Kenai Lake Fire RERAP & FireFamily+ Assessment
July 25, 2001

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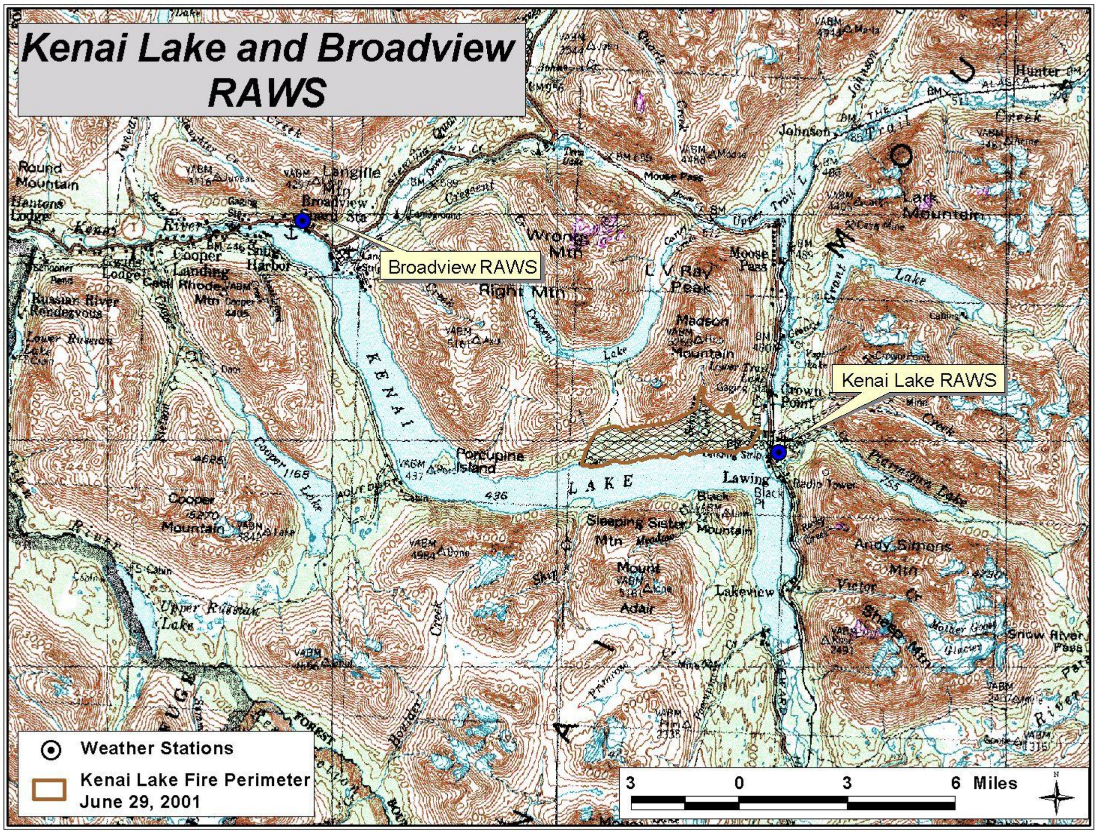
Introduction

The Kenai Lake Fire burned north of Kenai Lake on the Seward Ranger District of the Chugach National Forest from June 25 through July 8, 2001. The fire's size was approximately 3260 acres. This assessment uses the FireFamily+ and RERAP (Rare Event Risk Assessment Process) programs to examine the state of fire danger experienced in late June/early July 2001 in the context of 30 years of historical fire weather and provides probability estimates of the fire reaching various communities in its vicinity in the absence of the fire-ending precipitation event experienced July 4, 2001.

Weather Stations

Two weather stations are located in the vicinity of the Kenai Lake Fire. The Kenai Lake RAWS (Station ID 500908) lies approximately ¾ of a mile southeast of the head of the fire (60° 24' 36" N, 149° 21' 46''W). The Broadview RAWS (Station ID 500902) is located approximately 10 miles northwest of the fire (60° 29' 40''N, 149° 45' 18''W). Both weather stations are located at elevations analogous to those of the fire. Map 1 shows the location of the two weather stations in relation to the Kenai Lake Fire and surrounding topography.

Map 1



Weather data exists from the mid-1960's to 2001 for both the Kenai Lake and Broadview weather stations. Weather data was obtained from KCFAST (Kansas City Fire Access Software) through the http://famweb.nwcg.gov link. Raw data files in the 1972 format (.fwx) contained weather information from the mid-1960's to 2001 for both stations. Data files in the 1998 format (.fw9) only contained weather information from 1993 – 2001. Table 1 summarizes the year-by-year observation records of the two stations.

Table 1: Weather records per year for Broadview and Kenai Lake weather stations

Year	*500902 - Broadview*	*500908 - Kenai Lake*
1965		74
1966		189
1967	99	172
1968	133	198
1969	84	90
1970	71	172
1971	166	183
1972	157	157
1973	121	123
1974	108	106
1975	114	114
1976	118	123
1977	111	113
1978	97	84
1979	128	130
1980	134	136
1981	160	173
1982	104	134
1983	94	125
1984	98	112
1985	89	1
1986	111	130
1987	199	212
1988	183	184
1989	212	204
1990	77	58
1991	144	144
1992	122	18
1993	159	10
1996	128	75
1997	150	129
1998	147	147
1999	124	126
2000	145	147
2001	88	90
Sum	***4175***	***4383***

Weather observations from 1994 and 1995 were missing from the records of both weather stations. Presumably the stations were inoperable during that time or any data that was collected was not transferred to KCFAST and WIMS. Throughout the 1990's the Broadview station appears to be more complete than the Kenai Lake station. The Kenai Lake station contains only a few observations during the years 1992-1993.

Fire Family+

Fire Family+ is a program that analyzes historical weather patterns using daily weather observations from manual and automated weather stations. Charts 1, 2, 3 and 4 display respectively the maximum, minimum, average, and 2001 values for the Canadian Fire Danger Rating System Buildup Index (BUI) and Fire Weather Index (FWI) for the Kenai Lake and Broadview RAWS.

Chart 1: Kenai Lake RAWS FWI (1965 – 2001) with 2001 overlay

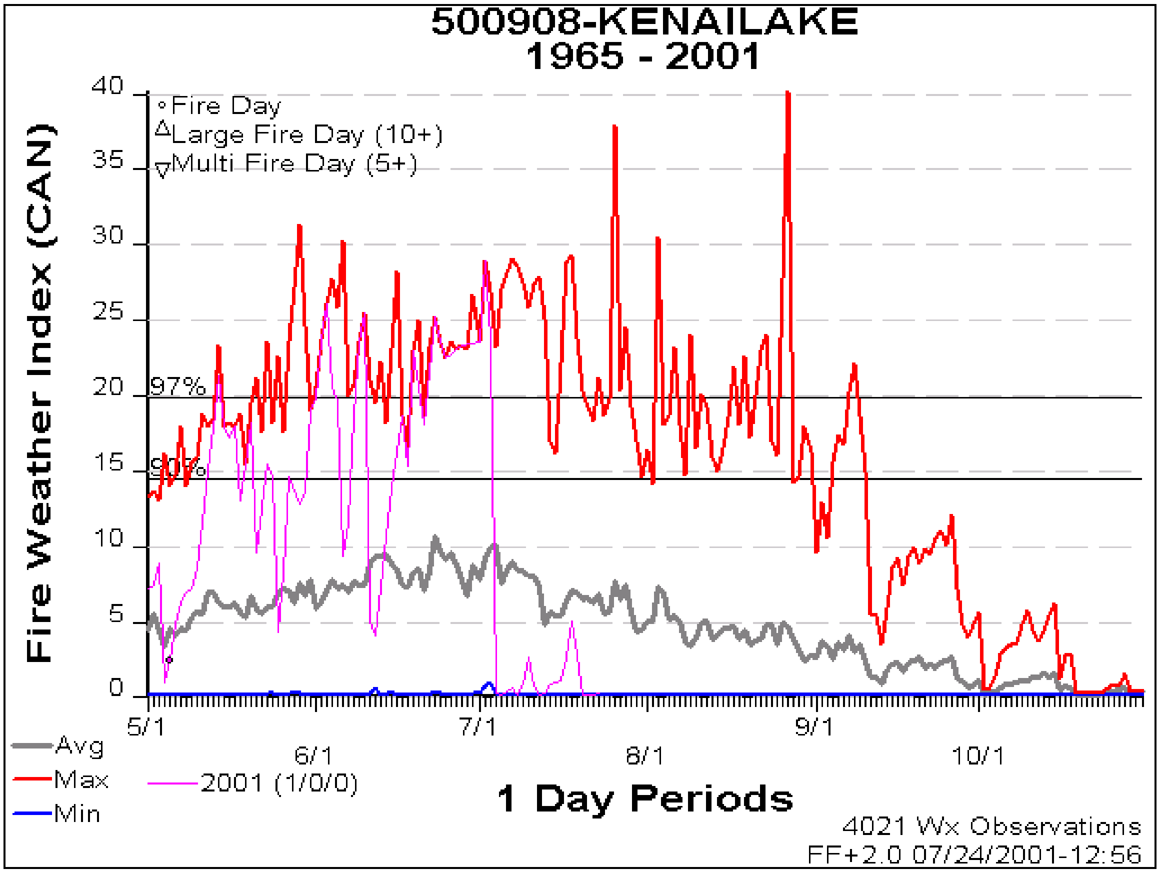


Chart 2: Kenai Lake RAWS BUI (1965 – 2001) with 2001 overlay

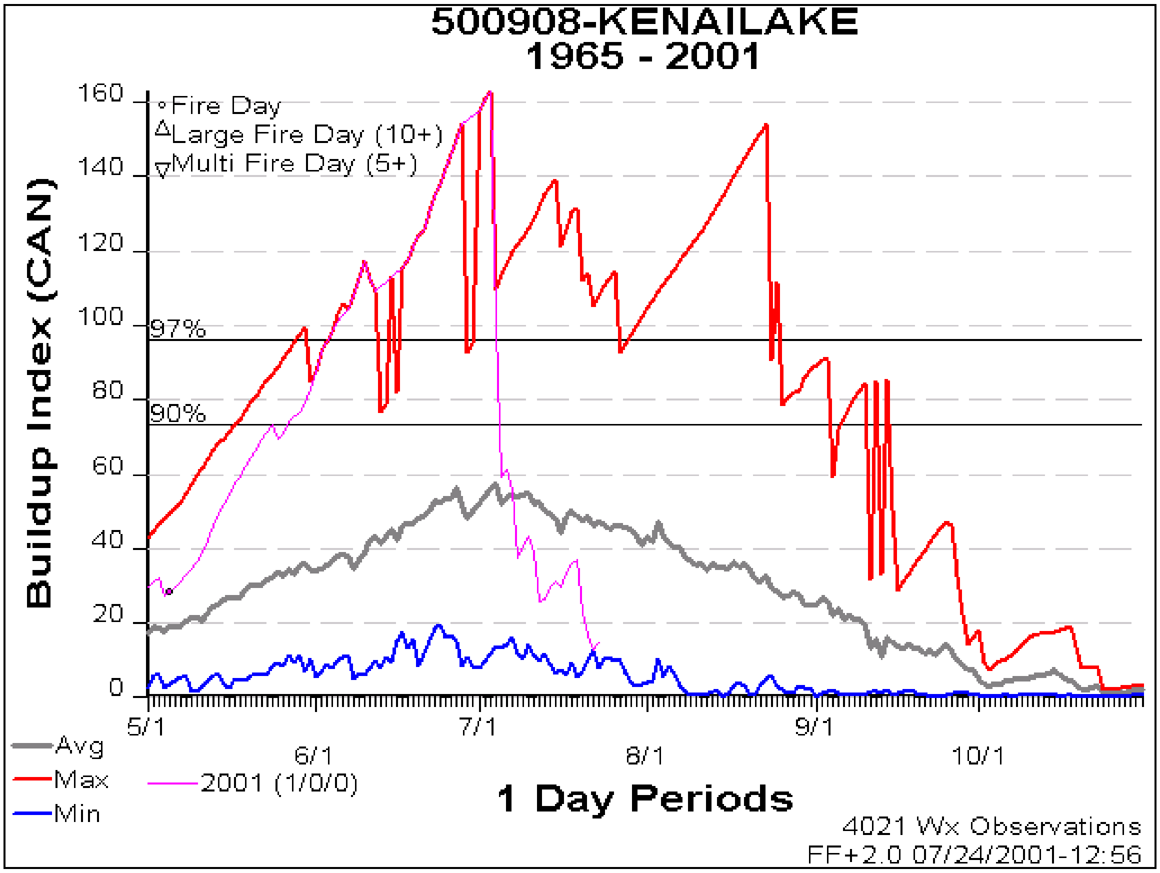


Chart 3: Broadview RAWS FWI (1967 – 2001) with 2001 overlay

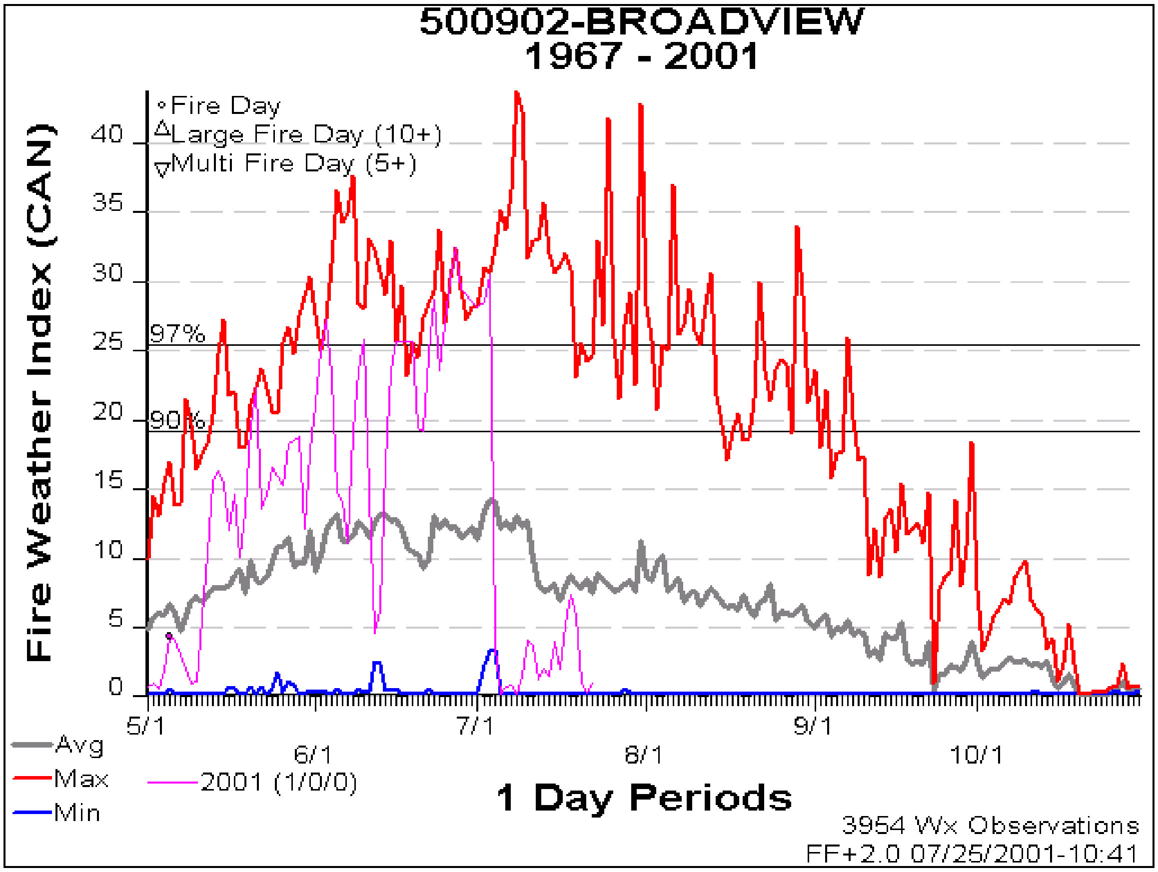
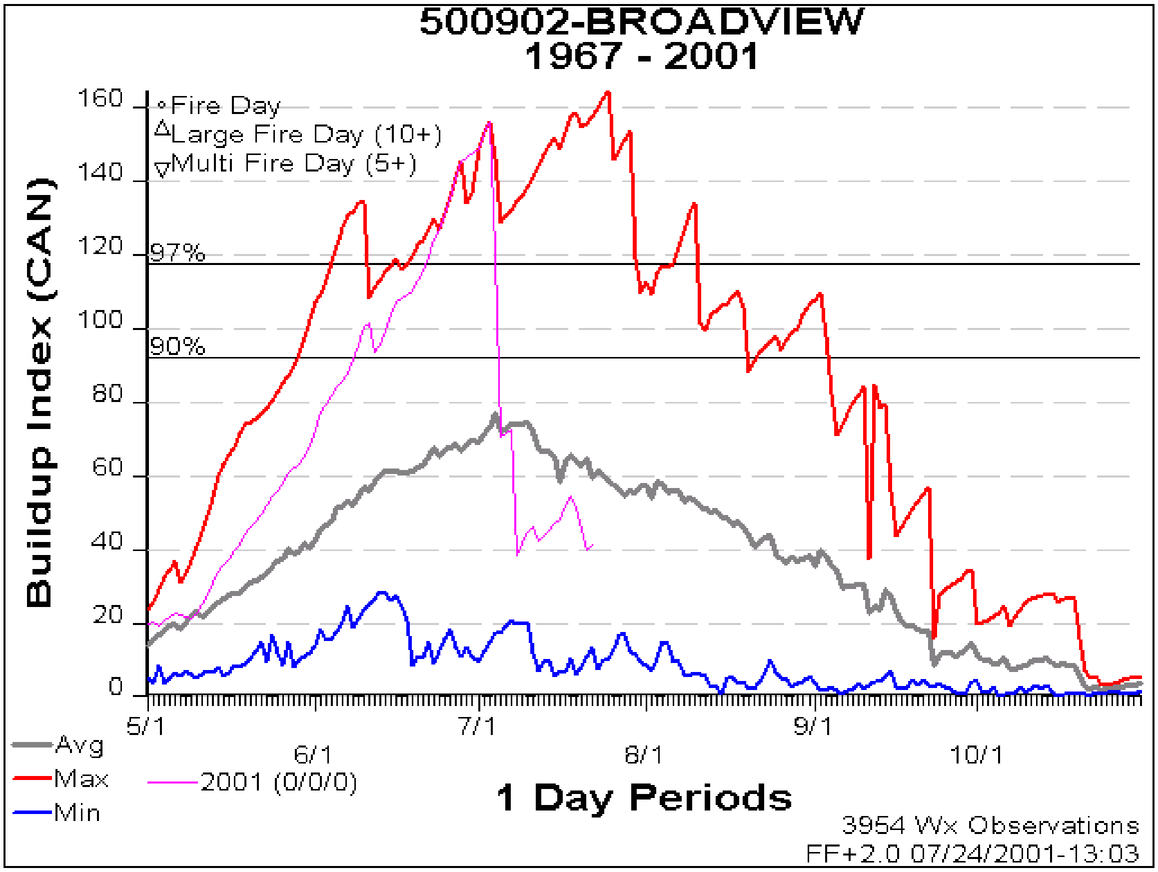


Chart 4: Broadview RAWS BUI (1967 – 2001) with 2001 overlay



Both the Broadview and Kenai Lake weather stations depict the serious fire danger situation during the last two weeks of June, 2001. Table 2 summarizes the extreme nature of the fire weather experienced at the Kenai Lake and Broadview weather stations from mid June through early July, 2001.

Table 2: Dates of significant threshold crossing for Kenai Lake and Broadview RAWs

	90th percentile	*97th percentile*	*At or Near Record High*
Kenai Lake Fire Weather Index	June 15, 2001	June 21, 2001	June 18 - July 4, 2001
Kenai Lake Buildup Index	May 27, 2001	June 3, 2001	May 31 - July 4, 2001
Broadview Fire Weather Index	June 14, 2001	June 24, 2001	June 25 - July 4, 2001
Broadview Buildup Index	June 8, 2001	June 21, 2001	June 24 - July 4, 2001

By mid-June both stations were above the 90th percentile for both the FWI and BUI values associated with all recorded weather observations over the past 30 years. By the third week of June both stations were above the 97th percentile of all FWI and BUI values. By the middle of the third week of June, both stations were recording all time high or near-all time high FWI and BUI values for each day. The Kenai Lake RAWS was tracking at or near all-time high BUI values from May 27 – July 3, 2001.

Precipitation

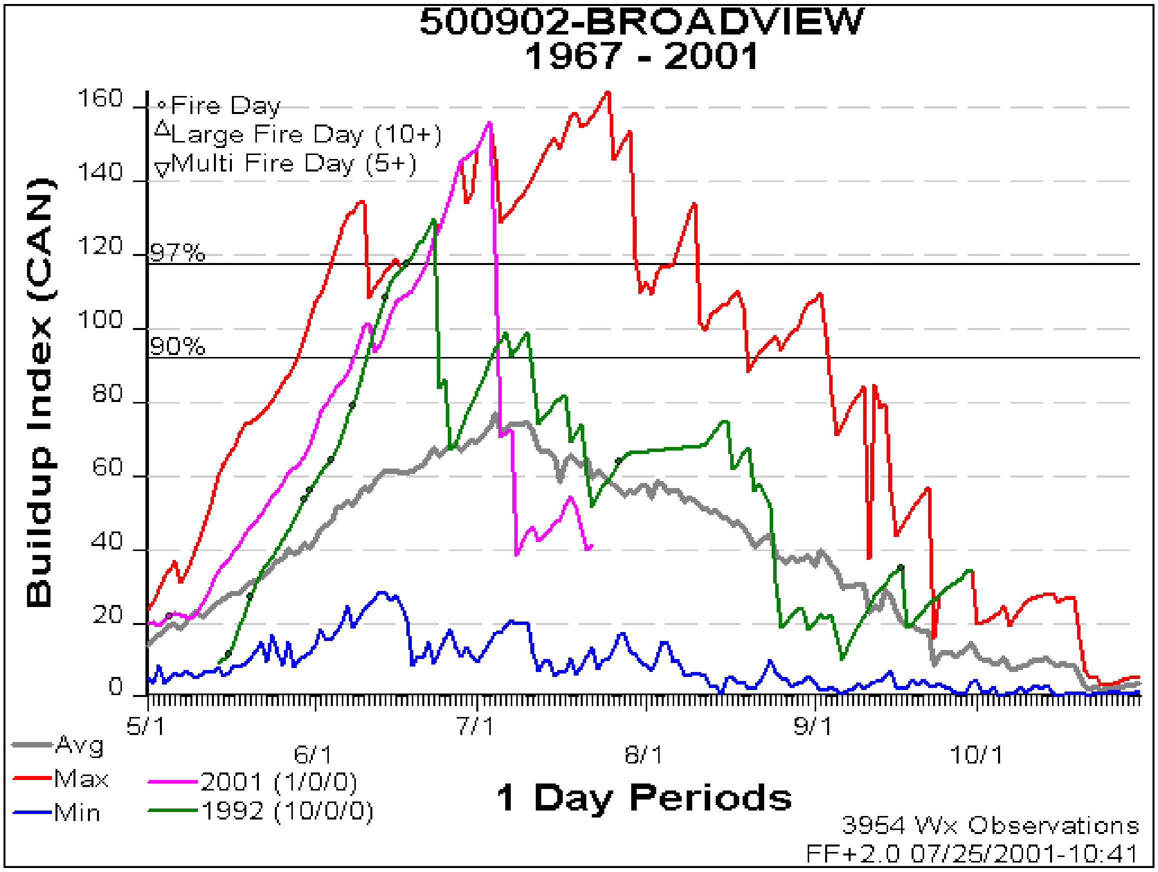
A major factor contributing to the high fire weather indices and extreme fire behavior experienced on the Kenai Lake fire was the lack of any measurable precipitation during the 16-day period from June 14 – July 3, 2001. Table 3 summarizes the duration of all drying periods greater than 10 days experienced at the Broadview weather station from 1990 through 2001 with the exception of 1994 and 1995. The Broadview weather station was used because it has a more complete weather record than the Kenai Lake weather station during the 1990's.

Table 3: Dates and length of drying period greater than 10 days at the Broadview RAWs (1990-1993, 1996-2001)

Year	*Period*	*Days*
1990	6/24 - 7/9	14
1991	5/17 - 5/26	10
1991	6/19 - 7/1	13
1992	5/17 - 6/23	37
1993	5/7 - 5/20	14
1993	5/24 - 6/10	17
1993	6/23 - 7/25	20
1996	5/1 - 5/18	18
1996	5/20 - 6/9	21
1996	6/15 - 6/30	14
1996	7/2 - 7/12	10
1997	6/22 - 7/8	15
1999	5/10 - 5/25	16
1999	6/5 - 6/16	12
1999	6/30 - 7/14	15
2000	5/27 - 6/6	10
2001	5/20 - 6/4	15
2001	6/14 - 7/3	16

The 16-day drying period in June 2001 was not exceptional when compared with similar drying periods over the past 10 years. Mid to late June drying periods greater than 10 days in length have been experienced in 6 of the 10 years examined: 2001 (16 days), 1997 (15 days), 1996 (14 days), 1993 (20 days), 1992 (37 days), 1991 (13 days), and 1990 (14 days). Chart 5 shows the BUI of both the 2001 and 1992 season when a drying period 37 days in length was recorded between May 17 and June 23.

Chart 5: Broadview RAWS BUI (1967 – 2001) with 1992 and 2001 overlay

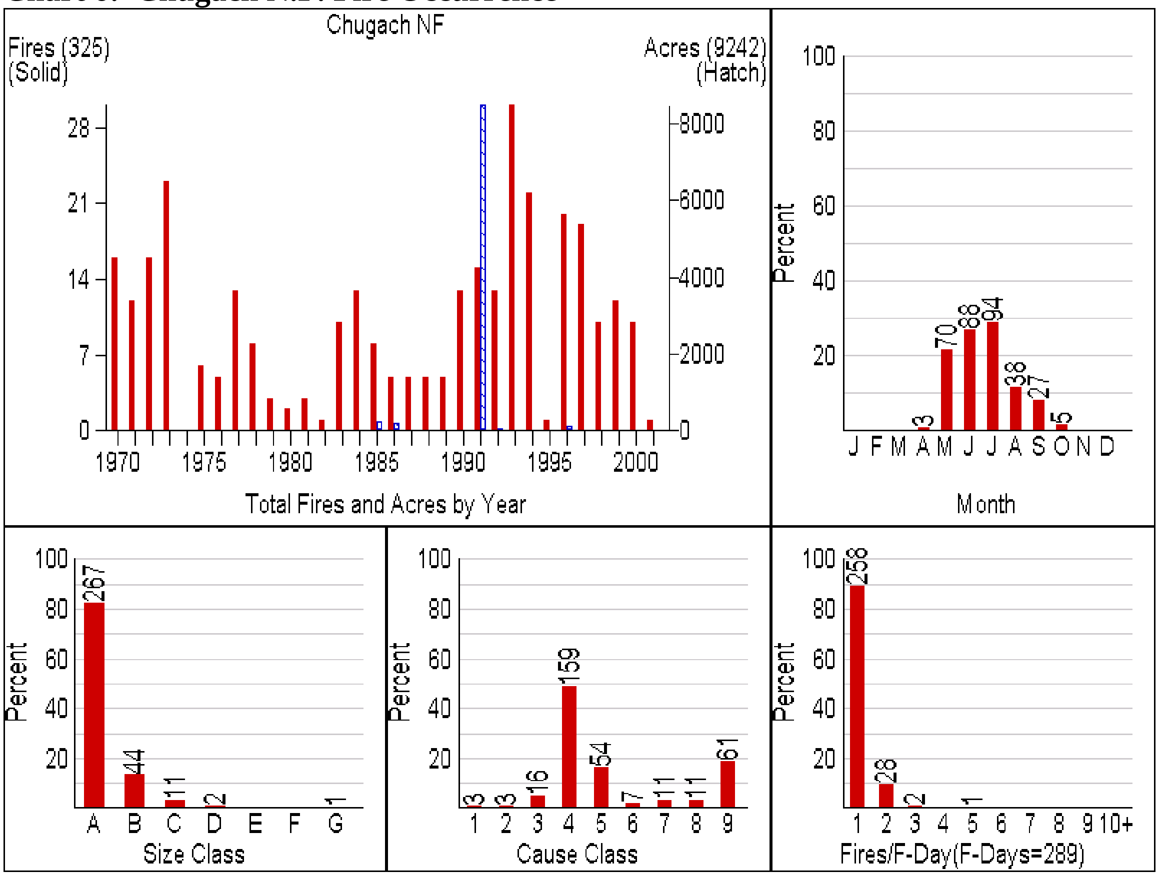


While the drying trend in 1992 was 21 days longer than that in 2001, the resulting BUI values were approximately the same by late-June. A 15-day drying-trend between May 20 and June 4 appears to have set the stage for the late June 2001 fuels scenario. During the nine days between the two 2001 drying trends (June 5 – June 13) the Broadview RAWS experienced four days with precipitation receiving a total of 0.14 inches of rain. Taken together, the late May and late June drying trends stacked on top of each other to create the extreme fire danger ratings in late June 2001.

Chugach N.F. Fire Statistics

Chart 6 displays a graph of fire statistics generated from fire occurrence data for the Chugach N.F. in Fire Family+. It was not possible to break the fire history data down by individual ranger districts.

Chart 6: Chugach N.F. Fire Occurrence



Overall, 325 fires have occurred on the Chugach N.F. from 1970 – 2000 (average = 10 fires/year) burning a total of 9200 acres. Most of this acreage occurred in 1991 when a single fire burned over 8400 acres. A significant increase in the number of fires experienced per year occurred between 1989 – 1997. Table 4 summarizes the percentage of all fire starts occurring in each month. Table 5 summarizes the breakdown of each fire by cause.

Table 4: Fire occurrence breakdown by month

	Percent of all fire starts
April	0.92%
May	21.54%
June	27.08%
July	28.92%
August	11.69%
September	8.31%
October	1.54%

Table 5: Fire Occurrence Breakdown by Cause

Cause	*Number of Fires*	*Percent*
Natural	3	0.92
Campfire	3	0.92
Smoking	16	4.92
Debris Burning	159	48.92
Incendiary	54	16.62
Equipment Use	7	2.15
Railroads	11	3.38
Children	11	3.38
Miscellaneous	61	18.77

Season Ending Events

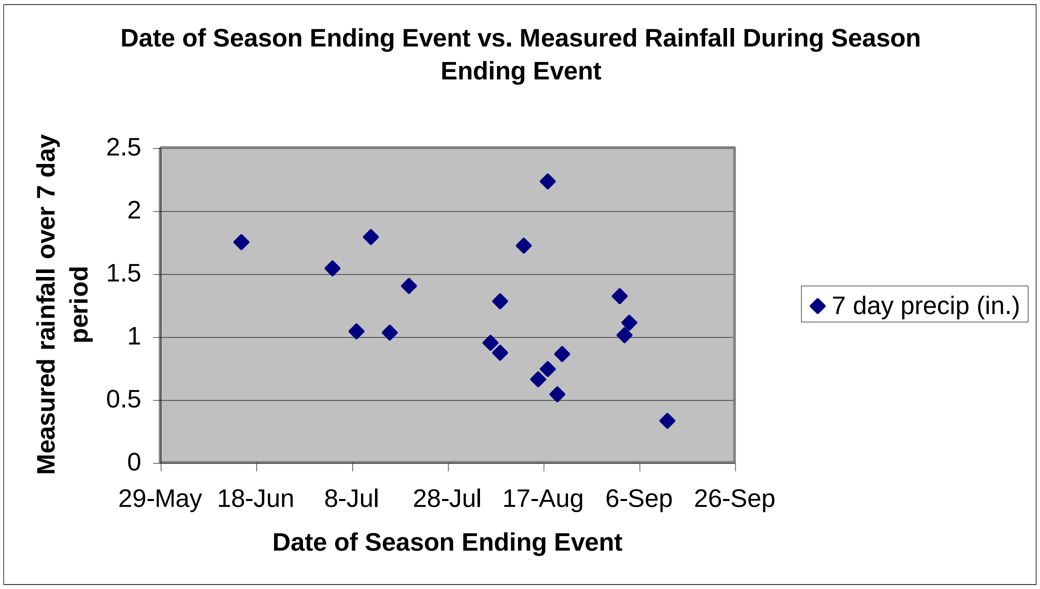
A season ending event is a weather event "where a wildland fire environment no longer supports fire spread for a given wildland fire" (Wordell, Tom; S-492 classroom materials; March 2001). Season ending event dates were determined for the Broadview weather station for the years 1980 – 2001 by visually examining Buildup Index and Fire Weather Index graphs along with fire occurrence and daily precipitation measures. In general, a season ending event was an event that caused a precipitous decline in the BUI and FWI followed by a continuous decline to the end of the season. Table 6 lists the season ending events for 1980 – 2001 along with the recorded rain over a seven-day period after the start of the weather event and the number of days with rain in that seven-day period.

Table 6: Season ending event dates for each year and associated rainfall and days with rain in a 7-day period

Year	*Date*	*7 day precip (in.)*	*Days w/ rain*
2001	4-Jul	1.54	6
2000	16-Jul	1.03	6
1999	6-Aug	0.95	5
1998	16-Aug	0.66	6
1997	8-Aug	0.87	5
1996	12-Sep	0.33	4
1993	13-Aug	1.72	6
1992	21-Aug	0.86	5
1991	4-Sep	1.11	5
1990	18-Aug	0.74	5
1989	20-Jul	1.4	6
1988	20-Aug	0.54	3
1987	3-Sep	1.01	6
1986	12-Jul	1.79	4
1984	18-Aug	2.23	6
1983	8-Aug	1.28	4
1982	2-Sep	1.32	5
1981	9-Jul	1.04	5
1980	15-Jun	1.75	6

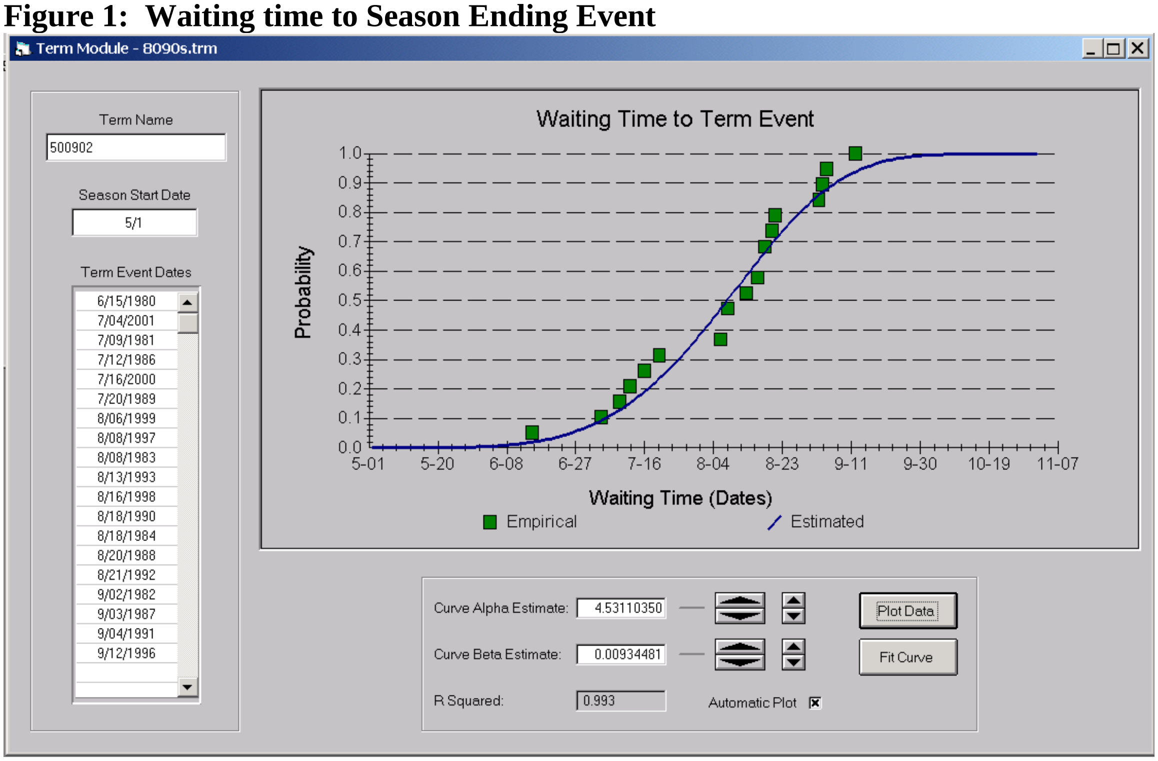
Season ending events on the Chugach N.F. are a function of measured rainfall in a seven-day period and time of year. The amount of rain required for a given weather event to be classified as a season ending event decreases from June through September. In general, greater than 1.5 inches of rain over a seven day period is required to end a fire season in June; 1.0 to 1.5 inches over a seven day period are required in July; 0.5 to 1.0 inches are required in August; and rainfall between 0.25 and 0.5 inches will end a season in September. Chart 7 illustrates the relationship between time of year and the required rainfall for season ending event status.

Chart 7



The season ending event data for the Broadview weather station was entered into the term module of the RERAP program. Figure 1 shows the Weibull distribution curve generated using the data.

Figure 1: Waiting time to Season Ending Event

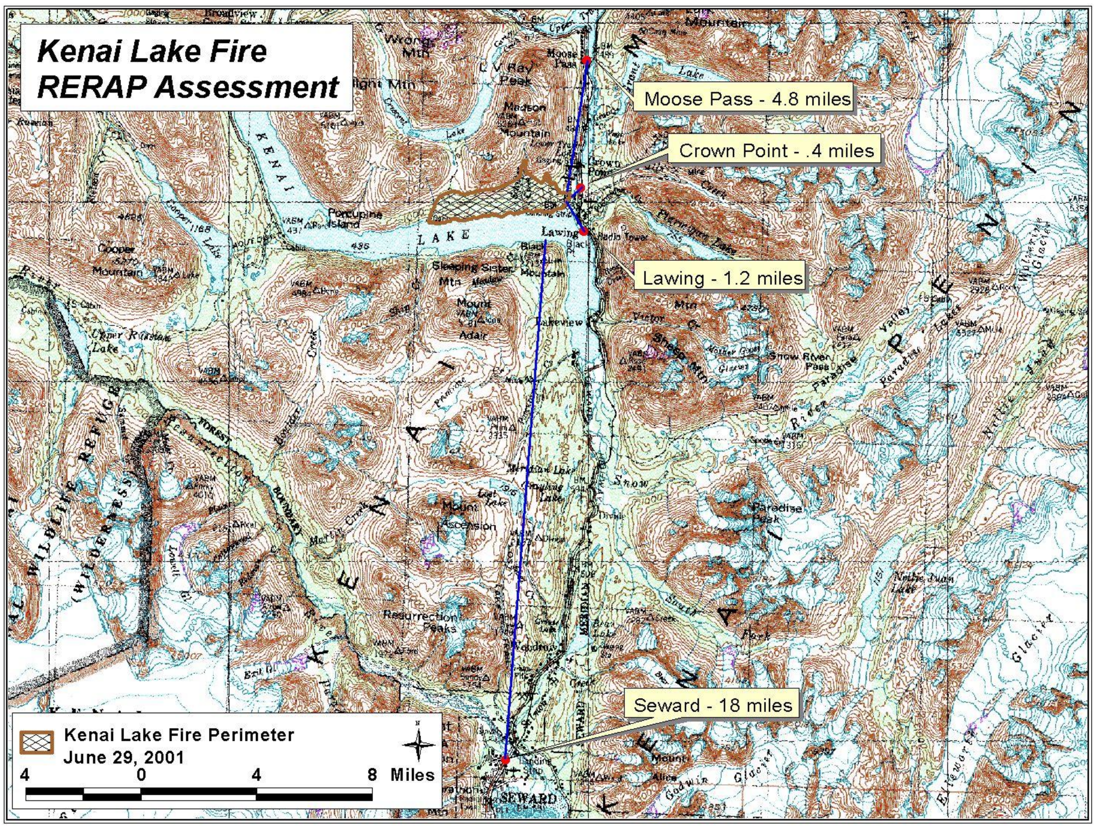


From this curve it is possible to estimate the likelihood of experiencing a season ending event near the Broadview RAWS throughout the summer. There is a 25% chance of experiencing a season ending event by July 21, 50% by August 8, 75% by August 25, and 90% by September 7.

RERAP

The RERAP program was used to estimate the likelihood of the Kenai Lake fire reaching various points in the absence of the season ending event experienced beginning July 4, 2001. Assessments were done to Lawing, Crown Point, Moose Pass, and Seward. Map 2 shows the location of the four sites and the assessment lines in relation to the perimeter of the Kenai Lake fire on June 29, 2001.

Map 2: RERAP assessment transects



The Broadview weather station was used to generate both percentile weather and term inputs. Data from 1980 – 2001 was used to generate term information while data from 1990 – 2001 was used to generate percentile weather reports. Fuels maps provided by the Chugach N.F. were used to generate segment information. A combination of fuel models 8 and 10 was used to characterize each of the segments. The fire was modeled starting June 29, 2001 with a season start date of May 1. RERAP is most often used to assess Fire Use fires in remote wilderness areas where suppression is not the management option of choice. Non-suppression strategies were not an option with the Kenai Lake fire. Different fire spread parameters were used in an effort to model the fire's potential to reach the identified locations with and without suppression tactics. In the absence of suppression, it was assumed that fire spread would be limited to the surface under low conditions, and spread to the crown under moderate, high and extreme conditions. It was assumed that fire suppression efforts would eliminate fire spread under low to moderate conditions and limit fire spread to the surface under high conditions. Even with suppression, fire spread was modeled in the crowns under extreme conditions. Rates of spread for extreme and high scenarios were developed through an analysis of the spread observed on the Kenai Lake fire from June 25 – 29. Two hundred and fifty chains/day was used for extreme conditions and 80 chains/day was used under high conditions. Under the suppression parameters the 80 chains/day associated with high conditions was significantly reduced to 1.5 chains/day through surface spread. Table 7 identifies the probability on June 29 that the Kenai Lake fire would reach the identified point prior to experiencing a season ending event for both the suppression and non-suppression parameters.

Table 7: Probability of Critical fire spread on the Kenai Lake fire with and without suppression

Site	*Probability w/ suppression*	*Probability wo/suppression*
Moose Pass	2.8 % (2.8 rare, 0 common)	32.6 % (30.9 rare, 1.7 common
Crown Point	33.3% (27.1 rare, 6.2 common)	95.1% (19.4 rare, 75.7 common)
Lawing	27.6 % (27.6 rare, 0 common)	85.7 % (43.5 rare, 42.2 common)
Seward	0%	0.003%

Under no conceivable conditions could the model be forced to drive the fire 18 miles south to Seward even with a spot fire on the south side of Kenai Lake. Values generated in the right column (non-suppression) are considerably more valid than those generated under a suppression scenario. RERAP assumes that fire growth will continue until a term event occurs. In the suppression scenario fire growth parameters were altered such that growth would only occur under rare and significant events. However, RERAP continues to assume that between rare and significant events a fire will not be controlled even if there is no fire growth. The probabilities generated under the suppression scenario are likely inflated. They reflect the unlikely situation in which the fire would not be controlled until the season ending event.

Conclusion

Graphs charting the BUI and FWI in FireFamily+ illustrate the serious fire danger situation near Kenai Lake from mid-June to early July 2001. The BUI appears to be a more consistent predictor of fire danger, less likely to fluctuate due to winds or minor precipitation.

Drying trends greater than 10 days in length are not uncommon in mid to late June. The combination of two or more drying periods greater than 15 days in length appears to be enough to push BUI and FWI values above the 97th percentile.

Relative to historical weather data, the July 4, 2001 season ending event occurred very early in the fire season. The normal probability of receiving a season ending event in the first week of July is around 10%. The amount of rain required for season ending event status decreases from June through September.