Plan for a National Fire-Weather Service focuses on the need for providing specialized weather services to forestry and range management interests. It is one in a series of plans being prepared by the Office of the Federal Coordinator for Meteorological Services and Supporting Research to describe present and planned services for specialized user groups. It has been prepared in response to Bureau of the Budget Circular A–62 with the advice and assistance of the Interdepartmental Committee for Meteorological Services and is endorsed by the Department of Agriculture, Department of Interior, and Department of Commerce.

This plan is directed toward improving and expanding existing fire-weather services in the 1968–1972 time period. It makes maximum use of the observational networks, data processing, communications and disseminating facilities of the Basic Meteorological Services of the Department of Commerce. It does not include related programs such as agricultural weather service, hydrology, climatology, and weather service to the general public which supplement the National Fire-Weather Service.

ROBERT M. WHITE
Federal Coordinator for Meteorological
Services and Supporting Research

Our Nation's forests constitute one of our major resources. Yet, an average of 120,000 fires yearly destroy timber and wildlife, grazing areas and watersheds, and cost almost $500 million. Here hundreds of acres go up in smoke near Machias, Maine. (Courtesy Press Herald-Evening Express, *Portland, Maine)*

Photographs not otherwise credited courtesy U.S. Forest Service

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INTRODUCTION

Specialized weather information is required for effective protection of forest and range lands. The possibility of a fire being started, the likelihood of its being detected, its behavior, the readiness of an organization to suppress a fire, the planning of suppressive action, and the prevention of other fires are dependent upon weather and the use of weather information. Detailed weather data are required to insure successful use of fire in prescribed burning. Day-to-day and hour-to-hour fire control activities must be keyed to weather conditions.

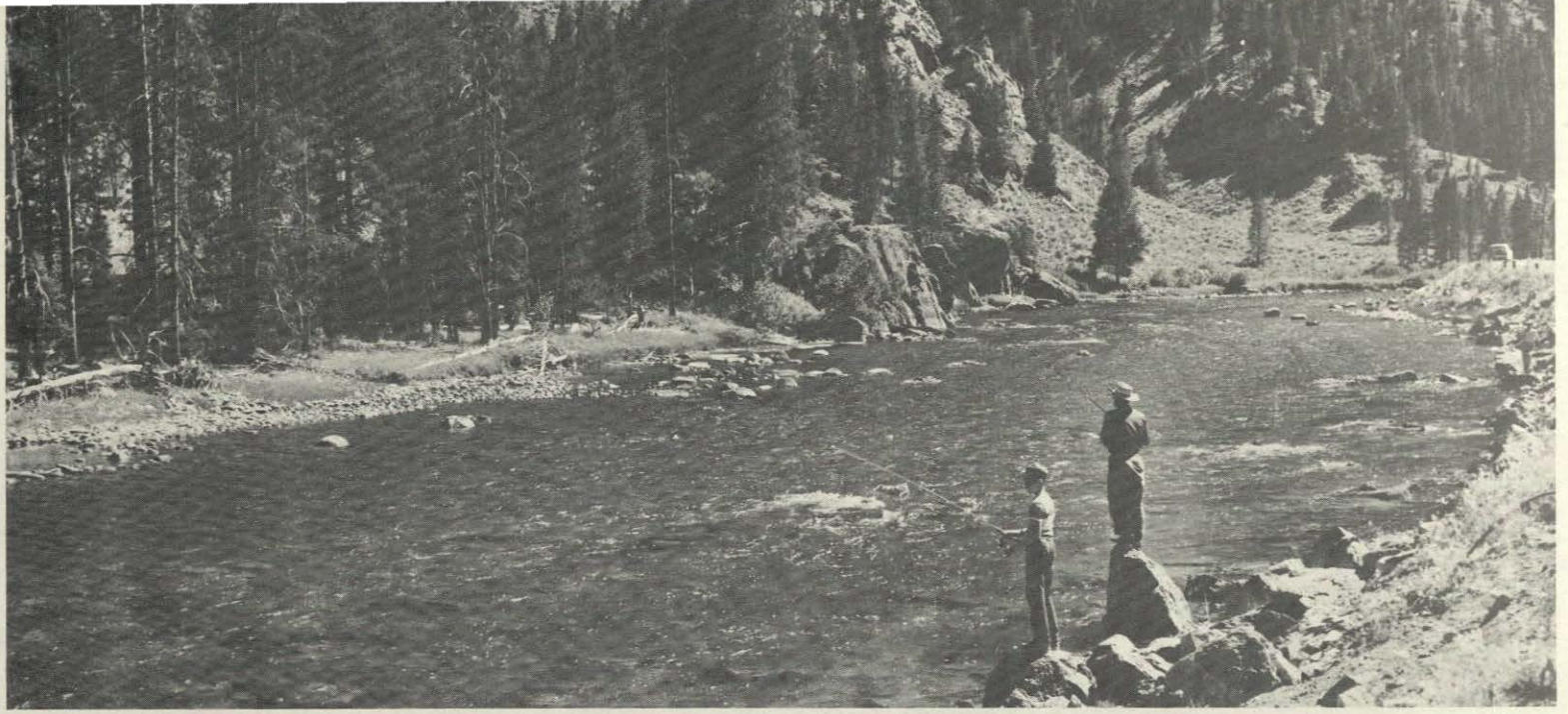
Many factors contribute to fire danger, such as the kind and arrangement of burnable fuels, seasonal variation of flammability, risk of fire starting, and values at stake. Day-to-day weather conditions generally determine the degree of fire danger and the action required to hold loss from fire within acceptable limits. Weather affects the flammability of fuels, rate of fire incidence, rate of spread, fire behavior, and difficulty of control. Success of any presuppression or fire suppression action is strongly influenced by the weather that occurs, the knowledge of the expected weather, and the way in which weather information is used.

Successful day-to-day fire control management is dependent upon knowledge of fire danger. Fire danger dictates the strength and deployment of the fire control forces necessary to cope with any fire likely to start. During periods of low fire danger, fire control costs may be lowered by reducing the staffing. During critical fire danger, extraordinary measures need to be taken to minimize loss from fire. Predictions of pronounced change in fire danger have resulted in imposing or lifting closures of vast commercial and recreational wooded areas. A weather shutdown of logging operations affects thousands of loggers and mill workers. Such measures have a pronounced impact on the public and the local economy and must be based on careful evaluation of fire-weather conditions.

When a fire starts, careful estimation of its spread and behavior is essential for planning the most effective suppression tactics to control the fire quickly, safely, and with minimum damage. Prediction of fire behavior is largely dependent on detailed weather forecasts. Fire must be fought at close quarters with a narrow margin of safety for fire-fighters. Complete and accurate weather information, tailored to the job at hand, is essential.

Fire is used as a forest management tool for removal of hazardous fuels, for removal of undesirable brush prior to planting or seeding with forest or range species, and for keeping undesirable growth at an acceptable level. Acreage of prescribed burning in some sections of the Nation exceeds that burned by wild fire. Safe

In Shasta National Forest, California.



Fish and wildlife are valuable assets of the National Forests and each year attract millions of visitors, such as these fishermen on the Salmon River in the Challis National Forest of Idaho. Fires are one of the chief menaces of these forest recreational areas.

use of fire to accomplish the desired burning objective without serious damage requires precise weather predictions.

Greatest economy and effectiveness of these fire control jobs cannot be achieved without a readily available source of reliable, specialized fire-weather information and close working relationships between fire control and fire-weather personnel acquainted with local conditions.

An improved and strengthened fire-weather service is an essential element for increasing the effectiveness of Federal, State, and private fire control programs. In Alaska, during the second year of specialized fire-weather service (1963), the Bureau of Land Management estimated benefits of one-half million dollars in reduced patrol costs, reduced fire suppression costs, and reduced resource loss. This represented a cost-benefit ratio of 1 to 33 for the fire-weather service. The improvement program envisaged in this plan will pay large dividends in terms of reduced losses of resources, increased use of forest and range lands, and protection of lives.

Weather Bureau support to forestry agencies began in 1914 and has gradually evolved on the basis of field experience. In 1961, a nine-phase program was established to improve and expand this support. Four of the nine phases have been completed. Implementation of the plan for fire-weather service reported in this document will provide, on a Nationwide basis, improved and expanded service to all fire control agencies. The planned service will feature: (1) Improved and expanded weather forecasts designed to support all phases of fire control activities, (2) Rapid and efficient dissemination of fire-weather service products to users, and (3) Effective research and development programs to advance fire-weather forecasting techniques and improve specialized fire-weather equipment. Annual costs for the fire-weather service after completion of this Plan will be $2.4 million.

ROLE OF FEDERAL AGENCIES

The Introduction to this Plan highlights the dependence of many forest and range management practices on day-to-day weather conditions as well as the importance of timely and accurate weather information in the suppression and control of fires. Recognizing the need for improved weather forecasting services to agriculture, of which forestry is a part, a Senate Resolution passed in July 1955 (84th Congress, 1st Session) requested a survey by the Secretaries of Agriculture and Commerce to ascertain what steps should be taken to remedy expressed deficiencies. The resulting report pointed out the need, among others, for an expansion of the Fire-Weather Service program for the forested areas and the range and grass lands of the country. To design the most effective and efficient Fire-Weather forecast service, three Federal agencies—the Department of Agriculture, represented by the Forest Service; the Department of Interior, represented by the Bureau of Land Management; and the Department of Commerce, Weather Bureau—have cooperated closely in the preparation of this Federal Plan.

As the agency responsible for providing weather forecasting services to all public interests, the Department of Commerce, Weather Bureau manages and operates the Fire-Weather Service program. In the operation of the program, weather forecast formats and techniques are designed by Weather Bureau Fire-Weather meteorologists to meet the needs of foresters and range management specialists. These are disseminated to the users by the most rapid method available, including radio and teletypewriter networks. Meteorological research directed toward the needs of forestry and range management agencies will be conducted under this Plan by Weather Bureau research meteorologists at key points throughout the country.

The role of the Departments of Agriculture and Interior is threefold. First, they are direct users of the service. Second, they have sustained research programs for determining the specific effects of weather elements on all facets of forestry and range land management. This research often yields an insight into forecast problems of direct interest to the Weather Bureau's forecast organization. Third, they play an important role in issuing joint releases with the Weather Bureau regarding the use of major recreation areas in the Nation's forests during periods of high fire danger.

1.0 USER REQUIREMENTS AND POTENTIAL SERVICE VALUE

Wood, water, wildlife, forage, and recreation resources contained in our forest and range areas are of major importance to the national welfare, particularly in view of a growing population. In many sections of the Nation, nearly the entire economy is dependent on these resources. For this reason, Federal and State

In many sections of the Nation a large portion of the economy depends on forest resources and products. Fire-Weather information is an important factor in the management of forested areas.

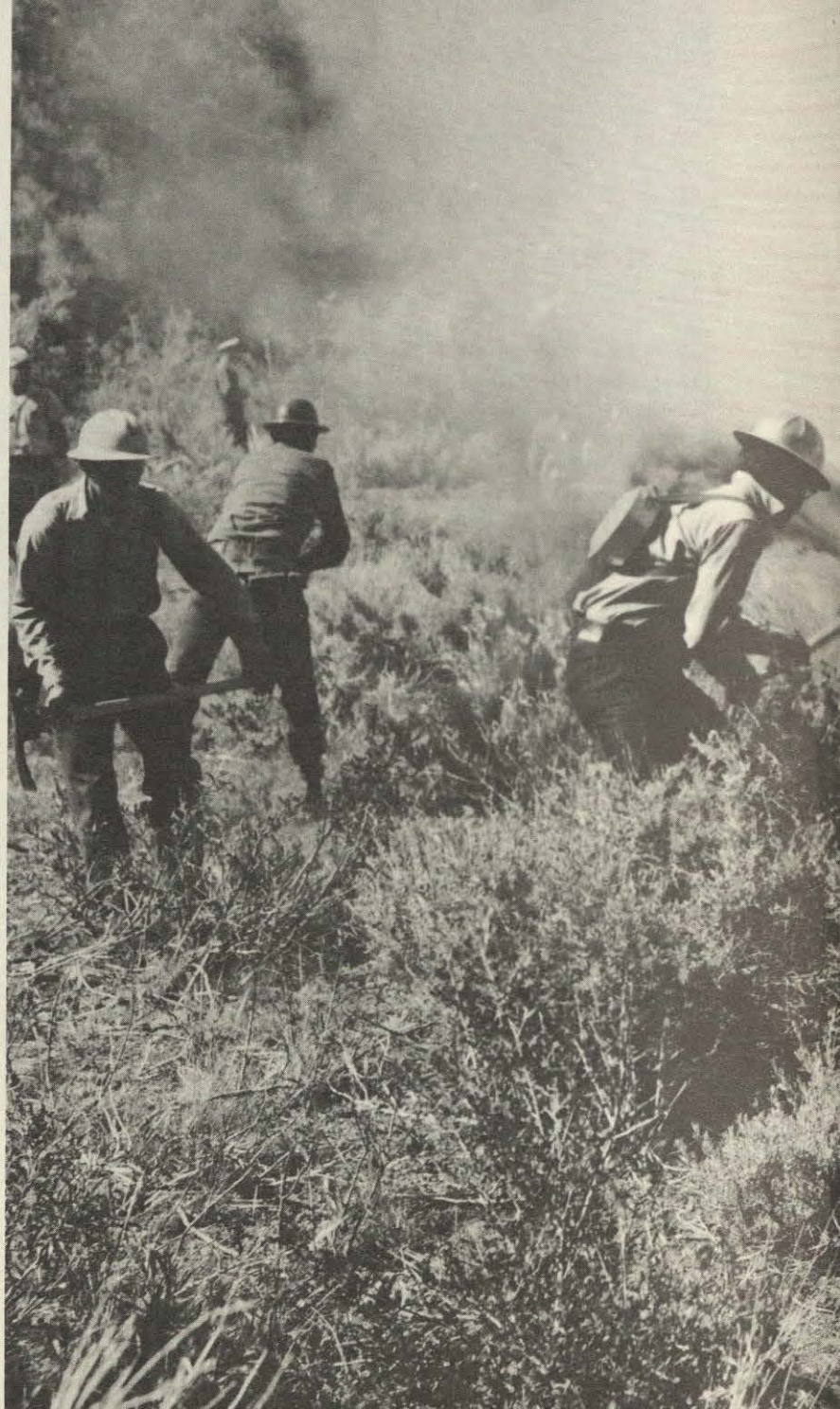
Knowledge of fire-weather, both current and forecast, is needed for the safety of on-the-scene fire fighters like these battling flames in the Angeles National Forest, California.

Agencies, together with private enterprises concerned with similar problems (e.g., major lumber companies), make major use of men and materials to insure effective management and protection of forest and grassland areas under their control.

Forest management requires careful planning to achieve a healthy stand of timber adequate to supply raw material, to shelter and feed wildlife, to conserve water, and to provide enjoyable recreational areas for the public. Cut timber must be replenished by seeding or transplanting and healthy growth must be encouraged by managed cutting, removal of undesirable growth, and control of pests. Although these and similar measures are of great importance, they are overshadowed by the sudden destructiveness of FIRE, which continually threatens forest areas. A substantial part of forest management programs, whether public or private, is devoted to the control of this threat. Weather conditions directly affect the possibility of a wild fire being ignited, the time of its detection, and its behavior. Proper use of weather information not only enables effective planning of pre-suppression actions, but improves the readiness of a fire control organization to take immediate control measures. Within any particular area, the variations that occur in the level of fire danger[1] are almost entirely dependent on the weather associated with the area. Day-to-day and hour-to-hour fire control operations must be keyed to existing and/or expected weather conditions. Consequently, for successful management and protection of forest and range areas, there is a growing demand by fire control agencies for weather information including observations, forecasts, and long range outlooks.

The fire problem is big. For example, from 1960 to 1964 inclu-

[1] General term expressing the degree of inflammability of fuels, the probable rate of fire spread, and the difficulty of control.



sive, an annual average of 120,000 fires burned 4,600,000 acres of forest land in the United States. In 1962 alone, forest fire losses were estimated at 7½ million board feet of lumber valued at $165 million. The overall annual loss must certainly amount to several times this stumpage value since it includes such factors as damage to soil and wild life, loss of stored water, and blighted recreation areas. Real annual loss may therefore be as much as $500 million. Fire detection and suppression costs exceed $100 million annually. Effective weather support, which will help to reduce these costs and losses, is clearly in the national interest.

An analysis of user requirements based on operational and planning activities established the meteorological parameters to be used by fire control agencies (as summarized in Table 1). These requirements vary somewhat in detail from locality to locality. Analysis of these user requirements indicates that although generalized area type products can provide some useful support, the most effective level of service will be provided through locally tailored interpretive products that are prepared by skilled fire-weather forecasters on the basis of detailed requirements determined locally by the fire-weather offices in consultation with local land management agencies.

2.0 PRESENT FIRE-WEATHER SERVICE PROGRAM DESCRIPTION

The Weather Bureau in 1914 inaugurated a Fire-Weather Service to assist foresters in fire control work. From this original service, the Fire-Weather Service has been evolving; improvements

More than 100,000 forest fires in the United States cost millions of dollars to fight, and destroy valuable resources each year. This one was in the Bitterroot National Forest of Montana. Accurate up-to-date fire-weather forecasts can greatly minimize these losses.

Table 1—FIRE-WEATHER USER REQUIREMENTS

USER TYPE—FEDERAL AND STATE FORESTRY AGENCIES					
Activities	Important Parameters	Operational Requirements		Planning Requirements*	
		Description	Forecast Period	Description	Forecast Period
1. Suppression (including air operations)	1. Humidity	Variable, critical below 30%	Up to 72 hr.		
	2. Wind	Speed, direction, and shifts	Do.		
	3. Stability	Lapse rate categories	Do.		
	4. Precipitation	Amount and duration	Do.		
	5. Temperature	Variable	Do.		
2. Pre-Suppression	1. Thunderstorms	Location, intensity (including lightning), direction, and rate of movement	Up to 24 hr.		
	2. Precipitation	Amount	Do.	Trend and departure from normal; total amount and period of occurrence	3 to 30 days
	3. Humidity	Variable, critical below 30%		Trend and departure from normal	Do.
	4. Wind	Speed	Do.	Trend and departure from normal	Do.
	5. Temperature	Variable	Do.	Trend and departure from normal	Do.
3. Slash Burning	1. Wind	Speed, direction and shifts	Up to 72 hr.		
	2. Humidity	Variable	Do.		
	3. Precipitation	Variable (none desired)	Do.		
4. Controlled Burning	1. Wind	Speed and direction (5 to 15 m.p.h.)	Do.		
	2. Humidity	20% to 60% relative	Do.		
	3. Precipitation	Generally less than .05 in.	Do.		
	4. Temperature	Generally 20° to 50°F.	Do.		
5. General Forest Management—spraying, dusting, seeding and other management practices	1. Wind	Speed and direction (less than 10 m.p.h. preferred)	Do.	Trend and departure from normal	Do.
	2. Precipitation	None expected	Do.	Trend and departure from normal; total amount and period of occurrence	Do.
	3. Stability	Stable conditions preferred	Do.		
6. Recreation	1. Temperature	Variable	Up to 5 days		
	2. Precipitation	Amount and duration	Do.		
	3. Severe weather	Variable	Up to 72 hr.		

* Climatological data summaries are also useful in planning activities.

in recent years (since 1961) have been introduced on a systematic basis in accordance with a nine-phase program. At the present time four of these phases have been completed.

The close working relationship developed over the years between the Federal and State Agencies and the Weather Bureau has made it possible to develop a type of service which possesses the flexibility and adaptability required to assist in many problems of forest management. The Fire-Weather Service as it exists today has developed from shared experience and mutual understanding between foresters and meteorologists; the success achieved is reflected in a growing demand for expansion of the current service program.

2.1 PRODUCTS AND SERVICE

The objective of the current Fire-Weather Service is to help protect life, reduce resource losses, and strengthen the national economy by providing specialized weather forecast and warning services economically, efficiently, and effectively to all wild land fire control agencies in the United States. In pursuit of these objectives, the Fire-Weather Service has developed three related programs: forcasting and consultation, data collection, and dissemination.

2.1.1 Forecasting and Consultation Program

Fire-Weather Service is provided to interested user groups in forest and range areas from Primary and Supplementary Fire-Weather Offices. Primary Fire-Weather Offices are Weather Bureau Offices located in or near major forested areas where they can best meet the needs of user agencies; these offices are staffed with one or more specially trained full-time fire-weather meteorologists. During the fire-weather season, these meteorologists are responsible for the issuance of fire-weather forecasts for their districts, and are on 24-hour call in critical periods. The size of a fire-weather district varies according to local needs, topography, and the complexity of weather patterns, usually ranging from 1,000 to 16,000 square miles. The number and timing of the forecasts provided by the Primary Fire-Weather Offices varies with the needs of local users, but they generally are issued once or twice daily in support of users' operations and planning. Warnings of conditions leading to unusually high fire danger may be issued at any time. In addition, the meteorologists provide special forecasts for the immediate area of any going fire, wild or controlled. Finally, the meteorologists provide, on request, additional forecasts in support of other important forest management functions, such as spraying or seeding.

Supplementary Fire-Weather Offices are Weather Bureau Offices which provide fire-weather service to a forested district as an "add-on" to their primary public service function. Their staffs do not include fire-weather meteorologists; in general, they provide fire-weather forecasts only on request or when fire danger is high.

In support of this direct service to users, certain Weather Bureau Forecast Centers have been designated as Fire-Weather Coordination Centers. These Centers support the Fire-Weather Offices by:

Mobile Fire-Weather Station which is moved to the scene of a going fire.

(a) issuing special area guidance forecasts, which provide a broad description of weather patterns and elements of special interest in fire-weather problems, as well as diurnal variations of these factors; (b) maintaining a 24-hour weather watch for changes of significance to fire-weather problems and alerting Primary and Supplementary Fire-Weather Offices as necessary.

Advanced techniques are now being employed in fire suppression, such as aerial application of fire retardants and the use of smoke-jumpers. Effective and safe employment of such tactics is frequently dependent on accurate assessment of weather factors. A significant additional capability has therefore been developed by the Fire-Weather Service in the form of mobile and portable fire-weather stations. The Mobile Fire-Weather Station comprises a truck-mounted modified camper unit equipped with appropriate meteorological instruments, two-way radio voice communication, and radio facsimile. These units are driven to the scene of a fire by fire-weather meteorologists. By this means the fire-weather forecaster can provide effective service to fire control headquarters and receive support from his home office. The Portable Fire-Weather Station, designed for use in the Southeast and readily adaptable to use in the rough terrain of Alaska, comprises a "suitcase" set of meteorological observing equipment which can be carried to the scene of a fire by automobile or helicopter.

Figure 1 indicates areas of the United States in which Fire-Weather Service is now being provided through Primary or Supplementary Fire-Weather Offices. Table 2 lists the Fire-Weather Offices and Coordination Centers. Table 3 lists the products of these activities.

The foregoing products and services are supplemented by an additional function performed by all Fire-Weather personnel: that of frequent consultation with fire control personnel. Forest management decisions often require that fire conditions at a given time and place be anticipated. To minimize risk associated with a given decision, consultation with the Fire-Weather forecaster is highly desirable. Weather elements normally discussed include amount, timing, and probability of weather changes; specific effects of predicted weather; and other weather-related information

Table 2—CURRENT FIRE-WEATHER SERVICE FACILITY LOCATIONS—END OF PHASE IV

Location	FW Coordination Centers	Primary FW Offices	Supplementary FW Offices	Mobile (M) or Portable (P) FW Units
Albany, N. Y.		X		P
Albuquerque, N.Mex.		X		(a)
Anchorage, Alaska		X		
Asheville, N. C.		X		P
Baltimore, Md.			X	
Beckley, W. Va.		X		P
Billings, Mont.		X		M
Bismarck, N. Dak.			X	
Boise, Idaho		X		M (2 units)
Boston, Mass.		X		P
Cheyenne, Wyo.			X	(c)
Chicago, Ill.		X		P
Cincinnati, Ohio		X		P
Columbia, S. C.		X		P
Denver, Colo.		X		(c)
Eureka, Calif.		X		M
Fairbanks, Alaska		X		
Fort Smith, Ark.		X		P
Fresno, Calif.		X		M
Harrisburg, Pa.		X		P
Hartford, Conn.			X	P
Houghton Lake, Mich.		X		P
Jackson, Miss.		X		P
Lander, Wyo.			X	(c)
Los Angeles, Calif.		X		M (2 units)
Macon, Ga.		X		P
Medford, Oreg.		X		M
Memphis, Tenn.			X	
Missoula, Mont.		X		M (2 units)
Monterey, Calif. (d)		X		M
Montgomery, Ala.		X		P
New York, N. Y.			X	
North Platte, Nebr.			X	
Olympia, Wash.		X		M
Pendleton, Oreg.		X		M
Phoenix, Ariz.		X		(b)
Portland, Oreg.		X		M
Raleigh, N. C.		X		P
Rapid City, S. Dak.		X		(c)
Redding, Calif.		X		M
Reno, Nev.		X		M
Sacramento, Calif.		X		M
Saint Louis, Mo.		X		P
Salem, Oreg.		X		M

Figure 1.—**Fire-Weather Program, End of Phase IV.**

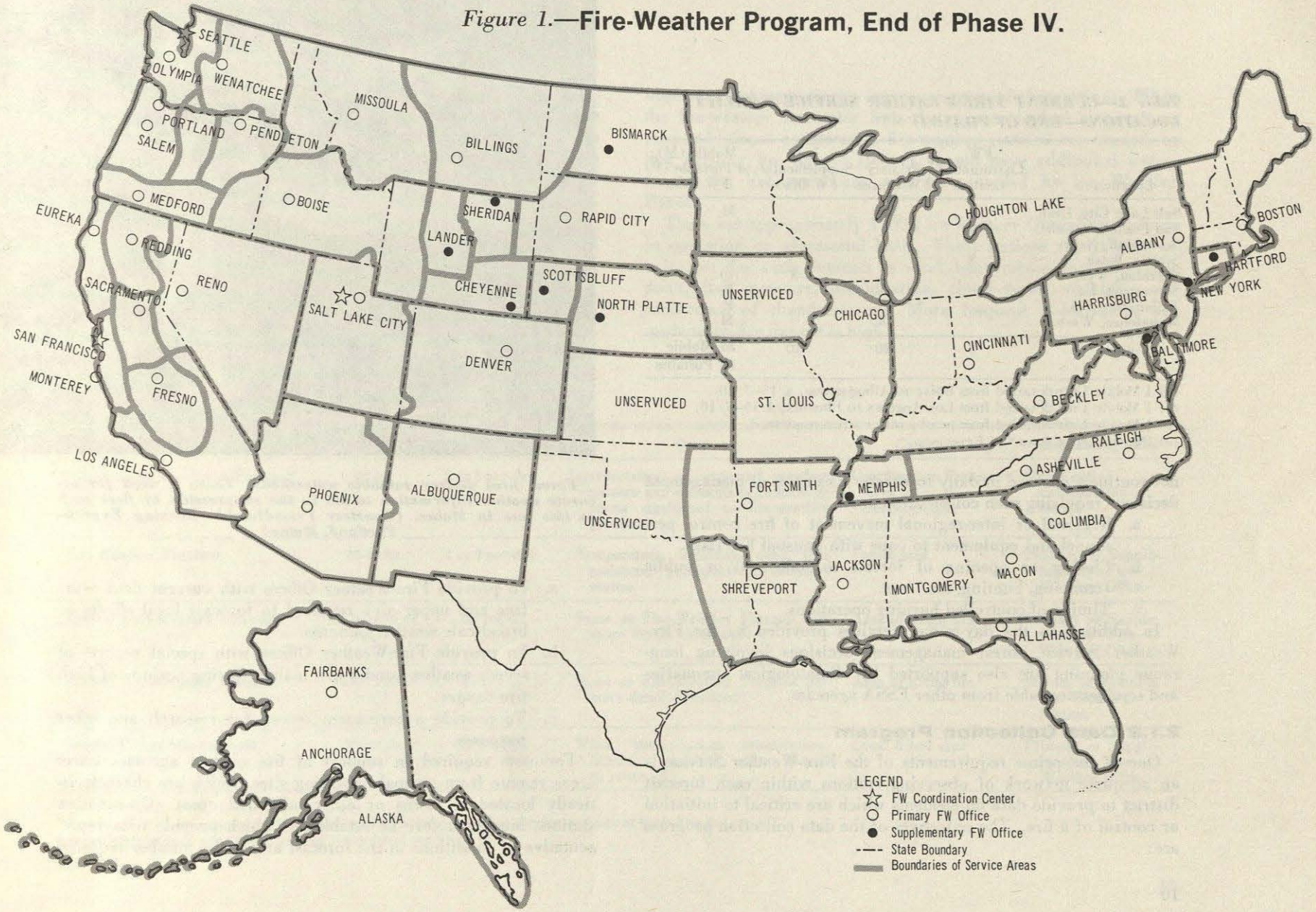


Table 2—CURRENT FIRE-WEATHER SERVICE FACILITY LOCATIONS—END OF PHASE IV

Location	FW Coordination Centers	Primary FW Offices	Supplementary FW Offices	Mobile (M) or Portable (P) FW Units
Salt Lake City, Utah	X	X		M
San Francisco, Calif.	X			
Scottsbluff, Nebr.			X	
Seattle, Wash.	X			
Sheridan, Wyo.			X	(c)
Shreveport, La.		X		P
Tallahassee, Fla.		X		P
Wenatchee, Wash.		X		M
Totals	3	40	10	20 Mobile 18 Portable

(a) 1 Mobile Unit detailed from Boise to Albuquerque, 4/15–7/10.
(b) 1 Mobile Unit detailed from Los Angeles to Phoenix, 4/15–7/10.
(c) 1 Mobile Unit detailed from nearby office when requested.
(d) Planned move from San Francisco.

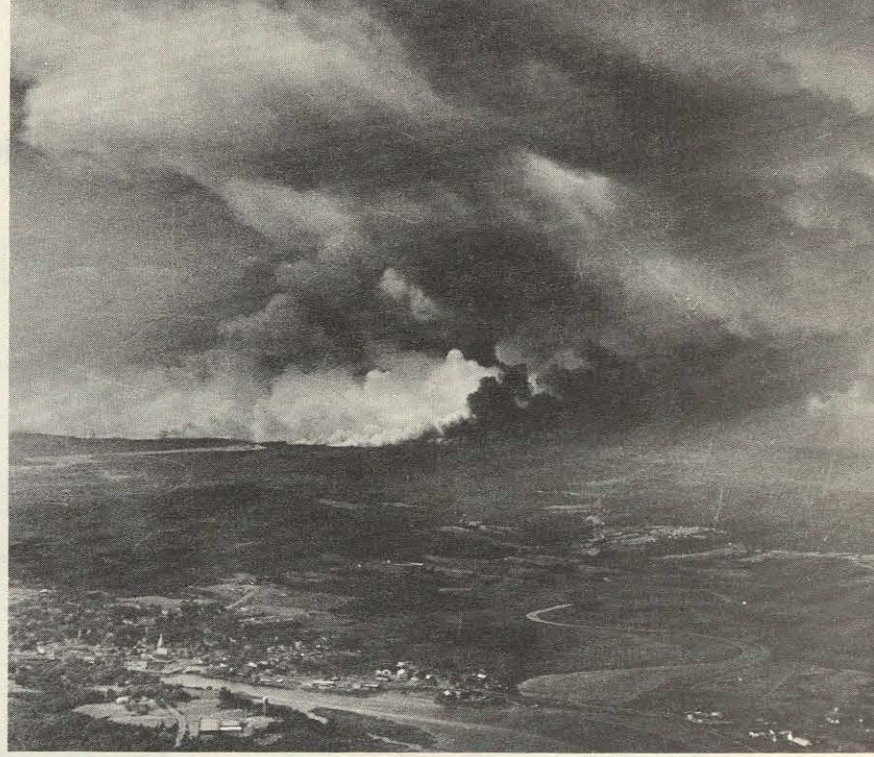
not routinely covered in daily forecasts. Examples of management decisions requiring such consultation are:

a. Regional or inter-regional movement of fire control personnel and equipment to cope with unusual fire risks.
b. Closing or opening of forests to industrial or public (camping, hunting, etc.) use.
c. Timing of controlled burning operations.

In addition to the day-to-day services provided by the Fire-Weather Service, forest management decisions involving long-range planning are also supported by climatological summaries and services available from other ESSA agencies.

2.1.2 Data Collection Program

One of the prime requirements of the Fire-Weather Service is an adequate network of observing stations within each forecast district to provide data on elements which are critical to initiation or control of a fire. The objectives of the data collection program are:



Forest fires destroy valuable watersheds. There is need for accurate weather information to aid in the suppression of fires such as this one in Maine. (Courtesy Press-Herald—Evening Express, Portland, Maine)

a. To provide Fire-Weather Offices with current data (surface and upper air) required to forecast local effects of broadscale weather patterns.
b. To provide Fire-Weather Offices with special reports of severe weather conditions, mainly during periods of high fire danger.
c. To provide a permanent record for research and other purposes.

Forecasts required in support of fire control agencies cover areas remote from normal observing sites, which are characteristically located in towns or other inhabited areas. Observation stations must therefore be established which provide data representative of conditions in the forecast areas; the number required

is a function of the climatic features of the area and the amount of detailed information needed by fire control personnel. In the interest of economy and efficiency, Fire-Weather observing stations are usually collocated with fire danger stations[2] operated by the fire control organization responsible for the area; observations are taken and reported by the fire control personnel, and the fire protection organization normally bears the costs of instrumentation, maintenance, and operation. Fire-Weather personnel may be consulted in locating fire danger stations, and will assist in training observers and inspecting to insure accuracy of observations. When the fire-weather forecaster feels that meteorological observations from additional co-operative fire-weather stations are needed, or that existing fire danger stations should have additional instruments, the instrumentation will be provided by the Weather Bureau.

There are approximately 1100 Fire-Weather Observing Stations in operation on a seasonal basis. These stations report once or twice per day such elements as wind, temperature, humidity, dew point, fuel moisture, precipitation, cloud types, visibility, and occurrence of thunderstorms. More frequent observations are made when fire danger is high.

[2] A fire control agency station providing observations for use in calculating fire danger ratings.

Table 3—FIRE-WEATHER SERVICE PRODUCTS

Product	Period	Cycle	Content	Coverage	Originating Office
Fire-Weather Guidance Forecast[1]	48 hr.	2 or 3 per day	Interpretation of expected weather pattern and elements of interest in terms significant to fire-weather problems	Coordination Center area of responsibility	Fire-Weather Coordination Center
Fire-Weather Forecast	36-48 hr.	1 or 2 per day	Temperature, humidity, wind, fuel moisture, precipitation, thunderstorms	Forest area	Primary or Supplementary[2] Fire-Weather Office
Special Fire-Weather Forecast	24 hr. and as req'd.	As req'd.	Same as Fire-Weather Forecast but more detail (localized)	Area of going fire	Primary or Supplementary[2] Fire-Weather Office
Special Fire-Weather Forecast	24 hr. and as req'd.	As req'd.	Same as Fire-Weather Forecast but more detail (localized)	Area of going fire	Mobile or Portable Fire-Weather Station
Special Forest Management Forecast[3]	Variable	On request	Wind, precipitation, temperature, humidity, stability, other factors as required	Local forest area	Primary or Supplementary Fire-Weather Office

[1] Internal product not disseminated to users.
[2] Produced at supplementary Fire-Weather Offices on demand or during periods of high fire danger.
[3] In support of such operations as pest control and seeding.

2.1.3 Dissemination Program

The effectiveness of the Fire-Weather Program depends upon adequate two-way communications to insure timely receipt of observations, transmission of forecasts and warnings, and provision of consulting services. Direct contact is therefore essential between Fire-Weather Offices and the headquarters of fire protection agencies, such as forest supervisors' offices and principal state headquarters (or offices designated to serve for each); these headquarters are responsible for relay of weather information to subordinate activities.

Communications currently employed to meet the above objectives are flexible to insure full utilization of existing facilities and, therefore, vary between fire-weather districts. They have been developed in accordance with the following guide lines:

a. Communications between fire-weather offices and Weather Bureau forecasters at fires and between fire-weather offices and fire-weather coordination centers are provided by the Weather Bureau.
b. Weather communications between protection agencies' headquarters (such as a Forest Supervisor's office, or a State Forester's office) and district or local fire protection units are provided by the protection agencies.
c. Weather communications between a fire-weather office and fire protection agencies' headquarters are provided by one of several possible arrangements:
   (1) By radio, utilizing facilities and frequencies furnished by the protection agency.
   (2) By fire-weather teletypewriter circuits, utilizing lines and equipment furnished by the Weather Bureau.[3]
   (3) By protection agency teletypewriter circuits, utilizing lines and equipment furnished by the protection agency.[3]
   (4) By TWX, telephone or telegraph under the following conditions:
      (a) The Weather Bureau pays tolls for fire-weather observations.
      (b) Protection agencies pay tolls for transmitting forecasts and warnings.

[3] Prorated costs to fire-control agencies requiring send-receive drops on Weather Bureau fire-weather teletypewriter circuits under C. (2), above, are based on local drop and channel charges and equipment rental. The Weather Bureau pays all long-line charges and rental for equipment in Weather Bureau offices. Conversely, when the Weather Bureau requires send-receive drops on fire-control teletypewriter circuits under C. (3) above, that agency is reimbursed by the Weather Bureau for local drop and channel charges and equipment rental costs.

Men and modern equipment used in fighting forest fires are highly susceptible to sudden wind shifts. Accurate fire-weather forecasts reduce the risks.

2.2 AREAS OF POTENTIAL IMPROVEMENT

The foregoing description outlines the present Fire-Weather Service which is meeting most needs of forestry interests in selected areas of the United States, although current staffing at a number of Primary Fire-Weather Offices does not allow for meeting new user requirements or for the effective application of new technology. In contrast, forestry interests throughout the remaining areas must, with few exceptions, plan and carry out their operations on the basis of forecasts and advisories which are designed to serve the general public. Weather Bureau Offices have, in some cases, made improvised arrangements to provide specialized products of particular importance to a locally significant forestry operation, as an "add-on" to their normal public weather service activities. These efforts usually lack effectiveness, and the level of service is unsatisfactory for the following reasons:

a. Public service forecasts and advisories, while frequently of general interest to forestry, do not cover all parameters of importance.
b. No forestry advisories are available for interpreting the forecast meteorological parameters in terms of probable effects on forestry operations.
c. No specialized forecasts are available for going fires or areas of controlled burns.
d. Special forestry observations, which are essential to the production of adequate forecasts, are not available to the forecaster.
e. Effective dissemination of fire-weather forecasts and warnings is lacking.

Because of the importance of forestry resources to the economy and public welfare, there is a demonstrated need to remedy these deficiencies by providing an improved level of Fire-Weather Service to other areas of the United States. This Federal Plan for a Nationwide Fire-Weather Service has been based on this need.

3.0 PLANNED FIRE-WEATHER SERVICE IMPROVEMENT PROGRAM

3.1 PRODUCTS AND SERVICES

User requirements in areas that are not presently receiving the improved Fire-Weather products and services described in Section 2.1 and widespread recognition of the Service Program's benefits have resulted in an increasing demand for broadening the scope of the Service. These products and services will be gradually phased into the remaining forest and grassland areas of the conterminous United States and Alaska. Figure 2 indicates the locations of the activities associated with the implementation of the remainder of the nine-phase program. Figure 3 depicts the nationwide coverage when the program has been fully implemented.

3.2 SERVICE SYSTEM CONFIGURATION

Improvement of the Fire-Weather Service is based primarily on carrying out the remaining phases of the nine-phase program to provide coverage for currently unserviced areas and areas not adequately served. This action constitutes the change necessary in the present system configuration to meet the specific requirements of user groups.

This expansion will require the establishment of Fire-Weather Offices at selected Weather Bureau locations noted in figure 2 to provide forecast service in areas that may cover part or all of a State, or parts of several States. These Fire-Weather Offices will perform functions and generate products as described in Section 2.1.1. In addition, they will assume responsibility for the provision of the specialized consultation service required for forest and range management. Staffs at undermanned offices now providing service will also be strengthened and the use of mobile fire-weather stations as advisory forecast offices at the sites of large wild fires or prescribed burning operations will be expanded to new areas as needed.

Figure 2.—**Fire-Weather Program, Phase V Through IX.**

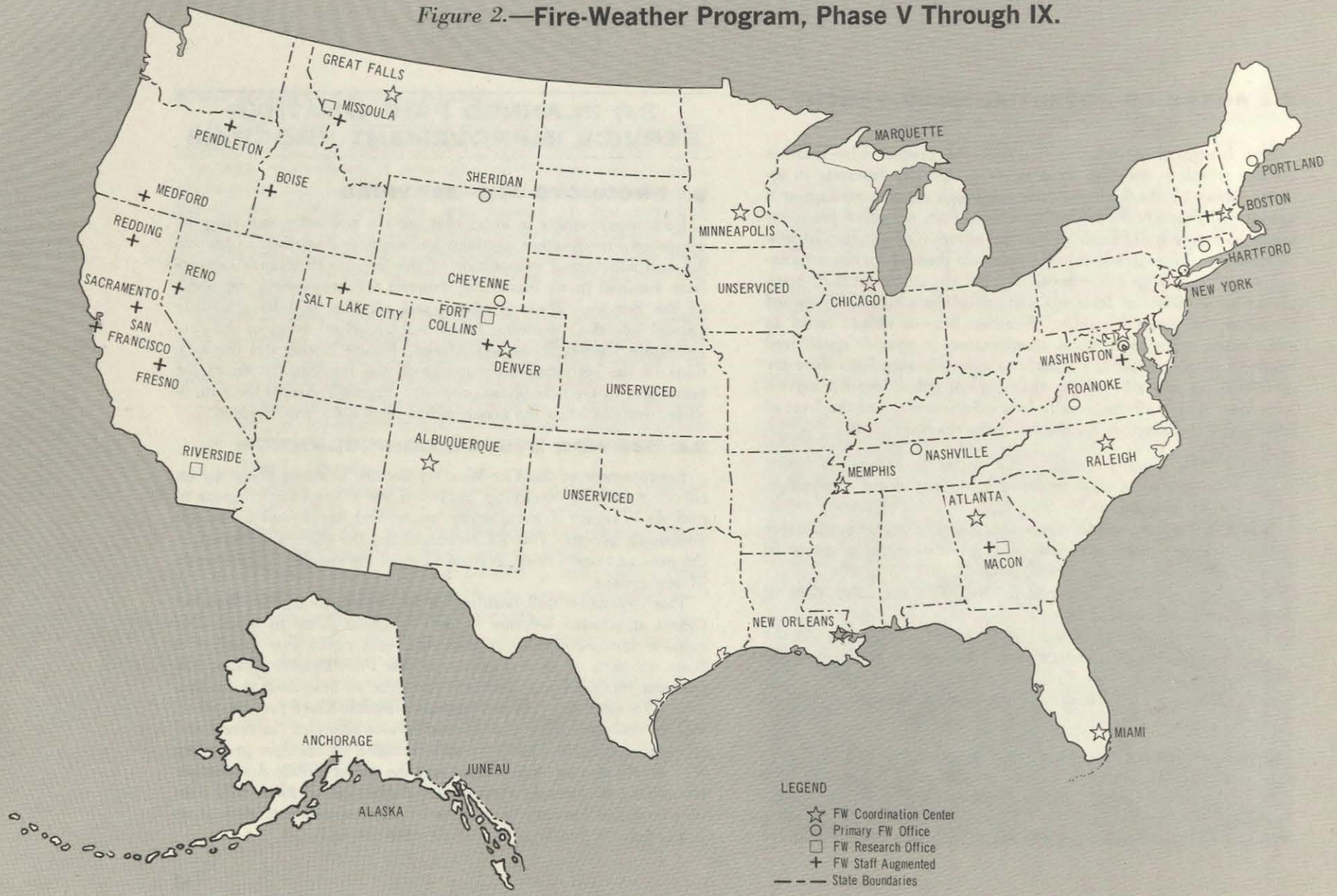


Figure 3.—**Fire-Weather Program, End of Phase IX.**

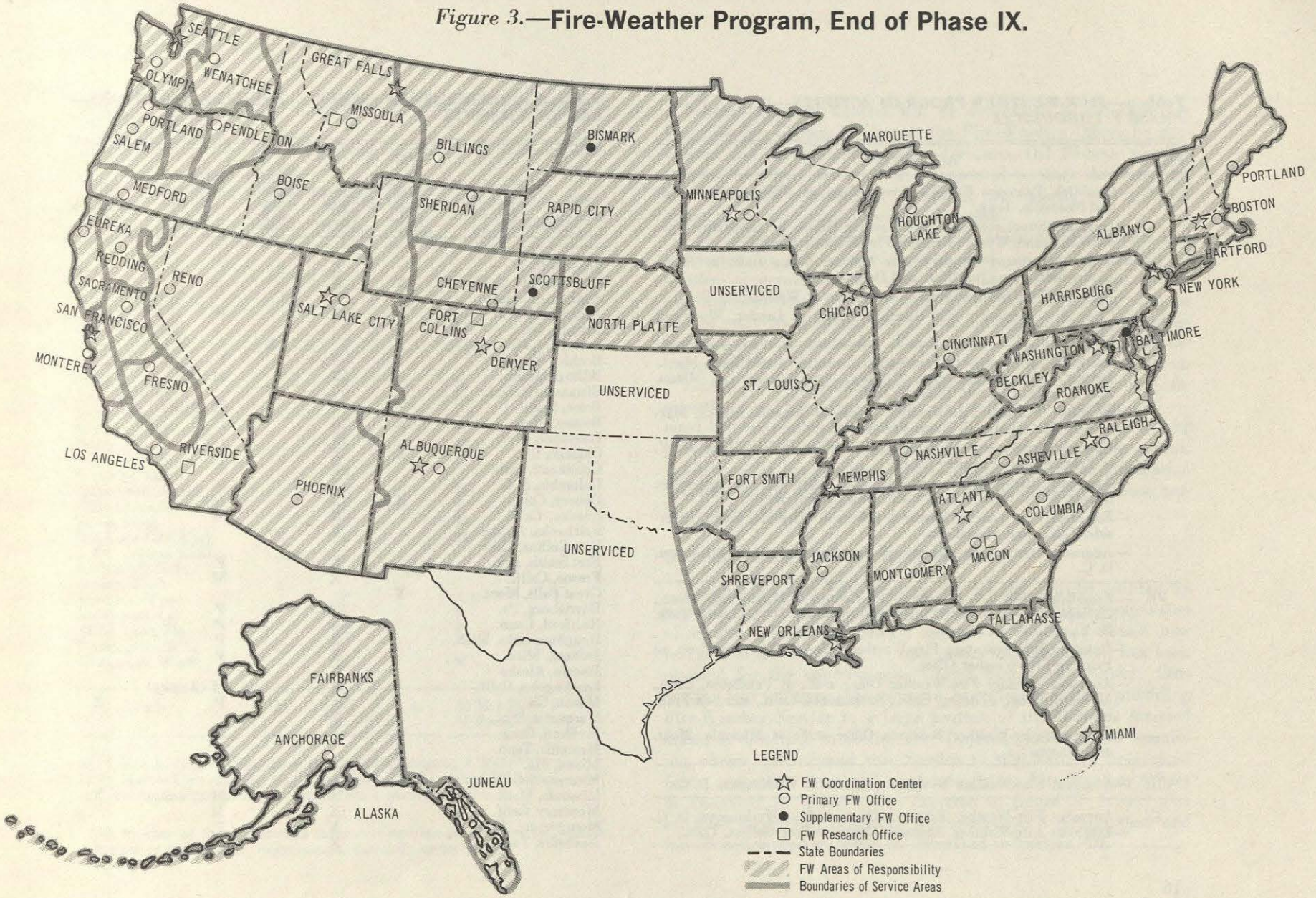


Table 4—FIRE-WEATHER PROGRAM ACTIVITY—PHASE V THROUGH IX

PHASE	ACTIVITY
V	—Establish Primary Fire-Weather Offices at Minneapolis, Minn. and Nashville, Tenn. —Upgrade Supplementary Fire-Weather Offices at Sheridan, Wyo. and Cheyenne, Wyo. to Primary Fire-Weather Offices. —Augment existing Primary Fire-Weather Office staffs at Boise, Idaho, Salt Lake City, Utah, and Denver, Colo. —Augment Fire-Weather Research program at Washington, D. C. —Close Supplementary Fire-Weather Offices at Lander, Wyo. and Memphis, Tenn.
VI	—Establish Fire-Weather Coordination Centers at Great Falls, Mont., Denver, Colo., Albuquerque, N. Mex., New Orleans, La., Miami, Fla., Atlanta, Ga., and Raleigh, N. C. —Establish Primary Fire-Weather Offices at Juneau, Alaska, Marquette, Wis., Portland, Maine and Roanoke, Va. —Upgrade Supplementary Fire-Weather Office at New York, N. Y. to Primary Fire-Weather Office. —Augment existing Primary Fire-Weather Office staffs at Anchorage, Alaska, Reno, Nev., Fresno, Calif., and Boston, Mass. —Establish Fire-Weather Research Offices at Missoula, Mont., Riverside, Calif., and Macon, Ga. —Augment existing Fire-Weather Research program at Washington, D. C.
VII	—Establish Fire-Weather Coordination Centers at Minneapolis, Minn., Chicago, Ill., Memphis, Tenn., Washington, D. C., New York, N. Y., and Boston, Mass. —Upgrade Supplementary Fire-Weather Office at Hartford, Conn. to Primary Fire-Weather Office. —Augment Primary Fire-Weather Office staffs at Pendleton, Oreg., Medford, Oreg., Redding, Calif., Sacramento, Calif., and San Francisco, Calif. —Augment Fire-Weather Research Office staffs at Missoula, Mont. and Macon, Ga.
VIII	—Augment Fire-Weather Research program at Washington, D. C.
IX	—Augment Fire-Weather Research Office staff at Washington, D. C. —Establish Fire-Weather Research Office at Fort Collins, Colo.

Table 5—FIRE-WEATHER SERVICE FACILITY LOCATIONS—END OF PHASE IX

Location	FW Coordina. Centers*	Primary FW Offices	Supplementary FW Offices	Mobile (M) or Portable (P) FW Units	FW Research Offices
Albany, N. Y.		X		P	
Albuquerque, N. Mex.	X	X		(*a*)	
Anchorage, Alaska		X			
Asheville, N. C.		X		P	
Atlanta, Ga.	X				
Baltimore, Md.			X		
Beckley, W. Va.		X		P	
Billings, Mont.		X		M	
Bismarck, N. Dak.			X		
Boise, Idaho		X		M (2 units)	
Boston, Mass.	X	X		P	
Cheyenne, Wyo.		X		(*c*)	
Chicago, Ill.	X	X		P	
Cincinnati, Ohio		X		P	
Columbia, S. C.		X		P	
Denver, Colo.	X	X		(*c*)	
Eureka, Calif.		X		M	
Fairbanks, Alaska		X			
Fort Collins, Colo.					X
Fort Smith, Ark.		X		P	
Fresno, Calif.		X		M	
Great Falls, Mont.	X				
Harrisburg, Pa.		X		P	
Hartford, Conn.		X		P	
Houghton Lake, Mich.		X		P	
Jackson, Miss.		X		P	
Juneau, Alaska		X			
Los Angeles, Calif.		X		M (2 units)	
Macon, Ga.		X		P	X
Marquette, Wis.		X			
Medford, Oreg.		X		M	
Memphis, Tenn.	X				
Miami, Fla.	X				
Minneapolis, Minn.	X	X			
Missoula, Mont.		X		M (2 units)	X
Monterey, Calif.		X		M	
Montgomery, Ala.		X		P	
Nashville, Tenn.		X			

Table 5—FIRE-WEATHER SERVICE FACILITY LOCATIONS—END OF PHASE IX

Location	FW Coordina. Centers*	Primary FW Offices	Supplementary FW Offices	Mobile (M) or Portable (P) FW Units	FW Research Offices
New Orleans, La.	X				
New York, N. Y.	X	X			
North Platte, Nebr.			X		
Olympia, Wash.		X		M	
Pendleton, Oreg.		X		M	
Phoenix, Ariz.		X		(*b*)	
Portland, Maine		X			
Portland, Oreg.		X		M	
Raleigh, N. C.	X	X		P	
Rapid City, S. Dak.		X		(*c*)	
Redding, Calif.		X		M	
Reno, Nev.		X		M	
Riverside, Calif.					X
Roanoke, Va.		X			
Sacramento, Calif.		X		M	
Saint Louis, Mo.		X		P	
Salem, Oreg.		X		M	
Salt Lake City, Utah	X	X		M	
San Francisco, Calif.	X				
Scottsbluff, Nebr.			X		
Seattle, Wash.	X				
Sheridan, Wyo.		X		(*c*)	
Shreveport, La.		X		P	
Tallahassee, Fla.		X		P	
Washington, D. C.	X				X
Wenatchee, Wash.		X		M	
Totals	16	50	4	20 Mobile 18 Portable	5

(*a*) 1 Mobile Unit detailed from Boise to Albuquerque, 4/15-7/10.
(*b*) 1 Mobile Unit detailed from Los Angeles to Phoenix, 4/15-7/10.
(*c*) Mobile Unit detailed from nearby office when requested.

* The number of these centers is subject to revision in accord with possible changes in the forecast organization, currently under study.

Selected Forecast Centers will be designated as Fire-Weather Coordination Centers to support the Fire-Weather Offices by providing: (a) fire-weather guidance forecasts, (b) 24-hour weather watches to insure detection of unexpected weather developments that may have a significant impact on fire danger, and (c) consultation during complex weather situations.

The ability to provide accurate and meaningful forecasts and advisories for fire control areas depends on the availability of weather observations from sites which are truly representative of conditions in those areas. Special fire-weather observing stations will be established as required to augment the existing meteorological and forestry networks. The number of reporting stations required will be a function of area size, topography, and vegetation.

Finally, the communications required for the collection of observations and the dissemination of forecasts, advisories, and related information to users and other interested subscribers will be provided by teletypewriter networks or other available means. Guidelines for the establishment and operation of communication facilities in the newly serviced areas will be similar to those outlined in Section 2.1.3.

3.3 IMPLEMENTATION PLAN

Improvements in Fire-Weather Service that will be realized by implementation of this plan are based on the continued expansion of features already underway, and the addition of certain new features to the Program. A nine-phase implementation has been planned for the conterminous United States and Alaska. Currently, four of these phases have been implemented, providing Fire-Weather Service to a large portion of the Nation's forested areas, as described in Section 2.1. Implementation of the remaining phases will expand this Service to the Nation's unserviced forest and range areas and augment existing Fire-Weather Offices as described in Table 4 and depicted in figure 2. It will also establish supporting programs for research and development and for education and training, as described in Section 4.0.

Upon complete implementation, as depicted in figure 3, specialized weather forecast and warning services will be provided to meet fire control agencies' established requirements in the conterminous United States and Alaska. Table 5 lists the Fire-Weather Service facility locations as the end of Phase IX.

4.0 SUPPORTING PROGRAMS

4.1 RESEARCH AND DEVELOPMENT PROGRAM

Future improvement of the Fire-Weather Service depends in part on a vigorous program of supporting research and development. This is particularly important because of the unique nature of fire-weather forecasting and of the small amount of work that has been done in this field. To insure effective accomplishment of the Service Program, the Weather Bureau will initiate an extensive fire-weather Research and Development Program that will keep the fire-weather service abreast of advances in meteorology and equip it to meet the requirements of the increasingly dynamic fire control organizations throughout the United States.

Much of the development of improved fire-weather forecasting techniques by the Weather Bureau and the fire-behavior research by protection agencies is closely related. Interests in some cases are nearly identical and, where practical, work should be carried on jointly to insure balanced progress and to strengthen the output of both in their own responsibilities. Development of forecast techniques must be concentrated on finding ways to improve the ability to predict local weather effects. Fire-behavior research is concentrated on identification and measurement of weather factors and their combinations that influence the behavior of fires.

In some areas, specialized problems are of mutual interest and have a high priority with the fire-weather forecasters and protection agencies. Examples of problems affecting fire-weather conditions in various areas of the United States are:

a. Northwest	Local effects of maritime and continental factors.
b. Southwest	Local effects of heating and topography.
c. Rocky Mountains	Forecasting thunderstorms and the effects of subsidence.
d. Lake and Central States	Effects of instability, subsidence, frontal passages, and extended drought.
e. South and East	Forecasting conditions of instability, land and sea effects, and extended drought.

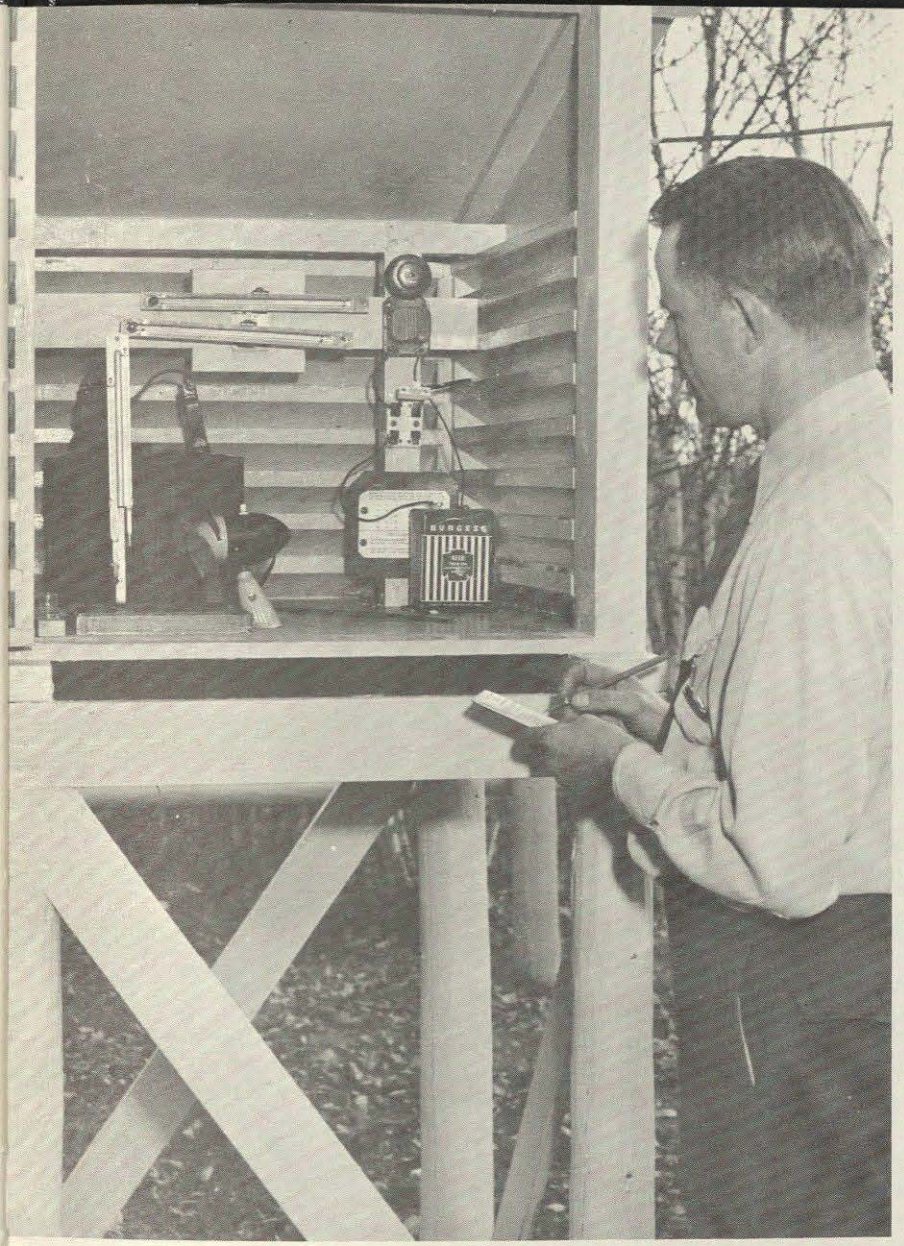
Because of the local and specialized nature of these problems, it will be necessary to detail men temporarily to field locations and to work with forest service fire research laboratories. The U. S. Forest Service has established fire research laboratories, at Riverside, Calif., Missoula, Mont., and Macon, Ga. A new laboratory is presently being established at Fort Collins, Colo. Close Weather Bureau collaboration with these laboratories is important; therefore, meteorological research positions will be set up at each.

Specific work required for an effective supporting research and development program is as follows:

a. Development of techniques for interpreting the National Meteorological Center's prognostic charts in terms of fire-weather elements such as maximum temperature, minimum relative humidity, wind speed and direction, surface turbulence, and fuel moisture.

b. Development of operational station forecast rules and techniques for fire-weather elements. These should be related closely with prognostic charts. Some work has been started in local station studies. These operational studies should be expanded and given careful direction and supervision.

c. Development of techniques for forecasting local conditions for surrounding areas in terms of the expected



There is close collaboration between the Weather Bureau and many fire protection organizations. Here a Forest Service ranger makes the regular weather reading at a fire-danger station in Superior National Forest, Minnesota.

values at a central, or key, station.

d. Investigation of typical wind drainage patterns and their relationship to temperature, humidity, and fuel moisture. These relations and patterns are necessary in the development of the above objectives.
e. Development of techniques for the use of radar in fire-weather forecasting, with special attention to thunderstorms and lightning.
f. Development of techniques for localizing thunderstorm forecasts and for forecasting the number of lightning strikes, the amount or lack of precipitation, and the extent of gusty surface winds in expected thunderstorms. Lightning-caused fires constitute a major problem in the Rockies and West Coast Areas.
g. Development of techniques for an improved 3 to 5-day outlook in terms of wind, humidity, temperature, and precipitation.

In order to improve the effectiveness of the research and development program, provision will be made for computer analysis of weather data. Up to 1961, a large number of fire-weather and fire-danger stations' records were punched on cards. There is need to bring these records up to date and to continue processing. Development work, listed as items a. through g. above, will also require data processing in increasing amounts as the program accelerates.

Further development of specialized equipment is also required as follows:

a. Portable vertical sounding equipment to obtain temperature, wind, and humidity profiles up to 10,000 feet near large fires in remote areas.
b. Automatic, low-cost weather stations and associated telemetering systems for routine use and for special local studies.
c. Inexpensive, portable equipment for securing temperature, wind, and moisture data from helicopters and small planes assigned to routine patrol, or on reconnaissance of large fires.

d. Improved meteorological equipment for mobile unit operation.

4.2 EDUCATION AND TRAINING PROGRAM

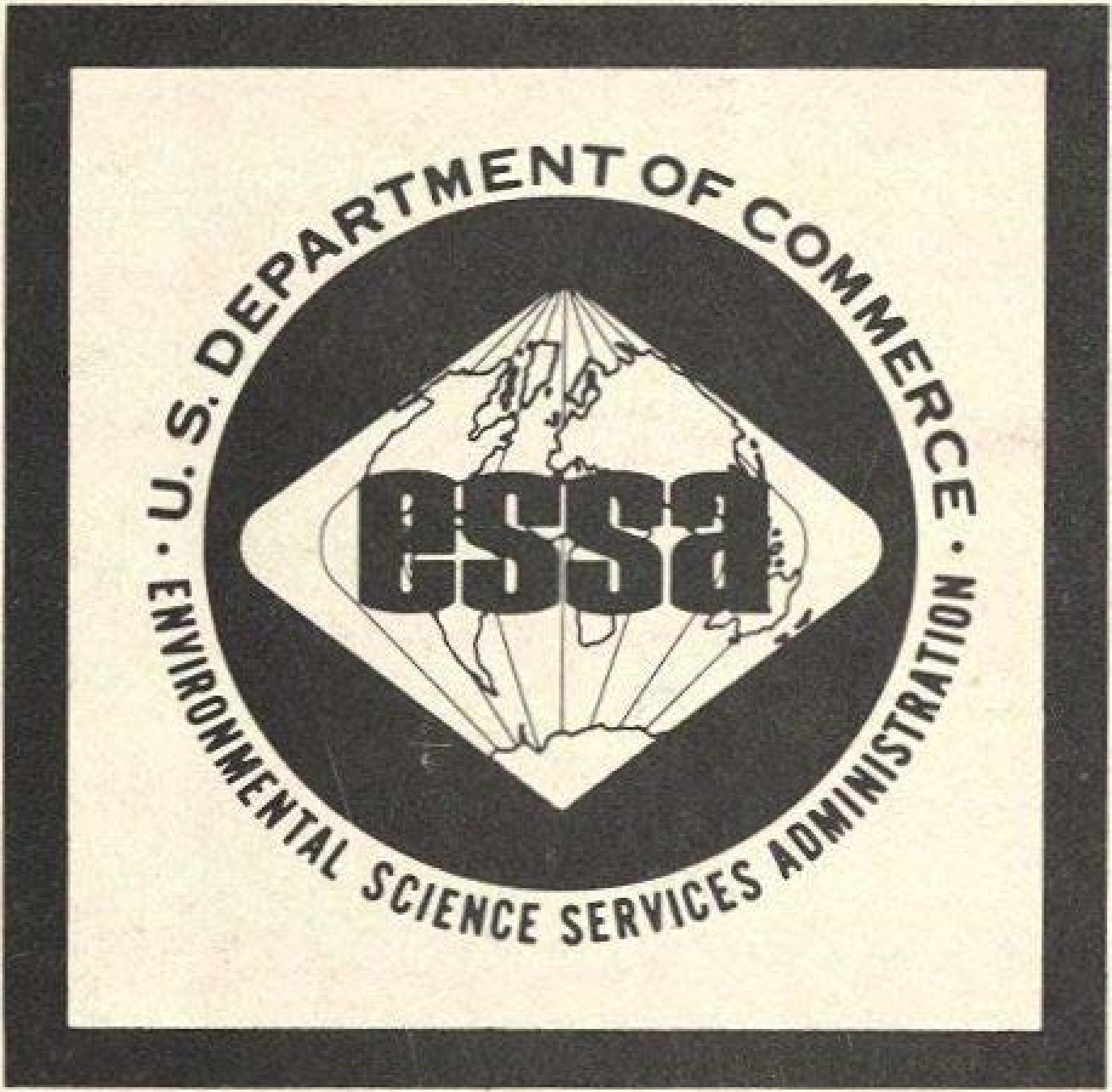
Any expansion or future improvement in Weather Bureau Fire-Weather Service depends on the availability of trained personnel to staff and maintain fire-weather offices. At present, there is no organized fire-weather training program to provide these required personnel other than the existing in-service (on-the-job) training, which employees receive upon entering into service.

In order to provide for the highly competent personnel required to fully implement the Fire-Weather Service Program and to adequately fill vacancies in the present organization as they occur, the Weather Bureau will establish training programs at two levels in addition to the present on-the-job training program.

First, the Weather Bureau will sponsor special Forestry Meteorological Institutes at Land Grant Colleges in selected areas of the country. These institutes will consist of a one-semester curriculum of intensive training for meteorologists in subjects related to forestry. It is not expected that one semester under such a training program will develop foresters or fire-weather specialists, but it will provide Weather Bureau meteorologists with a clear grasp of the problems of foresters and the relation of these problems to weather phenomena. Such intermediate-level training will also serve as a coordination mechanism to facilitate the exchange of ideas between meteorologists and foresters. Secondly, the Weather Bureau will sponsor advanced one-year University scholarships for fire-weather forecasters and research personnel. This training may cover the areas of forest meteorology, management, and other pertinent fields. This advanced and more formalized level of training will meet the future needs of research and program management and will be offered to selected personnel interested in the Fire-Weather Service Program.

An important additional objective of this multilevel training is to enhance the career development potential of personnel in fire-weather as well as other Weather Bureau programs.

Recreation is one of the valuable resources of the National Forests. Decisions on opening and closing of hunting and camping grounds such as this in the Sierra National Forest in California depend greatly on accurate weather information.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