NORTHERN FOREST EXPERIMENT STATION
JUNEAU, ALASKA
U. S. DEPARTMENT OF AGRICULTURE

U. S. FOREST SERVICE

RESEARCH NOTE NOR-8

July 1964

THE CHRONOLOGY AND ANALYSIS OF THE HUGHES FIRE, 1962 1/

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Fire in the interior basin of Alaska is commonplace. Lightning- and man-caused fires have burned and reburned millions of acres. Despite their commonness and extensiveness, the specific history and characteristics of a fire as they relate to fuels and weather have not been systematically observed and recorded.

The Hughes fire in July 1962 did provide an opportunity to make systematic and detailed observations on fire behavior, weather, and fuels. The results of those observations and measurements are the basis of this report. The information and knowledge gained from this and similar opportunities as they arise will aid the fire control manager to more accurately predict fire behavior and, thereby, increase the effectiveness of the control techniques he uses.

The assistance and cooperation of the Bureau of Land Management is gratefully acknowledged and, in particular, that of George Kitson, fire boss for the Hughes fire.

FIRE CHRONOLOGY

At 11 a.m. on July 19 a fire 2/ was detected on the southwest-facing slope of Nutltoktalogi Mountain about 25 miles northeast of Hughes, an

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1/ Research reported here was done at the Station's Forestry Sciences Laboratory maintained in cooperation with the University of Alaska at College.

2/ Designated as "Hughes NE 25, Number 48," in official records of the Bureau of Land Management.

Indian village on the Koyukuk River, and approximately 210 miles northwest of Fairbanks by air. The fire was estimated to be 5 acres in size when it was first reported by the Bureau of Land Management aerial detection patrol to the fire control dispatcher at Fairbanks.

The topography of the fire area is flat to rolling with only a few slopes exceeding 30 percent. Elevations range from 400 feet near the river to 1,600 feet at timberline.

First Day

Initial attack by five smokejumpers was made at 3:30 p.m. on July 19. The size of the fire was then estimated to be 50 acres. At 4:15 p.m., two air tankers dropped 2,000 gallons of fire retardant borate. At 11:45 p.m., a ground crew, consisting of 24 men, relieved the smokejumpers. Apparently no held line was established by the end of this day.

Second Day

By 2:30 p.m. on July 20, 40 additional men had been flown by military helicopter to the fire area as reinforcements. By 4 p.m. the fire was reported to have increased to an estimated 300 acres. At 10 p.m. burning was active in mixed spruce-birch-aspen fuels along the ridgetops. From smoke drift, the surface winds were estimated southwesterly at 5 miles per hour. From a perimeter map (fig. 1A) the fire size was estimated to have increased to 400 acres.

Third Day

By 9 a.m. on July 21, an additional 75 men with one line supervisor were shuttled to the fire. The total suppression force now consisted of two trained temporary employees and 139 lineworkers. A two-passenger helicopter and pilot were also on hand.

At 10 a.m., a portable fire weather station (fig. 2) was set up about 200 yards from the west edge of the fire and about 100 yards north of the base camp. This enabled fire weather observations to be made at frequent intervals each day throughout the active life of the fire. The morning observation was relayed through the fire control radio net to the Weather Bureau Fire Weather Forecast Center at Anchorage. Fire control personnel requested and received from the Weather Bureau special 12-hour spot forecasts at 8 a.m. and 4 p.m. daily.

The fire slowly began to increase in activity after 11 a.m. on the northeast and south sides. By 2 p.m., the north side had moved across a small creek and started into the open white spruce. On the east side, a narrow finger of fire, carried by dense reindeer lichen, spread rapidly along the center ridge. By 5 p.m. this finger had become 20 chains wide and 70 chains long. The south side had spotted across a large muskeg flat and was working into dense stands of black spruce.

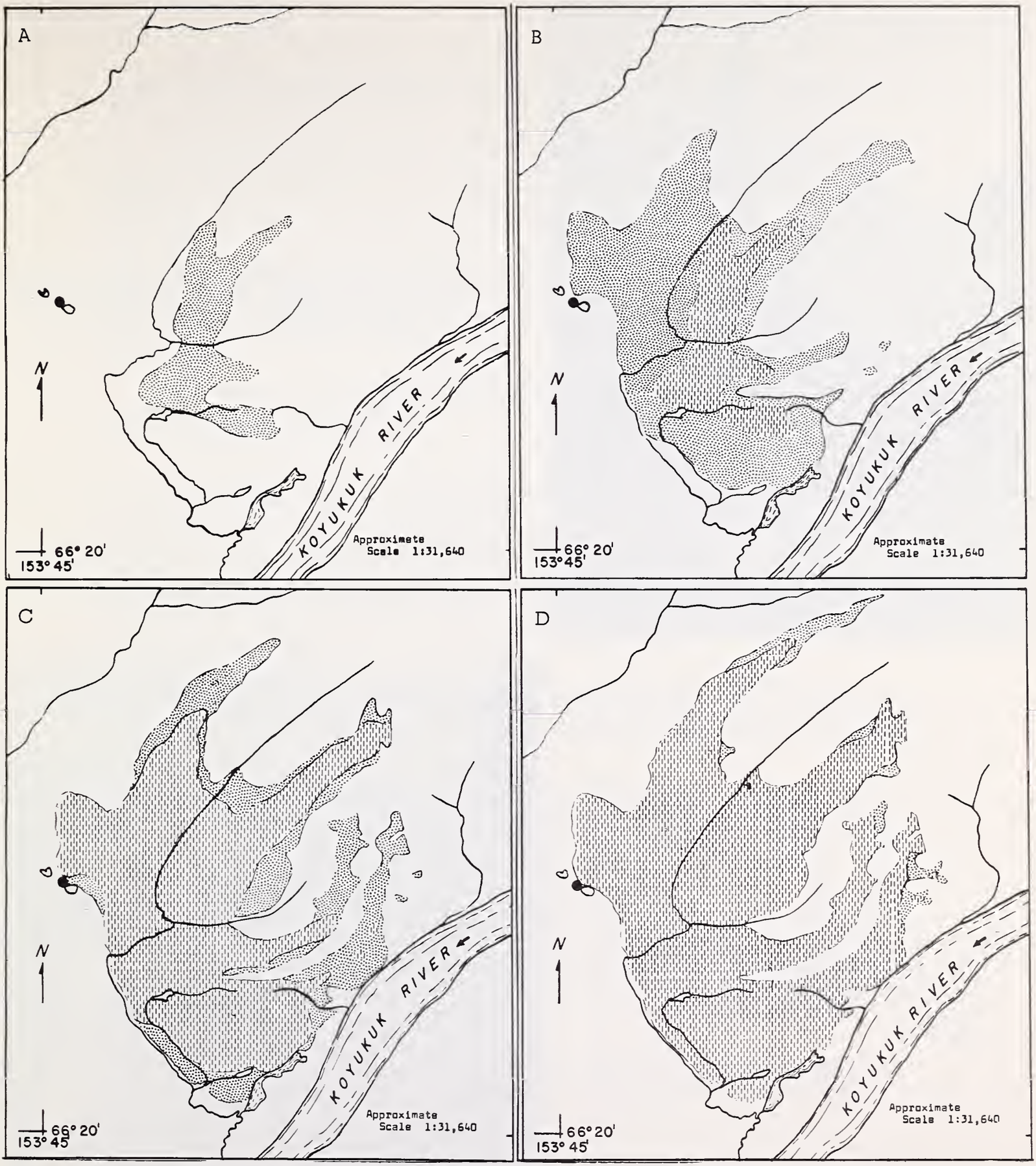

Figure 1.--Growth of the Hughes fire.

A. July 18 to 10 p.m. July 20
B. 10 p.m. July 20 to 6 p.m. July 21
C. 6 p.m. July 21 to 6:30 p.m. July 22
D. 6:30 p.m. July 22 to 6 p.m. July 23

burned each period; burned previous periods.

Figure 2.--The portable fire weather station used to measure wind speed, temperature, relative humidity, precipitation, and fuel moisture.

igure 3.--A fire control line 20 feet wide, cut through a stand of spruce. The trench width near the extreme right side of the clearing is 12 inches.

An indirect control line, about 50 chains long, had been cleared from a small pond near camp northerly through a stand of white spruce (fig. 3). The east edge of this control line was fired at 3:15 p.m.

The burnout slowly developed momentum and joined the main fire by 6 p.m. Heat generated by the burnout was insufficient to remove all fuels adjacent to the cleared line. Fire spread subsided rapidly after 7 p.m. Burned acreage was estimated at 1,550 acres--a net increase of 288 percent in 8 hours. About 80 chains of the fire perimeter on the southwest side burned out along the muskeg creek. Less than 15 percent of the total fire perimeter was under control. Figure 1B is a schematic map of the burned area as of 6 p.m. Weather observations recorded on July 21 are in table 1.

Fourth Day

There were a few scattered spots burning at 8 a.m. on July 22. Fire activity started increasing by 11 a.m. and the fire was burning freely on three sides by early afternoon.

A helicopter sounding was made at 10:30 a.m. Both canopy doors were removed to permit the air to circulate freely. A sling psychrometer was held in the airstream outside the aircraft canopy to record wet and dry bulb temperatures. The sounding data indicated the possible development of a temperature inversion between 3,000 feet and 5,000 feet (table 2).[3/] The temperature lapse rate was 2°F. per 1,000 feet at these levels as compared to 4° to 5° F. per 1,000 feet for all other altitudes between the surface and condensation level.

About 3:30 p.m., fire in dense spruce on the south and southeast sides produced a flattened toadstool-like smoke column. This confirmed the presence of the shallow band of warm air aloft that was indicated during the morning helicopter sounding.

The fire burned easterly in surface fuels along open ridges that were exposed to direct sunlight. Estimated wind velocities on these ridges were 6 to 8 m.p.h., 1.5 to 2 times those recorded at the portable weather station. Fire spread on these ridges was under control by 5:30 p.m. At 6:30 p.m. activity decreased and the air was sufficiently clear of smoke to map the perimeter. The estimated total burned area was 2,150 acres, an increase of 600 acres in 8 hours (fig. 1C). An estimated total of 500 chains of control line was held or burned out naturally by the end of the day. Fire weather observations made on July 22 are shown in table 1.

Fifth Day

Overcast skies and lower temperatures prevailed on July 23 (table 1). Very little spread was evident until 11:30 a.m. when a moderate run was

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3/ Lanning, John M. Use of helicopters for meteorological soundings on campaign fires. U. S. Weather Bureau (unpublished paper from Conference of Western Fire Weather Meteorologists, 1961, Monterey, California).

Table 1.--Fire weather data, Hughes fire, 1962

Time	Temperature	Relative humidity	Wind speed	Wind direction	Sky cover[1]	Precipitation	Fuel moisture[2]		
							Sticks	Slats	Fine fuel
	Degrees F.	Percent	M.p.h.			Inches	-----Percent-----		
				-----July 21-----					
1000	69	47	2	WNW	Clear	0	14.0	10.0	7.5
1200	73	58	5	WNW	Scattered	0	12.0	9.0	8.5
1400	79	31	3	West	Scattered	0	7.0	5.0	4.5
1800	69	39	5	West	Broken	0	7.0	6.0	6.0
2200	52	70	0	Calm	Scattered	0	8.0	8.5	13.0
				------July 22------					
0600	55	54	2	West	Clear	0	11.0	13.0	9.5
1000	63	50	6	West	Clear	0	11.0	9.0	8.5
1200	72	34	5	SW	Scattered	0	8.5	8.0	5.5
1600	74	29	4	SW	Scattered	0	8.5	7.5	5.0
2000	56	55	0	Calm	Overcast	0	8.5	7.0	9.5
				------July 23------					
0600	52	75	0	Calm	Overcast	0	11.5	12.5	15.0
1000	59	52	2	West	Overcast	0	10.0	10.0	9.0
1200	64	38	3	SW	Overcast	0	10.0	8.0	6.0
1600	65	42	3	SW	Overcast	(3/)	9.0	8.0	6.0
2000	54	94	0	Calm	Overcast	.05	30.0	30.0	25.0
				------July 24------					
0600	55	100	0	Calm	Overcast	.30	30.0	30.0	30.0
1200	61	94	3	SW	Overcast	.04	30.0	30.0	25.0
1800	59	94	2	SW	Overcast	.29	30.0	30.0	25.0
				------July 25------					
0600	59	78	2	W	Broken	.03	30.0	30.0	15.0
1200	61	68	3	W	Broken	(3/)	30.0	30.0	12.0

1/ Clear ..... Less than 0.1
Scattered ... 0.1 - 0.5
Broken ..... 0.6 - 0.9
Overcast.... More than 0.9

2/ Computed from wet and dry bulb temperature readings and table 1, Spread Phase, National Fire Danger Rating System. (Measured to 0.1 percent only when less than 10 percent.)

3/ Less than 0.01 inch.

made in fine surface fuels along the northeast ridges. The run continued until 4 p.m.

During the second helicopter sounding, a frontal line was observed approaching from the west at an undetermined rate. The sounding did not extend much beyond the condensation level because of restricted visibility (table 2).

Table 2.--Helicopter soundings over Hughes fire, 1962

Indicated altitude	July 22			July 23		
	Dry bulb	Wet bulb	Dew point	Dry bulb	Wet bulb	Dew point
Feet	Temperature degrees F.					
4.5	65	54	45	65	51	37
1,000	58	50	43	59	49	39
2,000	52	46	40	55	46	36
3,000	48	43	38	51	42	30
4,000	46	41	35	46	38	27
5,000	44	39	33	43	35	22
6,000	39	35	30	36	34	31
6,300	--	--	--	Estimated condensation level		
7,000	34	31	27	35	34	33
8,000	30	28	25	--	--	--
9,000	26	25	23	--	--	--
10,000	Condensation level ------			--	--	--

Suppression crews began experiencing difficulty in igniting the burnout along the control line on the northeast sector about 2 p.m.

At 3:30 p.m. a light, steady rain began and patches of low stratus clouds enveloped the higher ridges. The fire perimeter, mapped at 6 p.m. (fig. 1D), showed an estimated increase of 150 acres. The total area burned was estimated at 2,300 acres. The fire was declared "under control" at 4 p.m.

Post-fire Observations

The last weather observations were made at noon July 25 (table 1).

Although mop-up action continued until August 3, there was no discernible increase in burned area. A total of 0.71 inches of rain was recorded during the 30-hour period, 4 p.m. July 23 to 10 a.m. July 25.

ANALYSIS

The fire record reflects the influence fuel and weather have on fire behavior.

Fuels

A lichen-moss fine-fuel complex is abundant in most all fuel types of interior Alaska (figs. 4A and B). When alive, these fine fuels may contain over 400 percent to less than 10 percent moisture. The rate of moisture change for lichen-moss fuels is extremely rapid; it may lag behind changes in atmospheric moisture by less than one hour. Once ignited, such fuels are dominant carriers of fire. The abundance of lichen-moss fuels is one of the reasons why this fire, burning within relative humidities of 25-35 percent, with winds of less than 5 miles per hour, almost tripled in size during a single 8-hour burning period.

Lichen-moss fine fuels may gain moisture as rapidly as they lose it. As relative humidities reach 40 percent, or soon after, these fuels become difficult to ignite. This is one of the reasons the burnout at 2 p.m. on July 23 was difficult to light.

The muskeg fuel type[4/] was a natural barrier to fire, particularly along the south sector (fig. 5). Almost five miles of the fire perimeter burned out when it reached the muskeg type; large unburned islands were left in many of the swales. This was due to two major influences: (1) the tendency of muskeg to be fire resistant during wet years, and (2) prevailing southwest winds; fire burning against the wind into wet fuels has little chance of growth.

4/ Muskeg is defined as a boggy area having a thick carpet of sphagnum mosses, decumbent ericaceous shrubs, and sedges over unincorporated organic soil. Black spruce is common along the edges and often dispersed throughout muskeg areas. Drought conditions are usually necessary for sustained burning in an extensive area of this type.

A. Surface fine fuels, predominantly lichen, in mixed spruce-birch fuel type. Note log and branchwood remnants of past fires partially covered by the lichen.

B. Fine fuels, mostly beard lichen on dead, black spruce branches.

Figure 4.--Lichen-moss fuels.

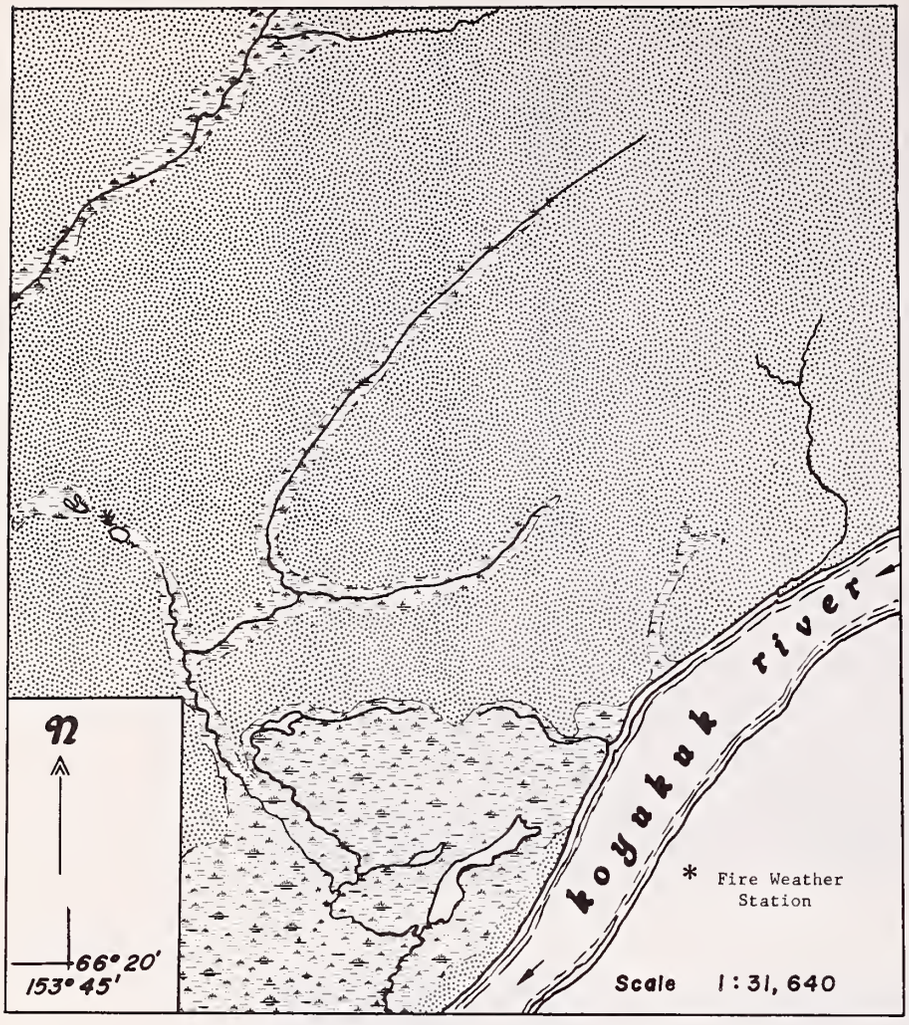

Figure 5.--General fuel types of the fire area.

Muskeg

Mixed spruce, birch or aspen

Weather

The 1962 interior Alaska fire season was mild. Although rainfall was below average for June and July, much of the flat land adjacent to major waterways remained flooded during this normal peak of the fire season. At Fairbanks, the 25-year normal rainfall during June and July is 3.29 inches; in 1962 it was 2.46 inches. About 28 percent of the normal annual precipitation of 11.9 inches falls during the summer months.[5] Below-average temperatures in May delayed normal spring thaw. The warm rains that followed accelerated snowmelt, and were a major cause of the flood conditions.

An indication of the relative severity of the 1962 fire danger was obtained by comparing spread index frequencies[6] for 1962 with those for a five-year period (1956-60). The spread index for the period averaged 25 or higher for 25 percent of the days for which fire danger was recorded. In 1962, less than 10 percent of the days had an index of 25 or higher (fig. 6).

5/ Watson, C. E. Climates of the states - Alaska. U. S. Weather Bureau, Climatography of the U. S., No. 60-49, Sept. 1959.

6/ Pirsko, Arthur R. Selecting fire control planning levels by burning index frequencies. pp. 109-122, U. S. Forest Service Fire Control Notes, Vol. 2, No. 4, October 1961.

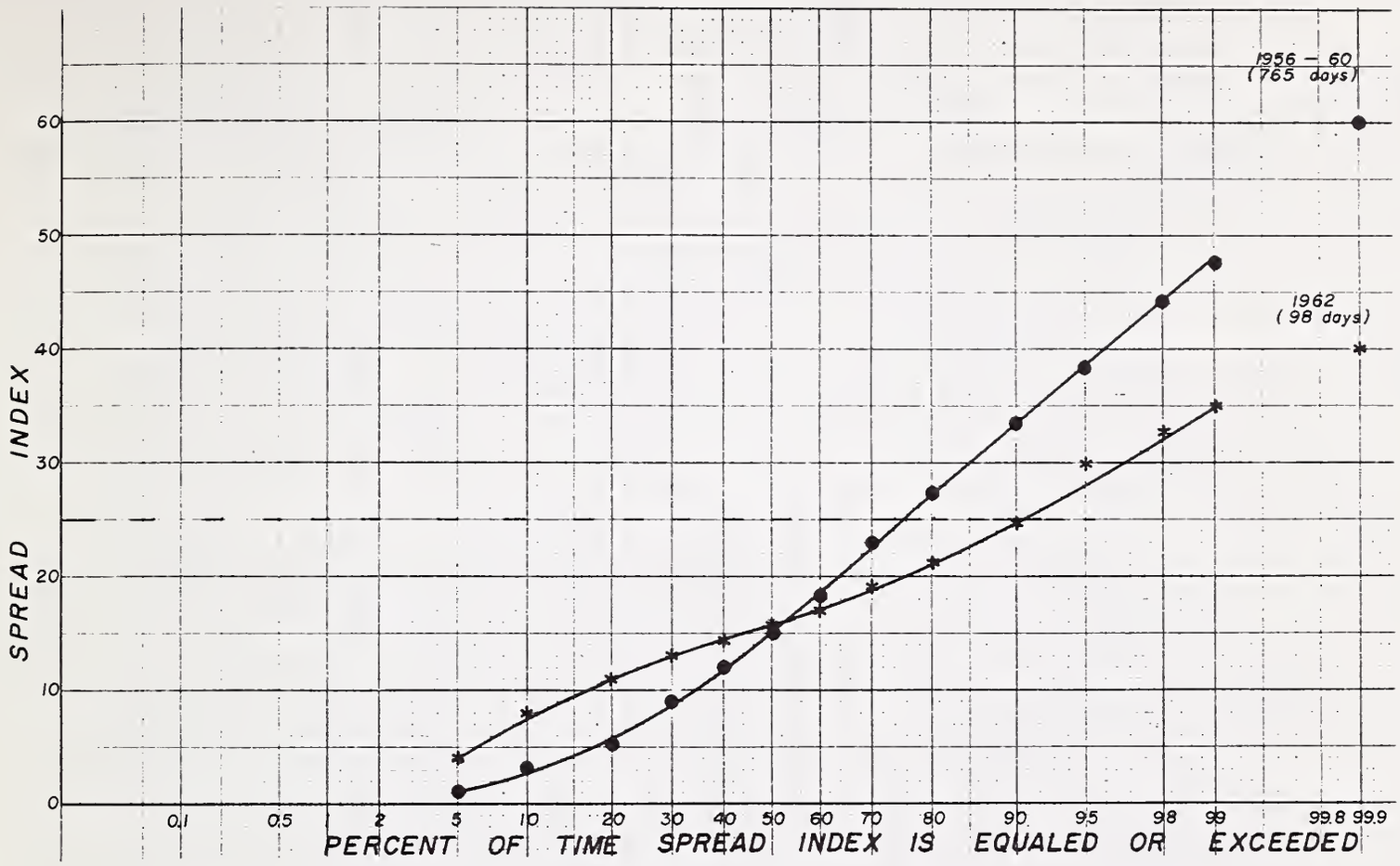

Figure 6.--Spread index frequency during 1956-60 and 1962 at Fairbanks, Alaska, as computed from spread phase tables, National Fire Danger Rating System. An index 0 infers the lowest, and 100 the highest possible rate of fire spread.

Seasonal severity may be measured also by wildfire activity in terms of annual number of fires and acreage burned. In 1962, a total of 92 fires burned about 39,000 acres of interior Alaska. In the 1940-61 period, the annual average was 184 fires and about one million acres burned.

The influence of weather on the Hughes fire can be seen by comparing diurnal fluctuations of fire danger rating indexes with daily spread of the fire (fig. 7). The most active period of fire spread corresponds closely with that period when the spread index was 25 or higher. On July 21, during 8 hours (11 a.m. to 7 p.m.) of active fire spread, an estimated 1,150 acres burned. Similarly, the active burning time on July 22 coincides with the period of high spread index. Duration and rate of spread was reduced on July 23 when light rain began at 4 p.m.

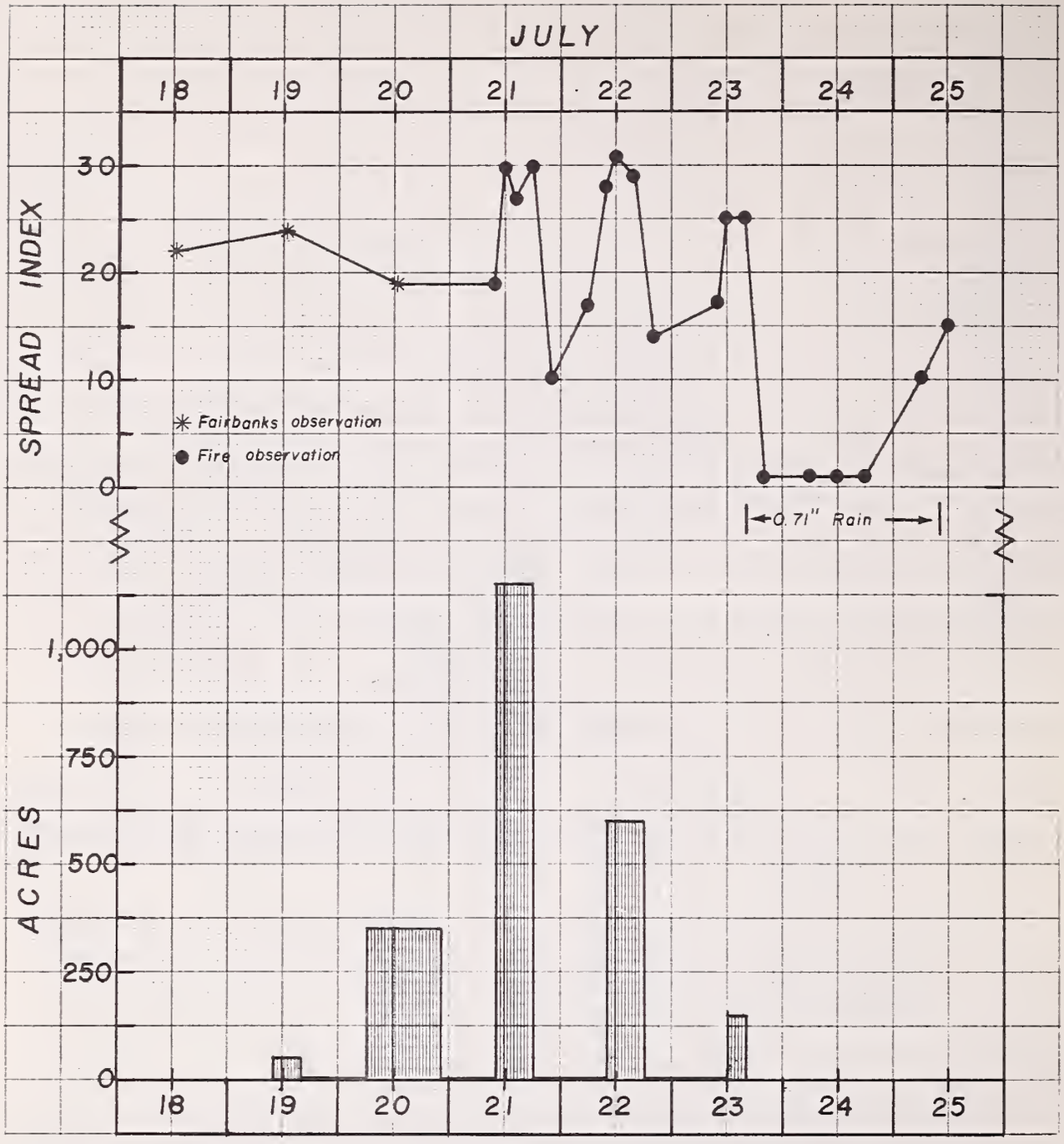

Figure 7.--Acres burned and daily duration of active burning associated with the spread index used in the National Fire Danger Rating System, Hughes fire, 1962.

Conclusions

Daily weather is a dominant factor influencing the flammability of interior Alaska's forests, particularly in areas where lichen-moss fine fuels are abundant. During relatively wet seasons, periods often occur when the relative humidity falls below 40 percent. Wildfires, burning in lichen-moss fuels, can be expected to rapidly increase in size during these periods. Conversely, these fine fuels become difficult to ignite soon after the relative humidity rises above 40 percent. The water content of lichen-moss fuels is apparently very sensitive to changes in atmospheric moisture.

GPO 987-319