1974
USDA Forest Service Research Paper PNW-178

WILDFIRE SMOKE CONDITIONS: INTERIOR ALASKA

RICHARD J. BARNEY
ERWIN R. BERGLUND

Pacific Northwest Forest and Range Experiment Station
U.S. Department of Agriculture Forest Service
Portland, Oregon

ABSTRACT

Records of 21 stations were analyzed for the occurrence, persistence, and related visibility resulting from summertime wildfire smoke and haze in interior Alaska. Maximum probability of smoke occurrence for any station and month was 8.7 percent in July for Bettles. Seasonal occurrence of smoke was greatest for Tanana--3.3 percent. Smoke persistence and visibility reduction were not found to the extent previously assumed.

KEYWORDS: Fire, wildfire, smoke, Alaska.

Richard J. Barney was Principal Fire Control Scientist, Pacific Northwest Forest and Range Experiment Station, Fairbanks, Alaska. He is now Principal Fire Management Scientist, Intermountain Forest and Range Experiment Station, Northern Forest Fire Laboratory, Missoula, Montana. Erwin R. Berglund was Assistant Professor, Department of Land Resources and Agricultural Sciences, University of Alaska, Fairbanks. He is presently Watershed Extension Specialist, School of Forestry, Oregon State University, Corvallis, Oregon.

CONTENTS

INTRODUCTION

Wildfires have been and are commonplace in Alaska. Aboriginal man, in addition to being careless with fire, started fires to control insects, herd animals, facilitate travel, and dry firewood (Lutz 1956, 1959). Near the latter part of the 1800's and into the 1900's white man made an impact on the Alaskan landscape by starting wildfires either to clear land for mining, grazing, and farming or to reduce undergrowth. After gold was discovered and railroad and road construction began, several million acres were burned seasonally (Hardy and Franks 1963). Nineteen major fires alone burned over 6.1 million acres between 1893 and 1937 (Lutz 1956).

Hundreds of wildfires occur each summer--some in excess of 100,000 acres each. In 1969, over 4,000,000 acres were burned (fig. 1). Some of the fires burn for long periods of time, often well into the winter months. Such fire activity under specific meteorological conditions results in a smoke pall covering hundreds of square miles and over 5.6 miles thick. From mid-June through mid-July, 1969, an estimated 145,000 cubic miles of smoke persisted in interior Alaska (Richardson 1971).

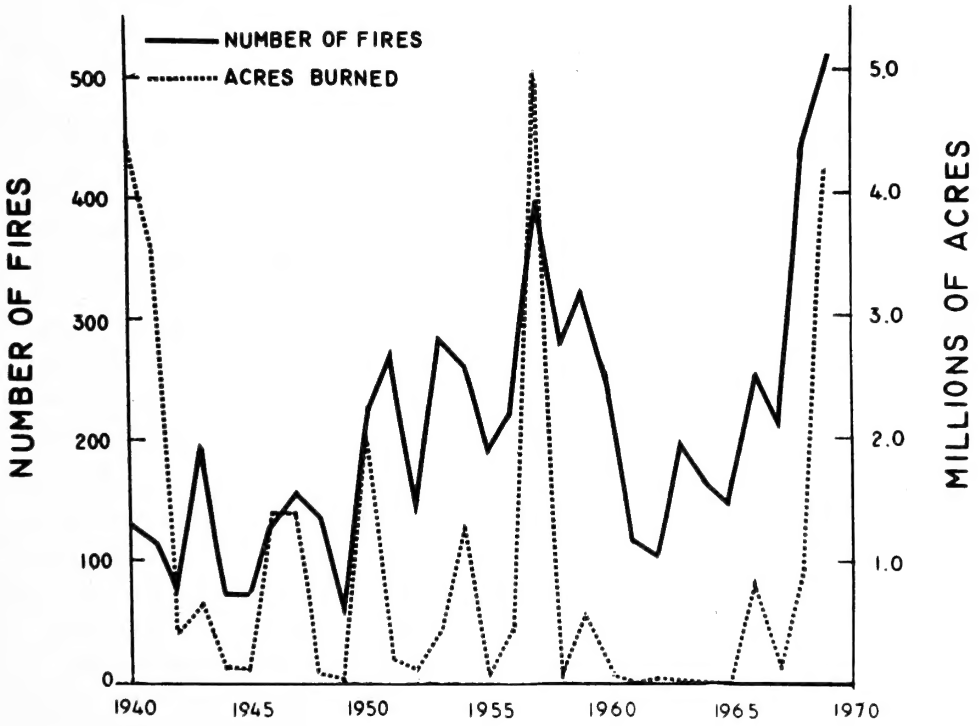

Figure 1.--Number of fires and acres burned by year, Interior Alaska, 1940-69 (Barney 1971).

Siberian forest fires are reported to produce drift smoke over Alaska. An analysis of upper air currents after Alaskan fires were extinguished in August 1970 revealed smoke originating from Siberia.[1/]

Smoke is an aerosol introduced to the atmosphere. The individual smoke particles, 0.001-0.3-μ diameter and averaging 0.25-μ, affect visibility by scattering, refracting, and reflecting light (Byram and Jemison 1948). Byram and Jemison found while viewing a distant landscape through thin smoke that color and brightness contrasts are reduced, most colors undergo a change in hue, color saturation is greatly decreased, and shadow contrast is reduced. Smoke is thus disruptive and potentially hazardous to air travel, as well as annoying (fig. 2) (Lutz 1956).

Military, commercial, and recreational air travel profit from clear, smoke-free skies (Hardy and Franks 1963). Smoke impact on military activities can have far-reaching effect when national defense is considered. The Bureau of Land Management has found that smoke drifting over high-value areas prevents aerial detection and attack (Richardson 1971). Smoke has inhibited fire control operations on numerous occasions, especially in close proximity to a fire. In 1969, a commercial air taxi operator in Fairbanks reported a flying business loss of \$30,000-\$50,000 due to the severe smoke conditions. In addition, recreational air travel was reduced when several "bush" airfields were closed due to smoke conditions (Barney 1971).

Tourism is a major economic concern in Alaska. Smoke could possibly affect tourism by reducing visibility. The actual impact is not known (Barney 1971), but insight into the potential impact is available. Miller (1971) reviewed tourism in Mount McKinley National Park. Of the Park visitors, 80 percent came because: (1) Mount McKinley is the highest mountain in North America (20,320 feet), (2) scenery is unparalleled elsewhere, (3) wildlife is abundant, and (4) an intrinsic value exists for visiting a National Park. Three of these four factors are associated with visibility. Miller hypothesized that during a severe fire season the expected impacts on visitors may be: (1) decreased visitation, (2) decreased length of stay, (3) restricted individual activities, (4) wildlife restlessness, (5) poor photography conditions, (6) more visitor complaints, (7) less camping, (8) fewer visitors on bus tours, and (9) less mountain climbing. Using 1969 data, Miller found only the length of stay to be significantly affected. A study by Hakala et al. (1971) reported that the 86,000-acre Swanson River fire on the Kenai National Moose Range in 1969 caused considerable recreational economic loss to the area. Over the period of closure for the Russian River (June 14-July 3) and Swanson River (August 3-September 1) recreational areas, a \$1,092,000 visitor use loss was realized. The total recreational loss, including the visitor use loss and the recreational value loss (prorated over 20 years), was estimated to be \$33,385,960.

[1/] Personal communication with James H. Richardson, Chief, Division of Fire Control, Bureau of Land Management, Washington, D. C.

A

B

Figure 2.--A southerly view from the University of Alaska, Fairbanks, overlooking the Tanana River Valley. (A) *Clear day;* (B) *1969 smoke conditions.*

Research on the health hazard of smoke from wildfires or slash fires has recently commenced. A laboratory analysis revealed that 12 pounds of hydrocarbons were released per ton of slash burned (Cramer and Westwood 1970). Data of Fritschen et al. (1970) indicate that smoke is a small component of slash combustion, and that carbon monoxide, carbon dioxide, and hydrocarbon gases constitute the major component (table 1).

Continuing laboratory analyses have not produced sulfur dioxide and photochemical smog from wood smoke. Consequently, the health hazard of wildfire or slash fire smoke occurs when the smoke particulates are in association with existing sulfur dioxide in the atmosphere. The most objectionable smoke would be that which adds to present pollution of urban and industrial areas (Cramer and Westwood 1970).

A paradox has developed over vegetation management in interior Alaska. Fire perpetuates the mosaic vegetative cover (Lutz 1956) but wood smoke is undesirable.

A paper on Alaskan forest fires by Hardy and Franks (1963) contained a table reporting the general visibility distances by hour of day and by number of days per month per distance class for several interior Alaska stations. Problems associated with reduced visibility were not indicated.

Table 1.--*Summarized laboratory analyses of combustion products from Douglas-fir* (Pseudotsuga menziesii *(Mirb.) Franco*), *western hemlock* (Tsuga heterophylla *(Raf.) Sarg.*), *and western redcedar* (Thuja plicata *Donn*) *slash*

Species	Sample			Combustion products[1/]					
	Number	Mass		Smoke particulate per unit of slash		CO, CO_2 and hydrocarbon gases per unit of slash		Residue per unit of slash	
		(kg)	*(lb)*	*g/kg*	*lb/ton*	*g/kg*	*lb/ton*	*g/kg*	*lb/ton*
Douglas-fir	1	8.2	18.04	2.3	4.6	1,176.6	2,358.1	1.5	3.0
Western hemlock	1	11.4	25.08	2.0	4.0	1,061.2	2,126.8	1.9	3.8
	2	12.1	26.62	2.0	4.0	1,260.2	2,525.7	1.6	3.2
Western redcedar	1	11.0	24.2	1.7	3.4	1,612.2	3,231.1	1.0	2.0
	2	11.0	24.2	2.2	4.4	1,456.2	2,918.5	2.9	5.8

Source: Fritschen et al. (1970).

[1/] CO, CO_2, and hydrocarbon gases.

OBJECTIVES

This study was developed to quantify the occurrence, persistence, and visibility reduction resulting from summertime smoke and haze in interior Alaska. The findings provide resource managers a better basis for assessing the environmental impact of smoke.

METHODS

Data were the hourly surface observations for individual stations available from the U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service Center, Asheville, North Carolina (table 2, fig. 3). Data were for a 183-day fire season from April 1 through September 30.

Table 2.--*List of stations and period of record used in analysis*

Station	Station identification number	Operating agency 1/	General period of record	Total years spanned
Anchorage	26451	WSO	11/53 - 12/69	17
Bethel	26615	WSO	7/48 - 12/64	17
Bettles	26533	FAA	1/45 - 12/71	27
Big Delta	26415	FAA	7/48 - 12/71	24
Fairbanks	26411	WSO	7/48 - 12/71	24
Farewell	26519	FAA	7/48 - 12/60	13
Fort Yukon 2/	26413	FAA	7/48 - 9/63	16
Galena	26501	FAA-AFB	6/53 - 12/70	18
Gulkana	26425	FAA	7/48 - 3/67	20
Homer	25507	FAA	7/48 - 12/71	24
Iliamna	25506	FAA	7/48-12/54, 1/57-12/62	13
Indian Mountain	26535	AFS	7/51 - 12/70	20
Kenai	26523	FAA	7/48 - 7/67	20
Lake Minchumina	26512	FAA	7/48 - 4/69	22
McGrath	26510	WSO	7/48 - 3/67	20
Nenana	26435	FAA	8/48 - 12/71	24
Northway 3/	26412	WSO/FAA	7/48 - 12/68	21
Summit	26414	FAA	7/48 - 12/71	24
Talkeetna	26528	FAA	7/48 - 12/65	18
Tanana	26529	WSO/FAA	7/48 - 12/62	15
Unalakleet	26627	FAA	7/48 - 12/61	14

NOTE: Several of the above stations operated on a limited schedule for at least part of the period shown.

1/ WSO = Weather Service Office
FAA = Federal Aviation Administration
AFB = Air Force Base
AFS = Air Force Station.

2/ Very poor records.

3/ Very poor records through 1957.

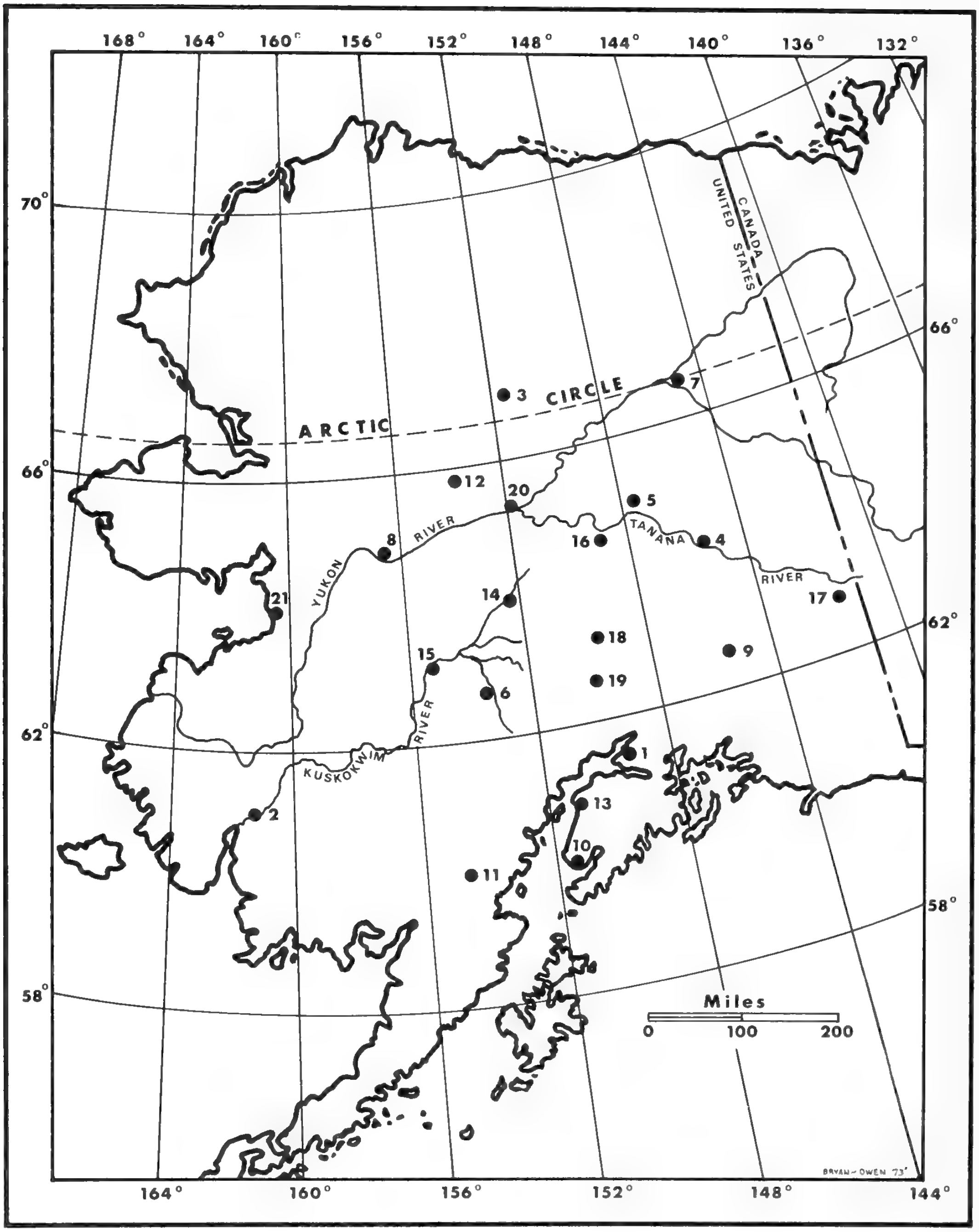

Figure 3.--Location of stations used in analysis:

1 Anchorage	7 Fort Yukon	12 Indian Mountain	17 Northway
2 Bethel	8 Galena	13 Kenai	18 Summit
3 Bettles	9 Gulkana	14 Lake Minchumina	19 Talkeetna
4 Big Delta	10 Homer	15 McGrath	20 Tanana
5 Fairbanks	11 Iliamna	16 Nenana	21 Unalakleet
6 Farewell			

This seasonal period was selected because it normally represents over 95 percent of Alaska's wildfire activity (Barney 1967). From these data, the trihourly observations in which either smoke, haze, or smoke and haze was recorded were utilized. The eight trihourly observations began at 0200 Alaska Standard Time each day.

DISCUSSION

SMOKE OCCURRENCE

Table 3 shows the percent probability of smoke, haze, or smoke and haze occurring by month and season at the 21 stations. Each percent probability of occurrence was calculated as:

$$\text{percent probability} = \frac{\text{number of smoke days}}{\text{potential number of days}} \times 100$$

A smoke-day was any day in which smoke, haze, or smoke and haze was reported at any one of the trihourly observations for the given station. The potential number

Table 3.--*Average daily probability (percent) of smoke, haze, or smoke and haze by month and season*

Station	April	May	June	July	August	September	Season
	Percent						
Anchorage	0	0	1.0	0	0.9	0	0.3
Bethel	0	0	1.4	1.5	.7	.2	.7
Bettles	.1	0	2.2	8.7	3.1	0	2.5
Big Delta	0	0	2.4	4.2	3.0	.1	1.7
Fairbanks	0	.1	3.3	6.3	4.6	1.3	2.8
Farewell	0	0	2.0	5.0	.5	0	1.4
Fort Yukon	0	0	2.7	7.7	5.4	.2	2.9
Galena	0	.2	3.3	5.7	1.2	1.7	2.2
Gulkana	0	0	0	1.2	0	0	.2
Homer	0	0	.2	.7	.3	0	.2
Iliamna	0	0	.8	2.0	.7	.2	1.4
Indian Mountain	0	0	2.7	5.8	2.8	.2	1.3
Kenai	0	0	.7	.5	1.7	0	.5
Lake Minchumina	0	0	1.1	3.7	2.0	0	1.2
McGrath	0	0	2.0	3.5	.8	0	1.1
Nenana	0	0	3.3	6.0	3.2	1.1	2.4
Northway	0	0	1.1	2.2	1.1	.2	.8
Summit	.1	0	1.0	1.2	.9	0	.6
Talkeetna	0	0	.9	.7	.7	0	.4
Tanana	0	0	4.4	8.4	5.6	0	3.3
Unalakleet	0	0	1.4	3.2	.7	1.4	1.2

of days was the days per given month or season summed over the number of years of record. This analysis was based on the entire period of record available for each station.

The data indicate that smoke does not present a problem in interior Alaska during April and May. The majority of the smoke occurred in June and July. Smoke occurrence probability was greatest during the month of July for almost all stations. This can be attributed to the fact that most large wildfires usually begin in June but often burn into July. Due to the concentration of smoke from several wildfires, smoke eventually becomes dense enough to be reported with some frequency. Smoke occurrence decreases through August and September.

The data reveal that smoke is not generally a major problem in interior Alaska. The greatest seasonal occurrence was reported at Tanana with 3.3 percent chance of smoke. Bettles reported the greatest probability of smoke in any month with 8.7 percent in July, while Anchorage reported no smoke in July and Gulkana reported no smoke in June and August.

AVERAGE NUMBER OF SMOKE DAYS

Table 4 depicts the average number of days per month on which smoke, haze, or smoke and haze was reported at each station. Data for this table include arithmetic

Table 4.--*Average, range, and total number of days per month that smoke, haze, or smoke and haze was reported during the April-September fire season*[1/]

Station	April		May		June		July		August		September		Number of years of data	Total number of smoke-days
	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range		
	Days per month													
Anchorage	0	--	0	--	0.29	0-5	0	--	0.29	0-5	0	--	17	10
Bethel	0	--	0	--	.41	0-4	.47	0-5	.23	0-2	.06	0-1	17	20
Bettles	.04	0-4	0	--	.67	0-6	2.70	0-18	.96	0-7	0	--	27	118
Big Delta	0	--	0	--	.71	0-11	1.29	0-10	.92	0-10	.04	0-1	24	71
Fairbanks	0	--	.04	0-1	1.00	0-10	1.96	0-14	1.46	0-16	.38	0-7	24	116
Farewell	0	--	0	--	.62	0-5	1.54	0-15	.15	0-1	0	--	13	30
Fort Yukon	0	--	0	--	.81	0-8	2.38	0-18	1.69	0-14	.06	0-1	16	79
Galena	0	--	.06	0-1	1.00	0-12	1.78	0-18	.39	0-3	.50	0-9	18	67
Gulkana	0	--	0	--	0	--	.35	0-3	0	--	0	--	20	7
Homer	0	--	0	--	.08	0-2	.21	0-3	.08	0-2	0	--	24	9
Iliamna	0	--	0	--	.23	0-3	.62	0-8	.23	0-2	.08	0-1	13	15
Indian Mountain	0	--	0	--	.80	0-8	1.75	0-17	.85	0-12	.05	0-1	20	69
Kenai	0	--	0	--	.20	0-3	.15	0-3	.50	0-9	0	--	20	17
Lake Minchumina	0	--	0	--	.32	0-4	1.14	0-15	.64	0-10	0	--	22	46
McGrath	0	--	0	--	.60	0-6	1.05	0-16	.25	0-3	0	--	20	38
Nenana	0	--	0	--	1.00	0-10	1.86	0-12	1.00	0-7	.33	0-6	24	101
Northway	0	--	0	--	.33	0-4	.67	0-5	.33	0-2	.05	0-1	21	29
Summit	.04	0-4	0	--	.29	0-6	.38	0-5	.29	0-4	0	--	24	24
Talkeetna	0	--	0	--	.23	0-5	.22	0-4	.22	0-2	0	--	18	13
Tanana	0	--	0	--	1.33	0-11	2.60	0-12	1.73	0-14	0	--	15	85
Unalakleet	0	--	0	--	.43	0-3	1.00	0-9	.21	0-3	.43	0-6	14	29

[1/] If smoke, haze, or smoke and haze is reported for any time in a 24-hour day, the day is considered in the summary.

averages each based on the sum of smoke-day observations of a given month for the years of record divided by the number of years of record.

The range of smoke-days is also shown. No station reported smoke in every month for each year or in a given month for the entire period. Therefore, all ranges from zero to the highest number of smoke-days were reported. The ranges indicate considerable variability when smoke is reported in interior Alaska.

Isolines of the average smoke-days indicate a definite geographic distribution within interior Alaska (figs. 4, 5, and 6). July exhibits the greatest average number of days, with smoke with the maximum intensity in the area of Bettles, Stevens Village, and Tanana. Furthermore, the area of maximum occurrence shifts to the northeast from this area to the Yukon Flats in August. In August, the isolines begin to dissipate. These isoline maps correspond to the reported patterns of fire (Barney 1969).

VISIBILITY REDUCTION PER TIME-OF-DAY

The diurnal distribution of trihour periods when smoke, haze, or smoke and haze was reported is shown in table 5. The values computed are the percent of total trihourly reports that occurred in each trihourly time period.

Smoke intensity and timing are critical in evaluating the smoke situation. The majority of smoke occurrences (table 5) appeared to fall in late evening to early

Table 5.--*Percent of total trihourly reports that occurred in each trihourly period when visibility was reduced by smoke, haze, or smoke and haze*

Station	Time of day								Total
	0200	0500	0800	1100	1400	1700	2000	2300	
	Percent								
Anchorage	20	20	8	16	8	8	8	12	100
Bethel	23	15	15	10	11	13	13	0	100
Bettles	12	14	13	10	12	13	12	14	100
Big Delta	12	11	13	13	13	11	14	13	100
Fairbanks	10	13	16	14	13	11	12	11	100
Farewell	15	10	15	14	14	11	9	12	100
Fort Yukon	18	0	23	19	18	7	15	0	100
Galena	12	12	13	15	12	12	12	12	100
Gulkana	14	4	9	9	14	14	18	18	100
Homer	15	19	15	8	12	8	8	15	100
Iliamna	14	11	18	9	14	9	11	14	100
Indian Mountain	12	12	14	14	12	11	12	13	100
Kenai	7	18	15	7	17	7	18	11	100
Lake Minchumina	11	13	19	14	13	10	10	10	100
McGrath	17	12	14	13	11	8	11	14	100
Nenana	9	16	16	13	13	14	11	8	100
Northway	14	15	15	10	10	12	12	12	100
Summit	11	10	14	12	11	12	14	16	100
Talkeetna	12	14	14	12	12	12	12	12	100
Tanana	12	14	15	14	12	10	12	11	100
Unalakleet	18	19	14	15	10	12	12	0	100

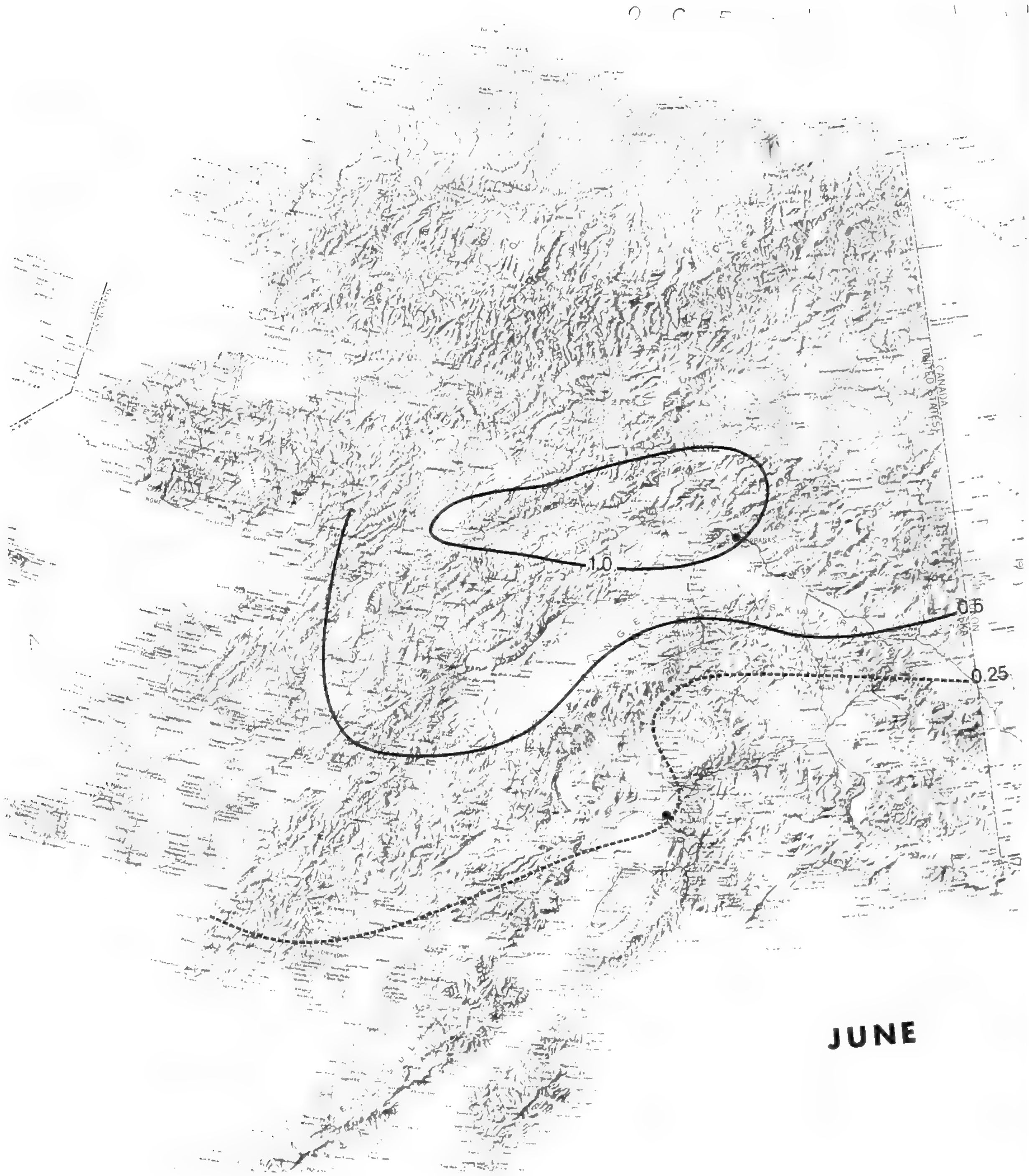

Figure 4.--Average smoke days isoline map - June.

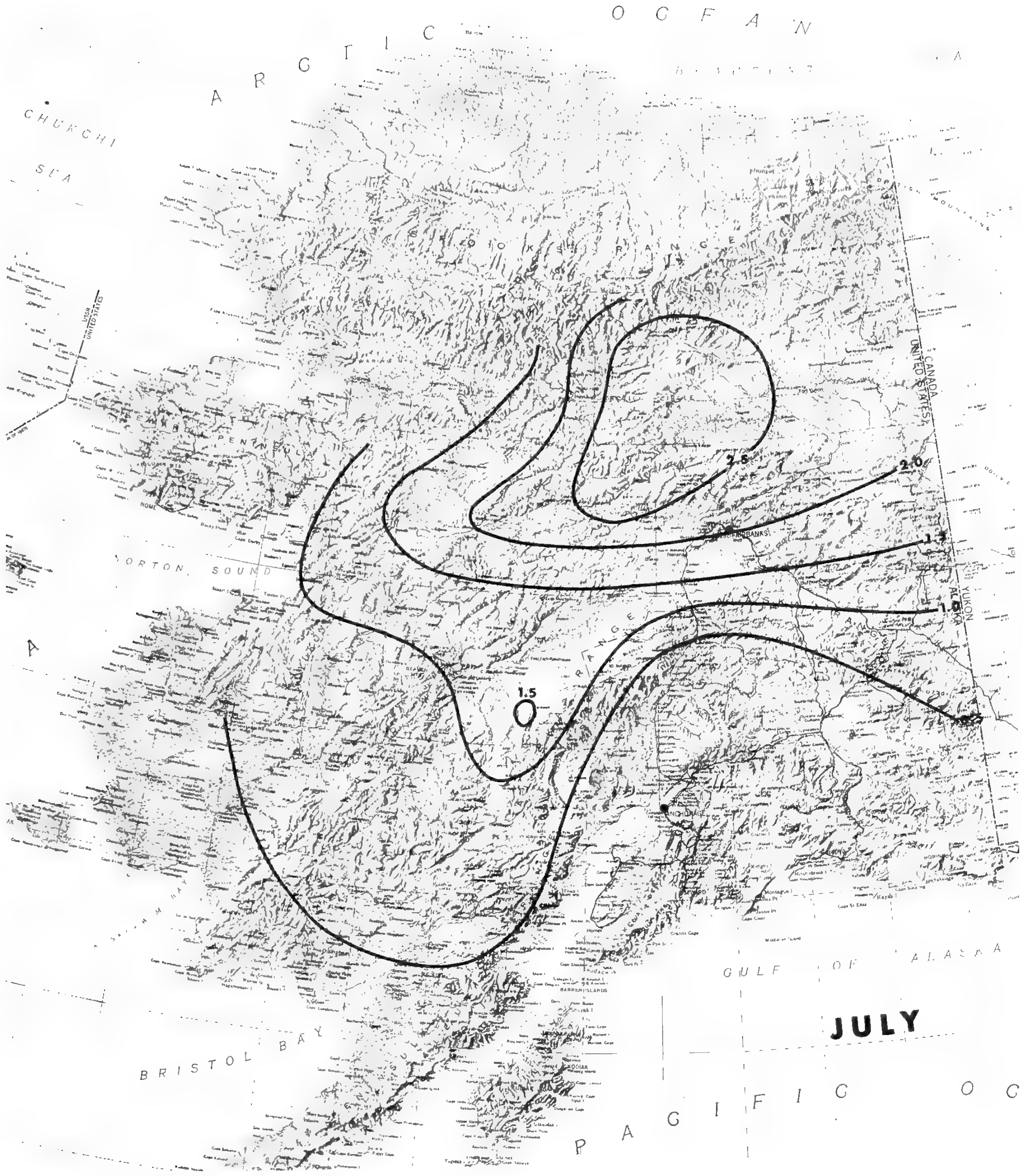

Figure 5.--Average smoke days isoline map - July.

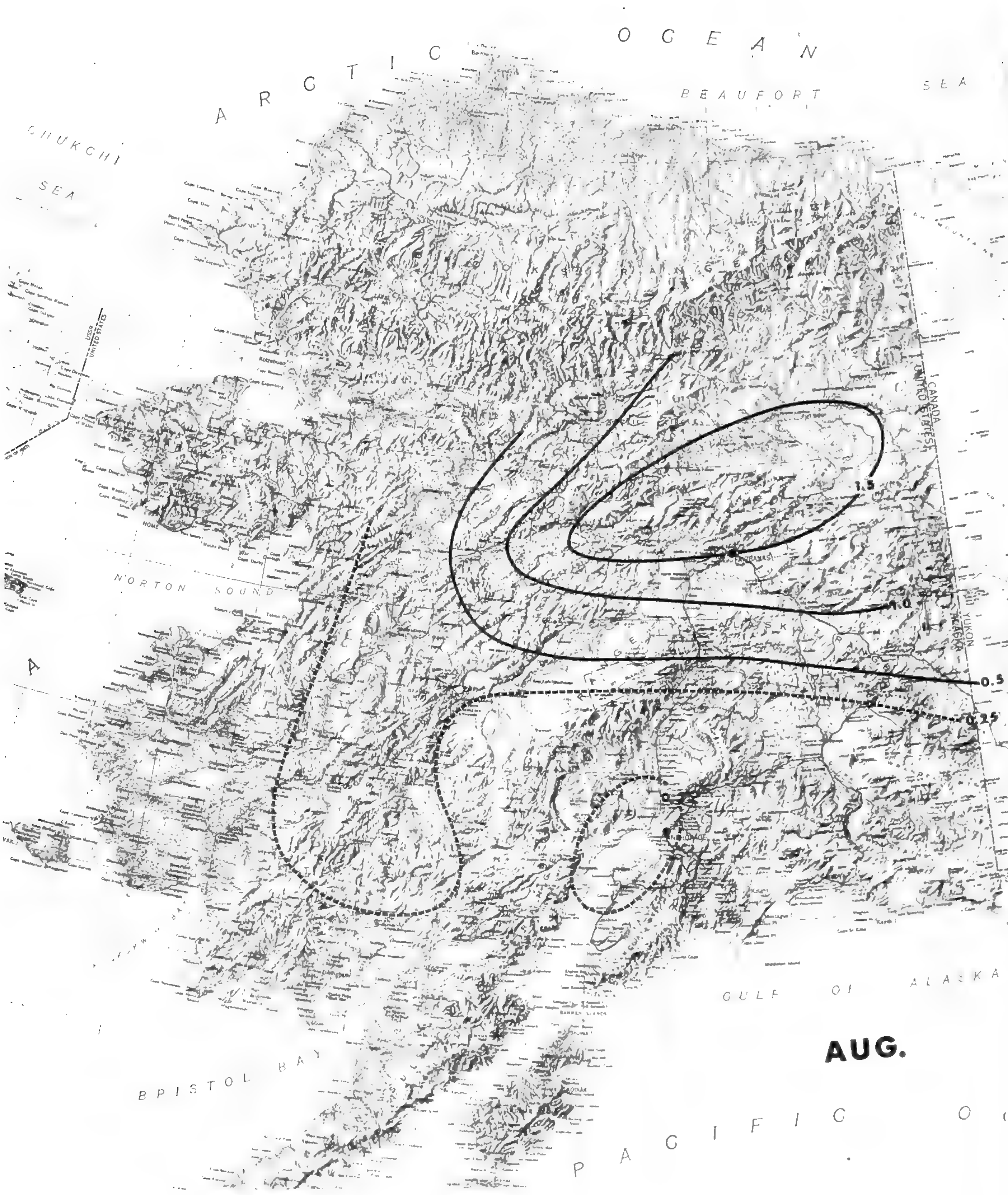

Figure 6.--Average smoke days isoline map - August.

morning. This corresponds to the time when, even in Alaska during the long daylight periods, general inversions exist. During inversion periods, smoke tends to become concentrated near the earth's surface. For a few stations, the majority of smoke observations occurred during midday. This may be due to fires close to the observing station.

VISIBILITY IMPACT

Quantitative visibility reduction when smoke, haze, or smoke and haze was reported is presented in table 6. Visibility classes are those defined by the Weather Service Reporting and Observing Procedures. The number of reports per visibility distance class was divided by the total number of reports for each station. Resulting values provide a percent of smoke observations that occurred in the various visibility classes.

Air transportation is important in Alaska. Most cities, towns, and villages have flight facilities. Due to different size airports and a variety of topographic conditions, landing requirements for ceiling and visibility are quite variable. Visual Flight Rules (VFR) weather minimums for airports with a control zone airspace are a 1,000-foot ceiling and 3-mile visibility. Outside of the control zone airspace, the VFR weather minimums for aircraft operations are "clear of clouds" and "1-mile visibility." Several airports are within controlled airspace for specified time periods and less restricted (standard VFR) for the remaining time.

Table 6.--*Percent of smoke observations per horizontal visibility distance from observation point when smoke, haze, or smoke and haze is reported*

Station	Distance class (miles)						Total
	0-1/8	3/16-3/8	1/2-3/4	1-2½	3-6	7+	
	Percent						
Anchorage	0	0	0	8	92	0	100
Bethel	2	0	2	34	62	0	100
Bettles	3	5	8	23	61	0	100
Big Delta	<1	<1	2	32	65	0	100
Fairbanks	<1	2	12	24	62	0	100
Farewell	0	2	13	34	51	0	100
Fort Yukon	2	9	11	19	60	0	100
Galena	<1	11	8	38	42	0	100
Gulkana	0	0	0	9	91	0	100
Homer	0	4	0	19	77	0	100
Iliamna	9	C	2	21	68	0	100
Indian Mountain	2	3	12	17	66	0	100
Kenai	0	4	7	24	65	0	100
Lake Minchumina	0	1	9	20	70	0	100
McGrath	0	3	12	37	48	0	100
Nenana	0	2	7	19	72	0	100
Northway	0	0	3	33	64	0	100
Summit	0	3	1	35	61	0	100
Talkeetna	0	0	3	27	70	0	100
Tanana	0	<1	10	24	65	0	100
Unalakleet	2	1	14	21	62	0	100

Airports with authorized instrument approach procedures also have specific weather minimums.[2]

Smoke is detrimental and potentially hazardous to recreational, commercial, and military air travel. The percent of time per distance class that visibility was reduced because of either smoke, haze, or smoke and haze is summarized in table 6. The majority of all reports occur in the 3- to 6-mile visibility class. No reports were made in the class, 7 miles or more. Visibility reductions of 0 to 3/8 mile were infrequent (generally 3 to 4 percent of the time except for Fort Yukon and Galena), while visibility reductions to up to 1 mile occurred approximately 10 percent of the time.

The data in table 6 do indicate that when smoke does occur it influences visibility and hinders safe air travel. Approximately 65 percent of the smoke reports for each station were in the visibility distance class of 3-6 miles. With the VFR visibility minimum for control zone airspace being 3 miles or less (depending upon location) it seems reasonable to assume that smoke infringed on this minimum approximately 35 percent of the time when it occurred. For authorized instrument approaches, visibility reduction occurred less than 10 percent of the time for most of the stations.

SMOKE PERSISTENCE

Smoke persistence was analyzed by tabulating the data into consecutive-hour classes. Only the days and periods of smoke occurrence were used in the calculations. Table 7 indicates smoke persistence as a percentage of smoke reports per various consecutive-hour classes.

The persistence of a smoke pall has a significant impact on summertime activities (Miller 1971). However, data indicate no smoke reports for consecutive trihourly periods in excess of 48 hours (table 7).

However, it is known that smoke may engulf sizable areas for time periods in excess of 48 hours. McVee[3] indicated a curtailment in fire operations due to smoke persistence for several continuous days. The smoke often passes sporadically like clouds, and prolonged periods of excessive smoke may not appear on a continuous basis.

Trihourly observations may be too infrequent. However, available data do indicate that when smoke is observable, it commonly persists for periods up to 24 hours at the reporting stations.

SMOKE POTENTIAL

The percent probability that a smoke-day will be followed by a smoke-day is presented in table 8. Data were initially tabulated as consecutive days when smoke

[2] Personal communication with Thomas J. Creswell, Director, Alaska Region, Federal Aviation Administration, Anchorage.

[3] Personal communication with Curtis V. McVee, State Director, Bureau of Land Management, Anchorage.

Table 7.--*Percent of reported smoke, haze, or smoke and haze observations by persistence class*

Station	Consecutive hours							Total
	0-3	3-6	6-9	9-12	12-24	24-48	48-72	
	Percent							
Anchorage	73	18	0	0	0	9	0	100
Bethel	55	29	13	0	3	0	0	100
Bettles	54	24	9	6	4	3	0	100
Big Delta	54	16	10	7	10	3	0	100
Fairbanks	57	20	8	5	9	1	0	100
Farewell	46	28	11	6	7	2	0	100
Fort Yukon	78	11	7	<1	3	0	0	100
Galena	49	28	10	6	6	<1	0	100
Gulkana	56	11	22	0	0	11	0	100
Homer	38	31	23	8	0	0	0	100
Iliamna	37	32	16	5	10	0	0	100
Indian Mountain	47	31	14	2	3	3	0	100
Kenai	63	27	0	7	0	3	0	100
Lake Minchumina	54	14	12	7	10	3	0	100
McGrath	51	22	11	3	10	3	0	100
Nenana	49	23	12	7	7	2	0	100
Northway	46	24	14	5	11	0	0	100
Summit	53	20	9	15	3	0	0	100
Talkeetna	45	5	17	11	5	17	0	100
Tanana	52	22	9	6	11	<1	0	100
Unalakleet	55	15	2	13	13	2	0	100

Table 8.--*Probability (percent) that tomorrow will have smoke following given consecutive days of reported smoke*[1/]

Station	Consecutive days[2/]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Percent													
Anchorage	21	100	100	100	0	0	0	0	0	0	0	0	0	0
Bethel	45	60	33	0	0	0	0	0	0	0	0	0	0	0
Bettles	63	55	73	82	44	75	100	33	100	100	0	0	0	0
Big Delta	71	59	60	50	67	50	100	100	100	100	100	100	100	0
Fairbanks	56	54	67	40	50	100	50	100	100	100	100	0	0	0
Farewell	25	75	100	67	50	100	0	0	0	0	0	0	0	0
Fort Yukon	72	38	63	80	100	75	33	100	100	100	100	0	0	0
Galena	57	46	67	75	100	100	100	100	100	50	100	100	100	0
Gulkana	67	100	0	0	0	0	0	0	0	0	0	0	0	0
Homer	100	25	0	0	0	0	0	0	0	0	0	0	0	0
Iliamna	50	50	50	0	0	0	0	0	0	0	0	0	0	0
Indian Mountain	57	56	78	57	75	33	100	0	0	0	0	0	0	0
Kenai	40	75	0	0	0	0	0	0	0	0	0	0	0	0
Lake Minchumina	59	70	71	80	50	0	0	0	0	0	0	0	0	0
McGrath	69	36	50	100	100	100	50	100	100	100	100	100	0	0
Nenana	78	54	40	50	67	50	0	0	0	0	0	0	0	0
Northway	47	25	100	0	0	0	0	0	0	0	0	0	0	0
Summit	46	33	100	50	0	0	0	0	0	0	0	0	0	0
Talkeetna	100	50	100	50	0	0	0	0	0	0	0	0	0	0
Tanana	57	50	70	71	60	67	100	50	0	0	0	0	0	0
Unalakleet	69	67	17	0	0	0	0	0	0	0	0	0	0	0

1/ Smoke must first be reported at the specific station before the table can be used.

2/ If smoke, smoke and haze, or haze is reported during any of the trihourly observations within a calendar day, it is considered a smoke-day.

was reported. A cumulative frequency by consecutive days per station was developed. Finally, the probability of smoke occurring in day (N+1) given that smoke had occurred the previous day (N) was calculated.

$$P_{N+1} = \frac{(\text{Day } N + 1) \text{ cumulative frequency}}{(\text{Day } N) \text{ cumulative frequency}}$$

That is, P_{N+1} is the probability (percent) that tomorrow (Day N+1) will have smoke if today was the Nth consecutive day with smoke.

In an attempt to provide fire managers and resource planners with more useful information, a table was developed showing the percent probability that the succeeding day will have smoke following periods of consecutive smoke-days (not consecutive trihourly periods) (table 8). The use of this table requires the determination as to how many consecutive days smoke has been reported. For example, if smoke was reported at some time period today at Bettles (and none yesterday), there would be a 63-percent chance that smoke would be reported at some time tomorrow; if today were the 5th consecutive day of smoke there would be a 44-percent chance of smoke tomorrow at Bettles. This table can be important for planning fire control operations as well as investigating the potential smoke persistence for a region. This table also indicates the maximum number of consecutive smoke-days reported at each station.

Table 8 is based upon limited data. Although the table should be used with caution, it does provide a useful guide for planning not previously available.

SUMMARY

Wildfires are common in interior Alaska. Many individual fires burn 100,000 acres or more and produce sizable smoke palls. Studies indicate that smoke interferes with air travel and recreation and may be hazardous to health.

An analysis of smoke occurrence revealed that the greatest probability of smoke was in June and July. This corresponded with the months of major fire activity. The maximum monthly probability for any station and any month was 8.7 percent in July for Bettles. Bettles also had the longest period of data records--27 years. On a seasonal basis, the greatest probability of smoke occurring for any station was 3.3 percent for Tanana.

Despite a wide range of values for each station's average number of smoke-days per month, isolines indicated a buildup of smoke intensity in June with a maximum in July and a dissipation in August. All 3 months exhibited definite regional locations.

Visibility reduction according to time of day indicated greater smoke accumulation during late evening and early morning. This corresponds to periods when weak inversions may develop.

Impact on air travel was found to be greatest in the 3-6-mile visibility class. No records indicated smoke in the 7 miles or more class, and reports were infrequent in the less-than-3/8-mile class. When smoke did occur, the data indicated that smoke may impair air travel.

Data revealed no smoke persistence for periods over 48 consecutive hours. However, Miller (1971) and personal experiences contradict these data.

A table provides land managers and other interested persons a relative smoke potential for a succeeding day given a known number of preceding smoke-days.

CONCLUSIONS

Apparently smoke does not occur to the extent previously assumed in interior Alaska. Sixteen to 21 years of record for each of 21 stations in Alaska indicate that the probability of occurrence of smoke, haze, or smoke and haze did not exceed 3.3 percent on a seasonal basis and 8.7 percent on a monthly basis. Visibility was reduced to 0-1/8 mile at nine stations, and no station ever recorded visibility reduction from smoke or haze in excess of 7 miles.

Data did not indicate smoke, haze, or smoke and haze persisting continuously at any one station for periods greater than 48 hours. All stations indicate that once smoke is reported, there is a chance of subsequent daily reports of smoke for up to at least 3 days and for as many as 15 consecutive days. At half the stations, smoke was reported for as many as 6 consecutive days. For 7 of the 21 stations, this condition may persist for up to 10 consecutive days.

The occurrence, extent, and duration of smoke, haze, or smoke and haze show the problem to be minimal. However, during extreme fire situations, smoke has a detrimental impact. Severe, infrequent smoke conditions of short duration may critically limit firefighting activity.

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KEYWORDS: Fire, wildfire, smoke, Alaska.

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